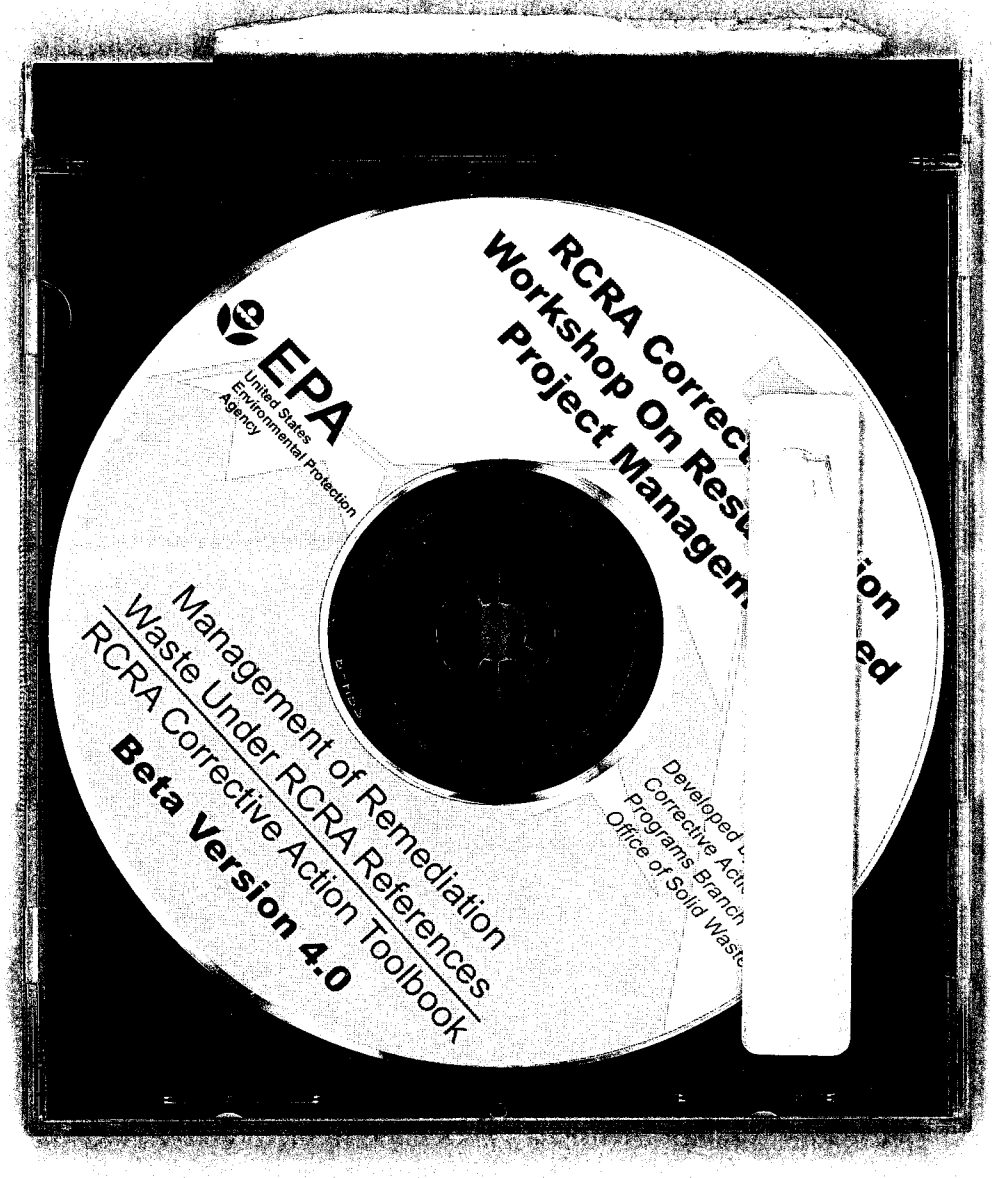
General
2/1/2000



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RCRA Corrective Action Workshop on Results-Based Project Management

Tools for Accelerating Schedules, Improving Efficiency, and Focusing Implementation on Protective Results

Offered by the Corrective Action Programs Branch, Office of Solid Waste

Denver, Colorado

February 8-11, 2000

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

(All material in the Handbook has been printed on recycled paper)

INTRODUCTION

Objectives of Introduction Module

Participants will:

- Understand overall objectives for the workshop
- Understand keys to success, ground rules and logistics
- Get to know other participants and instructors
- Be familiar with layout/content of workshop materials

3

Objectives of Introduction Module (Cont.)

- Hear opening remarks on why this workshop is important
- Learn about Post-workshop activities and support
- Gain insight in other modules via true/false exercises

4

Overall Objectives of Workshop

Primary Objective:

- Share tools and approaches to improve the rate in which we achieve Interim and Final Remedies results

Sub-objectives:

- Enhance communication
- Manage risks as well as uncertainties
- Capitalize on administrative flexibility

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Notes:

Also, note that the objectives and problems that were identified on the preregistration forms are posted on the wall as well as being supplied at the end of this Module. Instructors will be trying to address as many of these participant-identified objectives and problems as possible during the workshop; however, participants are encouraged to take advantage of breaks, lunches, and the evening social to discuss specific issues with instructors.

Due to Time Constraints, this Workshop Does NOT:

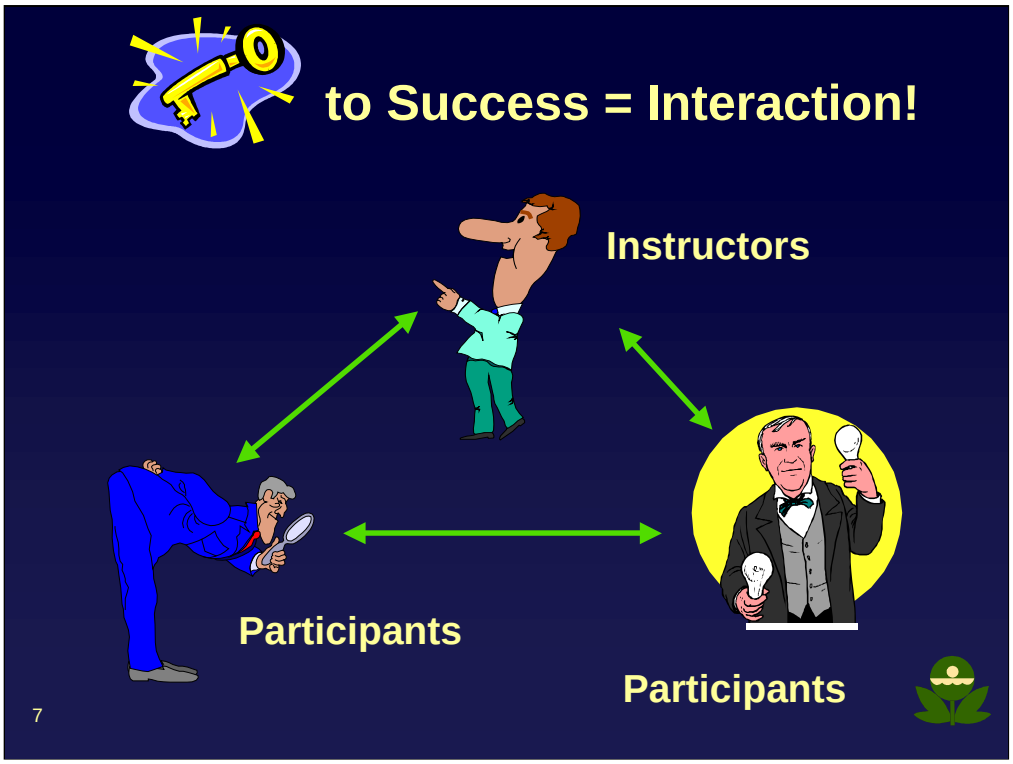
- Provide detailed background on the RCRA Corrective Action Program
- Convey an itemized list of all of the components of workplans and reports
- Provide detailed instructions on how to conduct an investigation or review data
- Teach participants to use any one particular process for implementing Corrective Action

6

Notes:

History of RCRA Corrective Action fact sheet provides background to Corrective Action; was sent to preregistrants in advance of the workshop and is included in the workshop Toolbook.

Extensive reference lists will provide participants with the means to access additional training, guidance, and other resources that can help with the implementation of RCRA Corrective Action. To the extent possible, the developers of the workshop have attempted to include instructions on where and how to obtain these resources whenever a resource is identified.



Notes:

While the instructors have considerable expertise, they clearly do not have all solutions to every Corrective Action-related problem. However, the workshop has been designed to take advantage of the wealth of experience of the instructors and the participants collectively to help develop solutions to the problems faced by the program. Facilitation will be used to promote interaction, which often will include having participants attempt to answer questions posed by other participants.

Workshop Groundrules:

- Respect each other's time and opinions;
- Try to avoid side conversations (except of course during breaks, where it is encouraged!);
- Participate in discussions;
- Be open to new ideas and approaches;
- Please be on time coming back from breaks so you don't miss key instructions or information; and
- **Please! Please! Please!** Complete your evaluation forms and turn them in so we can continue to make improvements in the workshop.

Participant Introductions and Experience Exercise

- Participant introductions and experience exercise
  - One word description of yourself outside of work
  - Add up total Corrective Action experience and divide by # of individuals at table (prizes!)
  - Capture answers on notes page

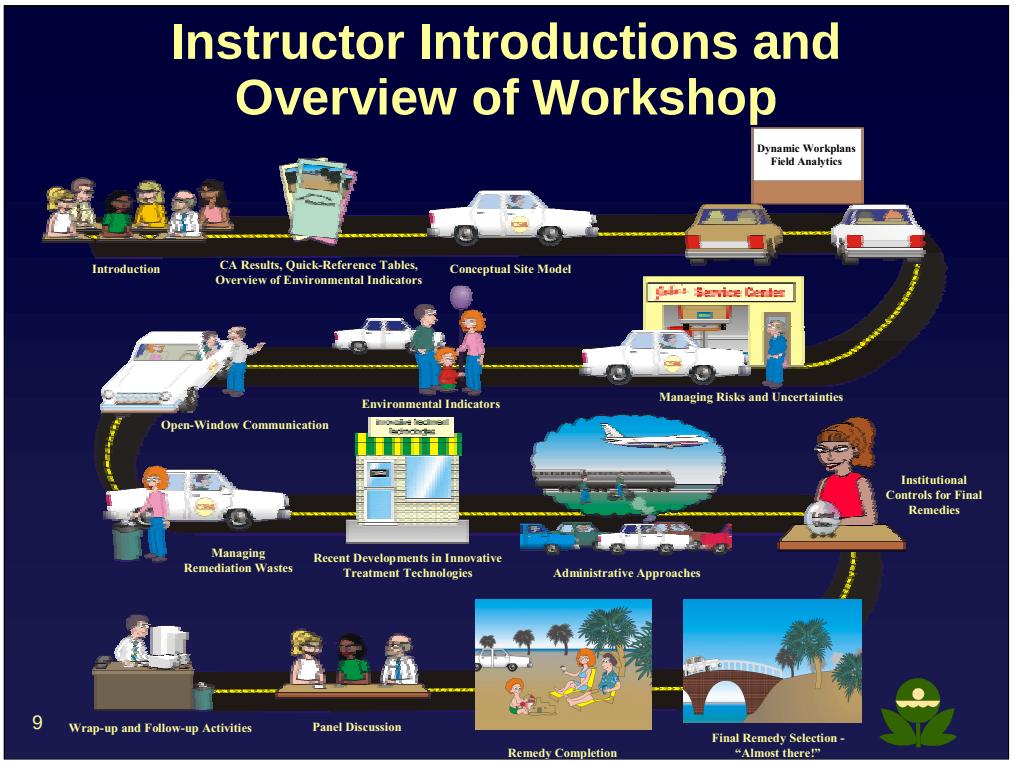
8

Notes:

Names and a one-word description of individuals at table:

Total table experience _____/ # of individuals at table =_____

Prizes given for most and least experienced table because the experienced individuals bring with them ideas as to what has worked and what hasn't worked in the past, and the less experienced individuals look at issues without being influenced by the past.


Instructor Introductions and Overview of Workshop
Dynamic Workplans
Field Analytics
Introduction
CA Results, Quick-Reference Tables, Overview of Environmental Indicators
Conceptual Site Model
Service Center
Open-Window Communication
Environmental Indicators
Managing Risks and Uncertainties
Institutional Controls for Final Remedies
Managing Remediation Wastes
Recent Developments in Innovative Treatment Technologies
Administrative Approaches
9
Wrap-up and Follow-up Activities
Panel Discussion
Remedy Completion
Final Remedy Selection - "Almost there!"

Layout and Content of Workshop Materials

- Workshop "Handbook" guides you through slides and exercises
- Workshop CD contains Toolbook and Remediation Waste Reference Handbook

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Notes:

Handbook:

- Agenda
- Table of Contents
- Instructor Biographies
- Workshop modules organization:
  - Module evaluation forms
  - Workshop slides and student notes
  - Useful Tools
  - List of references with instructions on obtaining them

CD:

- Tools Handbook - Resources/tools related to the module (e.g., guidance, fact sheets, form letters)

- Managing Remedial Waste under RCRA Reference Handbook - Resources/tools related to the Managing Remedial Waste module (e.g., guidance, *Federal Registers*)

Why this Workshop is Important!

- Needed followup to guidance in 1996 Advance Notice of Proposed Rulemaking
- Workshop is major component of RCRA Cleanup Reforms
- Reforms emphasize:

"FASTER, FOCUSED, MORE FLEXIBLE CLEANUPS"

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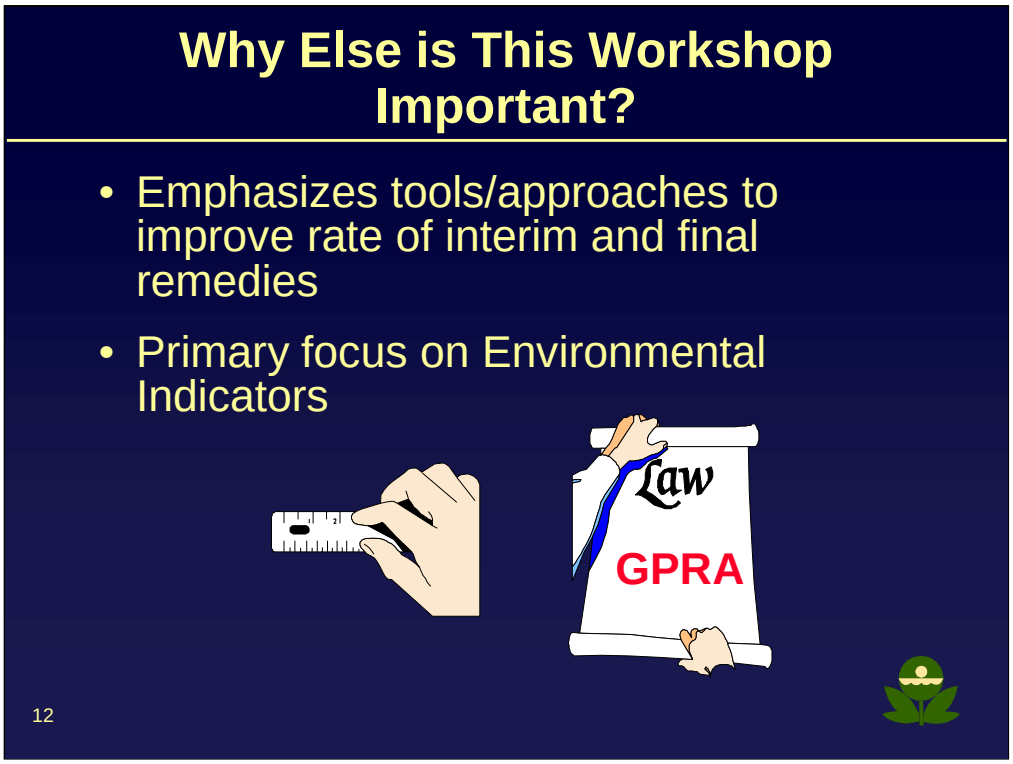
Notes:

A focus on results, rather than process, is a fundamental message of the May 1, 1996 Advance Notice of Proposed Rulemaking (ANPR) for the RCRA Corrective Action Program. The ANPR was issued for several purposes: it introduced a strategy for improving the Corrective Action Program (i.e., Subpart S Initiative), it requested information to assist in identifying and developing program improvements, and it provided a status report on the program and the latest Agency guidance for program implementation. A January 17, 1997 memorandum from EPA stated the expectation that the ANPR (in particular Section III) will be used as guidance for implementing the RCRA Corrective Action Program. A full copy of the ANPR and the January 17, 1997 is provided in the Corrective Action Workshop Toolbook.

Goals of the RCRA cleanup reforms include:

- Providing new results-oriented guidance with clear objectives
- Fostering maximum use of program flexibility and practical approaches through training, outreach, and new uses of enforcement tools
- Enhancing community involvement including greater public access to information on cleanup progress

Reforms Fact Sheet follows this page.



Notes:

Enacted in 1993, the Government Performance and Results Act (GPRA), or the "Results Act" places new management expectations and requirements on Federal Agencies by creating a framework for more effective planning, budgeting, and programmatic and fiscal accountability for Federal Programs. The intent of GPRA is to improve public confidence in Federal Agency performance by holding agencies accountable for achieving program results. References: "EPA Implementation of Government Performance and Results Act (GPRA)," U.S. EPA: (Available to download from the Internet: http://www.epa.gov/oigearth/gprasum.htm and http://www.epa.gov/ooaujeag/notebook/gpranew.htm)

EPA has identified the two environmental indicators as the means by which we will be tracking the Program's results in accordance with GPRA.

Reuse and revitalization of previously contaminated land is a high priority for EPA and is the primary goal of the Agency's Brownfields Initiative. RCRA plays an important role in many brownfields redevelopment projects and provides a fundamentally sound approach to the proper management of remediation waste to help prevent the brownfields of tomorrow. To the extent that we can make the redevelopment of these idle or underutilized urban properties attractive to developers, we discourage wasteful suburban sprawl. To that end, the EPA is exploring opportunities and implementing many innovative cleanup and redevelopment solutions while maintaining standards protective of human health and the environment. The principles, approaches, and tools addressed in this workshop are aimed at improving the pace of cleanups in general, which ultimately improves the pace at which previously contaminated land can be reused for beneficial purposes.

What are These Environmental Indicators?

- Environmental Indicators (EIs):
  1. Current human exposures under control
  2. Migration of contaminated groundwater under control
- Site-wide determinations
- New guidance available 2/5/99

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Notes:

Environmental Indicators (EIs) are measures being used by the RCRA Corrective Action program to go beyond programmatic activity measures (e.g., reports received and approved) to track changes in the quality of the environment. The two EIs developed to date indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated groundwater.

"Current Human Exposures Under Control" EI:

A positive "Current Human Exposures Under Control" EI determination ("YE" status code) indicates that there are no "unacceptable" human exposures to "contamination" (i.e., contaminants in concentrations in excess of appropriate risk-based levels) that can be reasonably expected under current land- and groundwater-use conditions (for all "contamination" subject to RCRA Corrective Action at or from the identified facility, i.e., site-wide).

"Migration of Contaminated Groundwater Under Control" EI:

A positive "Migration of Contaminated Groundwater Under Control" EI determination ("YE" status code) indicates that the migration of "contaminated" groundwater has stabilized, and that monitoring will be conducted to confirm that contaminated groundwater remains within the original "area of contaminated groundwater" (for all groundwater "contamination" subject to RCRA Corrective Action at or from the identified facility, i.e., site-wide).

More on Environmental Indicators

- Make sense environmentally
- Achievable
- Opportunity to improve public confidence
- Accepted by Environmental Commissioners of States (ECOS)
- Acknowledged by industry groups as appropriate and reasonable measures of progress

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Notes:

The importance of EIs, using the new EI guidance (to be discussed tomorrow in the EI module), and of achieving the GPRA goals was presented in a February 11, 1999 memo to EPA's Regional Administrators from Timothy Fields, Acting Assistant Administrator of the Office Of Solid Waste and Emergency Response. Included in that memo was the statement, "Achievement of the 2005 GPRA Corrective Action goals is my highest priority for the National RCRA Program. With this memorandum I am seeking a commitment from each Region to fulfill its share of our important goals for significantly reducing human exposure and controlling groundwater releases at RCRA facilities." This memo is included in the Workshop Toolbook.

So What are the Specific GPRA EI Goals and Why Should you Care?

By 2005,

- 95% of the RCRA Cleanup Baseline will have to achieve the human exposure EI, and
- 70% of the RCRA Cleanup Baseline will have to achieve the groundwater EI

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Notes:

The percentages are based on a baseline established in 1999 of approximately 1,712 facilities nationwide. These 1,712 facilities comprise roughly 1,500 high-priority facilities based on National Corrective Action Prioritization System (NCAPS) ranking plus approximately 200 other Regional and State priorities (e.g., brownfields sites).

GPRA is intended to be used for budget allocations based on the results achieved. Full impact of GPRA results is yet to be determined Government-wide

How Much Work is Ahead of Us To Meet Our GPRA Commitments?

- 1,712 facilities in our GPRA baseline
- EPA Region 8 has approximately 53 of these facilities
- Current status is available in “State of RCRA Report” included in back of this module

16

Notes:

A list of this Region’s RCRA Cleanup Baseline facilities is also included at the end of this module.

Are EIs all We Have to Accomplish?

NO!

- **EIs are important interim milestones en route to completing FINAL Corrective Action obligations**

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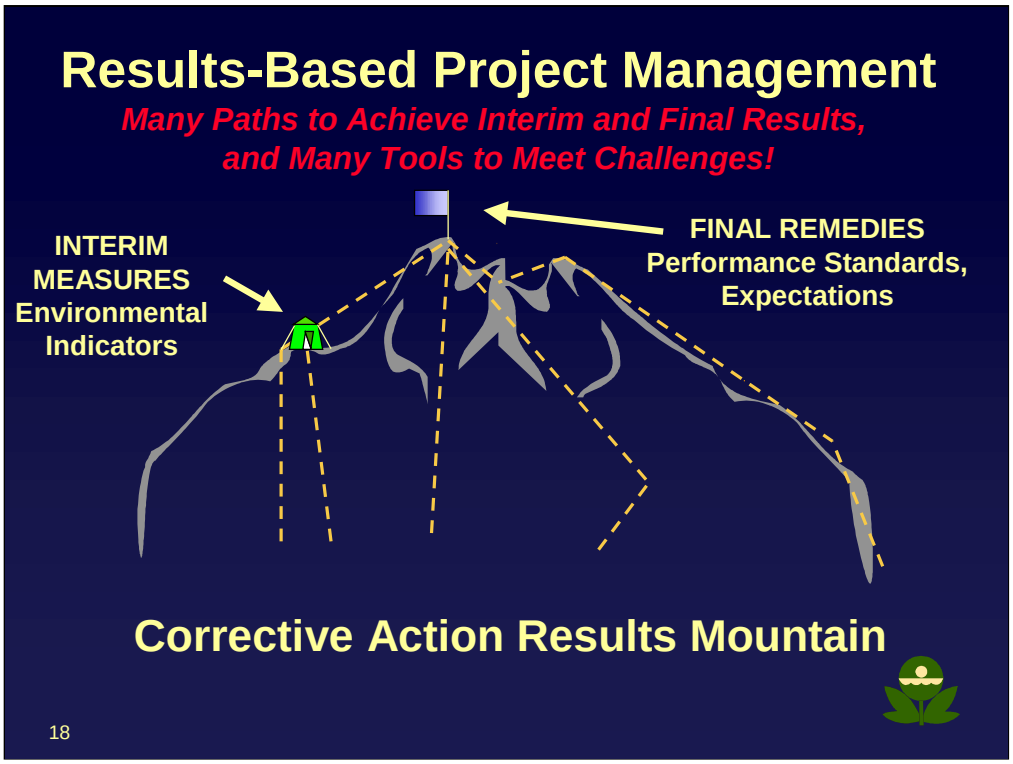

Notes:

As discussed previously, more detail will be provided on Environmental Indicators and Final Remedies in subsequent modules.

A results-based approach is focused on getting to interim measure and final remedy goals as quickly and efficiently as possible. This focus allows for, and even encourages, innovation to find the best route on a site-specific basis to achieve those goals. From EPA's perspective, there is no one "right" path to get to the goals!

What are the Basic Concepts of Results-Based Project Management?

- Maintaining focus and communication on achieving desired results, not administering a process!
- Identifying key decisions that need to be made to maintain focus on results
- Collecting only information needed to support those key decisions

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Results-Based Project Management (Cont.)

- Recognizing uncertainties are inherent, but can be managed
- Maximizing flexibility by using available tools to overcome impediments

20

What are Some of the Major Impediments This Workshop Can Help Us Overcome?

- Technical disagreements between EPA, States, and companies
- Excessive report and review requirements
- Reluctance of companies to perform cleanups
- RCRA requirements applied to remediation wastes
- Resource constraints
- Others?

21

Notes:

These impediments were recently identified in the following two reports from the General Accounting Office:

- "Progress Under Corrective Action Is Limited, But New Initiatives May Accelerate Cleanups," GAO/RCED-98-3, October 1997; and

- "Remediation Waste Requirements Can Increase the Time and Cost of Cleanups," GAO/RCED-98-4, October 1997

This workshop was specifically designed to help overcome many of these impediments. For example, "Open Window Communication" and the "Conceptual Site Model" were designed to help overcome impediments associated with frequent disagreements and excessive reporting. Tools to overcome impediments associated with RCRA requirements applied to remediation wastes are addressed in "Managing Remediation Wastes."

Notes:

An important feature of the RCRA Corrective Action Workshop is the emphasis that we (EPA Headquarters) will be placing on supporting the Regions and States in addressing implementation questions and challenges subsequent to the workshops. We will be making course instructors available to address critical or common questions and challenges that arise subsequent to the workshops. Since our resources are limited, we want to provide this support in a way that provides maximum value to the Regions and States. To accomplish this, we will need a key person from each State and Region who is interested in playing a pivotal role in this implementation effort.

Support from the Instructors:

After each workshop we will hold a series of conference calls, one each month, to address specific major questions and issues on the application of particular tools and approaches presented at the workshop. To the extent possible, questions and issues should be identified at least 2 weeks in advance of the call so we can make sure to have the right individuals on the call to address those issues. Additional support/training for key State and Regional personnel will be provided as general needs are identified.

What Else Can You Expect After This Workshop?

- Expanded Internet site available at:
  - http://www.epa.gov/correctiveaction/#workshop
- Modified workshop based on feedback
- Modules will be adapted to Interactive Internet

24

RCRA Corrective Action Brain Teasers

- Work in small groups to discuss and answer true/false statements regarding RCRA Corrective Action
- Correct answers will be provided in identified modules

25

Corrective Action Principles and Quick Reference Tables

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

Objectives

Participants will:

- Be able to describe the guiding principles for RCRA Corrective Action
- Be able use Interim and Final Corrective Action Quick Reference Tables to identify relevant results-oriented policies and guidance

2

Notes:

A fact sheet of the History of RCRA Corrective Action was distributed to pre-registrants and is available behind the Introduction tab of the Workshop Toolbook.

RCRA Corrective Action Operating Principles

- Taken from the May 1, 1996 Corrective Action Advance Notice of Proposed Rulemaking (ANPR)
- ANPR and this Workshop represent Agency's most current guidance
- Operating principles reflect a formal shift from process-driven toward results-driven implementation

3

Notes:

These operating principles are taken from 61 FR 19441 of the May 1, 1996 Advance Notice of Proposed Rulemaking (ANPR) for the RCRA Corrective Action program. The May 1, 1996 ANPR: 1) introduced a strategy for improving the Corrective Action Program (i.e., Subpart S Initiative); 2) it requested information to assist in identifying and developing program improvements; and 3) provided a status report on the program and the latest Agency guidance for program implementation. Since issuing the ANPR, the Agency has made a decision not to finalize comprehensive Corrective Action Regulations. In the absence of such regulations, EPA will rely on guidance, policy directives, and related regulations, including a January 17, 1997 memorandum from EPA that stated the expectation that the ANPR will be used as guidance (especially Section III) for implementing the RCRA Corrective Action Program. Full copy of the ANPR, as well as the January 17 memo is provided in the workshop Toolbook.

The principals espoused in the ANPR reflect a formal shift in EPA's philosophy regarding Corrective Action implementation from a process-driven program to a results-based program. Collectively, these principles provide a foundation that supports innovation towards protective, quicker, and more efficient Corrective Action implementation. Program implementers are encouraged to evaluate innovative approaches based on their consistency with these principles as opposed to basing the evaluation solely on consistency with any one particular process.

RCRA Corrective Action Operating Principles (Cont.)

- Corrective Action decisions should be based on risk
- Program implementation should focus on results
- Interim actions and stabilization should be used to reduce risks and prevent exposures
- Activities at Corrective Action facilities should be phased

4

Notes:

Corrective Action based on risk takes into account both current risks as well as risks that would be associated with reasonably expected future land and water resource use(s). Therefore, the absence of current risks does not eliminate the need to investigate and remediate contamination, as necessary, to prevent unacceptable future risks. A critical component of risk evaluation and risk management is the fact that uncertainties associated with environmental investigation and remediation are inherent. Basing Corrective Action on risk recognizes the need to strive for the appropriate balance between reducing uncertainties via data collection and managing uncertainties via remedial action and contingencies.

Corrective Action focuses on results and benefits from **early** identification of the "problem," the appropriate results that should be achieved, and the responses that are likely to achieve those results.

Taking interim and/or final actions to control unacceptable exposures to humans and further migration of contaminated groundwater represents the highest priority for the RCRA Corrective Action Program.

Operating Principles (Cont.)

- Program implementation should provide for meaningful inclusion of all stakeholders
- Corrective Action obligations should be addressed using the most appropriate tool for any given facility
- States will be the primary implementers of the Corrective Action program

5

Notes:

Effective communication between all interested stakeholders, early and throughout Corrective Action, is essential to identify concerns, focus resources, and avoid/minimize conflicts.

EPA recognizes that there are a variety of tools (e.g., permits, orders, voluntary agreements) to implement Corrective Action that may be acceptable provided that the appropriate results are achieved.

EPA recognizes that some States have their own approaches to implementing RCRA Corrective Action, which may differ between States and EPA Regions. This workshop was developed around key principles, approaches, and tools that have national application. Different approaches between States and EPA Regions should be accepted provided they are capable of achieving the desired results. The "Administration Approaches" module of this workshop is devoted to Region- and State-specific approaches and issues associated with improving the pace and quality of RCRA Corrective Action.

Corrective Action Quick Reference Tables

- Condense key results and supporting topics for interim (Table 1) and final (Table 2) Corrective Action remedies
- Serve as a tool to identify results-oriented policies and guidance
- Include:
  - topic, brief description, workshop mod(s) topic is addressed, and note(s) for detailed supporting narrative

6

Notes:

Tables and supporting narrative are provided behind the exercise on the next page, and are also on the CD in the Toolbox section.

Supporting narrative has been taken from May 1, 1996 ANPR, and other relevant guidance. As with all the materials in this workshop, the narrative supporting these tables should not be construed as regulations; however, they are appropriate to use to help guide program implementation.

Tables can be used to:

•Help identify and communicate the goals to focus resources

•Quickly identify actual/potential problems

•Help prioritize actions to address problems

•Focus decision-making on information needed to support actions

•Help identify likely areas of disagreement

RCRA Corrective Action Environmental Indicators

Notes:

There are many different Environmental Indicators (EIs) being used in different States and for different cleanup programs. This module addresses the two EIs being used in the RCRA Corrective Action program.

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Objectives

Participants will:

Part I

- Understand the background/history and role of Environmental Indicators (EIs) in the RCRA Corrective Action Program
- Become familiar with the new EI guidance* via discussions, scenarios, and regional experiences

2

Notes:

* "EI Guidance" is the forms/checklist of 2/5/99 in binder and CD. It contains:

- Cover memo
- Flowcharts
- Forms

A "User's Guide" is being developed to assist users in completing these "forms."

Objectives continued…

Participants will:

Part II

- Use the new EI guidance on real-world case study

3

Background and History of RCRA CA EIs

- Conceptualized 1993 (Fagan/Price) (Pre-GPRA)
- As an escape from “the process”
- Focus 1 - most important species (humans)
- Focus 2 - most mobile medium (groundwater)
- Guidance in memoranda and RCRIS 1994 and 1995 (Parker)
- Limited evaluation and documentation criteria

4

Background of RCRA CA EIs (Cont.)

- EIs measure the effectiveness of stabilization actions
- Stabilization/EIs is our first priority with limited resources
- Stabilize worst sites prior to final cleanups at fewer sites
- De-emphasize the corrective action process and emphasize the results (i.e., changes in the quality of the environment)

5

Notes:

Some elements of the Program's stabilization objectives (e.g., source control) may not be included in EIs, however the EIs are effective statements for important elements of stabilization.

Stabilization/EIs for the "worst sites first" is the best way to maximize the protection of human health and the environment given our resource limitations.

1997: EIs are the Metrics for GPRA

Our GPRA sub-objective is:

- Controlling current human exposure at 95% of high priority (GPRA baseline) sites by 2005; and
- Controlling migration of contaminated ground water at 70% of "high priority" (GPRA baseline) sites by 2005

6

Notes:

Meeting these goals is the highest near-term priority for the National RCRA program.

EPA recognizes that these are significant "stretch" goals for the program.

The EIs do not change the EPA's long-term goals for CA sites of groundwater restoration and source remediation.

Annual goals have been created to help ensure that we are on track to meet the 2005 goals.

Our progress to date is looking good (very near or surpassing our annual goals). (Of course we have been working at these sites for up to 15 years.)

Is there a wall out there (informational, budgetary, physical limitations) ?

Only the crystal ball knows.

The truth is we'll see. (Nobody can fault us for doing our best.)

EIs Became the Primary Near-Term Goals for RCRA Corrective Action

Environmental Indicators needed to:

- Reflect our overall program priorities
  - Protect humans & prevent spread of contamination
- Be implementable and meaningful
- Be as simple as possible, yet usable & defensible
- Allow for facility-specific conditions
- Communicate our results to public & Congress

7

Notes:

The EIs began very simply (as simple as possible) and yet, to be able to meet other needs, they became somewhat more (but hopefully not too) complicated.

To be communicable (and useful) to people at all levels of technical understanding, the EIs needed to result in a very limited list of answers (Yes, No, and Insufficient information to know).

This required that we neatly (and defensibly) sort all kinds of site-specific conditions into these three boxes (as we all know RCRA sites are nearly infinitely variable).

While simpler appears better, it can be more difficult to implement and to be implementable, we had to sharpen the points that divide sites into one or the other of the boxes clearly.

Updated EI Guidance
February 5, 1999

- Compilation guidance
- Replaces existing guidance (1994 and 1995)
- Available and appropriate for use now!
- "Interim-Final"
- EI guidance consists of two forms with series of questions
- Questions identify minimum documentation criteria for EI determinations

8

Notes:

The updated guidance is identified as "Interim-Final." This label reflects that the guidance is unlikely to change unless a simpler or more efficient way of performing the task can be found.

The questions in the EI forms were designed to be as few and simple as possible with the goal of helping individual project managers to evaluate EIs at their facilities.

"This guidance has been developed with the cooperation and input of representatives from all ten EPA Regions and at least one State from each Region. The guidance is in the form of questions to be answered in making an EI determination. The questions and answer options express the minimum criteria for EI determinations and are not to be modified for Regional, State or site-specific conditions. The 'Rationale' portion of the forms can be filled in to explain unique situations to any length necessary. While the signed hard-copies of these forms should reside in the facility's administrative files, these forms should also be kept in electronic format that can be posted on an 'EI database' web site to be developed by the Office of Solid Waste in the near future. The 'EI database' will help communicate successes and provide examples for overcoming barriers to progress." (from 2/5/99 cover memo from Elizabeth Cotsworth to RCRA Senior Policy Managers)

Objectives of 1999 EI Guidance

- Help ensure:
  - Appropriate factors are considered when evaluating and making EI determinations
  - EI determinations are defensible to a reasonable person
  - Consistency (across States and Region), and
- Help individual case managers decide when determinations are complete and adequately documented

9

Notes:

EIs are a means for documenting and summarizing professional judgments.

The guidance helps ensure consistency and equivalency of determinations by identifying a consistent list of factors that should be considered in making a site-specific professional judgment.

Recommended minimum documentation criteria help case managers decide when determinations are complete and adequately documented in order to survive internal and external audits, public scrutiny, and facility's questions.

EI determinations are likely to undergo public scrutiny because the general intent is to make this information available to the public. In addition, short cuts in determinations once made and documented are always subject to being picked up and highlighted.

EI Guidance has Three Levels

1) Cover memorandum
2) Flowchart (unofficial summary)
3) Guidance Forms
   a) Basic questions
   b) Criteria confirming (and documenting) responses (Checkmarks text)

- Will become more clear next segment of module where we discuss the guidance in detail and use the guidance for the Case Study

10

Notes:

Questions are answered with “YE,” “NO,” or “IN” (Insufficient information) with space for narrative description of the rationale and references for the given answers.

Background: General EI Definition

- Designed to track state of environmental quality
- Designed to be achievable (within GPRA schedule)
- Designed to be meaningful to the public
- EIs are site-wide determinations

11

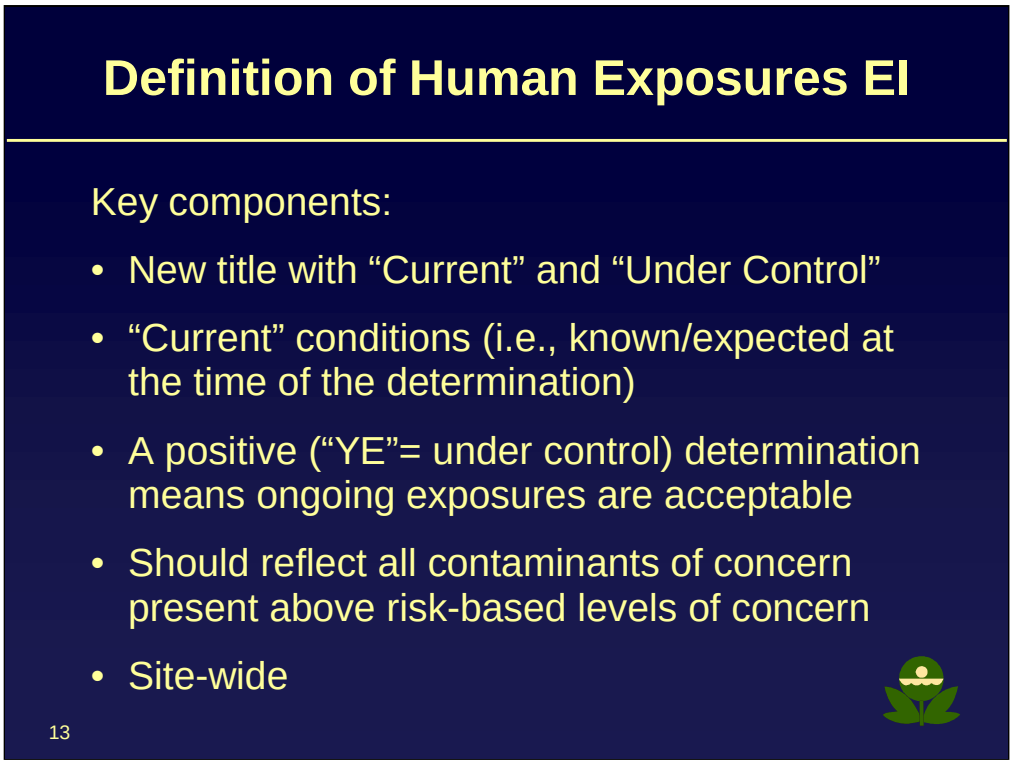
Notes:

This following definition is provided on page 1 of each evaluation form.

Environmental Indicators are measures being used by the RCRA Corrective Action Program to go beyond programmatic activity measures (e.g., reports received/approved, etc.) to track changes in the quality of the environment. The two EIs developed to date indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated ground water. An EI for non-human (ecological) receptors is intended to be developed in the future.

EIs are site-wide determinations. This means that while a particular unit or area-of-concern may not represent an unacceptable threat to humans or to groundwater, the facility would not achieve the EIs until all aspects of the facility subject to RCRA Corrective Action were considered in the determination.

Site-wide criterion applies even if another program (e.g., voluntary, unauthorized State, UST, or CERCLA) is working on part of the facility.



Notes:

Current Human Exposure Under Control EI is represented by RCRIS code CA725 (RCRIS stands for the RCRA Information System database).

This following definition is provided on page 1 of each evaluation form:

<u>Definition of “Current Human Exposures Under Control” EI</u>

A positive “Current Human Exposure Under Control” EI determination (“YE” RCRIS Status code) indicates that there are no “unacceptable” human exposures to “contamination” (i.e., contaminants in concentrations in excess of appropriate risk-based levels) that can be reasonably expected under current land- and groundwater-use conditions (for all “contamination” subject to RCRA Corrective Action at or from the identified facility (i.e., site-wide)).

The previous (1994) title (“Human Exposures Controlled”) did not clearly identify that the determination applied to current conditions only, and also implied to many readers that physical remedial actions were taken, when remedial actions (other than investigation and evaluation) may not have been necessary in all cases to ensure that human exposures were under control.

Migration of Contaminated Groundwater Under Control EI

Key components:

- This EI is strictly resource protection-based (not risk-based)*
- It reflects EPA's long-standing policies of groundwater protection
- Determinations are based on existing plume boundary (not property boundary or projected exposure point)
- Site-wide

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Notes:

* Risk frequently enters into the Contaminated Groundwater EI (RCRIS Code CA750) indirectly through the selection of the appropriate standard ("level") for identifying the extent of contamination (e.g., a drinking water standard). However, the EI is primarily related to the protection (prevention of further contamination) of the resource.

Background: Relationship of RCRA CA EI to Final Remedies

- Final Remedies remain the long-term Corrective Action objective
- Human Exposure EI (CA725) pertains ONLY to current land and water uses
- Groundwater EI (CA750) pertains ONLY to physical migration of contaminated groundwater (and acceptability of current impacts to surface water)

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Notes: (from Page 1 of each of the Human and Groundwater EI guidances)

While Final Remedies remain the long-term objective of the RCRA Corrective Action program, the EIs are near-term objectives, which are currently being used as Program measures for the Government Performance and Results Act of 1993 (GPRA).

The "Current Human Exposures Under Control" EI is for reasonably expected human exposures under current land- and groundwater-use conditions ONLY, and does not consider potential future land- or groundwater-use conditions or ecological receptors. The RCRA Corrective Action program's overall mission to protect human health and the environment requires that Final Remedies address these issues (i.e., potential future human exposure scenarios, future land and groundwater uses, and ecological receptors).

The "Migration of Contaminated Groundwater Under Control" EI pertains ONLY to the physical migration (i.e., further spread) of contaminated ground water and contaminants within groundwater (e.g., non-aqueous phase liquids or NAPLs). Achieving this EI does not substitute for achieving other stabilization or Final Remedy requirements and expectations associated with sources of contamination and the need to restore, wherever practicable, contaminated groundwater to be suitable for its designated current and future uses.

EIs = Min. Documentation and Max. Effectiveness

- Document only as much as necessary
  - Minimal restatement and maximum referencing
- More importantly, EIs are new FOCUSED way of looking at Corrective Action facilities
- EIs represent OPPORTUNITY to focus on key "problems" and "results" which are achievable in near term!
- Recent findings: EIs = faster results

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Notes:

References (as specific as possible, e.g., pages, section, chapter, volume) to in-depth reports or submittals are adequate documentation, although brief summary descriptions are very helpful.

How do Corrective Action EIs Relate to ASTSWMO and ECOS Measures?

- ASTSWMO's Remediation Task Force Report on EI is consistent with our EIs (although they are termed "Remediation Outcomes")
- ECOS has identified the RCRA CA EIs as Core Performance Measures (since 1998)
- EPA grant for ECOS EI recently resulted in 3 EI
  - 1) = Human Exposures = EPA's
  - 2) = Groundwater = EPA's
  - 3) = Area cleaned up (Tim Feilds memo)

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EIs Are Not a Cookbook!

- Assessing risks due to contamination is both complex and has potentially volatile results
- Cookbook approaches fail (thinking required)
- EIs are a means of documenting professional judgment
- Assessing risks commonly raises more questions than it answers (not a failure)
- Important to know what decisions can be made by project manager and when to consult with trained risk expert

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Will an EI Evaluation Warrant Additional Investigation?

- No! (but timing of data collection may change)
- Intent of EIs is to summarize an understanding of the site using data that would have to be collected as a normal part of Corrective Action
- Data necessary for EI determinations are a subset of data necessary for RFI-CMI (since data for future use scenarios and standards are not typically necessary)

Who Makes EI Determinations?

- Overseeing regulators (lead State or Region) (including individuals most familiar with facility)
- It is acceptable and appropriate for owner/operator to assist by making submittals and recommendations; however,
- EI determinations are a regulatory function, and are based on the information available to regulators and deemed appropriate for making the determinations

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Notes:

Those working at the facilities should be allowed to provide input to the EI evaluation process because they are at the site most frequently.

Likewise, those responsible for the contamination should be the ones responsible for making statements about what exposures can reasonably be expected.

Regulators' role should be to review submittals and accept them as reasonable or not.

It should be owner/operator's responsibility to notify regulators of changes that may affect the EI determination (this is an ongoing responsibility). Mechanism being developed.

Who Selects EI Evaluations Standards ("levels")?

- Lead Agency
- It is the professional responsibility of the Lead Agency to select appropriate "levels" for the EI determinations
- Appropriate "levels" depend on a number of factors (such as the use of the media, and acceptable risk levels (within the risk range))

Who Fills Out the EI Forms?

- Overseeing regulators and/or owner/operators (or their consultants)
- It is acceptable and appropriate for owner/operators to assist (e.g., by filling out forms, and even making recommended determinations)
- Teamwork can help to get to “Under Control”
- The ultimate responsibility for the content of the forms and the determination is the regulators

22

Who Signs EI Determinations?

- Overseeing regulators (lead State or Region) making the determination
- People do things (not agencies)
- To maintain credibility it is important to identify the individuals making the professional judgments

23

What Level of Confidence is Appropriate for EI Determinations?

- "Reasonable certainty" that can be documented and is verifiable (i.e., defensible to reasonable person)
- Does not mean 100 percent certainty
- Can be revisited and revised as new information becomes available

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Notes:

EIs provide a framework for documenting professional judgment. EIs also encourage consistency by establishing broad boundaries and listing the factors to be considered by all, while still allowing flexibility for professional judgment dealing with site-specific conditions.

Duration/Applicability of EI Determinations

- Codes entered in RCRIS “YE,” “NO,” or “IN”sufficient Information, remain in database ONLY as long as they are TRUE
- Codes should be changed when regulators become aware of contrary information
- New information should be included in EI determination (e.g. new SWMU, property, etc.)

Maintenance of Accuracy in EI Determination

- It is highly recommended that the EI determinations be based on written submittals by the responsible parties (particularly for exposure conditions and controls)
- Owner/operators should be made aware of their responsibility to notify regulatory agencies when they become aware of changes in conditions that could cause a change in EI status (possible model form letter)

EI Guidance Cover Page

- Signed hardcopies of forms should reside in administrative files
- Electronic version EI forms needed for “EI database” web site to be developed by OSW in the “near future”
- pdf interim web site very soon (volunteers now)
- Searchable web site/interactive forms with possible integration with SCEM builder

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Notes:

Advantages of sharing evaluation forms are increased sharing of good ideas to overcome barriers and get more sites “under control.”

Advantages of making EI results records available (in Program Accomplishment Reports (PARs) reports and/or on location maps) is to help encourage the regulated community and regulators to team up and do the right thing, and look good together.

Availability of EI Determinations

- Completed EI forms will be available to other regulators via web site (yet to be created)
- States and Regions will decide on the public availability

  Electronic format for EI forms is available on the web at www.epa.gov/epaoswer/osw/ei_guida.pdf
- Web site with completed EI forms (in pdf format) available at www.correctiveactionwksp.org/indictor.htm

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Closing EI Remarks

- Don't let the desire to show "YE" results lead to indefensible EI determinations
- Given our resources, we can only be faulted if we say it is a "YE" when that is not reasonable or defensible
- The more difficult the determination, the greater the need for acknowledgment by all stakeholders that a reasonable determination was made (or else we'll pay for it later)

29

Notes:

We need to "do what ever it takes" to get to the right answer.

Public participation was not specifically identified as an expectation in the guidance except where natural attenuation remedies will allow some further migration of the plume and we are still calling it "Under Control" (i.e., in particularly sensitive situations).

However, for several reasons (e.g., often significant Interim Actions will be involved in achieving EIs) public participation activities concurrent with EI determinations is highly recommended especially in cases where stakeholders could be impacted or alarmed by determinations made without their involvement.

EI Issues Conference Calls

- 1st Thursday of Month (typically 3:00 e.s.t.)
- State, Regional and HQ participants
- Opportunity to raise site-specific issues/problems
- Share information on developing issues
- Discuss and further develop guidance
- Contact to get name on call list:
  - Schuver.Henry@EPA.gov
  - (703) 308-8656

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Current Human Exposures Under Control EI

Key components:

- Intended to be realistic, risk-based evaluation
- Based on actual, “current” land use, not hypothetical or future land uses
- Looks at complete exposure pathways resulting in human exposure to levels of contaminants giving rise to unacceptable risk
- No ecological risk evaluated (eco-risk EI possible in future)

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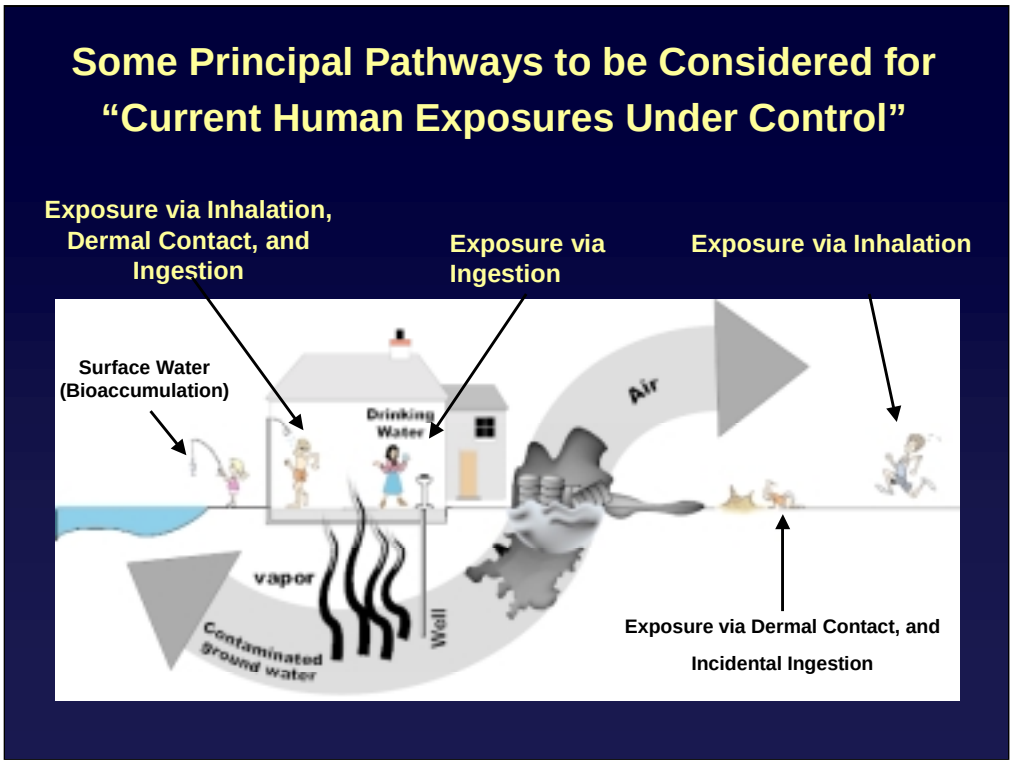
Current Human Exposures Under Control EI (Cont.)

Key components (continued):

- All media need to be considered (soil, sediment, water, air).
- A number of potential exposure pathways need to be considered if realistic (e.g., actual groundwater use to be considered).
- A number of potential exposure scenarios need to be considered if realistic (consistent with current actual land use).



Summary Exposure Pathway Evaluation Table (CA725 Question 3, Page 3)

Potential Human Receptors (Under Current Conditions)

"Contaminated" Media	Residents	Workers	Day-Care	Construction	Trespassers	Recreation	Food3
Groundwater	___	___	___	___			___
Air (indoors)	___	___	___				
Soil (surface, e.g., <2 ft)	___	___	___	___	___	___	___
Surface Water	___	___			___	___	___
Sediment	___	___			___	___	___
Soil (subsurface e.g., >2 ft)				___			___
Air (outdoors)	___	___	___	___	___		

Human Exposures EI Evaluation and Documentation Guidance

Tiered five-step screening process:

- has all relevant data been evaluated?
- any media contaminated above appropriate risk-based levels ("contamination")?
- are there complete pathways between humans and "contamination"?
- are exposures expected to be significant?
- have exposures been demonstrated (e.g., quantitatively) to be acceptable?

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Notes:

This slide presents an easy-to-read introduction to the EI guidance questions.

These questions will be discussed in more depth in the next section of this presentation.

The full text of these questions is in the 2/5/99 guidance provided in the Handbook

These questions are summarized and their functional relationships are illustrated in the EI flowcharts.

Exposure Controls for Human Exposures EI

The objective is to reduce 1) concentrations, or 2) exposures (e.g., cut the pathways):

- It is not necessary to investigate all areas if there are exposure controls in place that adequately limit, control, or prevent exposures to the concentrations likely or possibly present
- Optional pathway evaluation worksheet and example controls (early draft available)

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1. Examples of Physical Controls

- Caps
- Fences/Walls
- Security Guards
- Vegetative Cover
- Natural Inaccessibility
- Remoteness/Unattractiveness
- Vapor Barriers/Ventilation Systems
- Permitted releases – NPDES, CAA, etc.

2. Examples of Institutional Controls – Do not need to be legally binding documents (sitting in courthouse), could be written commitments (e.g. on facility letterhead). "EFFECTIVE controls"

- Posted Signs
- Land-use Restrictions (e.g., zoning, deed, Responsible Party statements)
- Level of PPE (Personal Protection Equipment)
- Safety Training/Newsletters
- Activity Permits/Notifications (e.g., construction permits/notifications)
- Well Restrictions
- Media-use Restrictions
- Responsible Party statements of activity/use restrictions
- Testing/Monitoring (and restrictions if necessary)
- Consumption Restrictions
- Restrictions on Frequency of Exposures

Current Human Exposures Under Control EI

Risk:

- Is the probability of an undesirable effect
- For environmental risk, it is the product of contaminant concentrations and exposures (i.e., = Conc. x Exposure) [& Toxicity]
- Can be reduced by controlling either concentrations or exposures
- Acceptability is a societal value judgment
  - Voluntary – Involuntary
  - Benefits – No benefits
  - Well-known – Not familiar
  - Warnings – No warnings

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Notes:

Risks* can be reduced by:

Reducing contaminant concentrations (cleanup, remediation, restoration, etc.)

or

Reducing exposures (effective controls on exposure intensity, frequency, magnitude)

Obviously, reducing contaminant concentrations (and removing all hazards) is preferable (for many reasons); however, given the GPRA timeframe, exposure controls are likely to be more frequently used to meet "Under Control" goals.

Acceptable risk levels are typically identified in State or EPA guidance (e.g., lifetime cancer risks within 10-4 to 10-6 range and Hazard Indices of <1).

*(Incremental risks due to environmental hazards)

Current Human Exposures Under Control EI

Summary and key communication points:

- Three possible answers ("YE," "NO," & "IN")
- "YE"(s)* exposures are "Under Control"
- A "NO" answer means that Current Human Exposures are Not Under Control
  - we are aware that unacceptable human exposures are currently occurring
  - these conditions should be addressed as soon as possible
- "IN"sufficient data to make a determination

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Notes:

There shouldn't be many "NO" status codes (if we are protecting human health)

"NO" status codes shouldn't exist for long (if we are addressing problems as soon as we are aware of them)

"YE"s status codes (exposures are "Under Control") need to be carefully communicated for sites where "un-natural" (or natural) background hazards exist (i.e., from sources other than these facilities, and/or not reachable by RCRA)

It is important for us (regulators) to be careful in the communication of what "under control" means. "Under control" means for a specific facility's releases and may not mean that there are not other unacceptable exposures (which are not the responsibility of the identified facility).

Additional guidance/methodologies for clearly and accurately communicating this issue will likely need to be developed in the future. (All we need is someone to do it.)

Migration of Contaminated Groundwater Under Control EI (Cont.)

- There are two primary elements:
  1) The stability of geospatial (horizontal and vertical) dimensions of "contaminated" groundwater
  2) Impacts of discharges of "contaminated" groundwater into surface water, if any
- Ongoing monitoring is required to document both stabilization of migration and impacts to surface water (by contamination)*

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Notes:

* Ongoing monitoring is typically only required where "contamination" has been identified (i.e., concentrations above "levels of concern").

Definition of Groundwater EI

Key components:

- A positive determination means the physical migration of contaminated groundwater has been stabilized (and impacts to surface water are currently acceptable)
- Monitoring will be conducted to confirm
- Should reflect all contaminants of concern present above appropriate levels of concern
- Site-wide

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Notes:

The Migration of Contaminated Groundwater Under Control is identified by RCRIS status code CA750

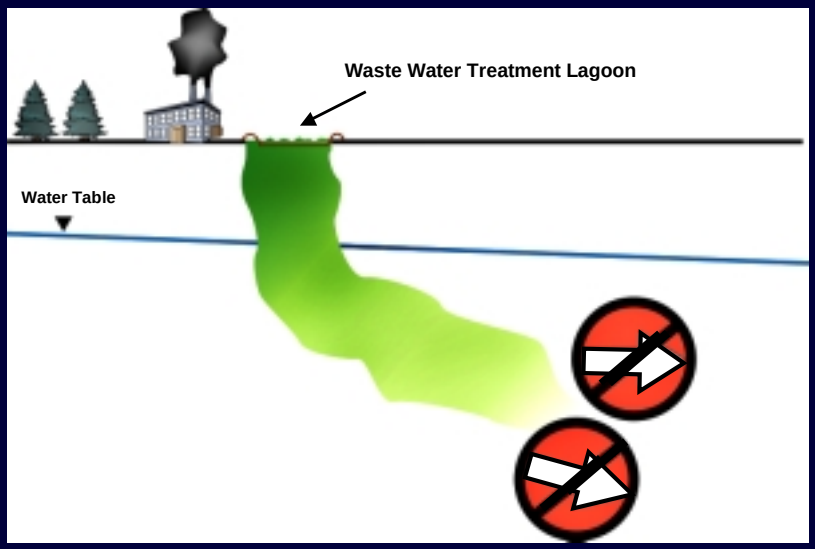
<u>Definition of "Migration of Contaminated Groundwater Under Control" EI</u>

A positive "Migration of Contaminated Groundwater Under Control" EI determination ("YE" status code) indicates that the migration of "contaminated" groundwater has stabilized, and that monitoring will be conducted to confirm that contaminated groundwater remains within the original "area of contaminated groundwater" (for all groundwater "contamination" subject to RCRA corrective action at or from the identified facility, i.e., site-wide).

Site-wide criterion applies even if another program (e.g., State, voluntary, UST, or CERCLA) is working on part of the facility.

The previous (1994) title (Groundwater Releases Controlled") did not clearly identify that the determination applied only to the physical movement of the outside boundary of contamination and even though the full text explained this, the title implied to some readers that it also included elements of source control. This title also implied to many readers that physical remedial measures were taken, when remedial actions (other than investigation, evaluation, and perhaps continued monitoring) may not have been necessary in all cases to ensure that the migration of contaminated groundwater was under control.

"Migration of Contaminated Groundwater Under Control" Environmental Indicator - Dissolved Plume Example



Notes:

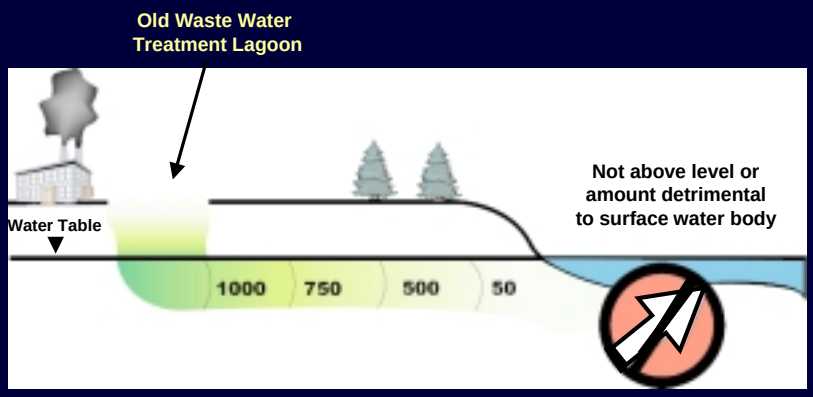
This illustration shows only a simple dissolved phase plume.

However, be aware that contaminants in a separate phase ("pure product"), for example,

- floating (LNAPL-Light Non-Aqueous Phase Liquids) like gasoline, or
- sinking (DNAPL - Dense Non-Aqueous Phase Liquids) like TCE, or perhaps
- neutral buoyancy (NNAPL - Neutral Non-Aqueous Phase Liquids) due to pure mixtures of light and dense chemicals

[may move in different directions, at different speeds, and due to different mechanisms (e.g., up-(water-table) gradient or down strata dip regardless of water pressure head and flow direction).]

"Migration of Contaminated Groundwater Under Control" Environmental Indicator - Dissolved Groundwater Plume Discharging to Surface Water Example



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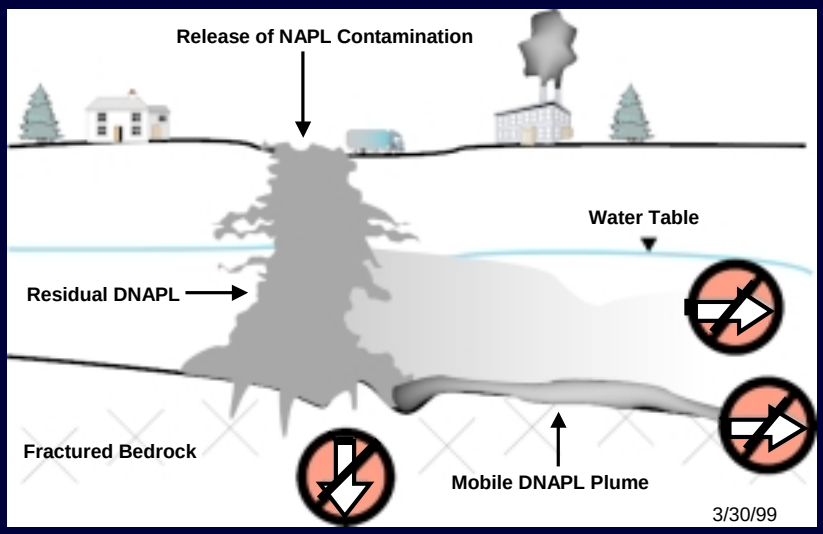
"Migration of Contaminated Groundwater Under Control" Environmental Indicator - Dissolved and NAPL Plume Example



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3/30/99

Groundwater EI Evaluation and Documentation Guidance

Tiered seven-step screening process:

- Has all relevant data been evaluated?
- Is groundwater "contaminated" above aquifer-appropriate, risk-based levels?
- Does monitoring data demonstrate horizontal and vertical migration has stabilized?
- Does contaminated groundwater discharge to surface water?

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Notes:

This slide presents an easy-to-read introduction to the EI guidance questions.

These questions will be discussed in more depth in the next section of this presentation.

The full text of these questions is in the 2/5/99 guidance.

These questions are summarized and their functional relationships are illustrated in the EI flowchart.

Groundwater EI Evaluation and Documentation Guidance (Cont.)

Tiered seven-step screening process (cont.):

- Is the discharge of contaminated groundwater into surface water likely to be insignificant (<10x gw std and no other issues criteria)?
- Are impacts to surface water, sediments, and ecosystems “currently” acceptable?
- Is there adequate monitoring to document no migration and no unacceptable impact to surface water?

Migration of Contaminated Groundwater Under Control EI

Summary and key points:

- Three possible answers ("YE," "NO," & "IN")
- Limited migration permissible if part of "formal" natural attenuation remedy (i.e., involving public participation)
- Background conditions considered in EI
- Predictive modeling may be a component, but monitoring is required to demonstrate a "YE" (with "contamination")

45

Notes:

Our 2005 goal for the Groundwater EI is only 70% due to the recognition of physical limitations that can prevent the physical control of plume migration.

The EI guidance was constructed to allow limited migration under "formal" natural attenuation remedies (i.e., where stabilization is expected in the near future and public has acknowledged this assessment/decision).

HUMAN EI

Objectives

Participants will:

- Become familiar with the new EI guidance via discussions, scenarios, and regional experiences
- Use the new EI guidance on real-world case study

2

In-depth Review of HUMAN EI

- Current Human Exposures Under Control
- RCRIS code CA725
- Background/Cover memo
- Flowchart
- Questions - slightly abbreviated in slides
- Response criteria - abbreviated in notes
- Full text in 2/5/99 Guidance

3

Reference: "RCRA Corrective Action Environmental Indicator (EI) RCRIS code (CA725)," US EPA, Interim Final 2/5/99.

HUMAN EI - Question 1

Has all available relevant/significant information on known and reasonably suspected releases

- subject to RCRA Corrective Action (e.g., SWMU, RU, AOC)
- been considered in this EI determination?

A “no brainer” gentle reminder

4

_____ If yes – check here and continue with Question 2.

_____ If no – re-evaluate existing data, or

_____ If data are not available skip to Question 6 and enter "IN" (more information needed) status code.

HUMAN EI - Question 2

Are media (groundwater, soil, surface water, sediments, or air)

- known or reasonably suspected to be "contaminated"?
- above appropriately protective risk-based "levels" (applicable promulgated standards, as well as other appropriate standards, guidelines, or criteria)?
- from releases subject to RCRA Corrective Action (from SWMUs, RUs, or AOCs)?

5

Notes:

Appropriately protective "levels" for the obvious land use (e.g., industrial) and for the aquifer-wide groundwater use.

This should not consider site-specific conditions that limit risks.

This is a straightforward hazard identification (potential risks under possible exposure scenarios).

Media listed in guidance.

Groundwater, air (indoors), surface soil (e.g., <2 ft), surface water/sediment, subsurface soil (e.g., >2 ft), Air (outdoors)

_____ If no (for all media) - skip to Question 6, and enter "YE," status code after providing or citing appropriate "levels," and referencing sufficient supporting documentation demonstrating that these "levels" are not exceeded.

_____ If yes (for any media) - continue after identifying key contaminants in each "contaminated" medium, citing appropriate "levels" (or provide an explanation for the determination that the medium could pose an unacceptable risk), and referencing supporting documentation.

_____ If unknown (for any media) - skip to Question 6 and enter "IN" status code.

HUMAN EI - Question 3

Are there “complete pathways” between “contamination” (“Above Levels of Concern” ALC) and human receptors *

- such that exposures can be reasonably expected?
- under the current land- and groundwater-use conditions?

6

Summary Exposure Pathway Evaluation Table (CA725 Question 3, Page 3)

Potential Human Receptors (Under Current Conditions)

“Contaminated" Media	Residents	Workers	Day-Care	Construction	Trespassers	Recreation	Food3
Groundwater	___	___	___	___			___
Air (indoors)	___	___	___				
Soil (surface, e.g., <2 ft)	___	___	___	___	___	___	___
Surface Water	___	___			___	___	___
Sediment	___	___			___	___	___
Soil (subsurface e.g., >2 ft)				___			___
Air (outdoors)	___	___	___	___	___		

HUMAN EI - Question 4

Can the exposures reasonably be expected to be significant, i.e., magnitude (intensity, frequency and/or duration)?

- An opportunity to use professional qualitative judgment and not require a Quantitative Risk Assessment for every complete pathway
- Most difficult portion of Human EI
- If there is any question consult a Risk Assessment specialist

8

HUMAN EI - Question 4 (Cont.)

Suggested:

- Semi-quantitative tool for assessing combination of concentrations and exposure magnitudes
- See-Saw Analogy
  - As concentrations go up (above “levels”), exposures had better go down (<< in “levels”)

9

Notes:

The “levels” used are developed from assumed exposure magnitudes, including some rate of intake (intensity), frequency, and duration of exposures (typically lifetime or carereer).

If the concentration of contaminants where exposures occur are 10 times the acceptable “levels,” then the exposure magnitudes (intensity times the sum of lifetime or career frequency and durations) had better be less than 1/10 of that assumed in the derivation of the accpetable “levels” to retain the ‘acceptable” product (risk) of concentrations times exposures.

HUMAN EI - Question 5

- Have the “significant” exposures (identified in Question 4) been shown to be within acceptable limits (i.e., is there a Quantitative Risk Assessment (QRA) demonstrating their acceptability)?
- What exposure limitations/controls are assumed in the QRA?
- What confidence is there in these, and what notification procedures for changes?

HUMAN EI - Question 6

- Check the appropriate RCRIS status codes for Human Exposures EI event code CA 725,
- Obtain supervisor (or appropriate manager) signature and date on the EI determination
- Attach
  - appropriate supporting documentation
  - a map of the facility.

GROUNDWATER EI

In-depth Review of GROUNDWATER EI

- Migration of Contaminated Groundwater Under Control
- RCRIS code CA750
- Background/Cover memo
- Flowchart
- Questions - slightly abbreviated in slides
- Response criteria - abbreviated in notes
- Full text in 2/5/99 Guidance

1

Reference

"RCRA Corrective Action Environmental Indicator (EI) RCRIS code (CA750)," US EPA, Interim Final 1/5/99.

GROUNDWATER EI - Question 1

- Has
  - all available relevant/significant information
  - on known and reasonably suspected releases
  - subject to RCRA Corrective Action (e.g., SWMU, RU, AOC)

  been considered in this EI determination?

- A “no brainer” gentle reminder

2

GROUNDWATER EI - Question 2

Is Groundwater

- known or reasonably suspected to be "contaminated"
- above appropriately protective "levels" (i.e., standards, guidelines, guidance, or criteria for protection of resource & beneficial uses)
- from releases subject to RCRA Corrective Action
- anywhere at or from the facility?

3

GROUNDWATER EI - Question 3

Has the migration of contaminated groundwater stabilized

- within "existing area of contaminated groundwater"
- as defined by the monitoring locations designated at the time of this determination (i.e, monitoring locations that define the plume)
- both horizontal and vertical dimensions?

4

GROUNDWATER EI - Question 4

Does “contaminated” groundwater

- discharge into surface water bodies?
- “contaminated” = > aquifer “levels” (stds)
- aquifer “levels” (stds) may be for the protection of surface water

5

GROUNDWATER EI - Question 5

Is the discharge of "contaminated" groundwater into surface water

- likely to be "insignificant" (i.e., maximum concentration <10x the appropriate groundwater "level")
- and there are no "other conditions"
  - which significantly increase the potential for unacceptable impacts to surface water, sediments, or ecosystems?

6

GROUNDWATER EI - Question 6

Can the discharge of "contaminated" groundwater into surface water

- be shown to be "currently acceptable"
  - not cause impacts to surface water, sediments, or ecosystems
  - that should not be allowed to continue until a final remedy can be implemented?
- this is a rapidly developing field, look to the latest guidance on methods and scale of demonstration

7

GROUNDWATER EI - Question 7

Will groundwater monitoring/measurement data (and surface water/sediment/ecological data, as necessary)

- be collected in the future to verify that "contaminated" groundwater has remained within
  - the horizontal (or vertical, as necessary) dimensions of the "existing area of contaminated groundwater?"

8

GROUNDWATER EI - Question 8

- Check the appropriate RCRIS status codes for Migration of Contaminated Groundwater Under Control EI event code CA750
- Obtain supervisor (or appropriate manager) signature and date on the EI determination below
- Attach appropriate supporting documentation as well as a map of the facility

9

Conceptual Site Model
(Part I)

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

CSM Module Objectives (Part I)

Participants will:

- be able to Define a “Conceptual Site Model”, and describe how it can help focus resources
- be able to describe how action levels, problem statements, and decision rules enhance a Conceptual Site Model
- be introduced to the Workshop Case Study (AMT, Inc.)

2

What is a Conceptual Site Model?

Tool to help us:

- Organize and communicate information
- Focus resources on contamination that represent most significant "problems" at any given point in time

3

Notes:

.

The CSM is used to organize and communicate information about site characteristics. It should reflect the best interpretation of available information at any point in time. As a consequence, if new data are inconsistent, either the data need evaluation, or the model needs to be revised.

The CSM is a primary vehicle for communicating technical data. It provides a good summary of how and where contaminants are expected to move and what impacts such movement may have. Hence, it supplies additional information to explain why a problem is a problem, why it is inconsistent with Corrective Action Results, and, therefore, why a response is anticipated. By highlighting Human receptors and groundwater releases, the CSM facilitates identification of environmental indicator concerns.

The CSM can help, for example, to establish whether there is a likelihood of imminent and substantial endangerment; justify characterization approaches; and prioritize investigation and remedial resources.

What is a "problem" in context of Results-Based Project Management?

- Condition(s) that likely warrants a response to achieve interim or final Corrective Action Results
- Defining the problem early in a Corrective Action is possible and prudent
- Defining problems helps prioritize resources
- Problem definition will evolve as data are collected

4

Notes:

The definition of a "problem" is presented in the context of "Results-Based Project Management."

Problems are conditions that require a response that will remove, modify, or otherwise reduce the impact of the problem. Problems are a subset of releases or potential releases. For example, contamination below an action level may indicate that a release has occurred, but it may not be at a concentration that would constitute a problem and warrant a response. Problems are what must be characterized, evaluated, and ultimately resolved.

In many cases, existing data will suggest a problem may exist, but the problem cannot be substantiated until additional site characterization is conducted. The CSM is a tool to help visualize and prioritize actual and potential problems and what should be done about them.

What Type of Information?

- General site information
- Site characteristics
- Actual/potential receptors, and release and transport mechanisms
- Soil contaminant source characteristics

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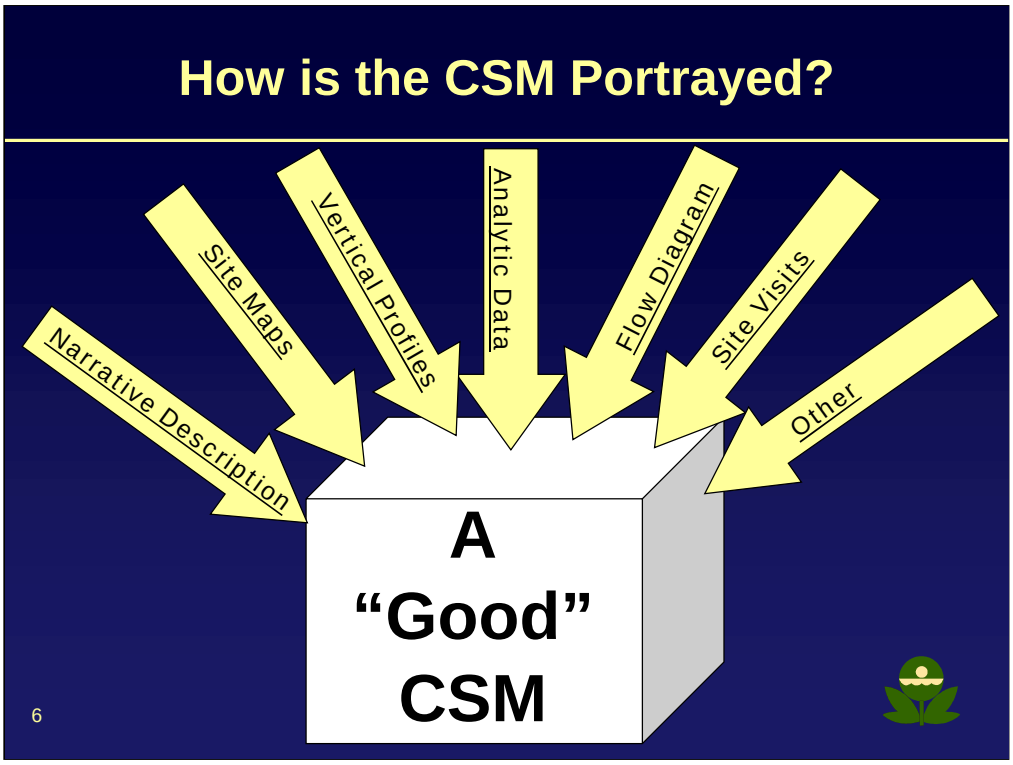
Notes:

- CSM can be initially based on limited information, then developed as data needed to make decisions are collected and analyzed.
- CSM guidance can be found in Appendix A to "Soil Screening Level User's Guide" (EPA 9355.423, July, 1996).
- General site information involves information relevant to site operations and past investigations.
- Site characteristics include a wide range of information related to geology, hydrogeology, and meteorology.
- Actual or potential receptors focus on identifying current, surrounding, and future land uses; and potential for acute effects and ecological concerns, based on potential media affected and exposure pathways.
- Soil contaminant source characteristics include process history of past releases and spills, including area effected, contaminants present, identification of possible NAPL presence, soil characteristics, and contaminant-specific properties.



Notes:

A CSM benefits from use of multiple formats to best portray available information.

A good narrative description is the best means of describing the site, its history, the nature of sources, quantitative aspects of migration pathways, and the identity of ecological and human receptors as well as the circumstances under which exposure is anticipated.

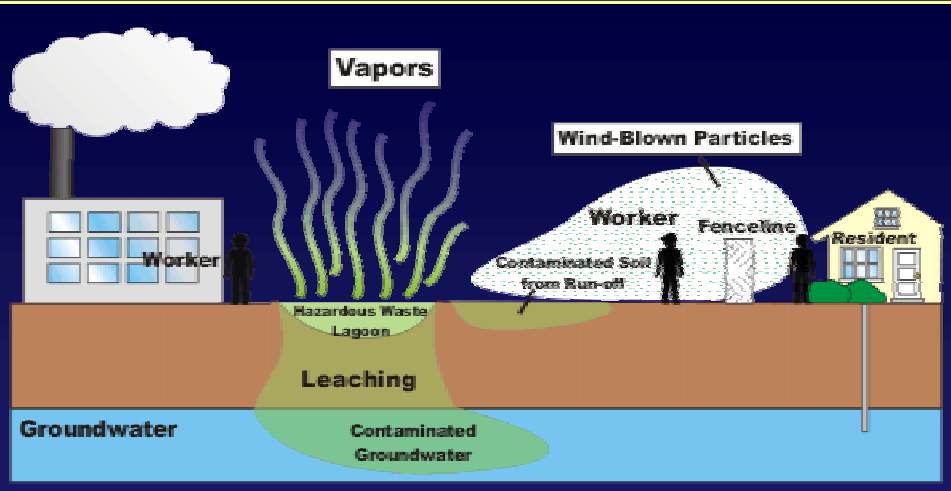
Maps should always be included in a CSM. At a minimum, maps should include relative position of sources, pathway determinants and near-field boundary constraints, surface water features, prevailing wind pattern, and plume contours.

If subsurface contamination is present, vertical profiles of the site should be included. These profiles should be supported by boring logs.

Tabular data should be included to support groundwater flow and contaminant distribution maps, but tables should be keyed to map features and should contain representative data only, not an exhaustive display of all data.

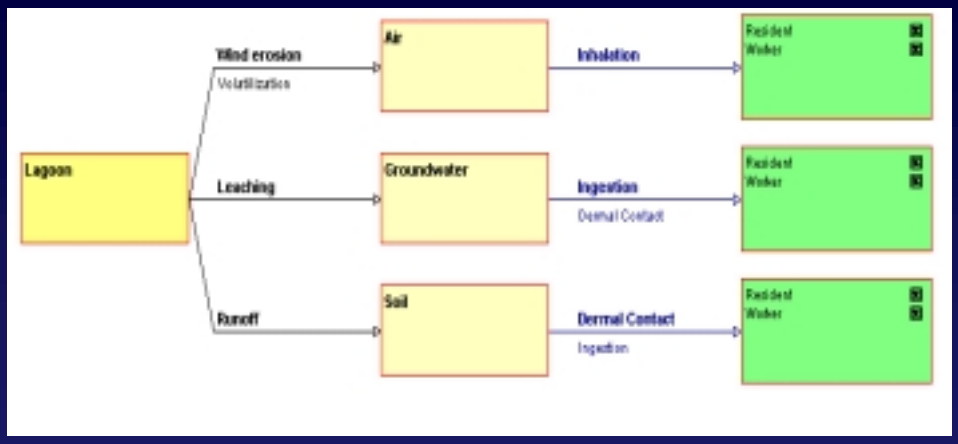
Flow diagrams are often helpful to illustrate the "interrelationships" from the original sources to the final receptors.

Picture Version of CSM



7

Flow Diagram Version of CSM



8

Notes:

For non-artists, you can use a flow diagram version of a CSM to illustrate the same questions as the previous pictorial CSM.

How can a CSM Help a Project Manager?

It provides a rational framework to organize

- what you know
- what you don't know
- what you need to know
- questions asked
- answers given
- decisions made

9

Notes:

If what you ask, answer, and decide flow from a CSM, then other stakeholders likely would benefit from also using the CSM as the primary organization/communication tool.

A CSM can be used to help justify what information is essential for successful management of actual/potential risks.

Ultimately, a CSM can Help Avoid...

"Traditional Approach" where:

- Process drives program focus and goals
- Workplans/reports often become major endpoints/milestones
- Focus is on eliminating "all" uncertainties before proceeding to remedy evaluation and selection
- Emphasis is on releases/SWMUs that can be quickly resolved, often lower risk ones

10

Notes:

The intent to characterize the full nature and extent of contamination has lost its context and become an end in its own right. Many current investigations go well beyond necessary and sufficient data to determine if a problem exists and what to do about it.

... And Forms the Foundation for...

Alternative Results-Based approach:

- Focusing on interim or final results that need to be achieved and the decisions that need to be made to achieve those results
- Asking the right questions at the right time
- Identifying and filling data gaps that need to be reduced to make decisions
- Making decisions in the presence of remaining unknown conditions, when adequate contingencies are provided

11

What are Three Other Tools That Work Well to Enhance the CSM?

- Action Levels
- Problem Statements
- Decision Rules

12

Notes:

EPA continues to support the concept of action levels (or screening levels) as a trigger mechanism for conducting additional corrective action activities (e.g., additional investigations, evaluation of remedial alternatives, site-specific risk assessments). Contamination found in a particular medium below an appropriate action level would not generally be subject to remediation or further study.

Action levels are health- or environmental-based concentrations derived using chemical-specific toxicity information and standardized exposure assumptions. Action levels are often established at the more protective end of the risk range (e.g., 10(-6)) using conservative exposure and land use assumptions; however, action levels based on less conservative assumptions could be appropriate based on site-specific conditions. For example, if the current and reasonably anticipated future uses of a site are industrial, an action level based on industrial exposure scenarios could be appropriate.

Action Levels

- Action or screening levels are a very helpful streamlining tool
- Superfund Soil Screening Guidance represents EPA HQ's most current approach

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Notes:

EPA HQ lastest guidance associated with action levels is the "Soil Screening Guidance" which is included behind the CSM tab of the Workshop toolbook. More detailed guidance assocaited with soil screening levels can be found at http://www.epa.gov/superfund/resources/soil/index.htm. Presently, the Soil Screening guidance is based on residential exposure scenarios; however, new guidance is being developed for non-residential exposure.

Program implementers and facility owners/operators should ensure that action levels used at RCRA Corrective Action facilities reflect up-to-date toxicity information and that action level assumptions are consistent with the physical conditions and current or reasonably anticipated exposure assumptions at any given facility. For example, risk to ecologic receptors is not accounted for in the action levels included in the 1990 proposal. If ecologic risks are a concern at a given Corrective Action facility, program implementers and facility owners/operators should consider developing facility-specific action levels to account for ecologic risk issues.

Problem Statements Effectively Communicate the Focus of Corrective Action

- A problem statement is a clear, concise format for communicating the condition that needs a response
- Example of a problem statement:
  - Lead above the preliminary remediation goal of 400 ppm is found in the upper 2 feet of soil

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Notes:

Problem statements are an effective tool for communication because they focus on participating in the decision-making process, and on what specific problem(s) need to be addressed.

Problem statements can be unit- or area-specific or can apply to a broader site-wide problem. An example of a site-wide problem statement could be: Contaminated groundwater is migrating beyond the facility property.

A problem statement provides linkage to the key decisions that need to be made at any point in time by:

–Specifying the condition requiring a response

–Reflecting current understanding

–Evolving with our knowledge of the site

Decision Rule

- When coupled with probable response, the problem statement becomes a

"DECISION RULE"

- A decision rule is an if/then statement that clearly indicates what decision will be made when specified conditions are encountered
- Decision rules clearly communicate
  - why response is needed, and
  - what that response will need to accomplish

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Notes:

Decision rules are an effective tool for communication because they provide the stakeholder with information on the criteria on which a decision is being made, as well as the response that likely will result from the decisions.

The problem statement is the conditional "if" element of the decision rule. As such, it provides the justification for collecting additional data and/or making a remedial response. Decision rules can be used to focus both investigation and remediation resources. To focus an investigation, for example, a decision rule could read: "If contamination is found in excess of 5 ppb in groundwater, then additional samples will be collected down-gradient to define the extent of the plume." Owner/operators have often complained about not knowing when "enough is enough" with regard to data collection. Decision rules provide the basis for giving the owner/operators an end point. Generally, owners/operators should prepare problem statements. In particular, the site manager must be prepared to redirect efforts that are improperly focused or prioritized. Decision rules can be general, such as in the first example, where the type of response to halt further migration of contaminated groundwater is not specified. However, the more specific the problem statement is, the clearer interested stakeholders are with respect to both the nature of the problem and of the response. For example, the second example dealing with chromium contamination clearly indicates the type of response that will be used for soil found with chromium in excess of the preliminary remediation goal.

Introduction to Case Study

Conceptual Site Model
(Part II)

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

CSM Module Objectives (Part II)

Participants will:

- be able to describe how “mass balance approach” using “Fugacity” helps us understand chemical occurrence, transport, and exposure potential
- discuss additional data needs for case study

18

Focusing on EIs First, What are the Two Most Important Questions?

- Is contaminated groundwater migrating above levels of concern?
- Are current human exposures under control?

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Notes:

Recall the two environmental indicators:

- Migration of contaminated groundwater under concern;
- Current human exposures under control.

If EIs have been achieved, then the key questions should be related to final remedial objectives..

Some Type/Amount of Data is Generally Needed to Answer Key Questions...

- But how much?
- Results-Based Focus directs data collection on what is **necessary and sufficient** to:
  - enable identification and implementation of interim and/or final remedies, and/or
  - determine that Corrective Action is complete.
- CSM is useful tool to identify "necessary and sufficient."

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Notes:

Uncertainties with environmental characterization, especially when dealing with the subsurface, are inherent and will always exist. Knowing when "enough is enough" with regard to data collection has historically been the subject of significant contention between owner/operators and regulators. Understanding the concept of "necessary and sufficient" can minimize these conflicts and accelerate cleanups in general.

Latest Agency position on the objective for site characterization:

Site characterization should describe the facility and identify and describe releases and potential releases of hazardous waste and hazardous constituents at the facility, including releases from solid waste management units and materials posing principal threats, as necessary to enable identification and implementation of interim and/or final remedies and/or to determine that Corrective Action is complete.

The focus of a results-based approach to site characterization is identifying the necessary and sufficient information to answer important questions at a given point in time, without being tied to traditional processes or specific documents. When filling a data gap will not change your answer to a question, the missing data is not needed and may serve only to divert time and resources from higher priorities.

How do We Focus Data Collection?

- Again, focus on EIs first!
- Helpful to understand what phase (soil, water, NAPL, air) chemicals want to be in
- Ultimately, understanding phases helps understand migration/exposure potential

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Notes:

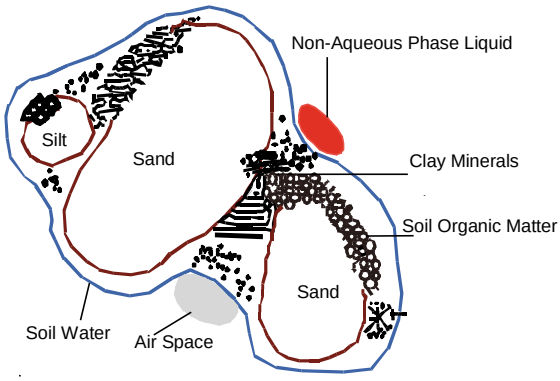
Focusing data collection on final results is appropriate if EIs have already been achieved.

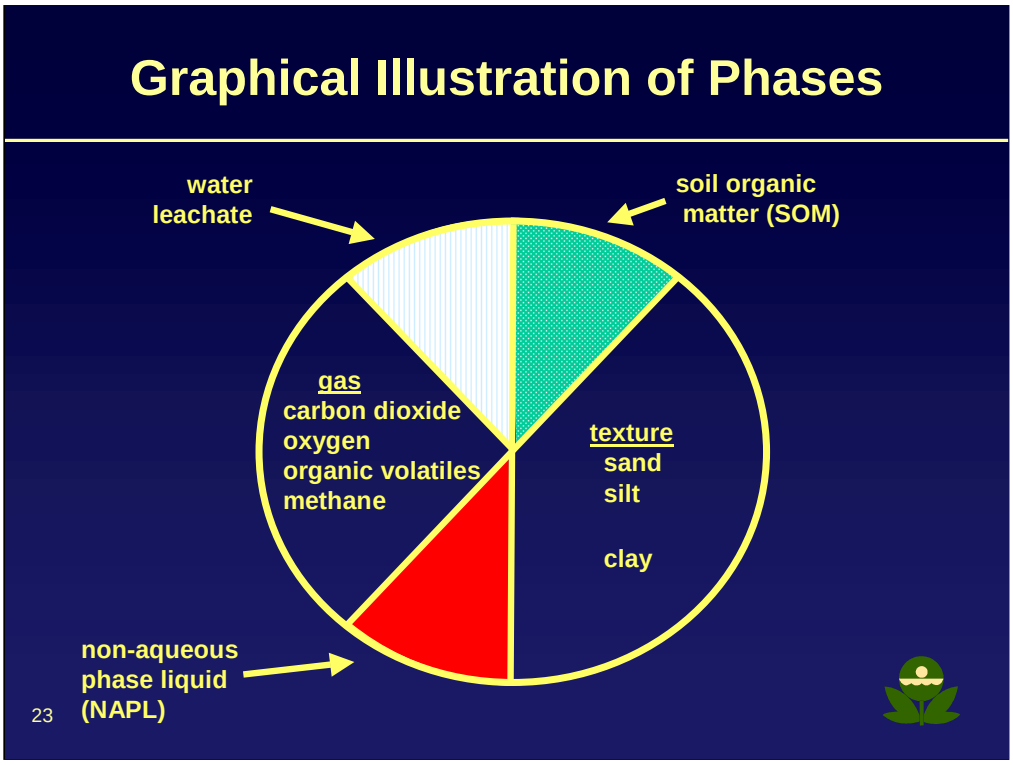
NAPL (Non-Aqueous Phase Liquid): Contaminants that remain undiluted as the original bulk liquid in the subsurface, (e.g., spilled oil).

Components of Soil Phases

Soil Phase % (Vol)			
		Typical	
	Range	Soil[1]	Aquifer
Soil Organic Matter	0-5	3	0.5
Mineral Matter	45-60	47	59.5
Water	0-50	25	40
Air	0-50	25	0
NAPL	0-50	0	0

[1]Vadose Zone





Notes:

Chemicals are associated with physical phases for exposure to receptors.

CSM considers chemicals in association with physical phases, including water, air, NAPL, and subsurface solid phase (soil-solid and aquifer-solid).

One or more physical phases link sources to receptors. Receptors become exposed to chemicals /contaminants through one or more physical phases.

Thinking of phases in terms of a "Mass Balance Approach"

- "Mass Balance Approach" attempts to answer how the chemicals are distributed among physical phases (i.e., air, water, solid, oil)?
- Where are the phases going (release/transport)?
- What are the exposures to phases (risks)?
- Which phases to manage with interim/final Corrective Actions?
- Which phases have the potential to prevent meeting EIs?

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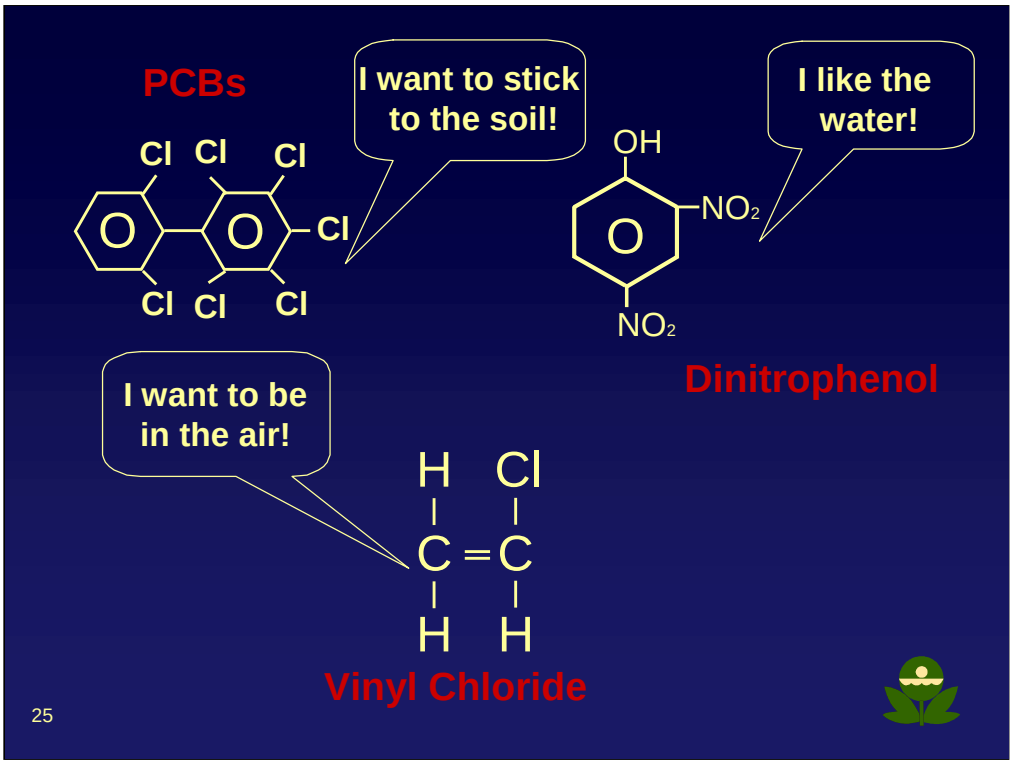
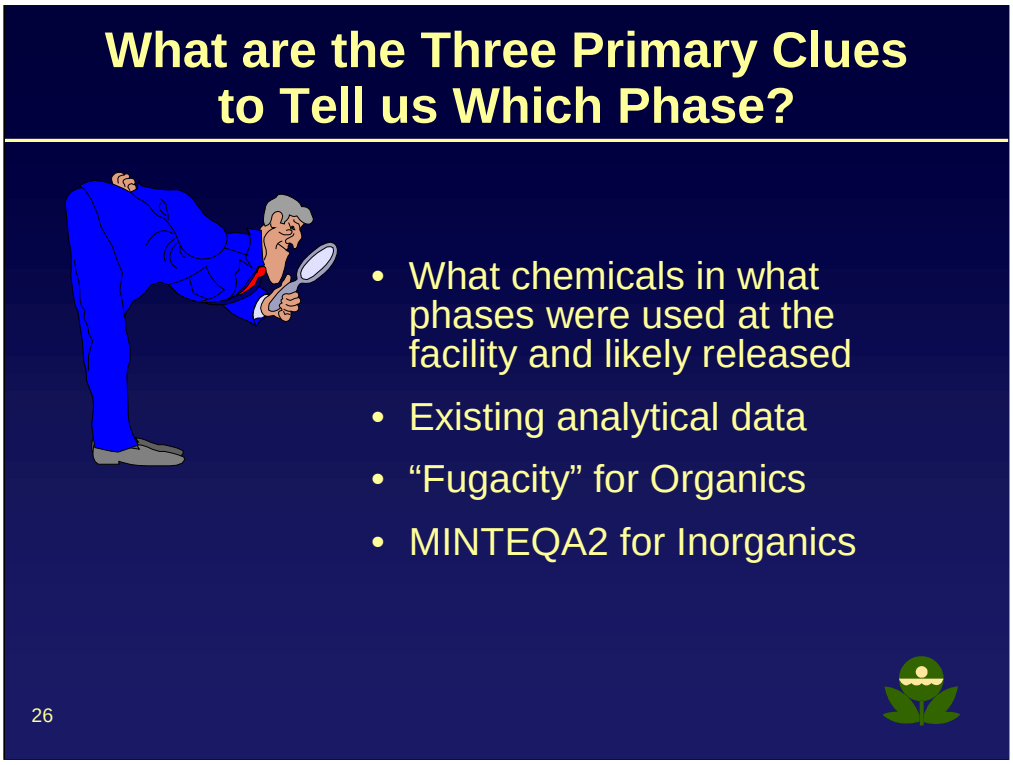
Notes:

Based on a general understanding of the chemicals managed at a facility, we can use a "mass balance" approach to determine which chemical wants to be in which phase. Likewise, the mass balance approach can help determine whether the phases could move and be available for exposure.


PCBs
I want to stick to the soil!
I like the water!
Cl Cl Cl
O O Cl
Cl Cl Cl
OH
NO2
O
NO2
Dinitrophenol
I want to be in the air!
H Cl
C = C
H H
Vinyl Chloride
25



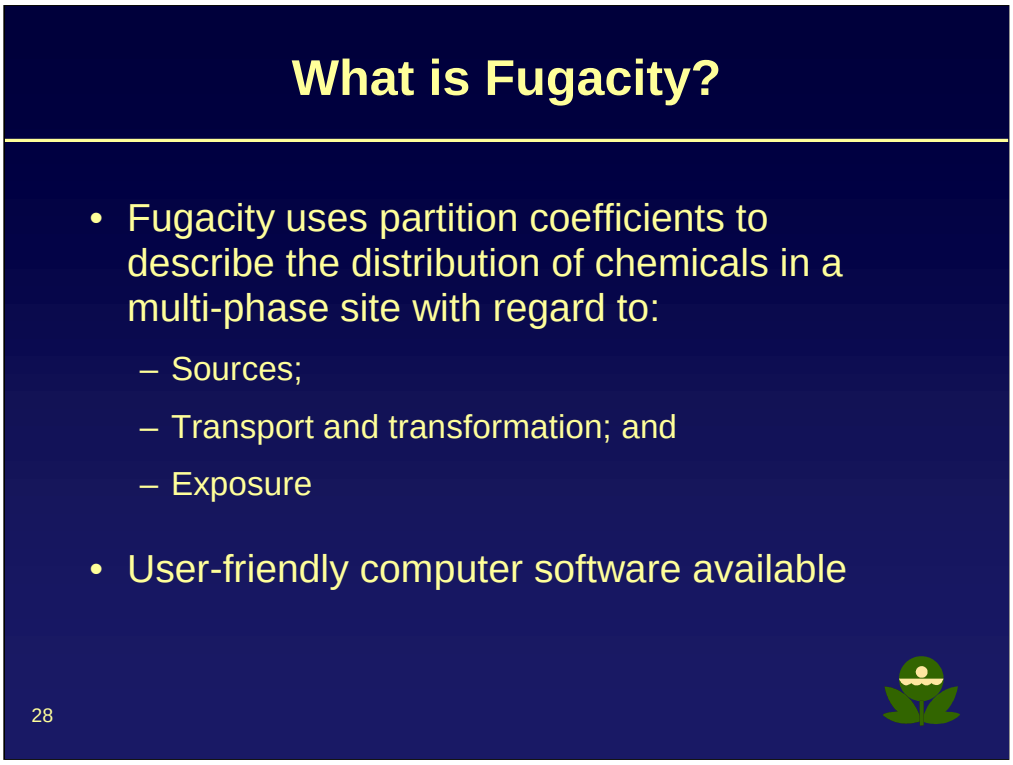
Notes:

Clue 1

A good file review and narrative history will often provide information about the phases of chemicals used and likely released at a facility. For example, processes that would lead one to believe that organics were likely to be mixed in water, as compared to organics being used and likely released as a separate phase, include petroleum wastewaters, MTBE (methyl tert-butyl ether), water soluble herbicides such as 2,4-dichlorophenol, and water soluble chemical feedstocks such as organic acids. Examples of organics likely to be released as a separate phase (NAPL) include chlorinated solvents, fuels, coal tars, etc.

Clue 2

Existing data can be useful in judging the phase of contamination. For example, past data confirming the presence of contaminants in soil gas would also confirm that the contaminant is available for transport and exposure via the air phase. However, existing data isn't always reliable because it depends on a number of factors such as where and how the sample was collected. In general, a positive detection in a phase confirms the chemical's existence and availability for transport and exposure in that phase; but not finding a chemical in a phase does not mean that it is not present in another phase. A potentially common example of this generality is when a certain concentration present in



Notes:

We are spending more time on this third clue because understanding a chemical's inherent properties helps us focus investigations on the most likely problems.

The fugacity tool for conducting a mass-balance analysis is readily available through publications in books, in scientific journal articles, and electronic publication via the internet.

Fugacity

Donald Mackay, Professor of Chemical Engineering at the University of Toronto, Canada, introduced the concept of fugacity in the 1970's to express the distribution of organic pesticides among various phases of the environment. His book *Multimedia Environmental Models - The Fugacity Approach*, 1991, Lewis Publishers, Inc., describes the basis and applications of fugacity for handling chemical reaction, advective flow, and diffusive and nondiffusive transport in multimedia environments.

Fugacity was introduced by G.N. Lewis in 1901 and has been widely used in chemical process calculations. Its convenience in environmental partitioning calculations became apparent only after 1980.

Results of Mass Balance Analysis Using Fugacity

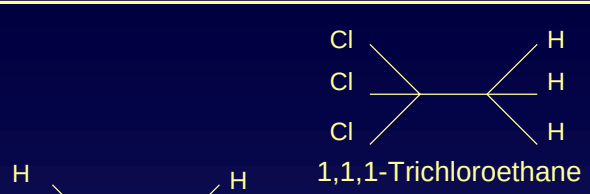
Physical Phase	% Chemical Associated with each Phase
Air	
Aqueous	
Solid	
NAPL	

29

Notes:

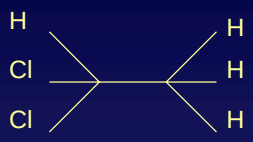
Mass Balance in a Four-Phase Physical System
NAPL, Water, Solid, Gas (Air)

Pathways for the Anaerobic Transformation of TCA



1,1,1-Trichloroethane

TCA

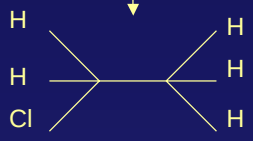


1,1-Dichloroethane

DCA

1,1-Dichloroethene

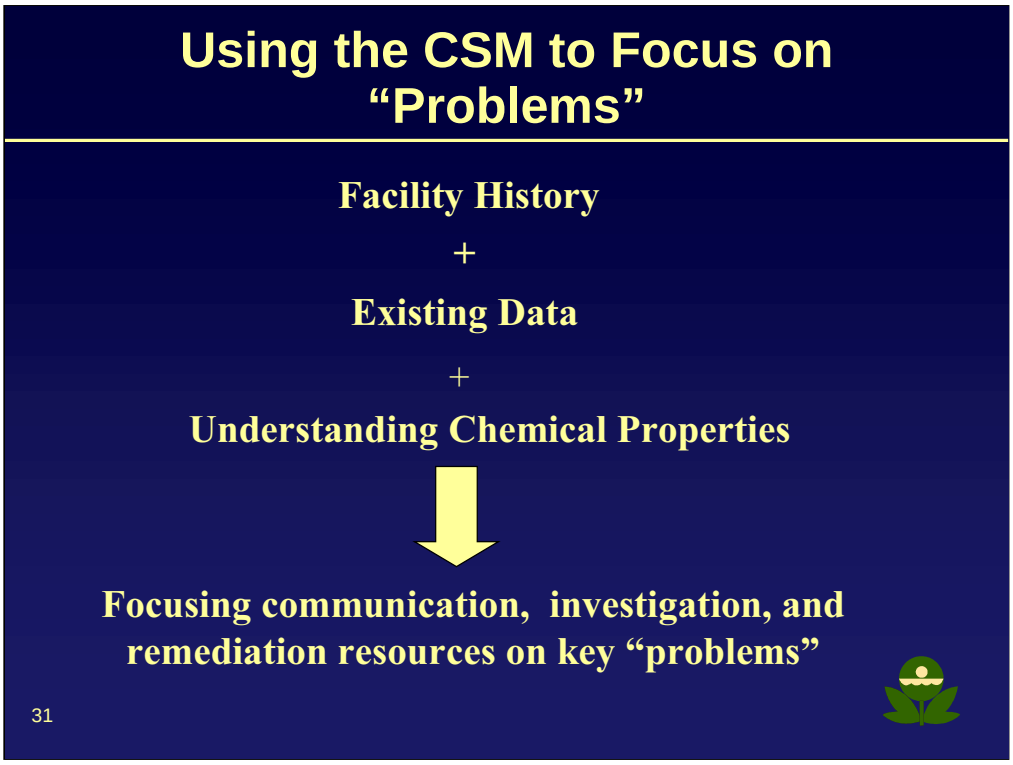
DCE



Chloroethane

CA

30



Notes:

CSM can help focus responses to problems. For example, if a response is needed, decision makers should be asking as early as possible:

What are the most likely responses?

What additional data are needed, if any, to evaluate/select responses?

What is the preferred response that will achieve interim or final Corrective Action results?

Has the response achieved the desired results?

Data Needs Exercise

- Work in small groups to discuss data needs to support EI evaluation (15 minutes)
- Volunteer table report back to large group (5 minutes)

32

Notes:

Use available information from case study and information developed from fugacity exercises to predict the phases of contaminants that could represent a "problem."

Make sure to think of primary sources (i.e., original release location), release mechanism (e.g., leaching, volatilization, etc.), secondary sources (e.g., high concentration areas that represent continued subsurface source), exposure mechanism (e.g., ingestion, inhalation), and actual or potential receptors.

Managing Risks and Uncertainties

Project Managers are also Risk and Uncertainty Managers, and sometimes Risk Assessors, for RCRA Corrective Action Projects

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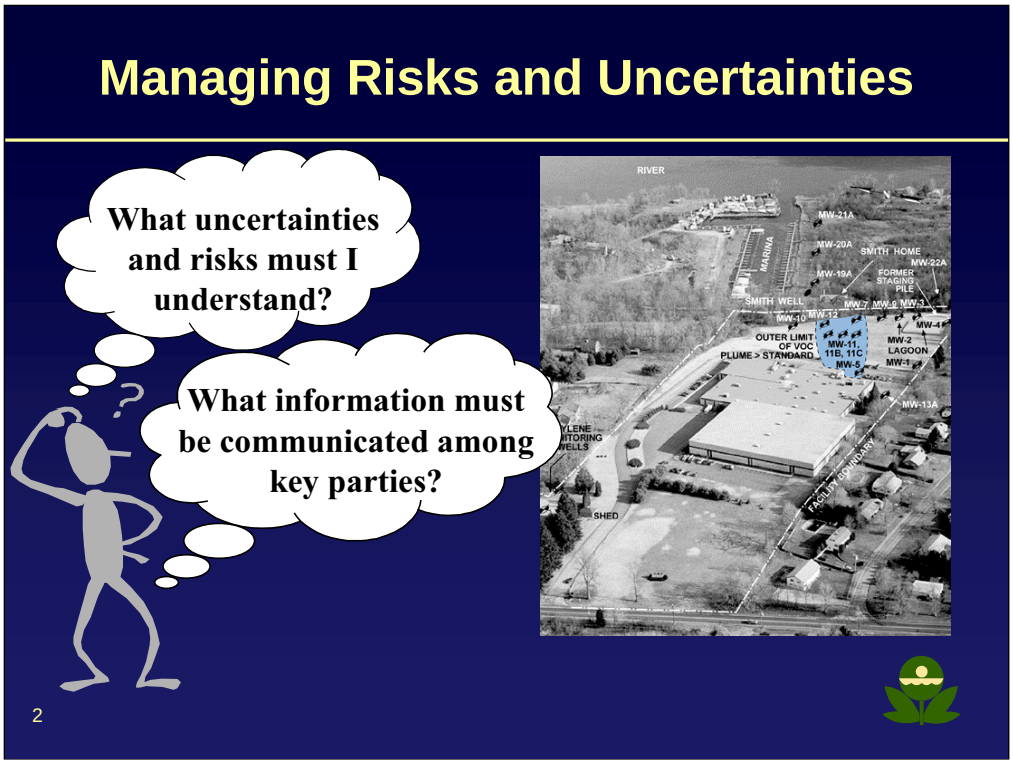


Notes:

Data collection and risk management decisions are often the focus of many corrective action project meetings, discussions, and disagreements.

Data collection and risk management decisions are often best addressed by focusing on three sub-elements:

1. What results need to be achieved and what decisions need to be made to achieve these results?
2. What amount and type of information is needed to make the decision?
3. What tools are available to identify, assess, and manage actual or potential risks?

Objectives

Participants will be able to:

- Understand and use tools to address technical uncertainties that exist in Corrective Action projects
- Define risk-related terminology and describe typical roles and responsibilities of regulators
- Decide the level of risk expertise needed and apply proper tools to assist in risk assessment and risk management activities

3

Notes:

Guidance on uncertainties is found in the reference materials provided for this module.

A list of internet sites with risk assessment and risk management tools also is included on pages 27 and 28.

What are “Uncertainties”?

- Things you do not know and may need to know to make project decisions
- Found in all Corrective Action projects

4

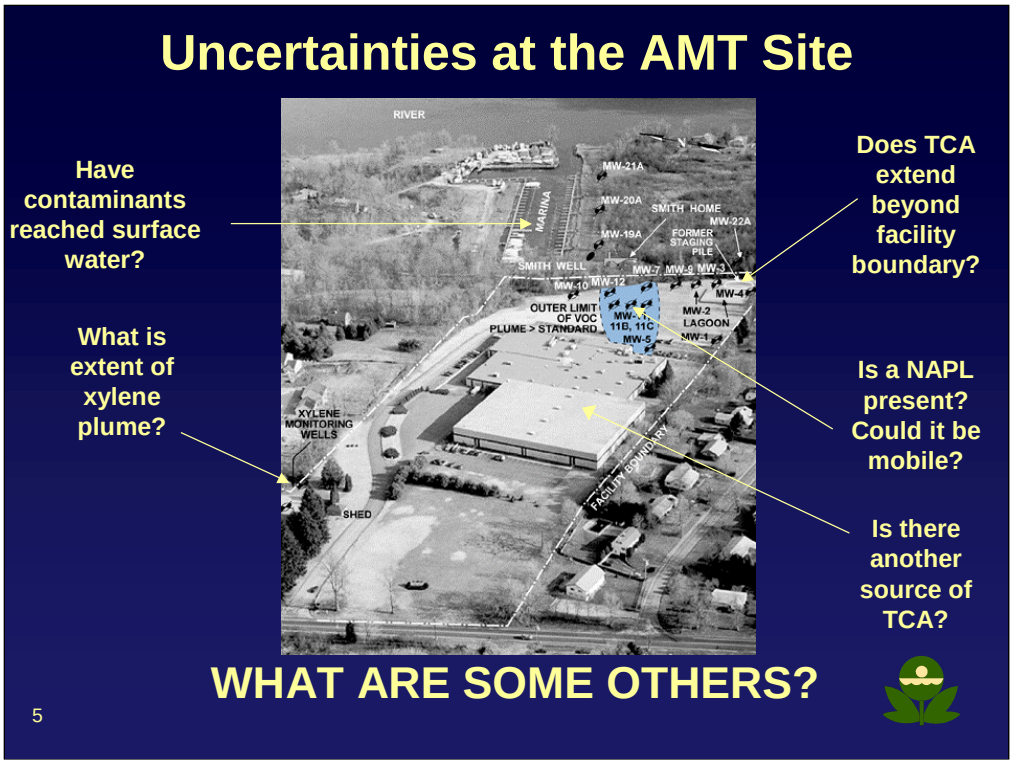
Notes:

Project managers should:

- Identify and understand uncertainties
- Understand whether uncertainties matter for decisions being made at the time
- If they do matter, decide what to do about them
- Communicate the answer

Why do uncertainties matter?

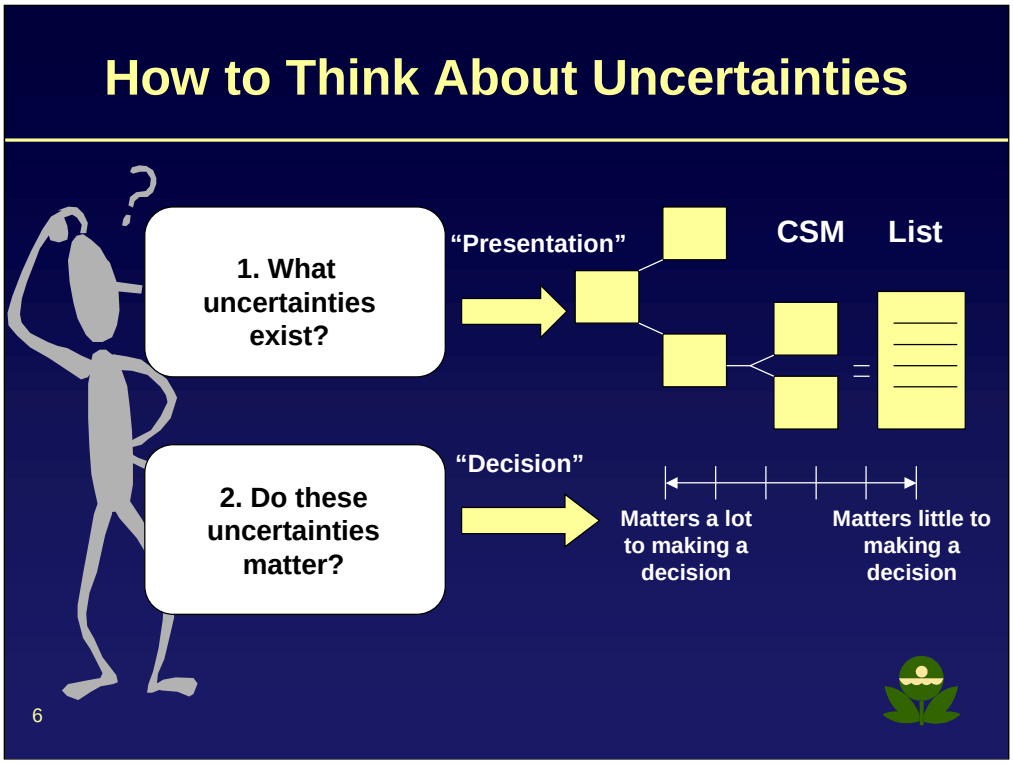
- Often the source of technical disagreements
- Failure to understand them leads to a conclusion that all uncertainties need to be eliminated before project decisions can be made



Notes:

The relevant case study information from the last module helps to understand the nature of these uncertainties:

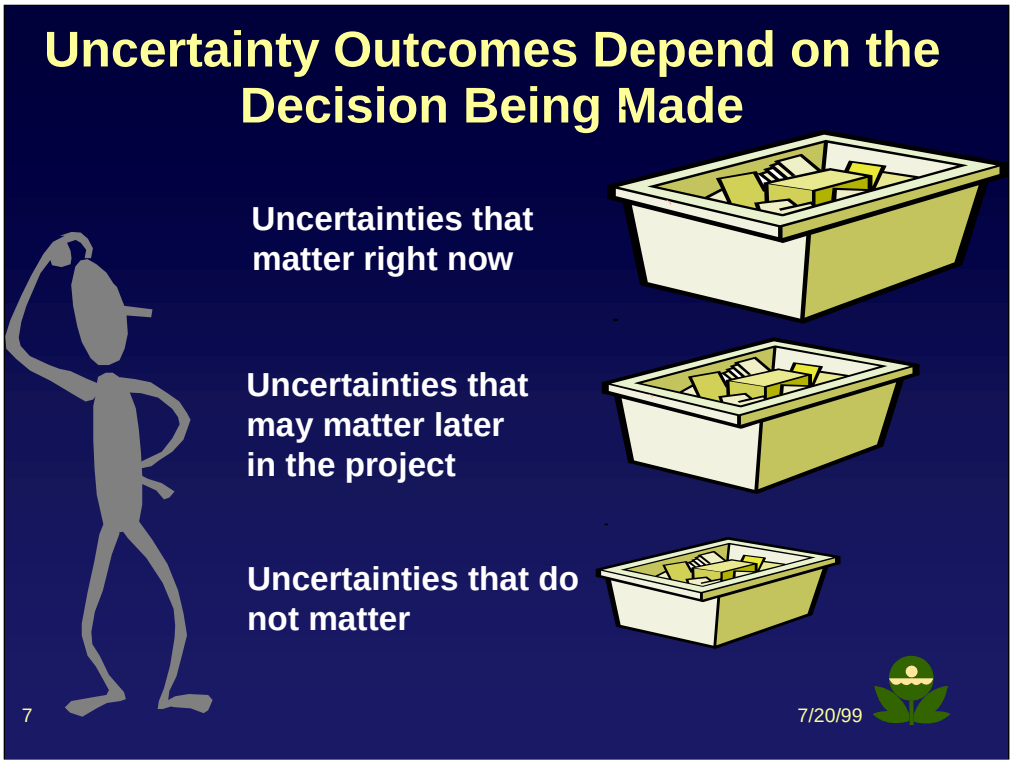
- Contaminants are not currently detected in wells MW 19A-21A nor in the Smith well. Are these results sufficient to conclude that the plume has not reached surface water?
- The monitoring well and borings around the hit of xylene in MW-6A show no migration of xylene. Are these data sufficient to define the extent of the xylene contamination?
- The lateral extent of the TCA plume is inferred from the wells located along the eastern boundary of the property and no detection of TCA at the Smith well. Is this adequate to determine whether the TCA plume extends beyond the boundary?
- MW-13A and 1A may indicate another source of TCA outside of the known plume. Is this significant?
- Fugacity analysis shows TCA, DCA, and DCE can be present as a NAPL. Is it important to know whether a mobile NAPL is present?



Notes:

Identification of uncertainties is a central part of a good Conceptual Site Module. Documentation can be aided by other tools, such as an uncertainty matrix, an example of which is included in the reference fact sheet.

The first decision about how to manage uncertainties relates to their significance given the decision being addressed.



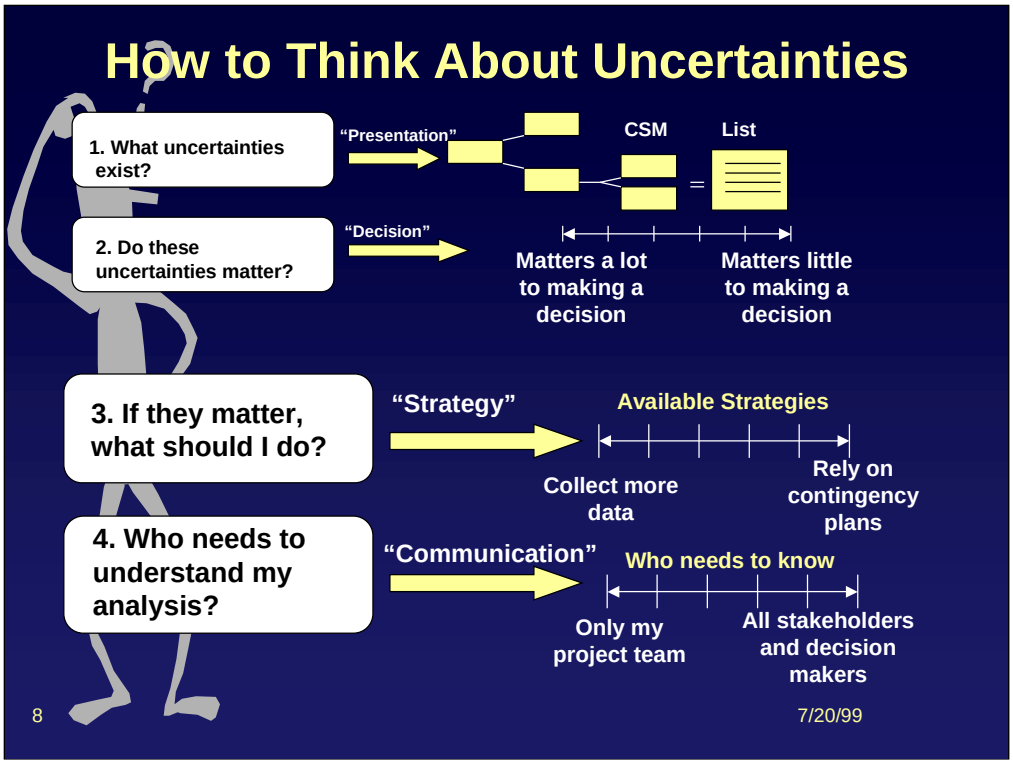
"Significance" of an uncertainty is simply an indicator of how important the uncertainty is to the decision and the management strategy to be considered.

Uncertainties take on significance relative to the decision being made and the timing in the process of that decision. An uncertainty about the viability or long-term effectiveness of a long-term remedy, for example, is less significant (or insignificant) in the context of an environmental indicator determination.

"Significance" is also often an indication of whether additional data collection is needed to reduce or eliminate the uncertainty. It is much less likely that additional data collection is needed for an uncertainty that is insignificant, or for one that can be effectively managed through a contingency plan or additional monitoring.

At any time, uncertainties can be:

- insignificant (although potentially later they will be important)
- significant and need to be reduced or eliminated (e.g., through additional data collection)
- significant but chosen not to be reduced or eliminated, but rather managed in other ways (e.g., contingency planning, additional monitoring)


How to Think About Uncertainties
1. What uncertainties exist?
"Presentation"
CSM
List
=
2. Do these uncertainties matter?
"Decision"
Matters a lot to making a decision
Matters little to making a decision
3. If they matter, what should I do?
"Strategy"
Available Strategies
Collect more data
Rely on contingency plans
4. Who needs to understand my analysis?
"Communication"
Who needs to know
Only my project team
All stakeholders and decision makers
8
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What to do if Uncertainties Matter

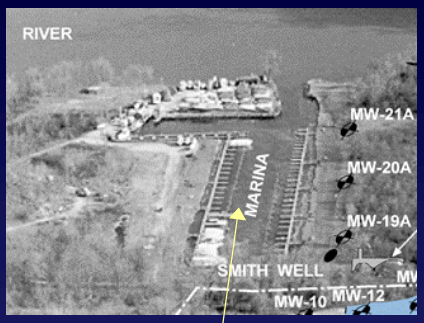
Example:

Are there exposures to residents at the Smith home?

- Options to address this uncertainty:
  - Collect additional data on possible vapors
  - Monitor routinely and develop contingency plan if future sampling shows vapors in home or detects in well
- Communicate decision to appropriate parties

Example #1: Are Contaminants Reaching Surface Water?

- Determination is important for making both the human exposure and groundwater controlled EI determinations
- Known conditions
  - –data from MW-19A - 21A show no detection at entry to marina
  - –sampling at Smith well shows no detection



Have contaminants reached the surface water?

Example #1: Are Contaminants Reaching Surface Water? (cont.)

Have contaminants reached surface water?

- Uncertainty: are current data sufficient to make a decision?
- Available strategies:
  - additional sampling points
  - continue monitoring at current points and develop contingency response if detected

Example #2: Are Vapors from the TCA Release Affecting Workers in the Plant

Are vapors affecting workers?

- Small Group Exercise: Use the uncertainty management matrix to analyze this uncertain condition.

Example # 3: Is a NAPL Present? Could it be Mobile?

Is there a NAPL?

- Is this a significant uncertainty for making an EI determination? For a final remedy?
- What are appropriate uncertainty management strategies?

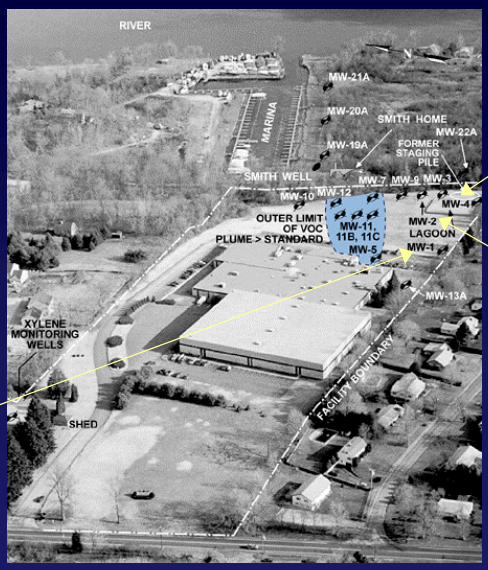
What is Risk?

"RISK" is the likelihood or probability that a given contaminant exposure or series of exposures may damage human health or the environment.

14

Uncertainty and Risk

Does metals contamination in surface soils pose an unacceptable risk?



Is the current TCA management approach an adequate risk management strategy?

Does the TCA plume pose a risk to receptors?

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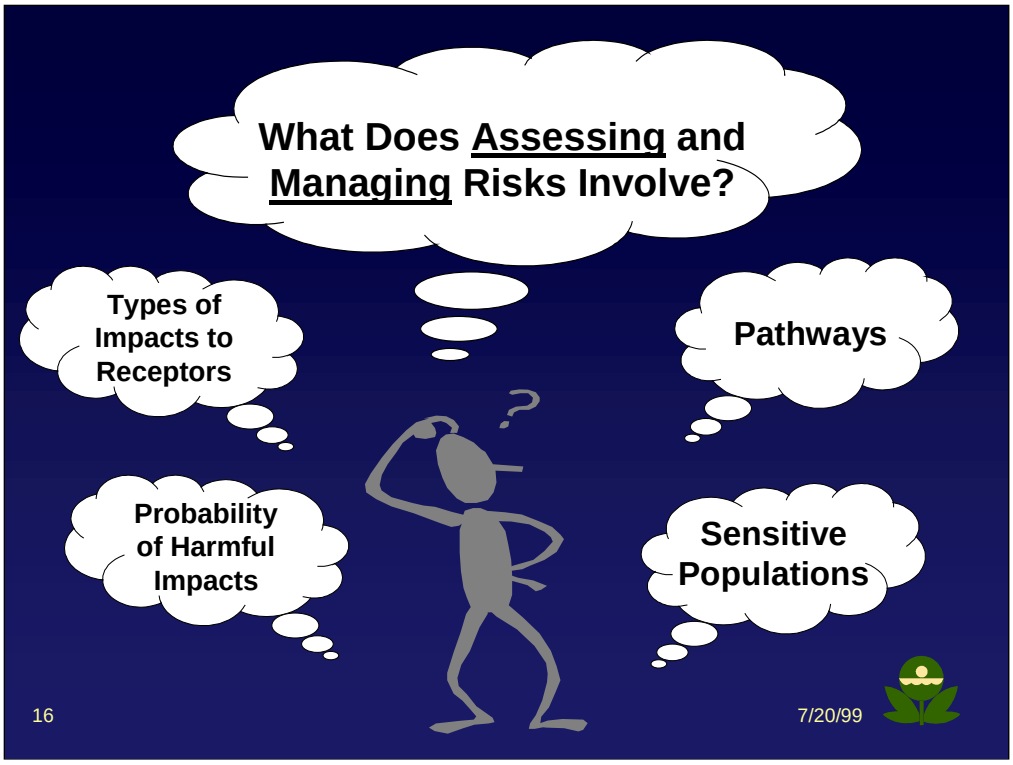

Notes:

Here are some traditional definitions of risk.

Risk is "a measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard."

U.S. EPA Terms of Environment, May 1998

Risk is "the probability of injury, disease, or death under specific circumstances. In quantitative terms, risk is expressed in values ranging from zero (presenting the certainty that harm will not occur) to one (representing the certainty that harm will occur). The following are examples showing the manner in which risk can be expressed: E-4 = a risk of 1/10,000; E-5 = a risk of 1/100,000; E-6 = a risk of 1/1,000,000. Similarly, 1.3E-3 = a risk of 1.3/1,000 =1/770; 8E-3 = a risk of 1/125; and 1.2E-5 = a risk of 1/83,000."

U.S. EPA Glossary of Risk Assessment Related Terms, February 1994

Risk is "the probability of a specific outcome, generally adverse, given a particular set of conditions."

Risk Assessment and Risk Management in Regulatory Decision-Making,
The Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997

Risk is "the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors."

EPA's Proposed Guidelines for Ecological Risk Assessments, September 1996

What are Risk Roles of Regulators?

- Vary among Regions, States, and individuals
- Always risk managers
  - They make decisions (or review owner/operator proposed decisions) regarding risk activities

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Notes:

Regulators also have a role in risk assessment activities (even if it is to verify risk assessment assumptions) before they can make risk management decisions.

Project managers need to realize that many key aspects of Corrective Action are risk activities. For example, setting media cleanup objectives in many cases is a risk-based activity.

Practical examples of the range of activities where regulators may be involved in conducting risk assessment activities include the following:

- Selecting an action level at a site where conditions are consistent with use of those action levels, their assumptions, and the decisions they support.

- Reviewing and recommending modifications to an ecological risk assessment data collection workplan.

- Using a risk assessor's expertise to calculate a media cleanup standard for a given set of pathways affecting a single receptor as illustrated in a conceptual site model.

Notes Continued:

What level of risk expertise is needed?

- Type of expertise varies with site conditions and decisions that need to be made
- Standardized tools can help project managers review or make risk assessment or risk management decisions

Some situations support a straightforward risk evaluation. For example, where:

- a single contaminant is the primary driver
- toxicity information is available
- fate and transport to receptors are well understood
- standard exposure pathways exist

Many situations will warrant more consultation or involvement of trained risk assessors. Examples include:

- Multiple contaminants could have synergistic effects
- Controversial chemicals pose issues (e.g., dioxins)
- No standardized toxicity information exists for human or environmental receptors

Other examples of situations that typically warrant more consultation or involvement of trained risk assessors may include:

- Unusual pathways (e.g. subsistence fishing) are present
- Level designed to be protective of humans does not address impacts to ecological receptors

Notes:

No single set of rules will determine when or how much to involve risk assessors.

- Recognize that owners/operators often use formal techniques and risk assessors in their work

Use the tools that follow to help define general conditions or tasks where more or less regulator risk assessor involvement may be helpful

Let's Make a Risk Decision!, cont.

5. What ecological impacts may exist?

6. What is owner/operator's expertise and approach?

7. Are data available/usable to make risk decision?

Project Manager

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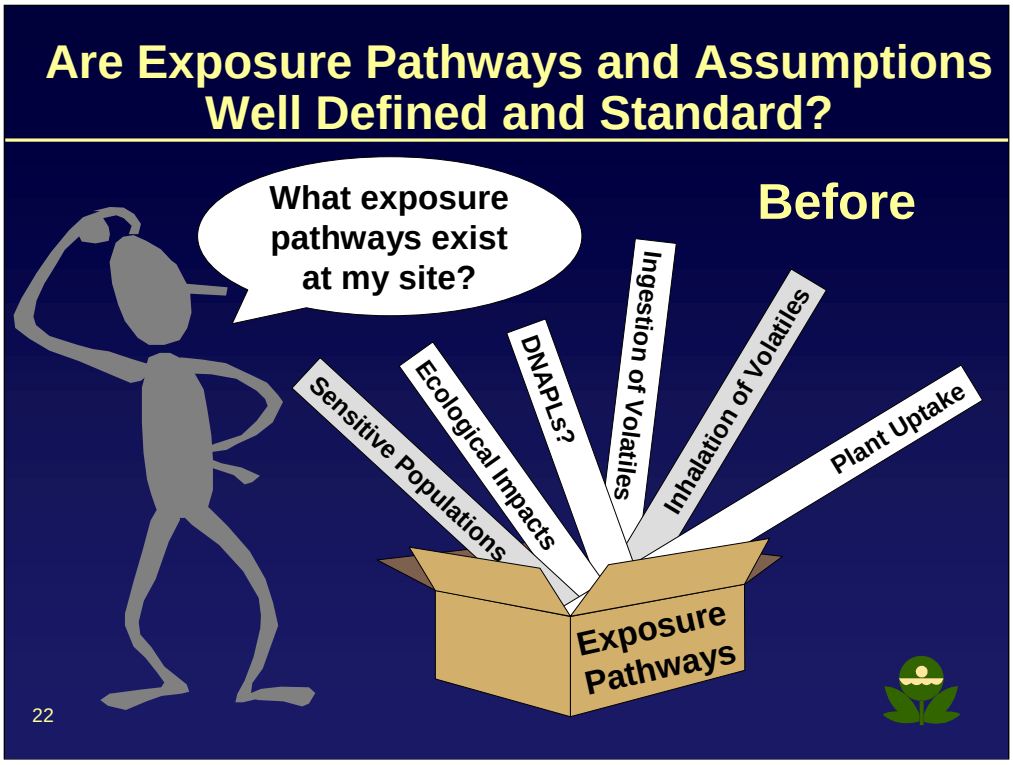
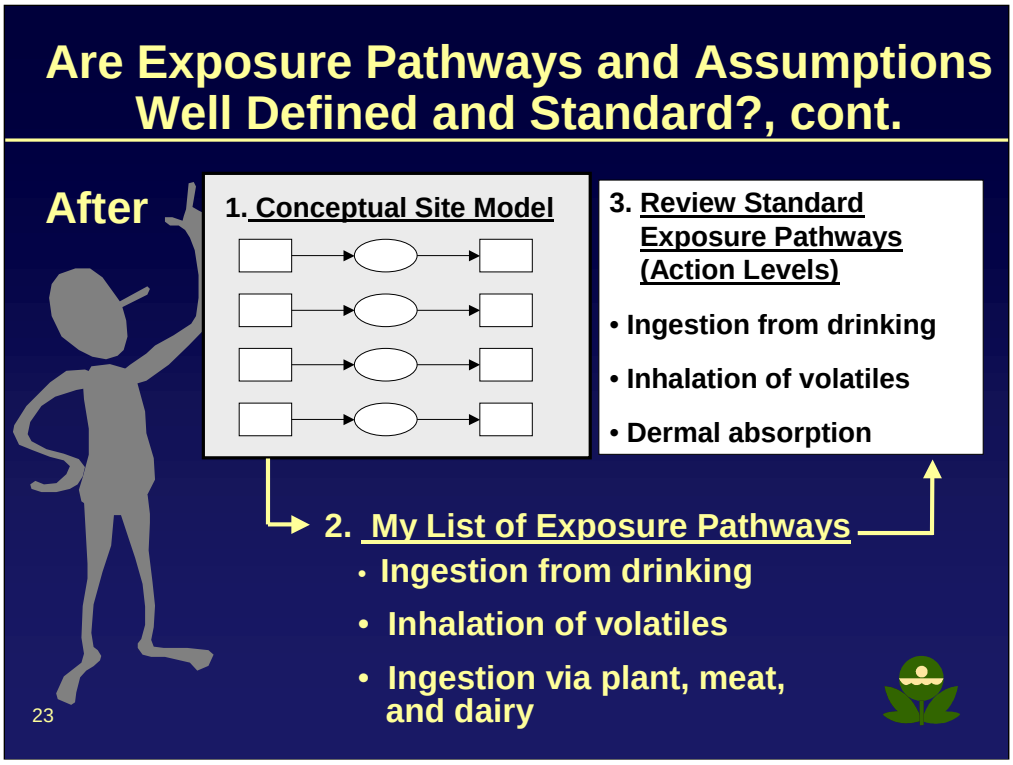
Let's Make a Risk Decision!, cont.
What door do I pick?
Newer Project Manager Has the Risk Expertise
Door #1
"It works often at many sites…"
Experienced Project Manager With Some Risk Expertise
Door #2
"I can help with risk too…"
Professional Risk Assessment
Door #3
"Help's always available (if you can find me)…"
Are there unique site issues that require a risk professional?
What is my level of expertise?
Project Manager
21



Notes:

- Guidance of defining pathways and assumptions can be found in *Soil Screening Guidance: Fact Sheet,* Publication 9355.4-14FSA, July 1996, and *Soil Screening Guidance: User's Guide,* Publication 9355.4-23, July 1996.

- Pathways addressed by SSLs for residential scenarios include:
  1. Direct ingestion;
  2. Inhalation of volatiles and fugitive dusts;
  3. Ingestion of contaminated groundwater caused by migration of chemicals through soil to an underlying potable aquifer;
  4. Dermal absorption;
  5. Ingestion of homegrown produce that has been contaminated via plant uptake; and
  6. Migration of volatiles into basements.



Notes:

- Pathways addressed by action levels may differ, as can the standard assumptions that underlie their use.

- Action levels such as SSLs still are based on the reasonable maximum exposure (RME) concept. Although they may correspond to a 1 x 10^{-6} risk for carcinogens and a hazard quotient of 1 for noncarcinogens, some uses of action levels may be based on other levels depending on assumptions and uses.

- Action levels for ecological impacts are also available under some circumstances (see tools on pages 27-28).

What Type of Risk-Related Decision Am I Making?

	Near-Term Priorities	
Risk decisions	Screening to Determine if Problem Exists	Evaluating if Environmental Indicators are Met
Some obvious starting points	EPA, Region, or State action levels (if applicable)	EPA Environmental Indicator Guidance
Do I need help from a risk professional?	May or may not involve risk professional depending on site circumstances	EI Module of this course evaluates this in detail

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What Type of Risk-Related Decision Am I Making?, cont.

	Ultimate Long-Term Objectives	
Risk decisions	Setting Final Cleanup Standards for Human/Ecological Receptors	Evaluating if Final Cleanup has been Achieved
Some obvious starting points	EPA Program Expectations for Final Remedies	
Do I need help from a risk professional?	May or may not involve risk professional	Seldom needed if standards clearly defined

Risk Assessment and Risk Assessment Tools:

Risk Assessment Guidance for Superfund, Volumes 1-3, EPA/540/1-89/001-004, March 1989 (www.epa.gov/cgi-bin/claritbw?op-Display&Document=clserv:epa-cinn:5561;&rank=4&template=epa)

Risk Assessment Guidance for Superfund (RAGS), Part D, (www.epa.gov/superfund/resources) - a standardized approach for assessing, documenting, and communicating risk assessment activities for hazardous waste sites

Soil Screening Guidance: Fact Sheet (www.epa.gov/superfund/resources) - an approach to using action levels for making risk decisions at hazardous waste sites

ECOTOX (www.epa.gov/superfund/resources) - software for evaluating ecological toxicity thresholds at hazardous waste sites

Risk Assessment and Risk Assessment Tools (cont.)

Center for Risk Excellence, compendium of risk assessment and risk management tools (http://riskcenter.doe.gov/cre) - links to software, databases, and other tools for risk professionals, including an on-line calculator for action levels

Regional and State Action Level Policies. For example, EPA Region IX Preliminary Remediation Goals (www.epa.gov/region09/waste/sfund/prg)

Risk Management Plan Data Elements, EPA/550/3-96/012, May 1996 (www.epa.gov/clhtml/pubalpha.html)

Integrated Risk Information System (IRIS), (www.epa.gov/iris) - toxicity information for contaminants

American Society for Testing and Materials, Risk-Based Corrective Action (www.ucop.edu/facil/eps/astm.html) - information on the use of risk-based Corrective Action concepts as developed by ASTM

Elements to Consider When Drafting EPA Risk Characterizations, March 1995 (www.epa.gov/ORD/spc/rcelemen.html)

Tool for Evaluating Risk Expertise

	Element	
Most EIs, some screening and final cleanup decisions	Type of Risk Decision	Many final cleanup decisions, some EIs/ screening decisions
Action level available	Standard tool available and applicable	No standard tool applicable
Standard pathways exist	Exposure pathways/ assumptions well defined and standard	Several nonstandard pathways present
Common, well-understood contaminants are present	Toxicity information for contaminants accessible and easily used	Several contaminants with synergetic effects or no toxicity data
Few ecological impacts	Ecological impacts exist	Substantial potential ecological impacts
Relies on standard tools or easily understood assumptions	Expertise and approach of owner/operator	Relies on professional risk assessor/uses nonstandard assumptions
Data are readily available and usable	Data available and usable to make a risk decision	Data are not currently available

Simpler — Risk Guidance Available and Generally Limited Help is Needed

May Need Some Assistance on Risk Issues

More Complex — Generally Need Assistance of a Risk Professional

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Conceptual Site Model
(Part III)

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

CSM Module Objectives (Part III)

Participants will:

- practice using a publicly available computerized “Site Conceptual Exposure Model Builder” to visually capture environmental conditions for the case study

2

SCEM Exercise

- Working with the instructor and via large group interaction, build a computerized SCEM CSM at the laptop at your table.

3

Recent Developments in Innovative Treatment Technologies

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

Module Objectives

Participants will:

- Be provided an overview of several Innovative Treatment Technologies
  - Monitored natural attenuation;
  - Passive treatment walls;
  - Vapor extraction;
  - Bioventing;
  - Phytoremediation;

2

Module Objectives, (Cont'd)…

- Soil washing;
- Solvent extraction; and
- Non-aqueous phase Liquid (NAPL) recovery

- Be provided an overview of EPA policies associated with natural attenuation

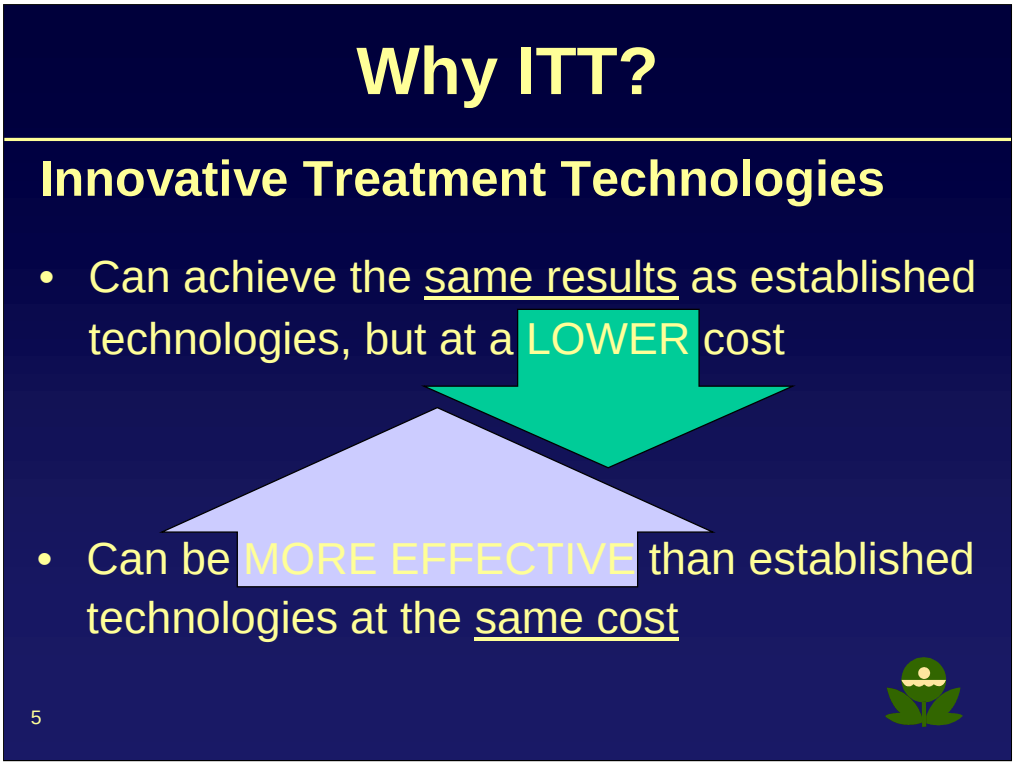
3

Exercise for Application of ITT to Case Study Site

With the case study as context for this exercise, evaluate the Innovative Treatment Technologies we have discussed.

List “pros” and “cons” for each ITT; and, identify information needs, where appropriate, in order to determine applicability for each ITT.

4



Notes:

A course on Innovative Technologies is sponsored by the Technology Innovation Office (TIO) in the Office of Solid Waste and Emergency Response (OSWER), U.S. Environmental Protection Agency (EPA), and by EPA's Office of Research and Development (ORD). Its purpose is to enhance the ability of participants to consider innovative treatment technologies as cost-effective alternatives to conventional technologies.

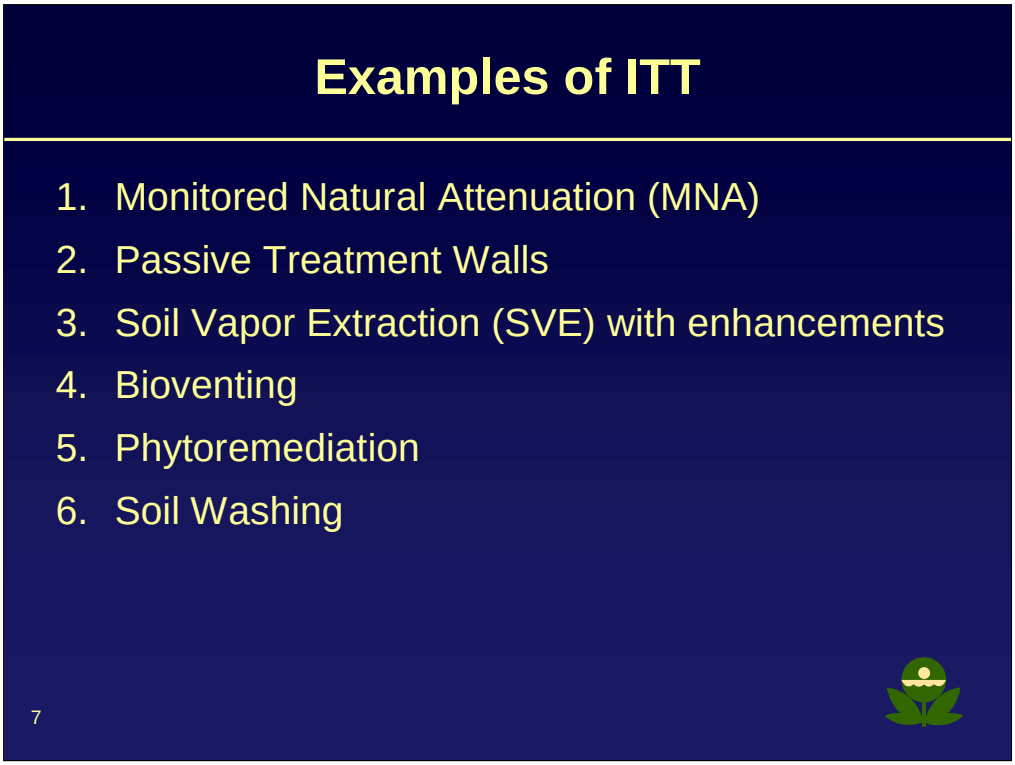
For additional information, please reference the following URL:

http://www.epa.gov/swertio1/index.htm

General Features of ITT

- Lack full-scale cost and performance data
- May be new technologies or new applications of existing technologies
- Generally do not include:
  - incineration
  - ex situ solidification and stabilization
  - pump-and-treat systems

6



Notes:

Additional Innovative Treatment Technologies addressed in the course sponsored by TIO include:

<u>Thermal, Physical, and Chemical Technologies</u>

- Thermal desorption
- Soil flushing and surfactant enhancements
- Soil washing and Solvent extraction
- Electrokinetic remediation
- Chemical oxidation

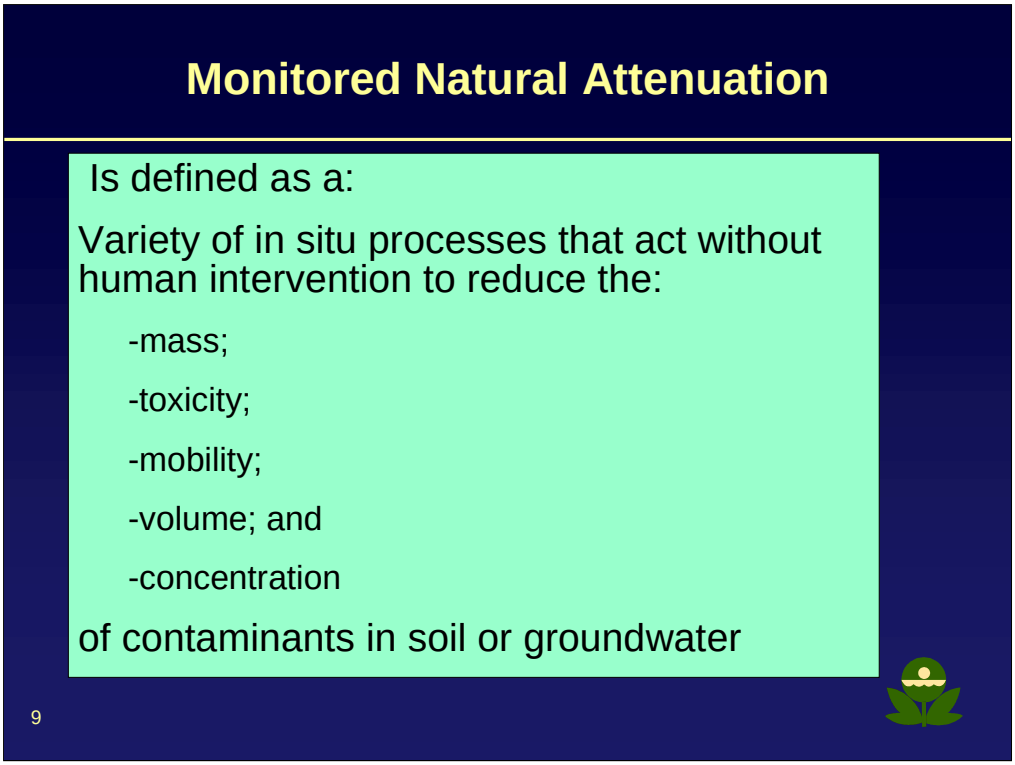
<u>Bioremediation Technologies</u>

- Solid-phase bioremediation
- Bioslurping
- Enhanced in situ groundwater remediation

Examples of ITT (Cont'd)…

7. Solvent Extraction
8. In-Situ Oxidation
9. Enhanced In-Situ Bioremediation of Groundwater
10. NAPL Recovery
    - Bioslurping
    - Gravity
    - Surfactant and Cosolvent Flushing
    - Six Phase Heating
    - Dynamic Underground Stripping

8



Notes:

The term "monitored natural attenuation" refers to the reliance on natural attenuation processes, within the context of a carefully monitored site cleanup program, to achieve site-specific remedial objectives within a timeframe that is reasonable when compared with other more active methods.

In situ natural attenuation processes include:

-biodegradation

-sorption

-dispersion

-volatilization

-dilution

-chemical transformation

Reference: Monitored Natural Attenuation Final Policy OSWER Directive 9200.4-17P, dated April 21, 1999, EPA document number EPA-540-R-99-009. Hardcopy available in Workshop Toolbook. The document also can be downloaded from the EPA web site at: www.epa.gov/swerust1/directive/d9200417.html

MNA Demonstration Through Site Characterization

1. Historical groundwater and/or soil data demonstrate declining trend in concentrations
2. Geological and/or geochemical data demonstrate natural attenuation processes and rates
3. Field or microcosm studies

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Notes:

Unless #1 is of sufficient quality and duration, #2 and possibly #3 will be required.

Historical data may include soil, groundwater, air, and NAPL phases, and three-dimensional profiles of contaminant concentration changes with time. Once it is known what chemicals and phases were used at the site, the Conceptual Site Model approach may be useful to evaluate chemical distribution among physical phases at the site as part of a monitoring program. Fugacity is one tool for evaluating the distribution of chemicals among physical phases at the site.

Geochemical data includes changes in concentrations of oxygen, iron, nitrate, sulfate, manganese, and methane (terminal electron acceptors).

Field or microcosm studies involve demonstration of biodegradation using site samples with naturally occurring microbial populations. Mineralization studies may be conducted to show biodegradation to CO_2, transformation intermediates may be characterized, and toxicity tests may be used to demonstrate decrease in toxicity. Poisoned control microcosms are used to separate abiotic chemical transformation from biological transformation.

Field-Scale Evaluation of MNA

1. Determine if natural attenuation is occurring using geochemical data
2. Determine groundwater flow and solute transport
3. Locate sources, releases, and receptors
4. Estimate the rate of natural attenuation
5. Compare the rate of transport to the rate of attenuation
6. Compare conditions at point of discharge to acceptable criteria

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Notes:

1. Geochemcial data refers to use of oxygen, iron, nitrate, manganese, sulfate, and carbon dioxide by microorganisms to degrade organic contaminants. Decreases in concentration may indicate use by microorganisms, and therefore add evidence for biodegradation.

2. Groundwater flow and solute transport data are used to determine the rate of transport of the target contaminants taking into account the influence of dilution, sorption, dispersion, and volatilization.

3. Sources, releases, and receptors are identified as part of the Conceptual Site Model and Environmental Indicators evaluation. The absence of contamination in a downgradient well means nothing until it is demonstrated that the downgraident well is in a flow path from the source of contamination. The absence of evidence is not the evidence of absence.

4. Rate of natural attenuation using first order rate kinetic approach is used in the model Bioscreen to evaluate natural attenuation, and has been found appropriate for a variety of sites.

5. Compare rate of transport of target chemicals (plume) to rate of attenuation to determine if plume is expanding or contracting. Can use this information in the evaluation of Environmental Indicators.

6. Are conditions at the point of discharge protective of public health and the environment? Does discharge meet regulatory criteria?

Use of Monitoring Wells in Determination of Natural Attenuation

The absence of evidence is <u>NOT</u> evidence of absence

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Notes:

The absence of contamination in a downgradient monitoring wells means nothing until it is demonstrated that the downgradient well is in a flow path from the source of contamination.

Final EPA Directive 9200.4-17P

- Title: "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites"
- Signed on April 21, 1999
- Available at: www.epa.gov/swerust1/directiv/d9200417.htm
- Hard copy also available in Workshop CD

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Notes:

Directive signed by Acting Assistant Administrator, and Directive cover memo signed by EPA Directors from the Office of Solid Waste (RCRA Corrective Action), Office of Emergency and Remedial Response (Superfund), Office of Underground Storage Tanks, Federal Facilities Restoration and Reuse Office, and Technology Innovation Office. Sign-off by these Directors reflects the cross-program coordinated effort that went into the development of the Directive.

Cover memo also includes names and phone numbers of EPA Headquarters, Regional and Office of Research and Development (ORD) contacts representing Superfund, RCRA, and UST programs.

What is the Purpose of Directive?

- Clarifies EPA's policies regarding use of MNA for soils and groundwater
- Appropriate to use as guidance for developing, evaluating, and approving MNA remedies
- Not intended to be detailed technical guidance
- Does not scale back EPA goals for remediation of soils or groundwater

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Notes:

While the directive does not focus in detail on technical aspects of MNA remedies, it does provide an extensive list of references for users to pursue technical guidance.

"EPA remains fully committed to its goals of protecting human health and the environment by remediating contaminated soils, restoring contaminated groundwaters to their beneficial uses, preventing migration of contaminant plumes, and protecting groundwaters and other environmental resources," - EPA Directive 7200.4-17P, page 1.

Definition of MNA in Directive

"The term 'monitored natural attenuation' refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) **to achieve site-specific remediation objectives** within a time frame that is reasonable compared to that offered by other more active methods."

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Notes:

The Directive continues with the following statement regarding natural attenuation processes:

"The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biologic processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include: biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants."

Provides Useful Background Information Dealing With...

- Contaminants of concern, including transformation products
- Specific characteristics associated with MNA for petroluem-related contaminants, chlorinated solvents, and inorganics
- Cross-media transfer of contaminants
- Advantages and disadvantages of MNA

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Notes:

The Directive cautions those considering MNA to recognize that while some (perhaps the more obvious) contaminants may be attenuating, other (perhaps less obvious) contaminants may be resistant to attenuation processes. For example, those considering MNA for gasoline often focus on the benzene, toluene, ethylbenzene, and xylene (BTEX) component, which has been found in a significant number of settings to attenuate sufficiently to afford adequate protection. However, a common additive to gasoline, methyl tertiary-butyl ether (MTBE), has been found to migrate significant distances and threaten down-gradient water supplies in the same settings where the BTEX component of the plume has stabilized or diminished due to MNA.

MNA remedies, involving cross-media transfer of contamination, should include a site-specific evaluation of the potential risks posed by the contaminant(s) once transferred to a particular medium. The Directive states EPA's preference for MNA remedies that rely more on those processes that destroy or degrade contaminants rather than just transfer them from one medium to another.

Guidance Deals With Topics Including...

- Role of MNA in EPA cleanup programs
- Demonstrating the efficacy of MNA
- Sites where MNA may be appropriate
- Reasonable timeframe
- Remediation of sources
- Performance monitoring
- Contingency remedies

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Some Major Messages

- MNA is appropriate at many, **but NOT all, sites**
- MNA is not a **walk-away, no-action, or presumptive** remedy
- MNA needs to be **technically** justified by the proponent
- MNA needs to address all contaminants of concern, **not just most obvious**

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Some Major Messages (Cont'd)...

- MNA used typically with other **"active"** measures, especially those focused on **sources**
- MNA is **most** appropriate for groundwater where plume is **already stable or shinking** (i.e., where plume is not migrating)
- MNA should be able to **achieve objectives in a reasonable timeframe**

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Notes:

Determining what is a reasonable timeframe should be a site-specific decision; however, the Directive recommends that the following factors be considered when evaluating the "reasonableness" of a proposed timeframe associated with an MNA remedy:

- Current as well as future use of the affected resource;
- Relative timeframe in which the aquifer may be needed;
- Subsurface conditions and plume stability, which can change over an extended timeframe;
- Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources;
- Uncertainties regarding the mass of contamination in the subsurface and predictive analyses;
- Reliability of monitoring and institutional controls over long periods;
- Public acceptance of the timeframe likely needed to reach objectives; and
- Availability of adequate funding of monitoring over the expected timeframe.

Some Major Messages (Cont'd)...

- Progress should be **carefully monitored**
- **Contingency measures** should be included when MNA is selected based mostly on predictive analysis
- A cleanup is **not** completed until **cleanup objectives** set by implementing Agency **have been achieved**

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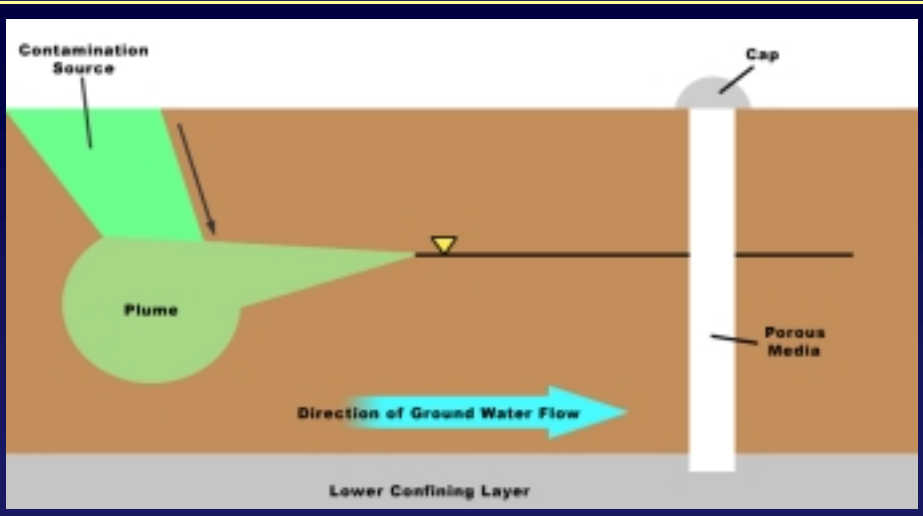
Passive Treatment Walls



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Notes:

An in situ permeable reactive wall is installed downgradient of a groundwater containment plume. The wall will intercept and react with contaminated groundwater. The process represents a low-cost, low-maintenance, remedial alternative for groundwater treatment.

The barrier material consists of a reactive medium that will degrade or retain the containment plume. Construction specifications for the barrier are based on the retention time required for specific contaminants.

Some reactive walls containing zero valent iron have been used to dechlorinate solvents dissolved in groundwater such as trichloroethylene and dichloroethylene.

Passive Wall Process Components

- Reactive media
  - zero valent metals (for example, iron filings)
  - chelators
  - sorbent materials (for example, activated carbon)
  - oxygen releasing compounds (ORC)
- Vertical barrier and "funnel and gate" components

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Notes:

Passive walls use reactive media to treat contaminant plumes. Such media have included:

-zero valent metals to treat halogenated compounds

-chelators to treat metals

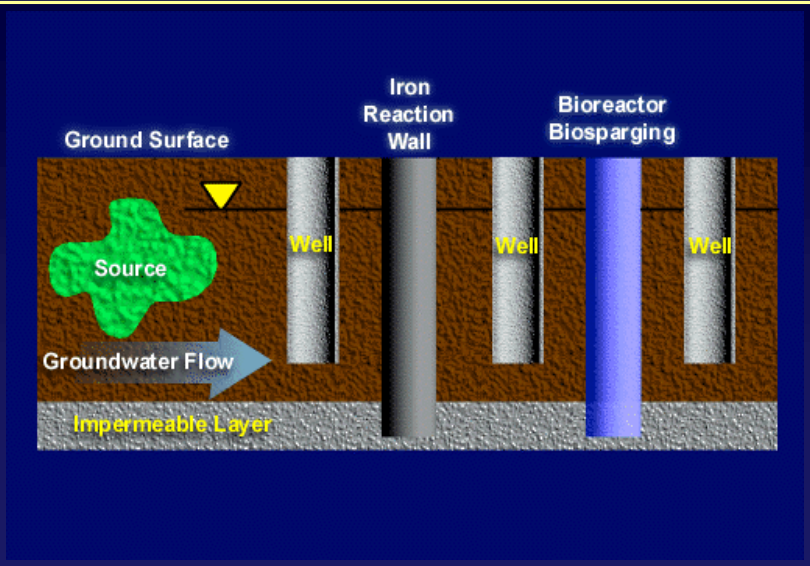
-sorbent materials

-gravel or other porous media through which air is sparged

Design and construction techniques for vertical barrier walls are used to "key" the treatment wall into the aquitard or lower confining layer.

Engineered fill materials commonly are used to construct "funnel and gate" systems to direct groundwater through a relatively impermeable funnel to the permeable and reactive wall (gate), reducing the amount of reactive media needed. The low-permeability funnel is typically constructed of sheet piling or soil-bentonite. Low-permeability capping material, such as concrete or bentonite, is recommended to cover and protect the wall and limit surface infiltration.

Example Process of Using Passive Treatment Walls



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Notes:

Reactive walls may be staged in series to remediate different types of contaminants consecutively or to provide secondary or further treatment. For example, in the illustration above an iron reactive wall could dechlorinate chlorinated hydrocarbons. The resulting hydrocarbon plume could be bioremediated by introducing oxygen. The oxygen could be introduced, for example, through using oxygen-releasing compounds or by sparging with air. The extent and rate of treatment would be monitored through a series of groundwater monitoring wells.

Applications of Passive Treatment Walls

- Contaminated groundwater in shallow contained aquifers
- Organic and inorganic substances
- High concentrations of contaminants

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Notes:

To ensure capture of the contaminant plume, the contaminated water-bearing zone should be isotropic and have a laterally contiguous confining unit. It is important to have site characterization data on groundwater flow rate and direction, hydraulic conductivity, and integrity of the confining layer.

Volatile chlorinated hydrocarbons are easily degraded using iron filings. Sorptive media, such as granular activated carbon (GAC), can treat petroleum hydrocarbons, chlorinated hydrocarbons, and SVOCs. Oxygen-releasing compounds can effectively promote the bioremediation of petroleum hydrocarbons. Research also has been done to demonstrate aerobic co-metabolism of chlorinated solvents. Selected metals such as chromium have been treated in the dissolved phase and converted to less toxic and less mobile valence states.

Concentrations of contaminants generally are not a limiting factor. The size of the contaminant plume and retention time required within the reactive medium dictate the thickness of the wall. Dense nonaqueous phase liquids (DNAPLs), if present, could exhaust or migrate through the permeable treatment media.

Advantages of Passive Treatment Walls

- Effective in meeting contaminant reduction goals
- Minimal Operation and Maintenance (O&M) requirements
- Effective in both high- and low-permeability soils

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Notes:

Passive treatment walls are an in situ technology that leaves little or no treatment residuals. Pilot and full-scale projects have shown excellent results in the treatment of volatile organic compounds (VOCs), including perchloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride (VC).

Operation and Maintenance (O&M) requirements for the wall itself are minimal. Monitoring requirements vary according to the specifications of the regulatory authority.

Unlike pump-and-treat systems, SVE, or air sparging, which work best in high permeability soils, passive treatment walls can work well in low- permeability soils as well.

Limitations of Passive Treatment Walls

- Need contiguous confining layer
- Reactive media may lose reactive capacity in time
- Sorptive media must be replaced periodically
- Biofouling may occur
- Chemical precipitation of dissolved solids may occur
- May not be cost-effective for deep confining layers
- Thorough groundwater modeling is essential

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Notes:

Subsurface characteristics can be limiting. The medium must have a contiguous confining layer into which the wall can be keyed.

Reactive media may lose reactive capacity over time. The medium must be replaced periodically as sorptive sites become saturated.

Biofouling of the medium can occur in the presence of naturally occurring microbial activity and limit the chemical reactivity of the medium.

Depth to the confining layer affects cost. Sheet piling can be used to place barriers inexpensively to depth of about 30 feet. A backhoe and slurry can be used to reach depths of about 50 feet, and a clamshell or longstick backhoe can reach a depth of about 80 feet. However, at depths greater than 30 feet, placement costs increase exponentially.

Groundwater modeling is essential to ensure capture of the plume and adequate retention time in the wall. Funnel and gate systems alter groundwater flow patterns.

Soil Vapor Extraction (SVE) with Enhancements

- SVE is a physical separation technique that volatilizes and recovers contaminants from the soil
- SVE processes include:
  - air sparging
  - directional drilling

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Notes:

SVE is an in situ process that removes volatile organic compounds (VOCs) from the vadose zone by application of vacuum through a system of extraction wells placed in the unsaturated zone.

SVE is known by several other names:

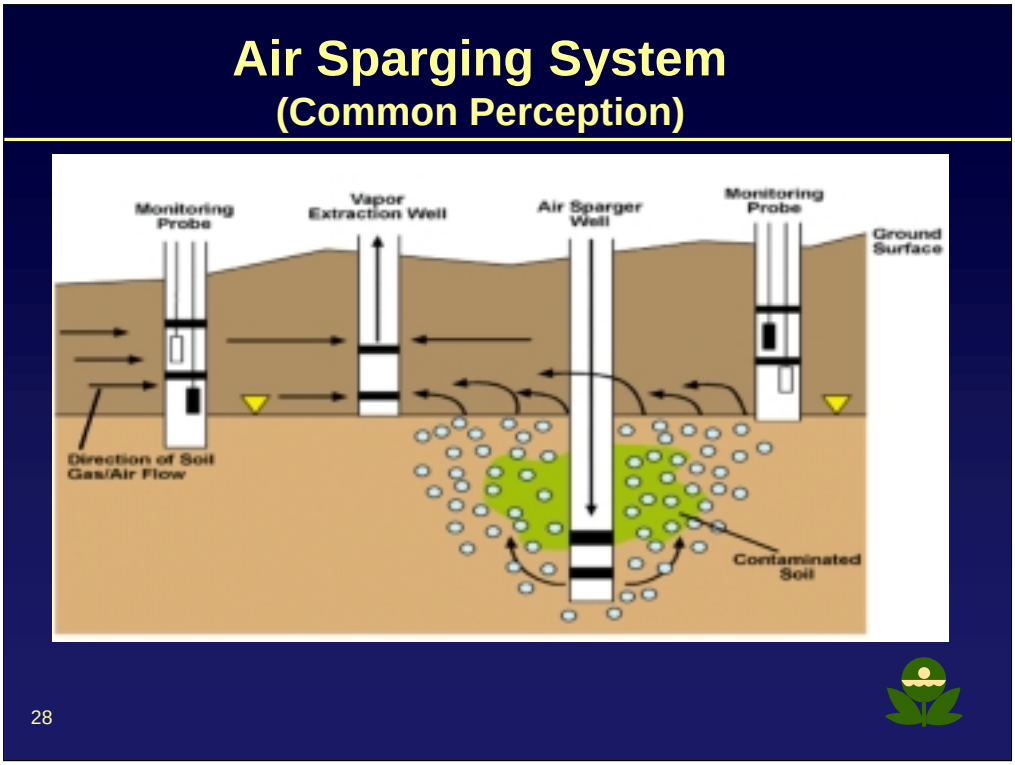
-soil venting

-vacuum extraction

-in situ air stripping

-in situ volatilization

-enhanced volatilization



Notes:

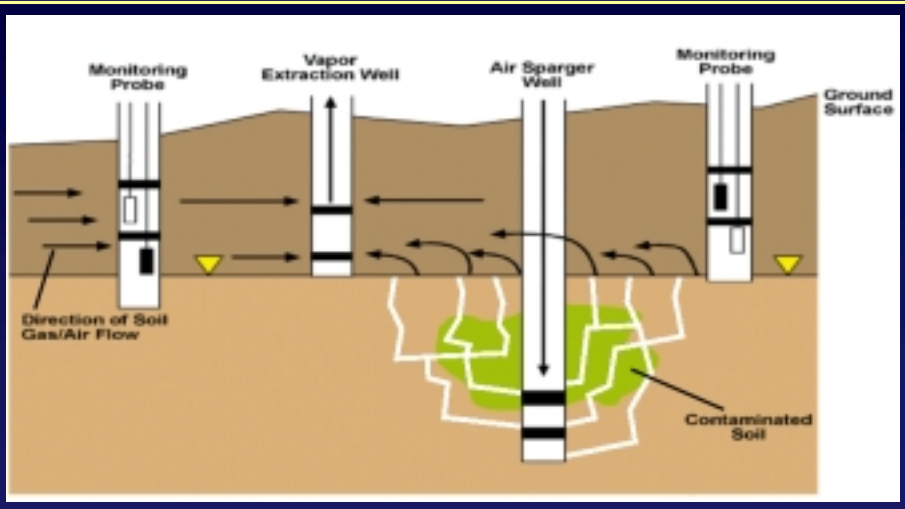
Air sparging is a physical separation process that involves injecting air into the saturated zone to volatilize dissolved contaminants. The principle of air sparging is based on the relative tendency of a compound to exist in the vapor phase rather than the dissolved (water) phase. This concept is expressed as Henry's Law.

The technology is particularly applicable for compounds with Henry's Law Constant values greater than 10^{-3} atm-m^3/mole. Refer to TOOLBOOK, tab labeled "Conceptual Site Model (CSM)," and document "SUBSURFACE CONTAMINATION REFERENCE GUIDE," Section 2.2 titled SOIL VACUUM EXTRACTION.

When air sparging is employed, compressed air is forced into the saturated zone through an injection well screened beneath the water table. As air moves through the saturated zone, VOCs present in the water are stripped and travel to the unsaturated zone. The sparged vapors are captured in the unsaturated zone by vapor extraction wells and treated above ground.

Injection wells may be either vertical or horizontal. Refer to the next section on directional drilling.

Air Sparging System
(More Accurate Perception)



Applications of Air Sparging

- Unconfined aquifer
- Permeable (coarse-grained) soils
- Shallow contaminant plumes

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Notes:

Air sparging is applicable only under unconfined aquifer conditions. Confining layers restrict vertical air flow and prevent the recovery of sparged contaminants.

Air sparging is implemented most easily and effectively in homogenous, coarse-grained (permeable) soils. Coarse soils provide a medium for even distribution of air, allowing for optimum mass transfer efficiencies and more effective removal of VOCs.

Air sparging is employed most commonly for contaminant plumes present at less than 30 feet below the water table. Although air sparging can be implemented at greater depths, the potential for uncontrolled migration of sparge vapors increases with increasing depth because of the potential for channeling along subsurface features. Sufficient vadose zone depth is also required to enable the vapor recovery system to perform adequately.

Applications at field scale has been primarily for BTEX contamination.

Limitations in Air Sparging

- Contaminant mobilization
- Limited effectiveness in heterogeneous soils
- Limited effectiveness in impermeable, fine-grained soils

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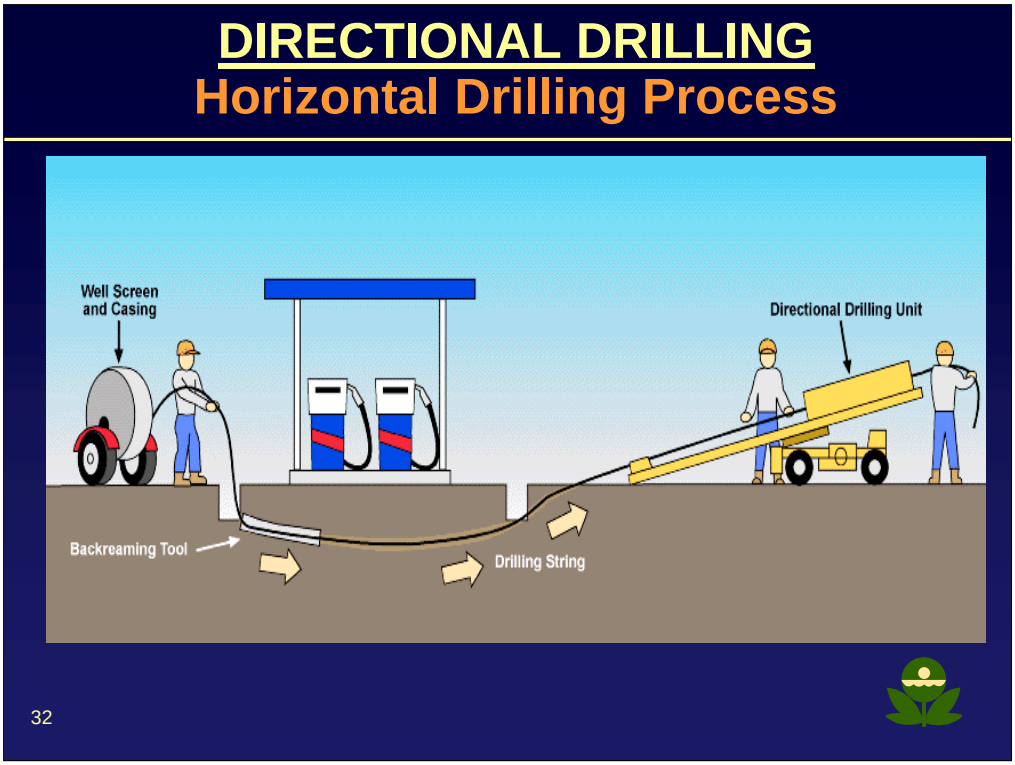
Notes:

Sparging may influence the movement of contaminants in an aquifer more than the natural gradient. The lateral migration of air within the saturated zone generally will be accompanied by a lateral spread of the dissolved contaminant plume. Where dense nonacqueous phase liquids (DNAPLs) are present, air sparging activities have been observed to disperse the separate phase, increasing the size and concentration of the VOC plume. The overall design of all remediation systems should incorporate measures to control the potential spread of the contaminants.

The effectiveness of air sparging is limited by the presence of soil heterogeneities, which can channel sparge vapor flow and result in inefficient mass transfer. As a result, the remediation time frame in heterogeneous soil may be dictated by the time required for contaminants to diffuse from zones of lower permeability to those of higher permeability.

Sparging in impermeable, fine-grained soils may result in formation of fractures or development of gas pockets. Injection of high-pressure air into an impermeable soil may cause fracture paths and vapors flow, resulting in poor contact between sparge vapors and contaminated soils. Pockets of gas may decrease soil permeability and impede the effectiveness of an air sparge system. They can also cause lateral displacement of groundwater, which, in the absence of groundwater controls, can result in lateral displacement of contaminants.



Notes:

Directional drilling employs specialized drill bits to advance curved boreholes in a controlled arc for installation of horizontal wells or manifolds for SVE and sparging technologies.

The borehole is initiated at a shallow angle, typically 5 to 30 degrees to the ground surface. After the arrival at a target depth, the drilling tool is reoriented to drill a horizontal borehole. Electronic sensors located in the drill tool guidance system provide orientation, location, and depth data to the driller.

Directionally drilled boreholes can be completed blind, terminating in the subsurface, or can be reoriented upward to return to the ground surface.

Advantages of Directional Drilling

- Allows application of SVE in areas not accessible by vertical drilling
- Concentrates remediation along the geometry of the contaminated zone and eliminates need for multiple vertical wells
- Allows placement of well screen immediately above the water table and over an extended area

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Notes:

Directional drilling technologies allow application of SVE in areas not generally accessible by vertical drilling techniques, such as under large aboveground structures.

Directional drilling can also increase the efficiency of SVE by concentrating subsurface remedial activities along the geometry of the contaminated zone and by increasing the zone of influence of a single extraction well. In extensive operations, use of horizontal wells can eliminate the need for numerous vertical wells, eliminating the need for redundant hardware for SVE systems.

Horizontal wells allow the placement of extraction well screens immediately above the water table and over an extended area.

Limitations of Directional Drilling

- Installation difficult for:
  - Low permeability soils
  - Cobbles and coarse gravels
- Costs increase dramatically with depth

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Notes:

Installation of horizontal wells in soils and clays can be difficult because of the reduction of the specific capacity of the well caused by the smearing of silts and clays against the borehole wall. This can result in lower effective permeabilities.

The presence of cobbles and coarse gravels may complicate horizontal drilling and result in increased costs for well installation.

Horizontal wells are most commonly installed to depths of 50 feet to 80 feet, but have been installed to depths of 235 feet. Approach lengths and installation costs increase considerably with well depth.

Bioventing

- Treatment supplies oxygen in the vadose zone
- Oxygen is used by microorganisms in soil to initiate aerobic biochemical conversion and degradation of hydrocarbons

For benzene, complete biodegradation (biological mineralization) is described as follows:

$$C_6H_6 + 7.5\ O_2 \longrightarrow 6\ Co_2 + 3\ H_2O$$

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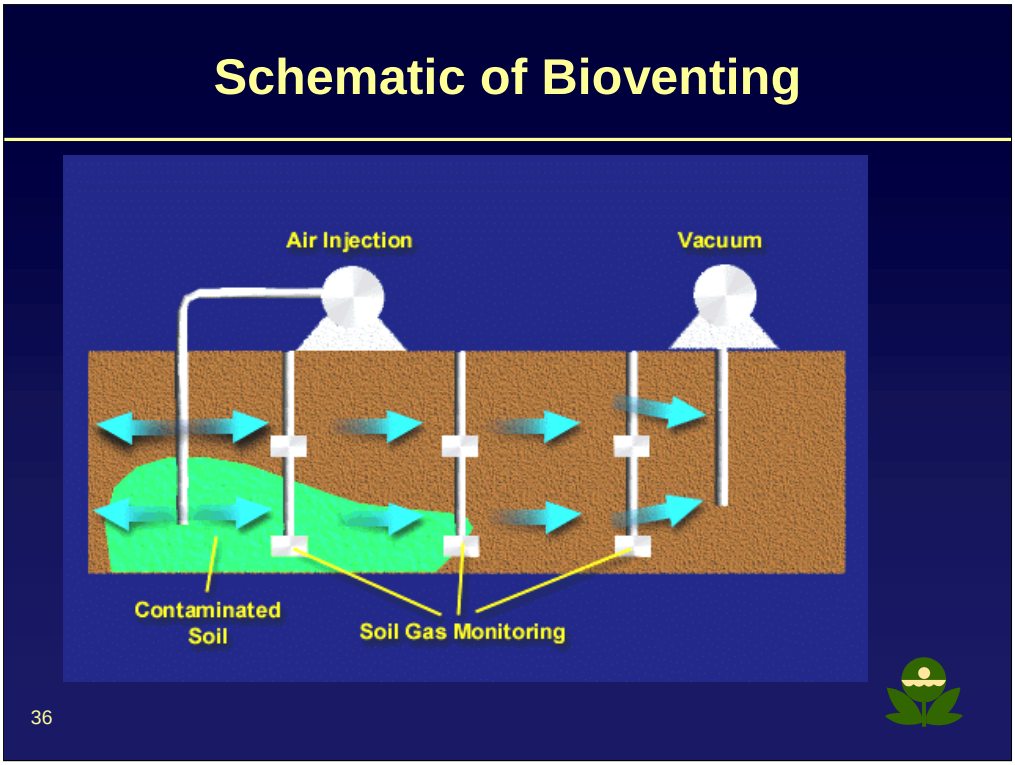
Notes:

Bioventing is an in situ technology that supplies oxygen to the subsurface vadose zone to enhance the aerobic microbial biodegradation of contaminants.

Bioventing provides oxygen to unsaturated soils by injection of air or another source of oxygen, such as hydrogen peroxide or oxygen releasing compounds (ORCs). Oxygen also can be introduced by vacuum extraction wells that simply draw air from the surface or from inlet wells. The oxygen is used by indigenous microorganisms.

Bioventing generally is effective for nonchlorinated hydrocarbons, such as petroleum and creosote compounds, and hydrocarbons with low numbers of chlorine atoms, such as vinyl chloride.

Research has shown that oxygen concentrations as low as 2% by volume in soil are sufficient to stimulate aerobic biodegradation.



Notes:

Bioventing may incorporate air extraction wells or air injection wells. Air extraction wells draw air from the ground surface through contaminated soils, while air injection wells push air into the subsurface.

If volatile contaminants can be controlled as shown in the diagram above, VOCs can also be treated using bioventing to biodegrade contaminants below ground surface, thus eliminating emissions to the surface and the need for above-ground treatment systems.

Sometimes SVE systems are used in conjunction with bioventing systems. Following removal of volatile contaminants, SVE systems may be converted to bioventing systems by reducing extraction flow rates. Use of an SVE system in a bioventing capacity targets less volatile contaminants, and may reduce operating costs by decreasing vapor treatment requirements or eliminating them altogether.

Application of Bioventing

- Permeable unsaturated soil
- Temperature affects rate of reaction
- Aerobically biodegradable fuel hydrocarbons and some chlorinated VOCs
- Hydrocarbons that cannot be removed by SVE alone

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Notes:

Bioventing is most appropriate for permeable, unsaturated soil where air (as the carrier for oxygen) can be moved through the soil to supply oxygen for biodegradation to the contaminated area.

The temperature of the subsurface generally affects the rate of biodegradation. The higher the temperature, over the range of 5º to 35º centigrade, the faster the rate of treatment. However, where subsurface environments are naturally cold (e.g., Alaska) indigenous microorganisms are acclimated to optimum performance at natural environmental temperatures.

Bioventing is designed primarily to treat aerobically biodegradable and semivolatile fuel hydrocarbon constituents (BTEX). However, some chlorinated volatile organic compounds (e.g., vinyl chloride) are aerobically biodegradable and are appropriate for the application of bioventing. And some chlorinated compounds, such as TCE, can be co-metabolically biodegraded under aerobic conditions when a substrate is provided (methane for TCE).

Bioventing is also applicable to less volatile compounds, for example, higher molecular weight polycyclic aromatic hydrocarbon (PAH) compounds, that do not readily partition to the air phase, but are aerobically biodegradable.

Limitations of Bioventing

- Limited to aerobically biodegradable chemicals
- Limited effectiveness in:
  - Low permeability soils
  - Soil with low moisture content

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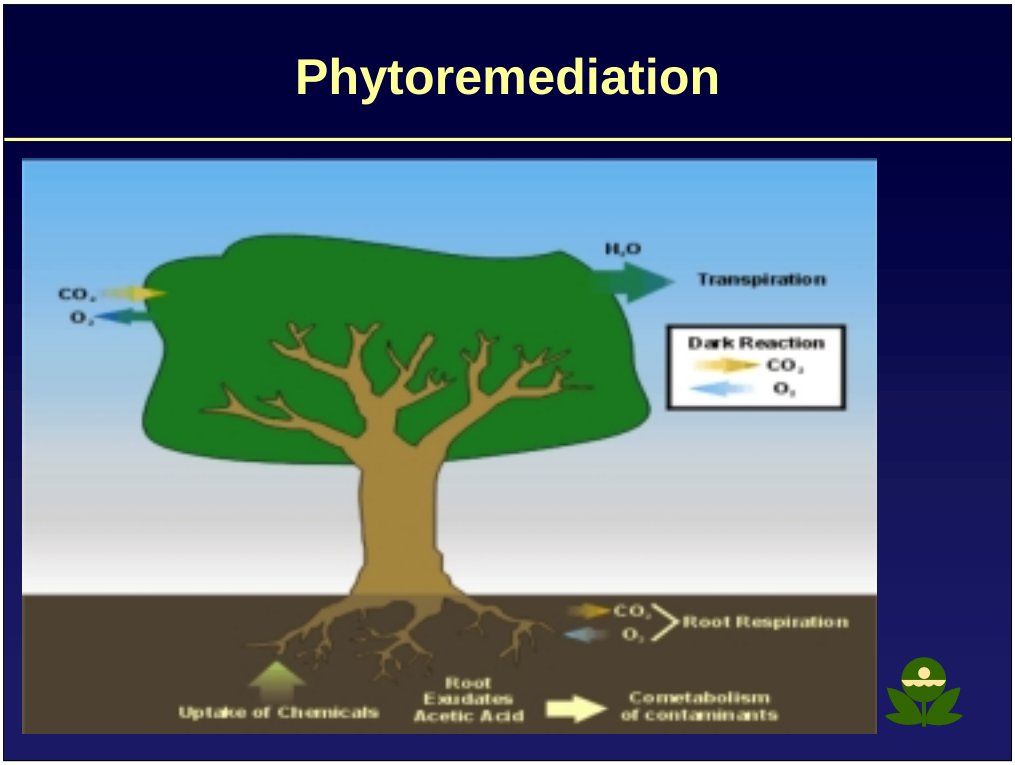
Notes:

Chemicals that are not aerobically biodegradable are not amenable to treatment using bioventing (for example, perchloroethylene (PCE) or carbon tetrachloride (CT)).

Low-permeability soils limit the ability to supply oxygen to the contaminated area, thus reducing or eliminating biodegradation.

Low moisture content in soil reduces microrganism activity and results in reduced biodegradation rate and extent, even when oxygen is present through the application of bioventing. Because bioventing tends to dessicate soils, moisture may need to be added to soil through surface irrigation to maintain adequate moisture for microorganisms.

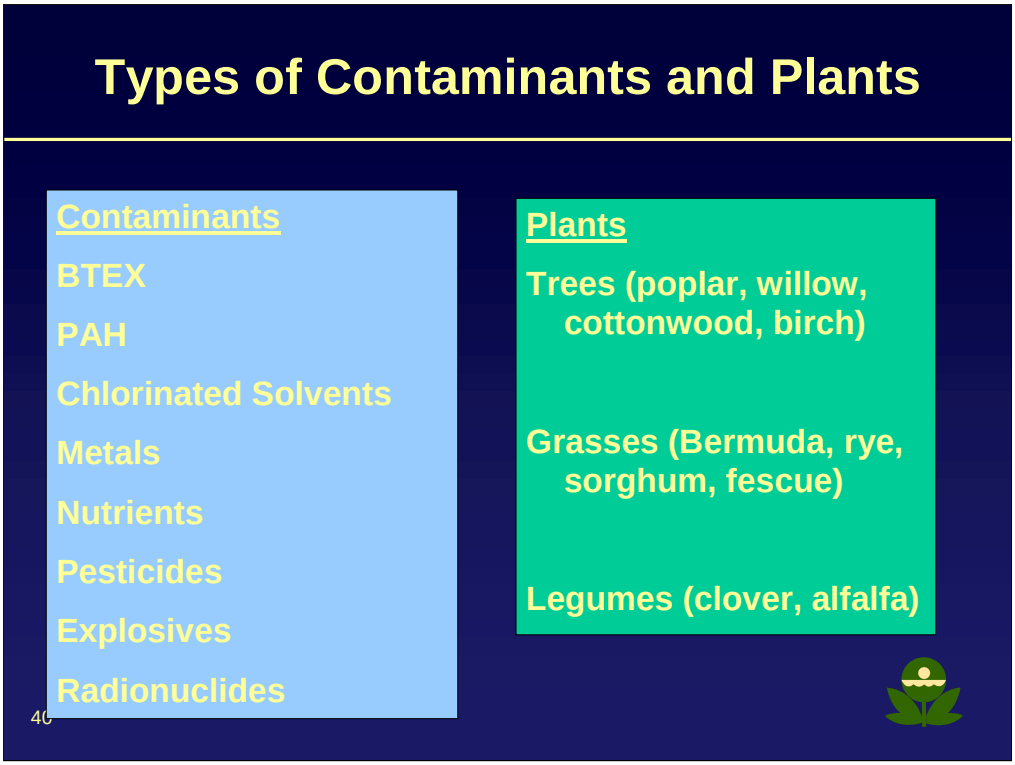


Notes:

Phytoremediation is the use of plants to remove, contain, accumulate, or degrade environmental contaminants in soil, groundwater, surface water, sediment, and air. That definition applies to all biological, chemical, and physical processes that are influenced by plants and that aid in the cleanup of contaminated substances.

Plants can be used in site remediation through degradation and mineralization of organic chemicals and through accumulation and concentration of inorganic chemicals, including heavy metals, from soil into above ground plant tissues.

Phytoremediation is still in the relative early stages of development and is being field-tested at various sites in the United States.



Notes:

Contaminants that are potentially treatable using phytoremediation include nonhalogenated and halogenated organic chemicals, inorganic chemicals (nutrients, metals, and radionuclides), pesticides, and explosives. For chemicals that are hydrophobic (associated with the soil solid phase), plant roots may be used to bring microorganisms in the plant root zone (rhizosphere) into contact with the chemicals.

Plant types that are used depend upon the depth of contamination, ability of plants to grow in a given climate, and site specific situations.

At Aberdeen Proving Grounds, 183 hybrid poplars were planted at a cost of $15,000 over a one-acre site to remediate groundwater contaminated with 170 mg/L 1,1,2,2-tetrachloroethane and 61 mg/L trichloroethyene (TCE). Although groundwater concentrations have not been reported, tree tissue data indicate that evapotranspiration of volatile contaminants occurs.

At the Edward Sears site in New Jersey, 208 hybrid poplars were planted at a cost of $25,000 over a one-half-acre area to remediate groundwater contaminated with PCE and TCE. While TCE was reduced from 28 ug/L to 1 ug/L in 9 months, results thus far cannot be used to differentiate between evapotranspiration or soil volatilization.

Mechanisms of Phytoremediaton

- Extraction of chemicals
- Stabilization of soils
- Degradation of chemicals within the plant or root zone
- Volatilization of chemicals
- Hydraulic control of leachate
- Vegetative caps

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Notes:

Hyperaccumulators are defined as plants that transport metals from the soil and contain more than 0.1 percent, dry-weight basis, of Ni, Co, Cu, Cr, or Pb, or 1.0 percent of Zn or Mn.

Volatilization of chemicals, while less desirable than degradation, may be preferable to the prolonged risk of groundwater contamination.

Hydraulic control (phytohydraulics) uses plants with high transpiration rates to take up large quantities of water and reduce subsurface water content, thereby achieving hydraulic control of the site to prevent further migration of contaminants.

Limitations of Phytoremediation

- Limited to shallow soil, streams, and groundwater
- Longer remediation time
- Toxicity and fate of degradation products is unknown
- Potential for contaminants to enter food chain
- Design must incorporate soil and climate conditions

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Notes:

Phytoremediation is limited to the depth and extent of root zone establishment. For hydraulic control, it is limited to the depth to which it can affect water movement.

Longer remediation times are required due to several factors, including rate of plant establishment, rate of growth of the root zone, and low biological activity (low rate) in colder seasons.

Degradation products may be toxic and more mobile or less amenable to phytoremediation than the parent contaminant. More research is necessary to address this topic.

Contaminants may enter the food chain through uptake into grasses and parts of trees that are subsequently consumed.

In matching a species for a particular containment application at a site, criteria related to site soil and climate must be considered. Locally available indigenous plants are generally best suited for establishment and growth.

Soil Washing

- Soil washing is an aqueous based ex situ technology that uses mechanical processes to separate and wash soil particles

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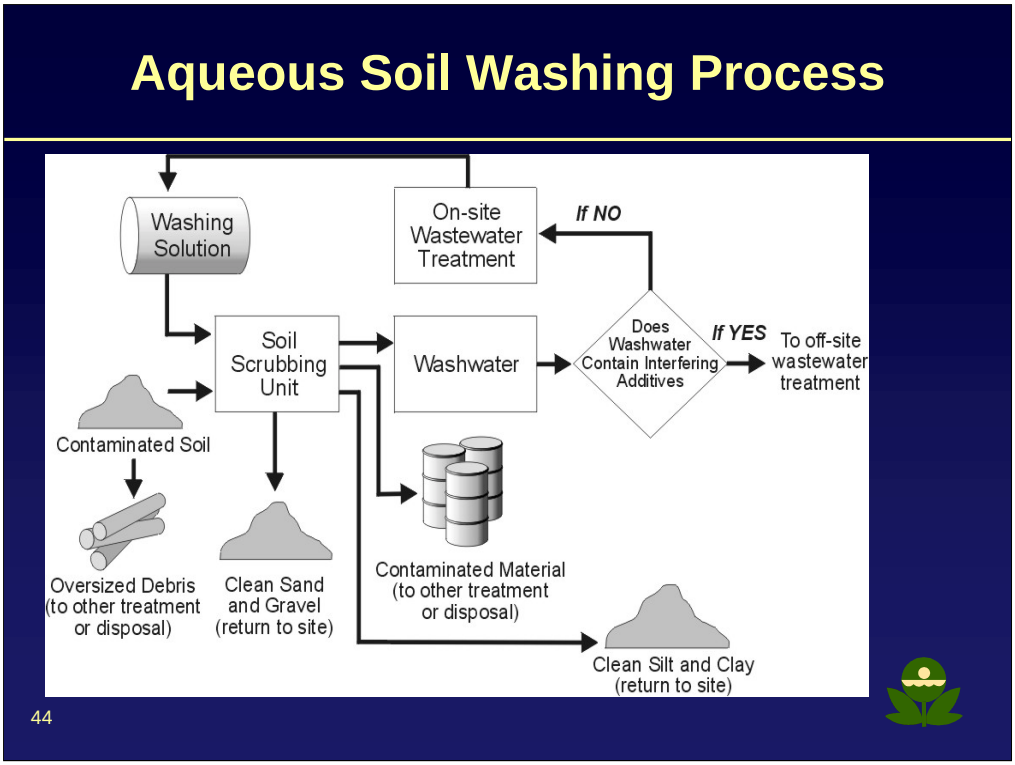
Notes:

Soil washing removes contaminants in two ways: (1) dissolution or suspension of contaminants in the wash solution, and (2) separates particles by size.

Contaminants associate more with organic carbon, silt, and clay by sorption (fine grained soil mineral fraction)

Contaminants associate less with sand and gravel (coarse grained soil mineral fraction



Notes:

Four phases of soil washing:

1. Soil Preparation. Pretreatment of soil to remove oversized material. Creates a more homogeneous feed stream for delivery to the soil washing/scrubbing plant. Common sizes removed are ½ inch and larger. Example, at the Libby Montana, wood preservative site, contaminated soil was deparated into two classes: (1) materials larger than ½ inch diameter, and (2) materials smaller than ½ inch. Example, soil for the Electric Power Research Institute was separated into two fractions: (1) larger than soil particles (2 millimeters in diameter), and (2) soil particles (sand, silt, and clay). Particle classification and separation is a function of the type and requirements of the soil washing unit.

2. Soil Washing. Aqueous washing solution removes pollutants from solids. Washing methods include surface attrition, acid or base amendment for solubilization, mixing with solvents for dissolving contaminants released from solid to the liquid fraction. Solids are separated and sent for further processing.

3. Wastewater Treatment. Wastewater will contain primarily fine-grained solids, dissolved salts, organic humic compounds, free floating hydrocarbons, etc.

4. Management of Residuals. May be disposed in a regulated landfill, or may require further treatment.

Advantages of Soil Washing

- Relatively low-cost alternative for separating wastes
- Closed treatment system that permits control of ambient volatile emissions
- Can reduce the volume of contaminated media and the concentrations of contaminants

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Notes:

Soil washing can be used as a pretreatment step to concentrate contaminants and reduce the volume of wastes that require further treatment, thereby reducing the overall costs of a cleanup project.

Because the technology is primarily a separation and volume reduction process, it frequently is used with other technologies.

Examples: Wood preserving site (Libby, Montana), and EPRI sites with PCP contamination. Separation by material sizes provided a strategy to both reduce the volume of more highly contaminated materials, and concentrate contaminants for treatment in smaller reactors where better process control could be applied.

Limitations of Soil Washing

- Wash-water additives may make it necessary to treat wastewater before discharge.
- Effectiveness very much depends on soil conditions and nature of contaminants.
- Further treatment is usually required.

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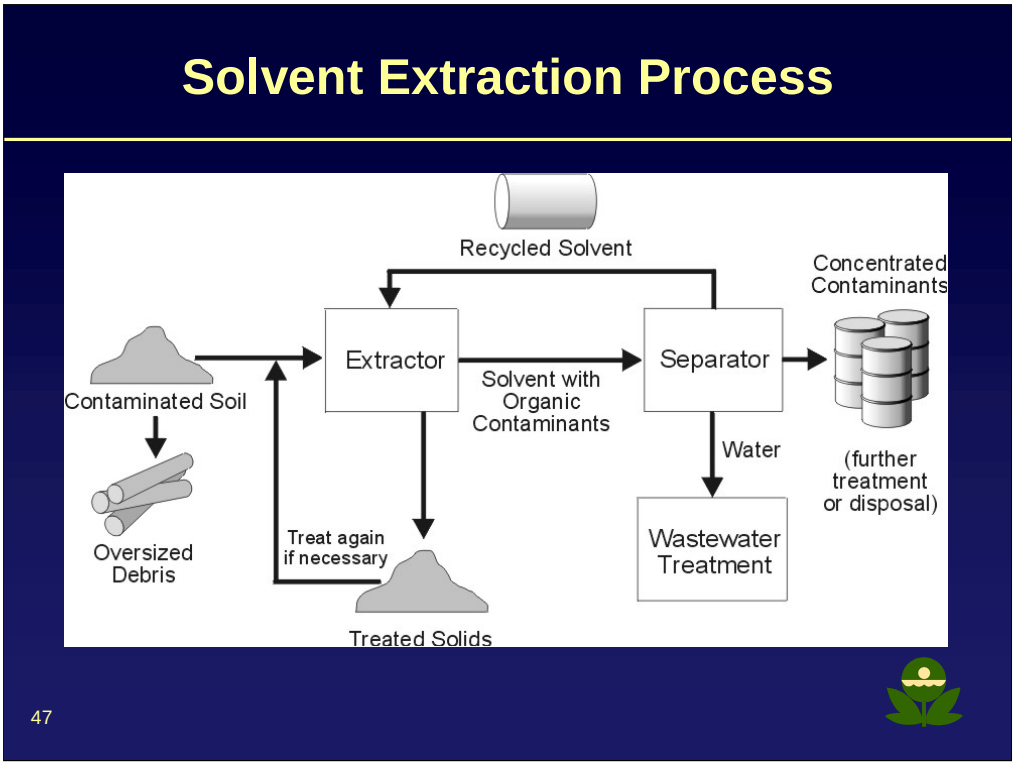
Notes:

Introduction of additives such as surfactants, acids, bases, etc., may require treatment of wastewater be

Most soil washing processes are relatively ineffective on soils with high clay and silt content.

Further treatment on concentrated contaminants, fine-grained soils, and wash-water may be required.

Costs quoted by soil washing vendors included in EPA REACH IT range from $30 to $195 per ton.



Notes:

Process description:

1. Feed preparation
2. Extraction
3. Recovery of solvents and organic compounds
4. Separation of solids

Methanol has been used at Hill Air Force Base, Utah, for sites contaminated by fire training activities. Methanol partitions the contaminants from the solid soil phase into the solution phase. The solution phase is recovered and reused.

Methanol has been used to treat containerized soil contaminated with PCP and other wood preservative chemicals including PAHs. The solvent extraction process was combined with photodegradation technology to degrade the organic chemicals in the extracted solvent on site within a period of a few hours.

Advantages of Solvent Extraction

- Reduces the volume of hazardous wastes to be treated
- Adaptable for different contaminants, concentrations, and soil conditions
- More effective than aqueous soil washing for hydrophobic contaminants

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Notes:

Extraction efficiencies of 90 to 98 percent on PCB sediments have been reported.

Vendors costs range from $30 to $800 per ton of contaminated soil.

Example of the application of the solvent ethanol for pentachlorophenol (PCP) removal from contaminated soil. Treatment combination used was solvent extraction, followed by photodegradation of chemicals in the solvent phase.

Limitations of Solvent Extraction

- Traces of solvent may remain in the treated solids
- Least effective on very high molecular weight organics
- Can become expensive if solvent reuse is not possible
- Generally not applicable for inorganic contaminated soil

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Notes:

Traces of organic solvent may remain in the treated soils, therefore, toxicity of the solvent is an important consideration.

Often high ratios of solvent:soil are required for contaminant removal.

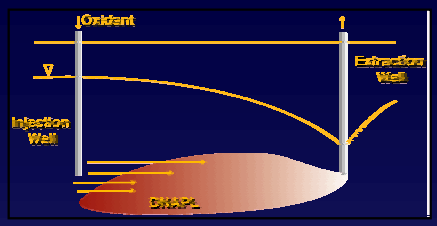
Often a combination of solvents are best, rather than one solvent, which can increase costs of treatment.

Treatability studies should be performed to determine effective combinations of solvents, rate of extraction, and solvent reuse aspects.

In Situ Oxidation

Description

- Injection of strong oxidants
  - Fenton's Reagent, hydrogen peroxide, or potassium permanganate
- Oxidation and/or dechlorination process
- Best for compounds with unsaturated carbon-carbon bonds



Contaminants Treated

- VOCs
- SVOCs
- Petroleum hydrocarbons

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Fenton's Reagent - reaction between hydrogen peroxide and ferrous iron (II) to generate a hydroxyl radical (this radical is second only to fluorine in oxidation potential)

Complete oxidation of organic compounds yields innocuous by-products commonly founds in nature, primarily carbon dioxide and water

In Situ Oxidation:
Status

- Over 50 full-scale cleanups for BTEX
- 42 field demonstrations on chlorinated solvents
- At least four vendors
- More study needed on long-term effectiveness on chemicals not oxidized initially (rebound)

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Vendors:

In-Situ Oxidative Technologies

- ISOTEC process using Fenton's reagent chemistry (hydrogen peroxide and proprietary iron-based catalysts) - can completely oxidize most petro and aromatic hydrocarbons, chl solvents, pesticides and herbicides

- 3 full scale projects in design, 14 full scale projects constructed (primarily in NJ), 3 full scale cleanups

Geo-Cleanse International, Inc. (GCI)

- Geo-Cleanser Process uses Fenton's reagent chemistry (H_2O_2 and ferrous sulfate)

- injected reagents are not envr hazardous, intermediate products are natural, nonhazardous mono and fatty acids, end products are CO_2 and H_2O, and in the case of chl solvents, chloride ion. Remaining reagents decompose to water and O_2 and provide nutrients for natural remediation processes, or precipitate as nonhazardous metallic salts

- been applied successfully at 40 commercial sites for full scale cleanups

- cost is $2 - $25/lb/contaminant (excludes excavation, permitting, and disposal of residues)

Potential Vendor:

BSI Environmental

- uses Fenton's for soil and sludge contamination (ex situ)

- potential for in situ gw treatment

- 1 full scale

- cost is 100K - 220K/yd^3 (excluding excavation, permitting, and disposal of residues)

In Situ Oxidation

Pros

- Destroys NAPL
- Permanent solution
- Low capital
- Low energy
- Rapid cleanup and closure
- Enhances existing pump and treat systems with little modification

Cons

- Contaminant volatilization (BTEX)
- May require large quantities of oxidizing agent
- Possible incomplete oxidation or formation of intermediate contaminants
- Other carbon sources compete for oxidant
- May require multiple injections

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Pros:

low cost - no permanent structures or monthly maintenance fees

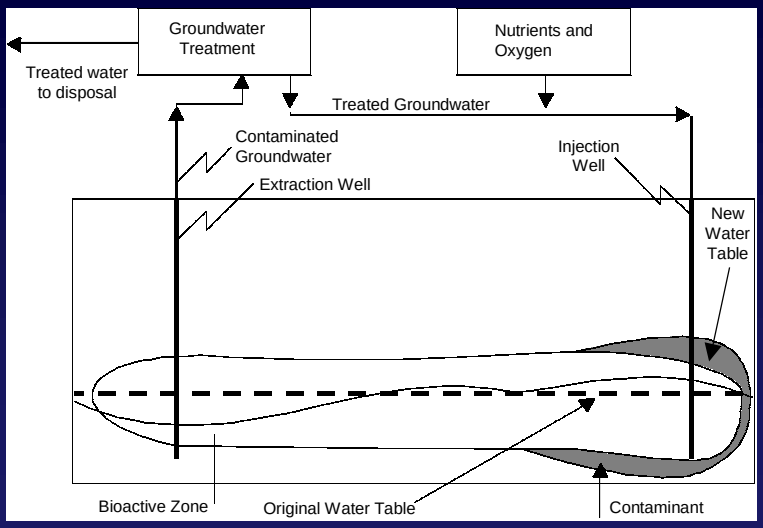
minimal site disruption - ability to remediate under structures and pavement, around utilities, and without interrupting site operation or closing facilities

time - reduces contaminant levels within hours and contaminant reduction is verifiable within days

Cons:

certain organics can not be effectively oxidized by Fenton's reaction including methylene chloride, alcohols, and ketones

Enhanced *In Situ* Bio-Remediation of Groundwater



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Notes:

Promotes and accelerates the natural biodegradation process in saturated soil.

Generally consists of a water recirculation system, aboveground treatment of ground water, conditioning infiltrating water with nutrients, and an oxygen source.

One design option consists of central withdrawals of ground water and reinfiltration through injection wells, surface ponds, or infiltration galleries at several locations around the outer border of the treated area. Hydrological control or engineered barriers (slurry wall) can be used to isolate the site.

Generally, the groundwater is withdrawn at a higher rate than it is infiltrated. Surplus is discharged off-site after being treated to meet permit requirements.

To support biodegradation in the subsurface, and aboveground treatment system may be used to degrade contaminants in the withdrawn ground water and to condition the water before reinfiltration.

Types of In Situ Bioremediation Processes

- Aerobic processes
- Anaerobic processes
- Cometabolic processes

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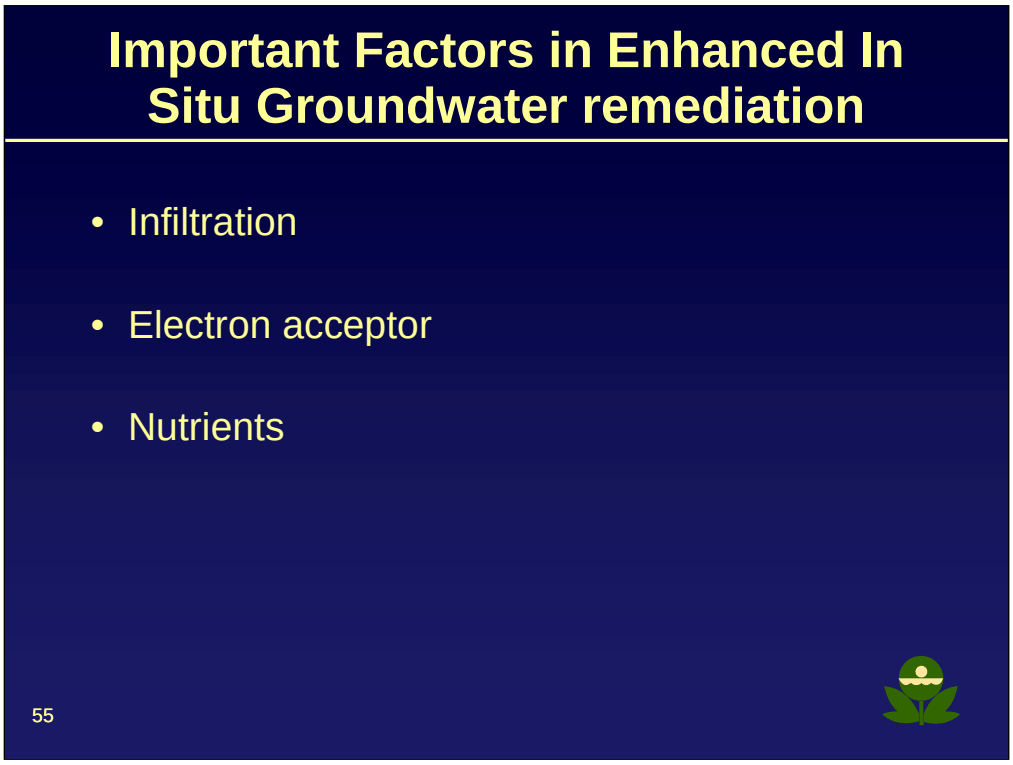
Notes:

Aerobic biodegradation involves the use of dimolecular oxygen (O2) by microorganisms and the oxidation of organic contaminants. Highly oxidized compounds such as PCE and TCE are impossible or difficult to biodegrade aerobically because they cannot donate electrons. These oxidized compounds can, however, be reduced under anaerobic conditions.

Anaerobic biodegradation occurs without O2 as the electron acceptor. Inorganic electron acceptors in the subsurface include: nitrate (NO3-) ferric iron ($Fe+^{3}$), sulfate ($SO4-^{2}$), and manganese (Mn+4). Adequately characterizing a plume for electron acceptors is critical to understanding , predicting, and controlling the likely bioremediation processes.

Cometabolism is a process in which organic contaminants are degraded fortuitously (by accident) by the enzymes of microbes metabolizing substrates for food and energy. Therefore, the chemical undergoing cometabolism does not provide energy or food for the microorganism, and actually microbial energy and enzymes in the process of transformation.



Notes:
Infiltration:
Injection wells drilled into the saturized zone are the most direct method for providing electron acceptor and nutrients.
Infiltration galleries or surface applications can reduce installation costs, however, direct contact with ground water is less assured.

Electron acceptor:
Aerobic biodegradation provides the most rapid reactions, and the amount of contaminant biodegraded is proportional to the amount of oxygen added. Oxygen concentrations that can be achieved at 50 F include: for air, 10mg/L; for oxygen saturated water, 40 mg/L, and for hydrogen peroxide at 200 mg/L, 94 mg/L of oxygen.
A method to potentially improve the delivery of oxygen is through the use of oxygen releasing compounds (ORC) that are placed in the bottom of injection wells.
Hydrogen peroxide at less than 100 mg/L can inhibit bacterial activity, and upon reaction to provide O2 may "degas" oxygen out of the saturated zone and into the unsaturated zone. An example of this occurred at the Champion International Site in Libby, Montana, where concentration of O2 in the unsaturated soil above the H2O2 injection well was up to 40% by volume.
The reaction of NO3- (electron acceptor) with toulene, is shown below:

Toulene + NO3- → CO2 + N2

About 4 – 7 ppm NO3- are required to degrade 1ppm of hydrocarbon

The need for addition of nutrients depends upon the amount and bioavailability of nutrients present at the contaminated site. Nitrogen (N) and phosphorus (P) are generally considered to be required to accomplish aerobic biodegradation of carbon and the amount of N and P required is based on the amount of carbon contaminant. The ratio that is generally used is: C:N:P = 100:10:1 (by weight)

Applications of Enhanced In Situ Groundwater Remediation

- Treats two media (soil and water) simultaneously
- Broadly applicable for organic compounds
- Considered a natural process with public acceptance
- Routinely used at UST sites and wood preserving sites

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Notes:

Technology is more cost effective at sites where both soil and ground water are treated that, for example, conventional pump and treat technology where the water is first pumped from the subsurface, and then must be treated separately in an above ground reactor.

The process also reduces toxicity upon biodegradation of the parent compounds and intermediates.

Example includes the Champion International Site in Libby, Montana, for treatment of wood preserving wastes including creosote, containing PAHs and pentachlorophenol (PCP). Reference: Champion International Superfund Site, Libby, Montana Field Performance Evaluation. Bioremediation Unit: In Situ Bioremediation of the Upper Aquifer. EPA/600/R-97/044, U.S. EPA Office of Research and Development, Washington, D.C. August, 1997. Another example is traverse city, Michigan, under the direction of the Kerr Environmental Research Laboratory, Ada, Oklahoma (Dr. John Wilson).

Limitations of Enhanced In Situ Groundwater Remediation

- Contaminants must be biodegradable
- Requires extensive site characterization
- Mobility of contaminants may require the use of an aboveground water treatment system
- Depth to groundwater and cleanup levels may limit applicability

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Notes:

Site characterization is required to determine both applicability and performance of the technology.

Addition of water witrh nutrients and oxygen (or other electron acceptor) may increase the level of the water table and cause spreading/mobilization of contaminated water at the site. This would generate the need for contaminant, either hydraulic or structural, or both.

Careful process control is critical to technology performance. For example, addition of too much H2O2 may inhibit biodegradation and addition of any oxygen may oxidize reduced iron that causes precipitation and reduce water flow rates. H2O2 may degas in the subsurface and influence permeability and release oxygen into the vadose zone.

NAPL Recovery

- Bioslurping
  - Enhanced recovery using applied vacuum
  - Compare with conventional gravity removal technique

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Bioslurping

- Product and water are withdrawn as a liquid column, slugs, droplets, or vapor
- Smearing of LNAPL product minimized
  - Water table not depressed
  - Horizontal permeability > vertical permeability
- Applied to LNAPLs including petroleum hydrocarbons, gasoline, jet fuels, diesel, and heating oils

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Notes:

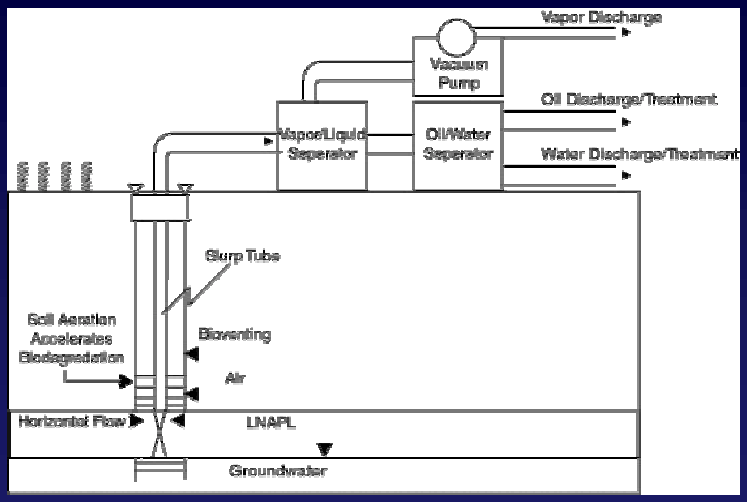
Product and water are drawn up the slurp tube as a liquid column, slugs, droplets, or vapor. Product and water can be drawn up as a column provided liquid flows into the well fast enough and depth below the ground surface does not exceed roughly 25 feet; otherwise, product is "slurped" up through the entrainment.

Because the water table is not depressed, vertical "smearing" of light nonaqueous phase liquids (LNAPLs) is minimized. In almost all natural settings, horizontal permeability is greater than vertical permeability.

The liquid stream extracted from the bioslurper well flows through a vapor-liquid separator to the vacuum pump and to an oil-water separator.

Bioventing of soils in the vadose zone is achieved by withdrawing soil vapor from the recovery well.

Bioslurper System



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Notes:

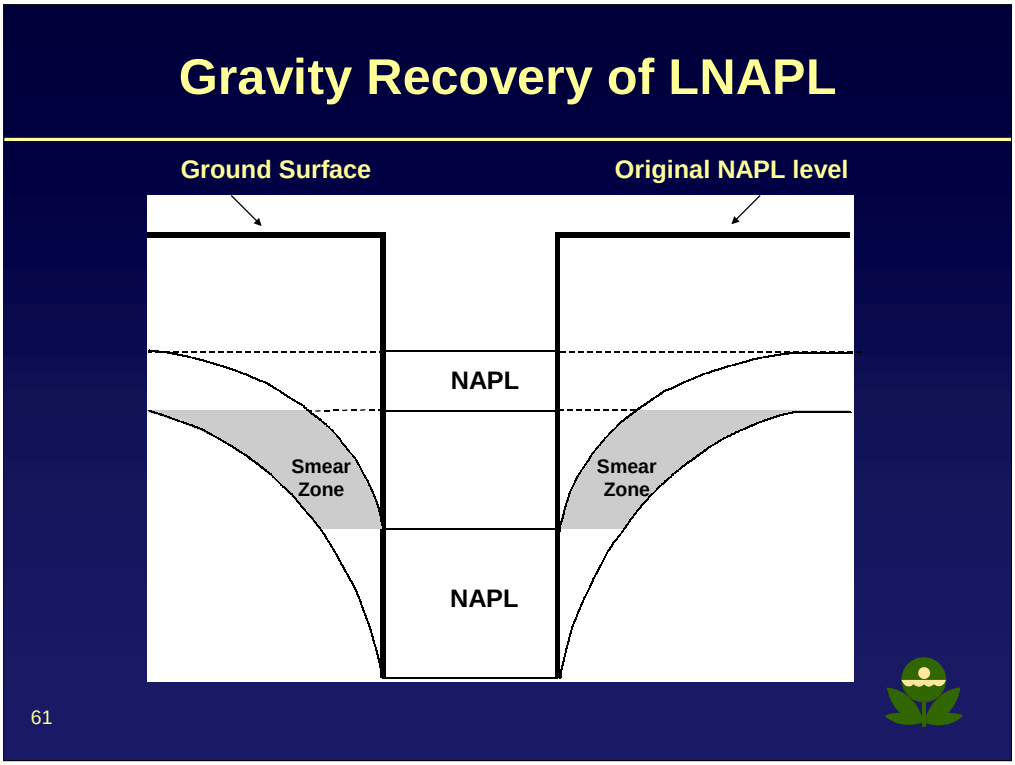
Components of the bioslurping system include:

- •Slurp tube extending to LNAPL
- •Vacuum extraction pump
- •Vapor-liquid separator
- •Oil-water separator

A bioslurper system consists of a "slurp" tube that extends into the LNAPL free product layer in the well.

Product is drawn up by the vacuum extraction pump. The system pulls a vacuum of as much as 500 millimeters of mercury (mm Hg) on the recovery well to create a pressure gradient to draw LNAPL into the well. The bioslurper is operated to cause little drawdown in the aquifer, minimizing the quantity of extracted groundwater requiring treatment.

Recovered fluids and vapors are separated so free product can be recovered and recycled. Ground water and soil vapors may be treated (when required) and discharged.



Notes:

Gravity LNAPL recovery is conventional, not innovative, and is shown for comparison with Bioslurping. Water tables depression pump lowers water level and causes of "cone of depression" for LNAPL to enter the recovery well. Change in hydraulic gradient provided by lowering the level of water and LNAPL provides to driving force for LNAPL movement into the recovery well.

Drop in LNAPL level causes "smearing" of NAPL across aquifer due to capillary forces in aquifer material, creating residual saturation of NAPL in pores of aquifer. Residual saturation is more difficult to remove than free product.

The trapped residual in the aquifer material constitutes a continuous source of contamination to groundwater that will persist after product removal from the water table is completed.

Advantages of Bioslurping

- Enhanced recovery due to vacuum driving force
- Non-smearing of aquifer since LNAPL flows horizontally
- Minimal ground water extracted
- Promotes biodegradation
- System can be reconfigured for bioventing

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Notes:

Recovery of product is enhanced over conventional methods because, as opposed to gravity alone (groundwater cone of depression), the vacuum provides a driving force.

Containment flow proceeds along a horizontal flow path that reduces entrapment of product or the "smearing" that is typical of dual pump systems.

Minimal ground water is extracted. Extraction of ground water usually increases costs significantly because of the need for aboveground treatment and potential additional permitting requirements.

As vapor is extracted from the subsurface, oxygen in air drawn from the surface promotes aerobic biodegradation (bioventing) throughout the vadose zone and capillary fringe.

After product recovery is completed, bioslurper system can be reconfigured into a full-time bioventing system to remediate the contamination in the vadose zone.

Limitations of Bioslurping

- Works only with LNAPLs
- Not effective at depths of greater than 25 feet below ground surface
- Requires close monitoring and frequent maintenance

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Notes:

Bioslurping works only with LNAPLs.

Contaminants cannot be drawn (pumped) as a column if the free-phase layer is at a depth of greater than 25 feet below ground surface (bgs)

Bioslurping requires close monitoring and frequent maintenance to keep the system operational, because three media (product, vapors, water) must be treated or disposed of simultaneously.

Surfactant and Cosolvent Flushing: Status

- Over 30 field/pilot scale completed or in progress
- About 10 full scale/commercial completed or in progress
- Majority of projects target DNAPLs (TCE)
- Few cosolvent-only projects
- Major Issues
  - Recovery and re-injection (recycling)
  - How surfactants affect bioremediation
  - How flushing can be coupled with other technologies

64

Definitely need more cost data. One report on costs from a demonstration site indicated that it was quite expensive, but this was at a demo which is typically an expensive undertaking to demonstrate the efficacy of a technology, not the costs.

Also need to develop uniform ways of determining costs. This is an ongoing battle with many technologies - do you report in $/gall treated or $/soil treated or $/cont. removed or others? Many of the projects report costs in different ways. (RTDF is working on this)

It is also hard to determine how effective the technology was - if you don't know how much dnapl was there to begin with, how do you know the removal efficiency.(RTDF is working on this)

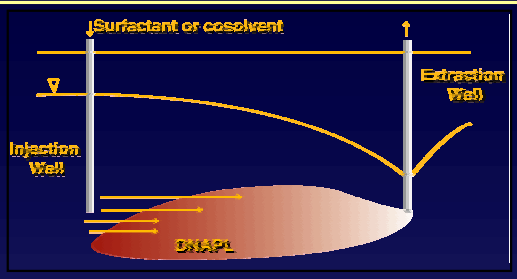
There is a question as to when do you cease application of the s/c. How clean is clean and what are the better technologies to use a polishing steps after bulk napl is removed? (RTDF)

Each state has different reg. On re-injecting treated gw. It is difficult (and expensive) to design systems if in some states you can re-inject h20 that still has cont. in it but in others you can virtually only inject clean h20. (TIO working on this)

Surfactant and Cosolvent Flushing

Description

- Added through trenches or injection wells to mobilize or solubilize NAPLs
- Surfactants enhance mobility of hydrophobic organic compounds by lowering interfacial tension between water and NAPL
- Cosolvents increase solubility
- Recent applications use surfactant/cosolvent mixtures



Contaminants Treated

- VOCs, SVOCs
- Petroleum hydrocarbons
- PCBs
- Pesticides

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First field tests performed 7 years ago. Most projects are for DNAPLs, but some for LNAPLs.

This is a bulk or residual NAPL removal process more than a polishing step.

Technology under development by various industries and academic institutions. Funding has come from EPA, DOE, DOD. Several consulting firms now do this commercially (INTERA,RADIAN).

Developed mainly because p&t have failed

Many field tests conducted solely for the purpose of feasibility and research and demonstration of the technology. Now the field tests are focused on actually cleaning up sites - one being used at a dry cleaners site in FL.

Surfactants: DOWFAX 8390, Sulfosuccinate, OT/Tween, Triton-x-100

Cosolvents: Alcohol, ethanol, n-pentanol

Often a mixture of surfactants/cosolvents is used

Surfactant and Cosolvent Flushing

Pros

- Treats wide range of contaminants
- Removes NAPLs
- Enhances existing pump and treat systems with little modification

Cons

- Can increase plume size and concentrations
- Difficult to recover surfactants; recovery increases costs
- Difficult to remove contaminants from extracted groundwater with surfactants
- Can cause well fouling
- Some regulatory hurdles for reinjecting treated groundwater

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The hardest part is to identify the DNAPL and quantify how much is there.

Several tests have been developed to help with this process

difficult to use in heterogeneous low permeability soils

Lab studies need to be performed to determine the correct surfactant/cosolvent for the project. Each project may require different s/c mixtures due to nature of cont. and site geochemistry.

Large volumes of water, contaminants, and s/c are generated that must be separated and treated at the surface (this is a v. costly step)

Some investigators are looking into ultrafiltration, solvent extraction, air stripping, vacuum steam stripping, photochemical treatment to separate h20/cont./s/c.

Because many flushing projects are targeted at DNAPLs there is a concern about mobilizing the dnapl to a clean part of an aquifer or into a new aquifer. This is a significant concern. You need to get hydraulic control to make sure that you are not going to lose any dnapl

Questions for Case Study Site

Which of the following are potentially applicable to the Site?

- ❑ Passive Treatment Walls
- ❑ MNA
- ❑ SVE
- ❑ Bioventing
- ❑ Phytoremediation
- ❑ Soil Washing
- ❑ Solvent Extraction
- ❑ Product Recovery

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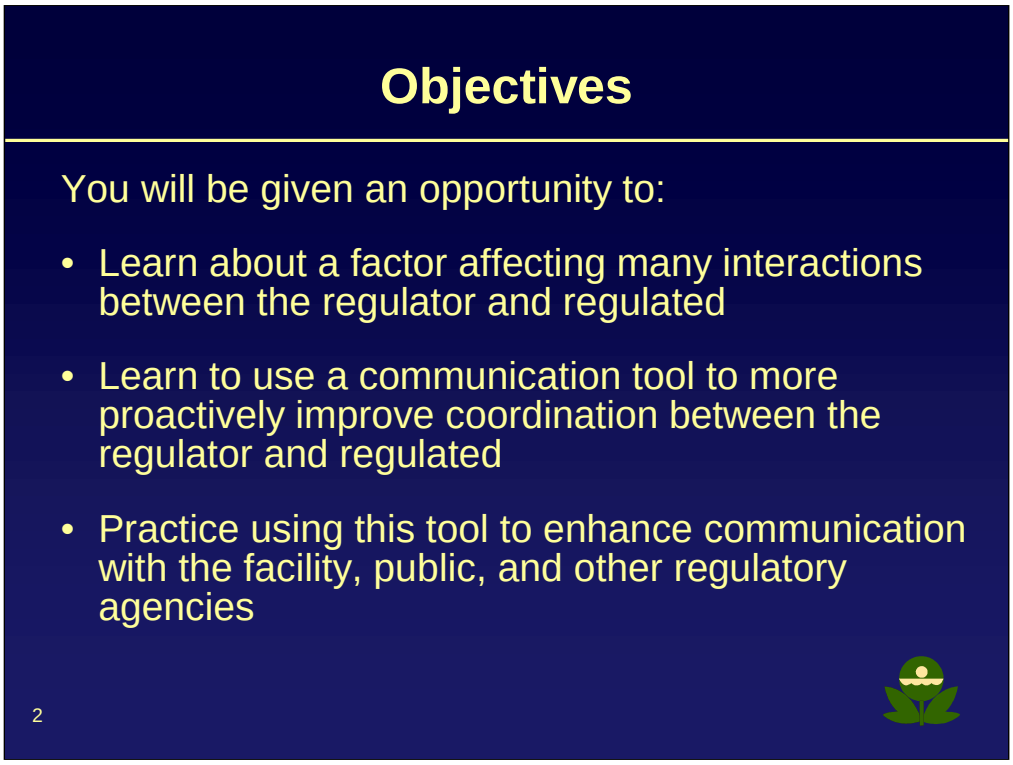
“Open Window” Communication

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.



Notes:

In this module, you will be introduced to a tool to help you channel the emotions, energy, and natural conflicts inherent in a Corrective Action toward a focus on the substantive and technical issues. This improves your ability to achieve Corrective Action Results more easily, effectively, and quickly.

You may use this tool to reduce the amount of unknown information in a Corrective Action project. As you reduce the amount of unknown information, you can better reduce or manage the level of uncertainty in a Corrective Action project.

You will practice using this tool to enhance communication between the facility, the public, and other regulatory agencies to achieve a Corrective Action Result.

A task
of a RCRA Corrective
Action Project Manager
is to **influence another**
to change.

Resistance

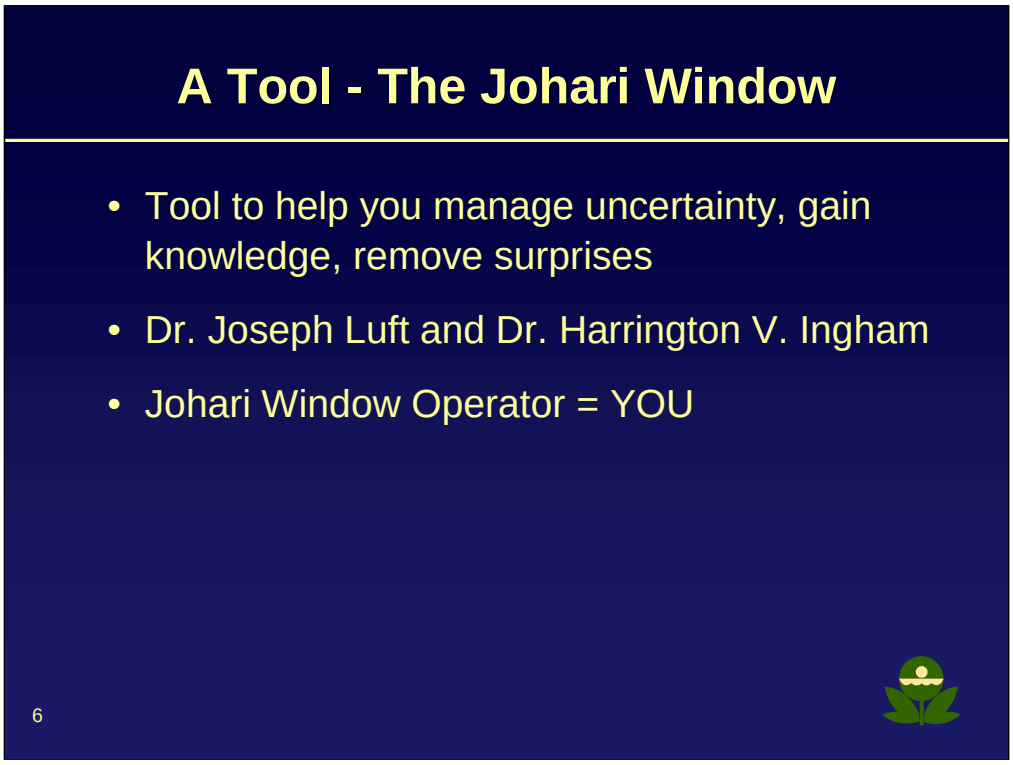
- Often a person's first response to making a change
- Natural human tendency when faced with:
  - uncertainty
  - unfamiliarity
  - the unknown
  - being "pushed" or forced
  - areas where one has been "burned"
  - no valid options or the opportunity to make a choice

Reducing Resistance

- **Resistance results from:**
- Uncertainty
- Unfamiliarity
- The Unknown
- Perception of being thwarted or disregarded
- Pushing or forcing
- No valid options or the ability to make a choice

- **Resistance reduced by:**
- Managing uncertainty
- Gaining knowledge
- Removing surprises
- Involve early and continuously
- Trying other solutions
- Options and flexibility

5

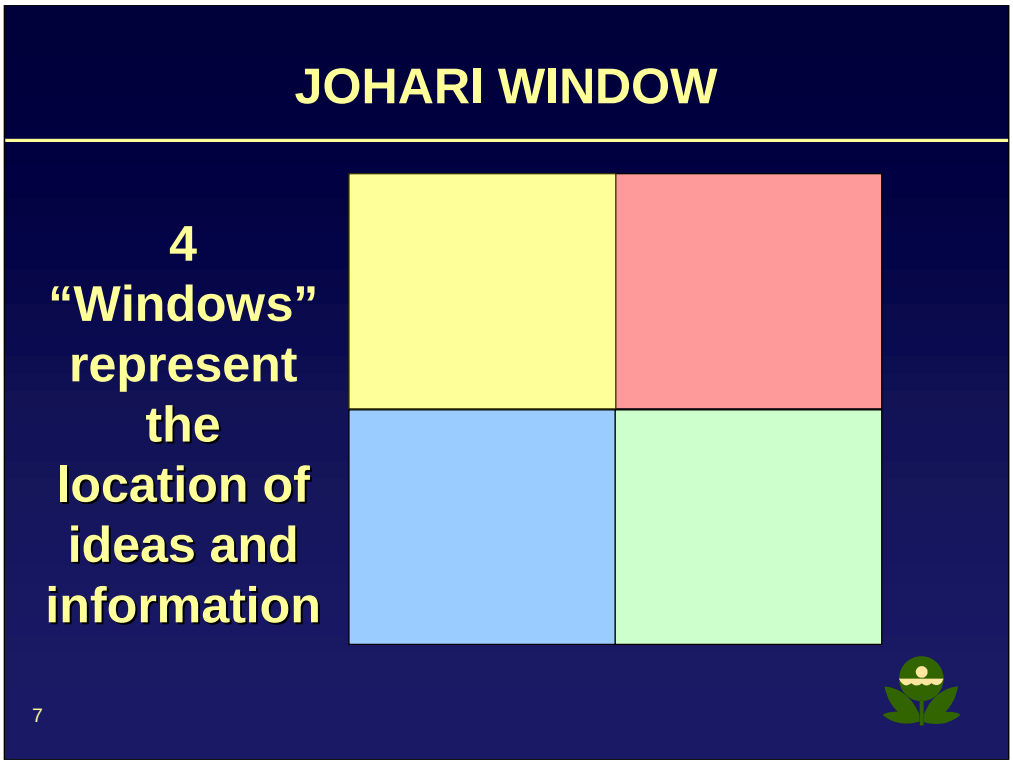


Notes:

The word "Johari" is a combination of the names "Joe" and "Harry," Joseph Luft, Ph.D., and Harrington V. Ingham, M.D., of the University of California at Los Angeles. Drs. Luft and Ingham developed the Johari Window model during a summer laboratory session in the 1950's. It first appeared in the *Proceedings of the Western Training Laboratory in Group Development* issued by the University of California at Los Angeles.

The Johari Window model addresses awareness in interpersonal relationships. The Johari Window is a tool to help you increase your understanding and skill in interpersonal relationships, such as those between the public, facility, and regulatory agencies in Corrective Action.

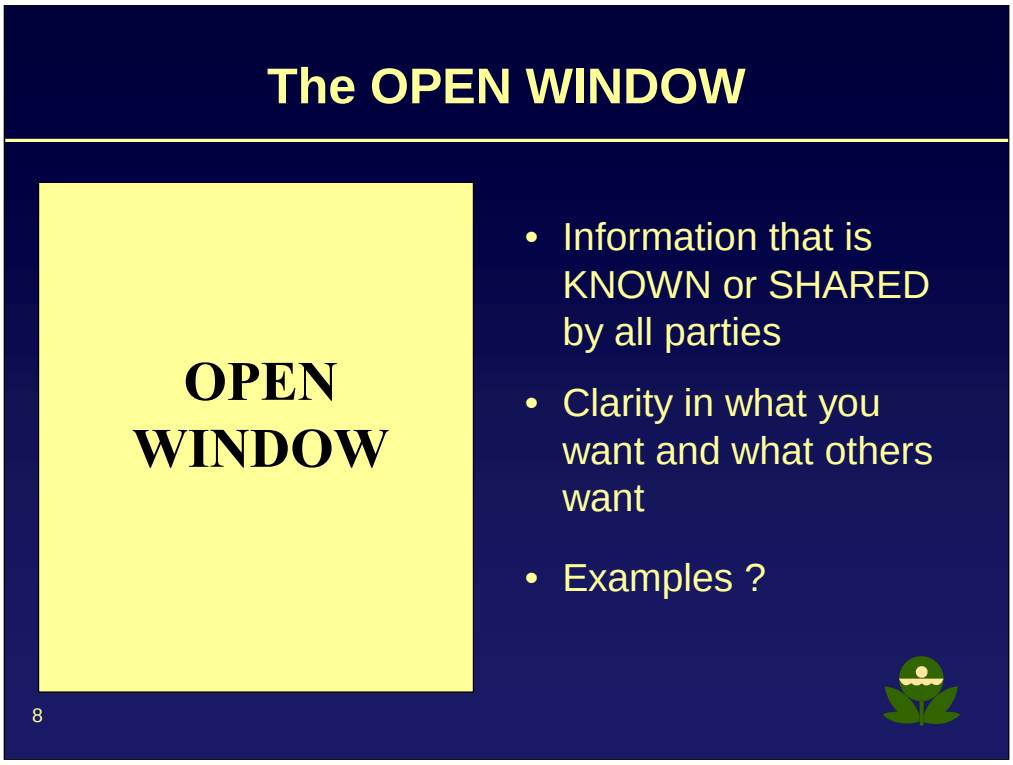
Although the facility and public can also operate the Johari Window, for the purposes of this presentation, assume the "operator" of the Johari Window is YOU.



Notes:

The Johari Window is a model that includes four "windows" to represent the location of ideas and information available within a group of people who are dependent upon one another to achieve a common outcome. In the case of a Corrective Action, the group represented by the Johari Window is the regulatory agency, the facility, and the public. At any one time during a Corrective Action, information important to the success of the project is available in one of four "windows:"

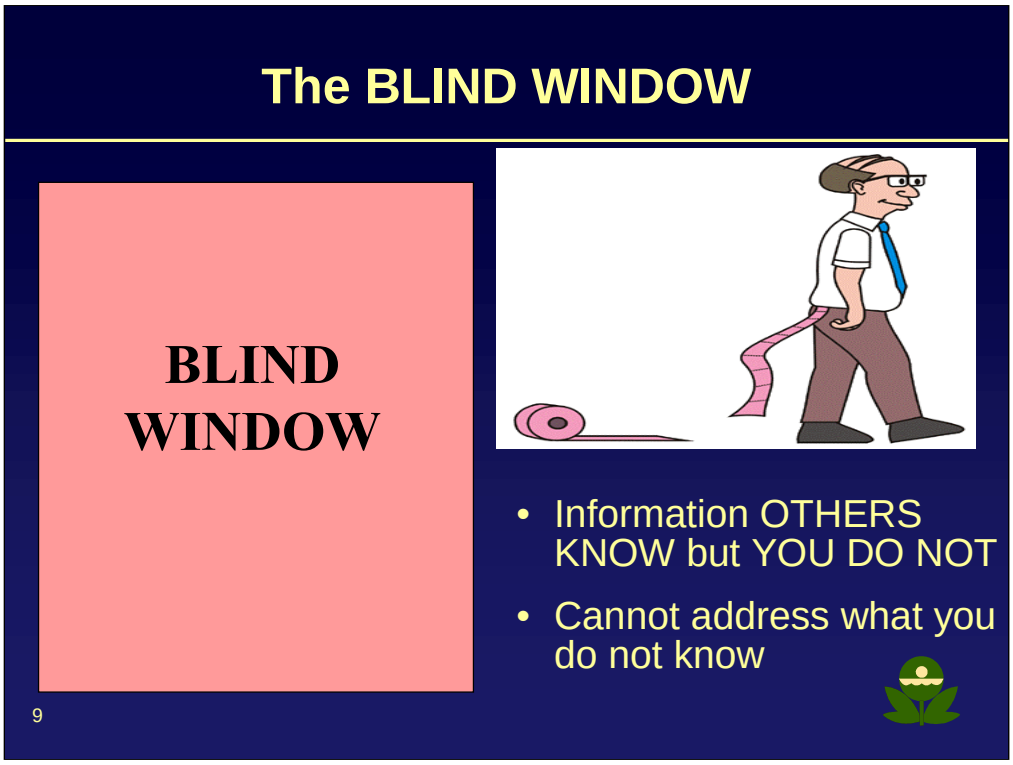
- Open Window;
- Blind Window;
- Hidden Window; or
- Unknown Window



Notes:

The Open Window contains information that is known or shared by all parties. In a Corrective Action, it is information that is readily known to the regulatory agencies, the facility, the public, and any other involved party.

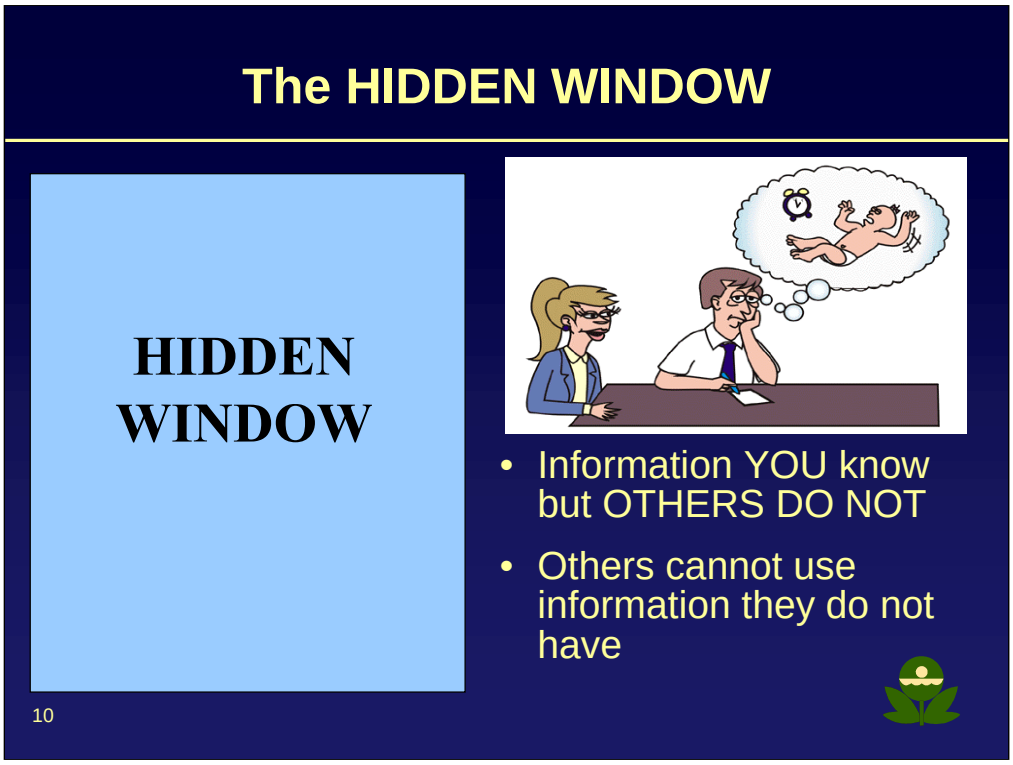
Examples of information typically in the Open Window in a Corrective Action include information as written in a RCRA Facility Assessment that is both understandable and available to all parties, the publicly stated concerns of an environmental group, or an annual report made available by a facility.



Notes:

The Blind Window contains information that others know but you do not know, information that others have but you do not have. Lacking certain information, you may be "in the dark" when it comes to making certain educated decisions.

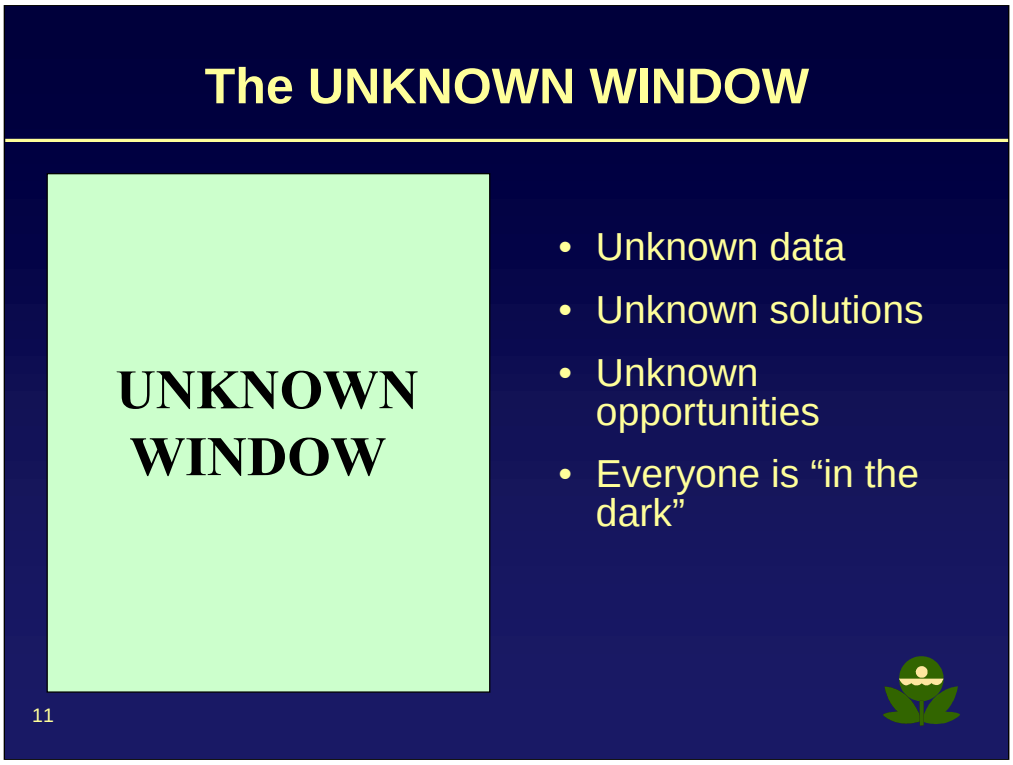
Examples of information that may be in a Blind Window in a Corrective Action include specific public needs and concerns, site characterization data or information regarding a facility's past history that the facility may be reluctant to reveal, or the results of another regulatory agency's recent facility inspection.



Notes:

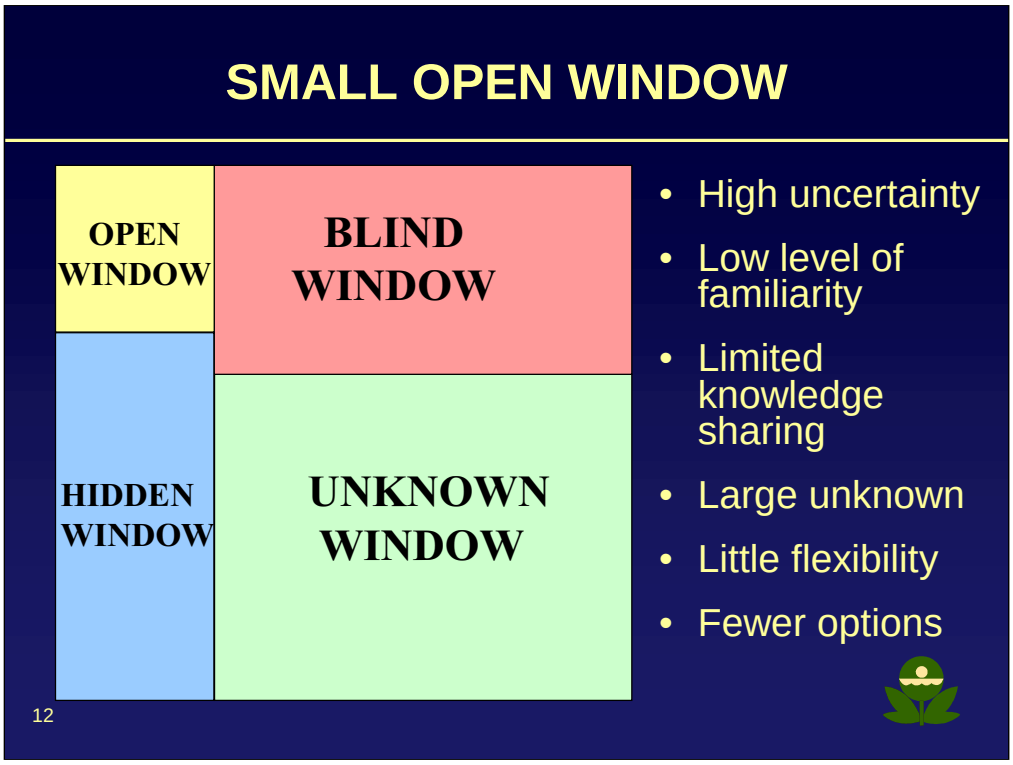
The Hidden Window contains information you know but others do not know, information that is visible to us but not to others. Lacking certain information, others may be "in the dark" when it comes to making certain educated decisions.

Examples of information that may be in a Hidden Window in a Corrective Action include a pending enforcement action on the facility, the stated concerns of an EPA or State technical support group that likely will significantly impact the facility's proposed technical approach, or the lack of EPA or State resources to conduct significant public participation efforts.



Notes:

The Unknown Window contains information not yet available to either you or others. This information may be in the form of data, solutions, or opportunities. In a Corrective Action, this information may be an innovative technical approach to a Corrective Action, a new available technology developed yet not known by the particular facility, regulatory agency, or public. Or, it may be site characterization data, such as buried drums, as yet completely unknown to anyone.

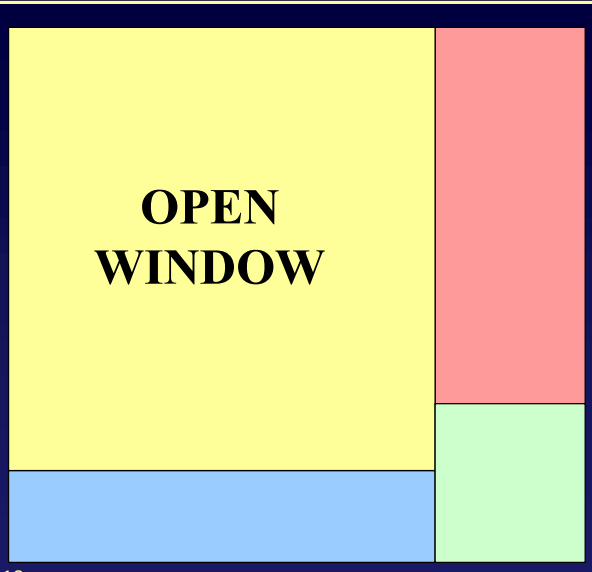


Notes:

Generally, in a new or difficult working relationship, the Open Window is small. Communication is superficial and guarded. Suggestions are not implemented and often left undeveloped. Productivity is low. Much information is kept hidden or is unknown, and people are often blind to information that others have.

Your task in building open and productive communication is two-fold: to reduce the size of the Hidden Window, and to reduce the size of the Blind Window. Through reducing the size of the Hidden and Blind Windows, the size of the Unknown Window is automatically decreased.

LARGE OPEN WINDOW



- Easier to manage uncertainty
- Familiarity
- Knowledge sharing
- Little that's not known
- More options

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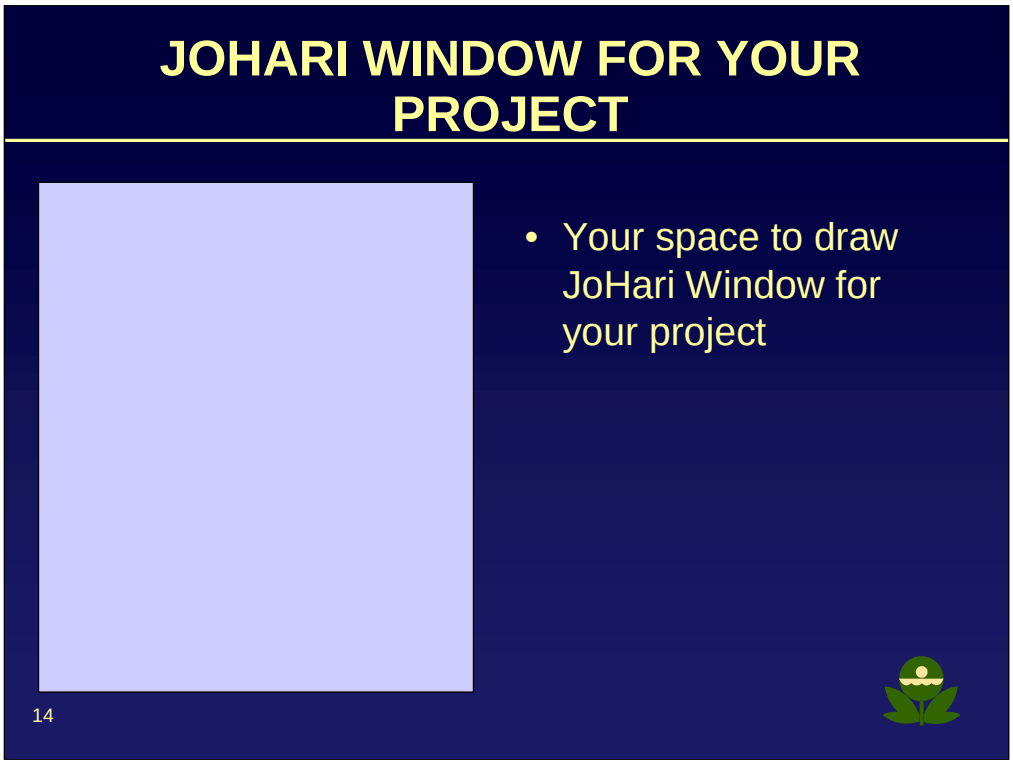
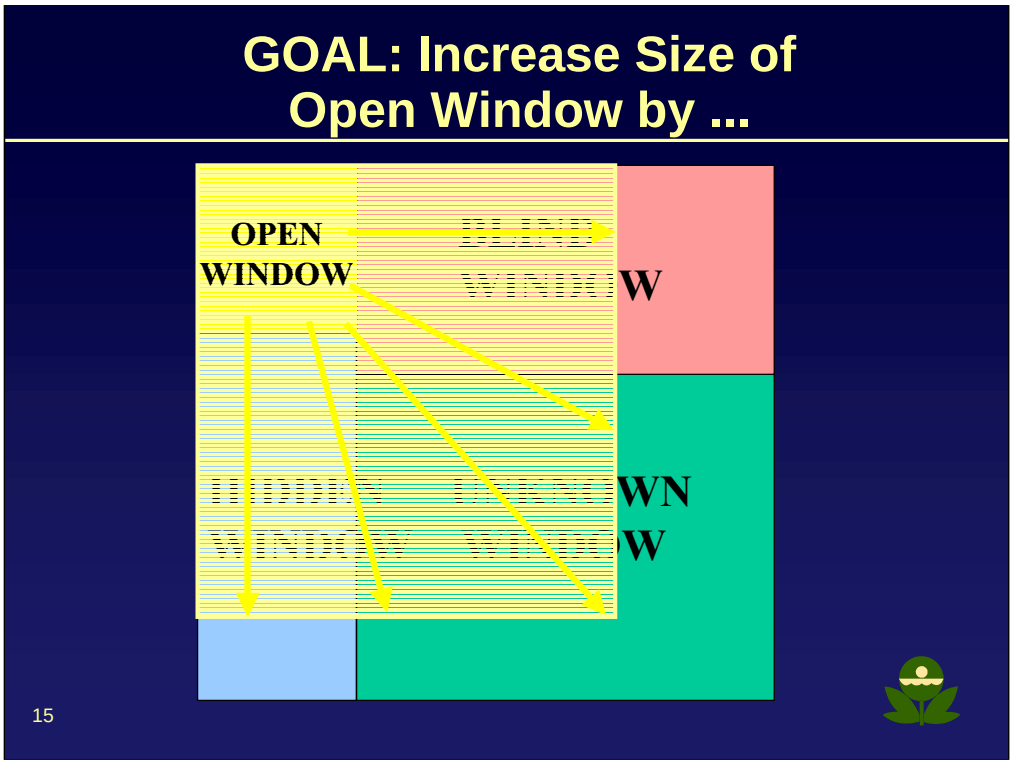


Notes:

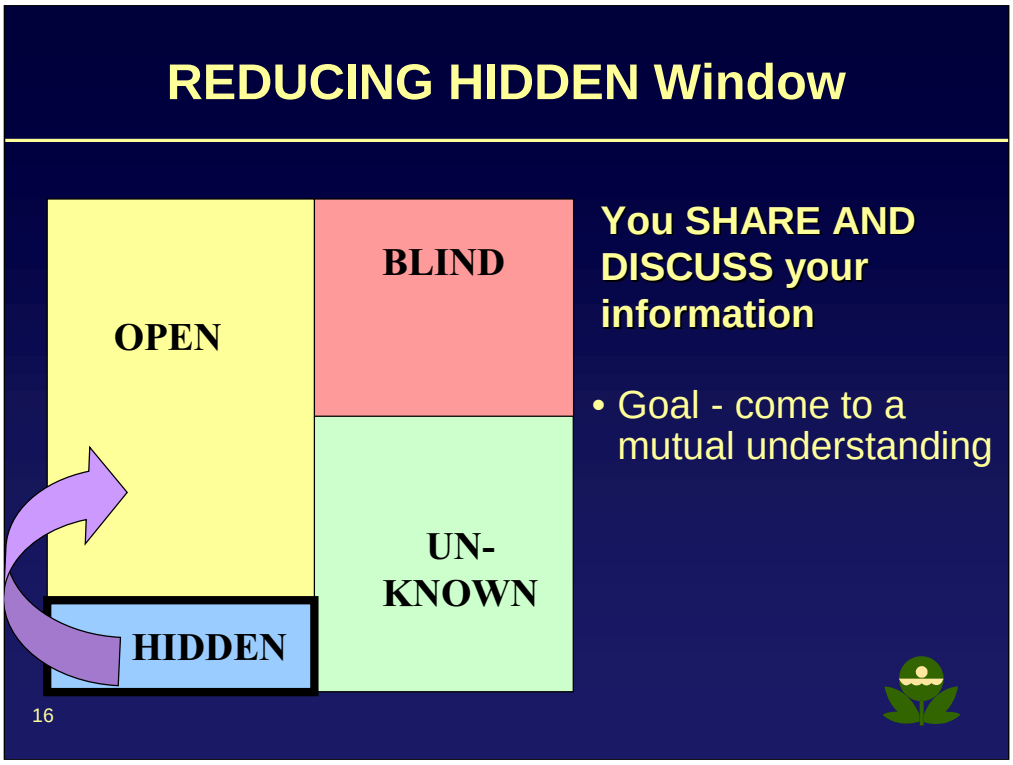
The Open Window contains information that is known or shared by all parties. In a Corrective Action, it is information that is readily known to the regulatory agencies, the facility, the public, and any other involved party.

Examples of information typically in the Open Window in a Corrective Action include information as written in a RCRA Facility Assessment that is both understandable and available to all parties, the publicly stated concerns of an environmental group, or an annual report made available by a facility.



Notes:

As the size of the Open Window increases, the size of the Unknown Window automatically decreases. New solutions, unknown data, and unforeseen opportunities become known by either yourself, the public, the facility, or another regulatory agency. As more information is both shared and sought out by these parties, innovative solutions become more and more available.



Notes:

You reduce the size of the Hidden Window by SHARING AND DISCUSSING INFORMATION that you or your agency knows but that the public, facility, or other regulatory agencies may not know. Such information might include your personal goals and expectations regarding a particular corrective action, the requirements of your agency or of the regulations, or technical information in a form that is both understandable and useable.

Notes:

Some means for you to SHARE AND PROVIDE INFORMATION with the public, facility, and other regulatory agencies regarding a Corrective Action include:

The EPA or State's Conceptual Site Model for the Facility. This is a tool to help focus discussions on substantive and technical issues versus personalities.

Environmental Indicators. The facility and public may benefit from being made aware of the EPA or State regulatory agency assumptions regarding the corrective action.

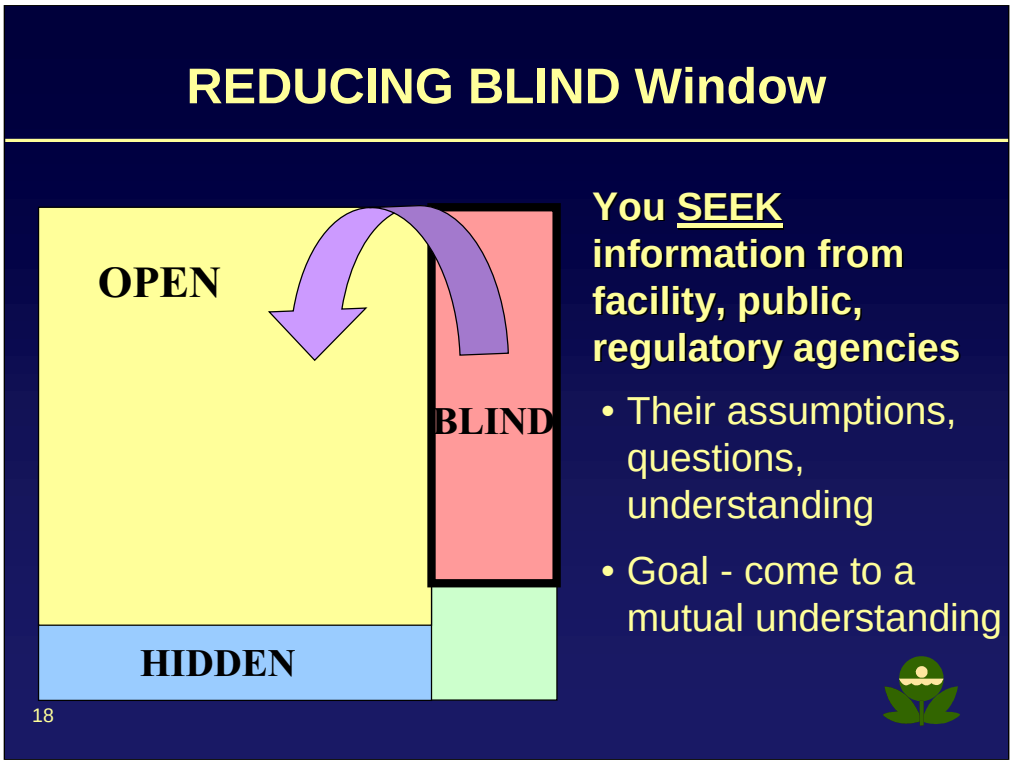
Letter of Expectations. This describes your agency's primary expectations for a facility deliverable or activities, such as a focused RCRA Facility Investigation or a Facility-led (Voluntary) Corrective Action.

Site Visits, Interactive Briefings, Working Meetings. Early, regular, and routinely scheduled opportunities for the facility, regulatory agency, and public to interface provide the means for the exchange of information.

Core Technical Group. This is a group of designated representatives from the facility, regulatory agency, and public that meets on a routine basis to discuss the goals and progress of a corrective action. The Core Group minimizes opportunities for the spread of misinformation or miscommunication by serving as a focal point for the exchange of information between the regulatory agency, the facility, and the public.

Public Availability/Poster Sessions. These offer an opportunity to share information with the public, and to seek information from the public.

Interagency Committees. These offer an opportunity to share information with other regulatory agencies relevant to a corrective action project or program.



Notes:

You reduce the size of the Blind Window by SEEKING INFORMATION. You seek information from the facility and the public, information you need to know that you don't currently know that will help achieve a Corrective Action. Such information might include the specific goals of the facility (near and long-term) for the corrective action, the facility's predicted end land use, the public's specific questions and concerns, and the facility's risk assessment assumptions that help determine a Corrective Action decision.

Notes:

Some means for you to share, discuss, and more easily come to a mutual understanding with the facility, the public, or other regulatory agencies for a Corrective Action include:

Conceptual Site Model. This is a tool to help focus discussions on substantive and technical issues versus personalities. It helps you understand the facility's fundamental technical assumptions for a Corrective Action. Many of these are obtained in a facility's conceptual site model. Through seeking a facility's assumptions, you begin to understand where the assumptions (yours, the facility's, and even the public's) differ.

Facility's Environmental Indicator Forms. Some EPA Regional Project Managers have suggested facilities complete Environmental Indicator (EI) forms for the purpose of comparing their (Project Manager) technical assumptions with those of the facility. This helps identify the specific areas of agreement and disagreement which in turn helps focus the discussions on the technical issues.

Site Visits, Interactive Briefings, Working Meetings. A site visit to the facility can provide you with valuable information. The old adage "a picture is worth a thousand words" appropriately describes the value of getting information firsthand, seeing with your own eyes, and hearing with your own ears. As with opening the Hidden Window, interactive briefings and working meetings with the facility, public, or other regulatory agencies is a means to exchange (provide and seek) information relative to a Corrective Action.

Teleconferences. Regular and routine teleconferences with the facility, the public, or the other regulatory agencies afford you the opportunity to continually build your knowledge base.

Notes:

EPA's most comprehensive public involvement guidance for RCRA Corrective Action under permits and 3008(h) orders is outlined in Chapter 4 of RCRA Public Participation Manual, EPA 530-R-96-007, September 1996. Following are the overarching principles outlined in this manual for you to consider in developing effective communication between the regulatory agency, facility, and public.

Early participation. The need for public information and involvement varies from site to site. By canvassing the public early in the Corrective Action process, the regulatory agency and facility can determine the level of public interest and need for information. This, in turn, increases the likelihood of a public participation effort tailored to meet the specific community needs.

Public participation is often most effective if initiated early in the Corrective Action process. An important benefit of early participation is an increased likelihood of gaining the public's trust. Parties that trust one another can more easily communicate and cooperate to achieve a Corrective Action.

Consistency with Superfund. EPA encourages permitting agencies and facilities to make public participation activities during Corrective Action consistent with those activities required under Superfund. For example, public participation activities for a significant interim action would equal or exceed those required for a Superfund removal action.

Shared responsibility for public participation activities. The Corrective Action process may involve several steps initiated by a regulatory agency or a facility. Thus, public participation is an activity shared by the regulatory agency and the facility. Public participation activities will often be more useful if initiated by the party who performed the latest cleanup step.

Minimum Public Participation

- At the initiation of Corrective Action
- At selection of significant interim measures
- Prior to remedy proposal, when community acceptance is weighed as a remedy balancing factor
- At selection of a final remedy
- At completion of Corrective Action

Notes:

You can refer to the following documents to learn more about some means to SEEK (and share) INFORMATION from the public. Although many of these are Superfund documents, the same fundamental principles and practices apply to developing open and productive communication with the public in a RCRA Corrective Action.

The *Superfund Community Involvement Handbook and Toolkit* Dec 15, 1998 includes the following sections:

• Public Availibility/Poster Sessions

• Public Meetings

• The Community Visioning Process

• Risk Communication

• Facilitation

• Conflict Resolution/ADR

"About the Community Advisory Group Toolkit: A Summary of the Tools," EPA 540-K-97-007, September 1998

"Guidance for Community Advisory Groups at Superfund Sites," EPA 540-K-96-001, December 1995

"Community Advisory Groups (CAGs) at Superfund Sites," EPA 540-F-96-016, August 1996

Reducing Resistance

- Resistance results from:
- Uncertainty
- Unfamiliarity
- The Unknown
- Perception of being thwarted or disregarded
- **Pushing or forcing**
- **No valid options or the ability to make a choice**

- Resistance reduced by:
- Managing uncertainty
- Gaining knowledge
- Removing surprises
- Involve early and continuously
- **Trying other solutions**
- **Options and flexibility**

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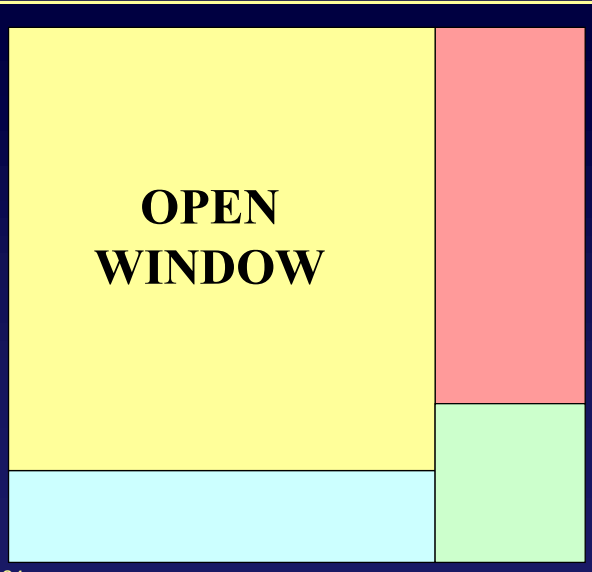
LARGE OPEN WINDOW



- Now, build on areas of agreement
- “Break off a small piece”
- Look for small successes
- Take change in “chunks”
- Be flexible

24

“Imagination is more important than knowledge.”

Albert Einstein

Notes:

These Communication Tools are designed specifically for a RCRA Corrective Action Project Manager. You can find these communication tool sheets in your Handbook.

Table Exercise Using Case Study

- Pick ONE of the following:
  - AMT Inc.
  - Mr. and Mrs. Smith
  - Another regulatory agency.
- Draw the JoHari Window.
- Brainstorm some options to open the Johari Window and reduce resistance with this party.
- Write a group report, and be prepared to report out to the larger group.

27

Managing Remediation Waste

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

Objectives

Participants will be able to:

- Identify the subset of remediation waste that is subject to RCRA hazardous waste requirements
- Apply some commonly used Federal remediation waste regulations and policies to tailor RCRA hazardous waste requirements to the circumstances of remediation

What Are We Going to Do?

- Discuss regulations and policies that guide your decisions about whether remediation waste is subject to regulation under RCRA
- Discuss regulations and policies that allow you to tailor RCRA requirements to the circumstances of remediation
- Give you an opportunity, working in small groups, to apply these remediation waste regulations and policies to an example from your work experience or a case study

3

Early Identification of Remediation Waste Requirements

- Typically, cleanup sites generate cleanup wastes commonly called “remediation wastes”
- Failure to identify the subset of remediation waste that is subject to RCRA requirements early in cleanup often leads to delay
- What types of remediation waste are usually regulated as hazardous waste under RCRA?

4

Notes:
Project Managers for cleanup sites typically have to oversee management of contaminated soil, groundwater or other environmental media, contaminated debris, and other cleanup wastes. These materials are commonly called "remediation wastes." Some remediation wastes are subject to regulation as hazardous waste under RCRA. The subset of remediation waste that is subject to regulation as hazardous waste under RCRA is commonly called "hazardous remediation waste.”

Because of the nature of the RCRA requirements, many project managers find that a small volume of hazardous remediation waste drives their cleanup decisions, often to the detriment of the larger cleanup action. For many years, EPA has recognized the barriers the RCRA requirements can present during cleanup actions. In an effort to overcome these barriers, EPA has established many rules and policies specific to hazardous remediation waste. These include: (1) the contained-in policy, (2) the area of contamination policy, (3) site-specific land disposal restriction treatment variances, and (4) the recently promulgated hazardous waste identification rule.

We will focus on successful early identification of hazardous remediation waste and appropriate application of EPA’s regulations and policies for remediation waste.

For Waste: Normal RCRA Applies

- Use the waste designation process under RCRA to determine if non-media, non-debris remediation wastes are hazardous
- Remember retroactivity of listings

5

Notes:

As with any other waste designation, first evaluate whether the material is considered solid waste, then, if solid waste, evaluate whether it is hazardous waste.

Look at: listings; characteristics.

For wastes disposed of prior to 1980, that were then treated, stored, disposed of or otherwise handled after 1980 (e.g., removed from the land and re-disposed off-site), RCRA listings may apply depending on the specifics of the handling.

See 55 FR 8762-8763 (March 8, 1990)

For Environmental Media and Debris: Contained-In Policy

- Contaminated environmental media is not solid waste, so it cannot be hazardous waste.
- Is subject to regulation if it “contains” hazardous waste
- EPA and authorized States make “contained-in” decision

6

Notes:
Contaminated environmental media (soil, groundwater, surface water, sediments) are not solid wastes and therefore cannot be hazardous wastes. However, when contaminated environmental media "contain" hazardous waste, EPA's policy is that the media must be managed as if they were hazardous waste unless and until they no longer contain hazardous waste. This is known as the "contained-in policy.” The contained-in policy therefore governs when contaminated environmental media must be managed as if they were hazardous waste. EPA's policy is that contaminated environmental media generally contain hazardous waste when: (1) the media exhibit one of the characteristics of hazardous waste (usually one of the toxicity characteristics), or (2) when hazardous constituents from listed hazardous waste are present in the media at concentrations greater than health-based levels calculated using a reasonable maximum exposure scenario (for example, protective, site-specific, risk-based cleanup levels). It is critical that contained-in decisions be made as early as possible in a cleanup. Ideally, the decisions should be made before or at the same time as contaminated environmental media are removed from the land. The contained-in policy also applies to man-made and environmental debris.

Environmental media and debris that do not or no longer contain hazardous waste are generally not subject to RCRA requirements (except, under certain circumstances, the land disposal restrictions).

References: The contained-in policy was first articulated in a November 13, 1986 EPA memorandum, “RCRA Regulatory Status of Contaminated Groundwater.” It has been updated many times in Federal Register preambles, EPA memos and correspondence, see, e.g., 53 FR 31138, 31142, 31148 (Aug. 17, 1988), 57 FR 21450, 21453 (May 20, 1992), and detailed discussion in HWIR-Media proposal preamble, 61 FR 18795 (April 29, 1996).

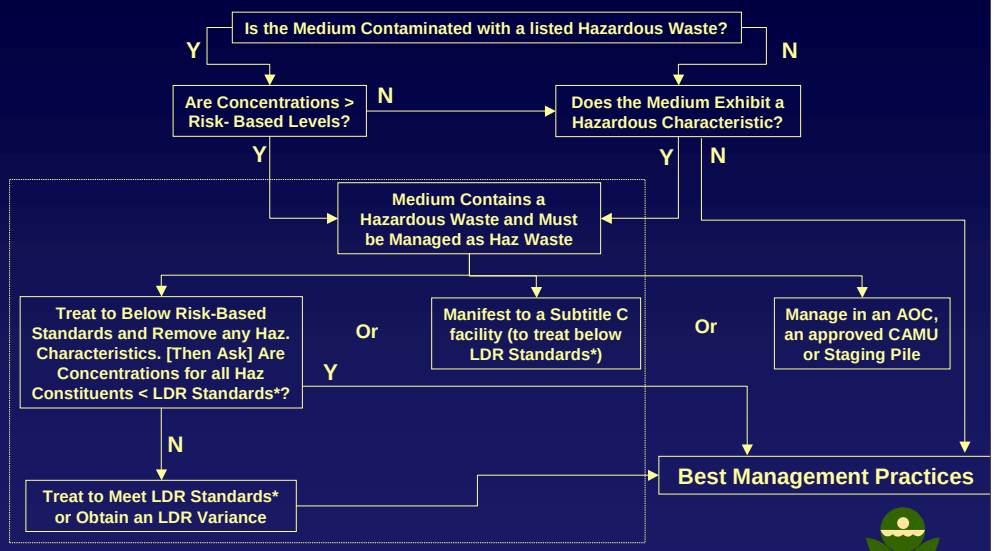
For Environmental Media and Debris: Contained-In Policy (Cont.)

- Environmental media and debris that do not or no longer contain hazardous waste are generally not subject to RCRA requirements <u>except</u>, under certain circumstances, the land disposal restrictions

Do Media Contain Hazardous Waste?

1 ALL MEDIA REGARDLESS OF SOURCE OF CONTAMINATION	If media fails one or more characteristic test	Yes
	If media does not exhibit a hazardous characteristic	No
2 MEDIA CONTAMINATED WITH LISTED HAZARDOUS WASTE	If concentrations of hazardous constituents are determined to be above health based levels	Yes
	If concentrations of hazardous constituents are determined to be below health based levels	No
3 MEDIA CONTAMINATED WITH CHARACTERISTIC HAZARDOUS WASTE ONLY	If media fails one or more characteristic test	Yes
	If media does not exhibit a hazardous characteristic	No

Management of Contaminated Media – EPA Region 4



9

* LDR Standards may be Universal Treatment Standards or, when applicable, the Alternate LDR Treatment Standards for Contaminated Soil (40 CFR 268.49

Area where LDR Applies

For Waste: Do LDRs Apply?

- Use the normal process for LDRs
  - Check to see if waste prohibited (by waste code)
  - Look up treatment standards

10

Notes:

Waste prohibitions are listed, by waste code, in 40 CFR part 268 Appendix VIII, Table 1.

This table also lists the dates the prohibitions become effective.

Treatment standards are generally listed in 40 CFR 268 40.

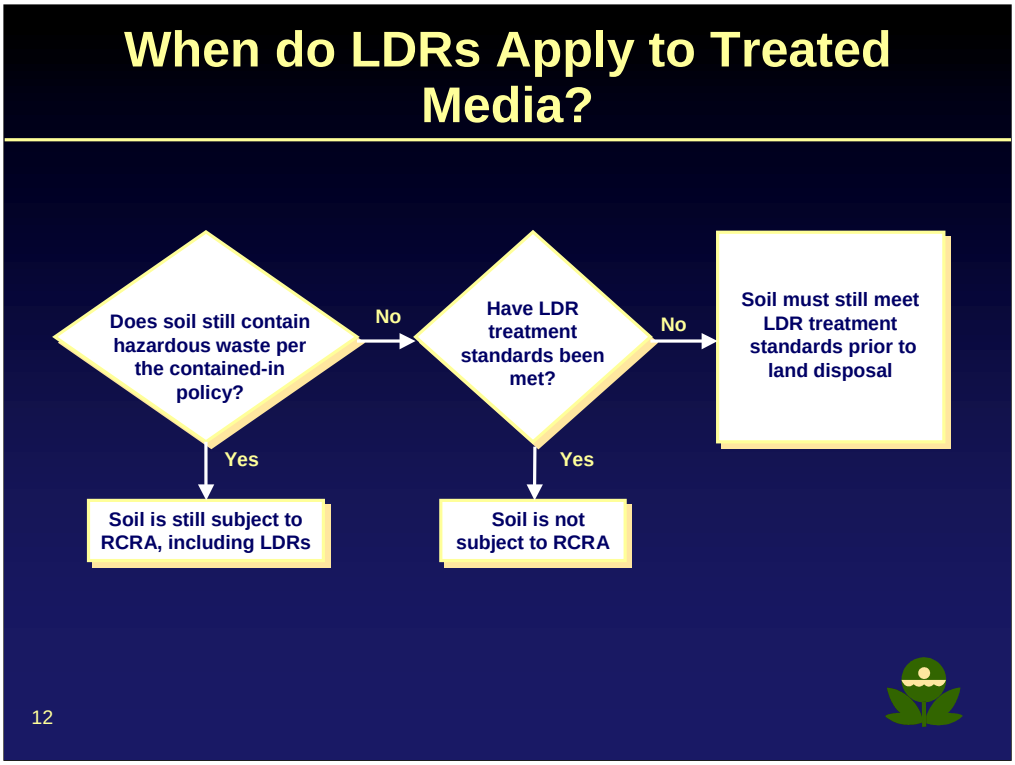
Notes:

Three principles informed EPA's policies on application of LDRs to contaminated media.

First – LDRs attach only to prohibited hazardous waste (including hazardous waste contained in environmental media) when it is (1) "generated," and (2) subsequently placed in a land disposal unit. Therefore, if contaminated environmental media is not removed from the unit (i.e., "generated") LDRs do not apply. Similarly, if contaminated environmental media is removed from the land (i.e., "generated") yet never placed in a land disposal unit, LDRs do not apply.

Second – once a decision has been made to "generate" and land-dispose contaminated environment media, LDRs generally apply only to contaminated environmental media that contain hazardous waste. Exception to this rule flows from principle three.

Third – once LDRs attach to any given hazardous waste (including hazardous waste contained in environmental media) the LDR treatment standards continue to apply until they are satisfied and elimination of the "hazardousness" of the waste or contaminated environment media does not automatically satisfy LDRs. Application of this principal is covered in more detail on the next slide.



Notes:

One of the principles that governs EPA's policies on application of LDRs to contaminated environmental media is that once LDRs attach to any given volume of hazardous waste (or environmental media that contain hazardous waste) the LDR treatment standards continue to apply until they are satisfied. In other words, elimination of the property that caused the waste to be hazardous in the first instance (or the environmental media to contain hazardous waste in the first instance) does not automatically satisfy LDRs and the LDR treatment standards may, in fact, continue to apply to the decharacterized waste or to the environmental media that no longer contains hazardous waste.

This principle comes from application of the logic of the Chemical Waste opinion #l. In that opinion the D.C. Circuit held that land disposal prohibitions attach at the point that a hazardous waste is generated and continue to apply until threats posed by land disposal of the waste are minimized. (Chemical Waste Management v. EPA, 976 F.2d at 13, 14, and 24.) In illustration of this principle, the court held that (in the case of characteristic hazardous waste) elimination of the property that caused EPA to identify a waste as hazardous in the first instance does not automatically eliminate a duty to comply with LDRs.

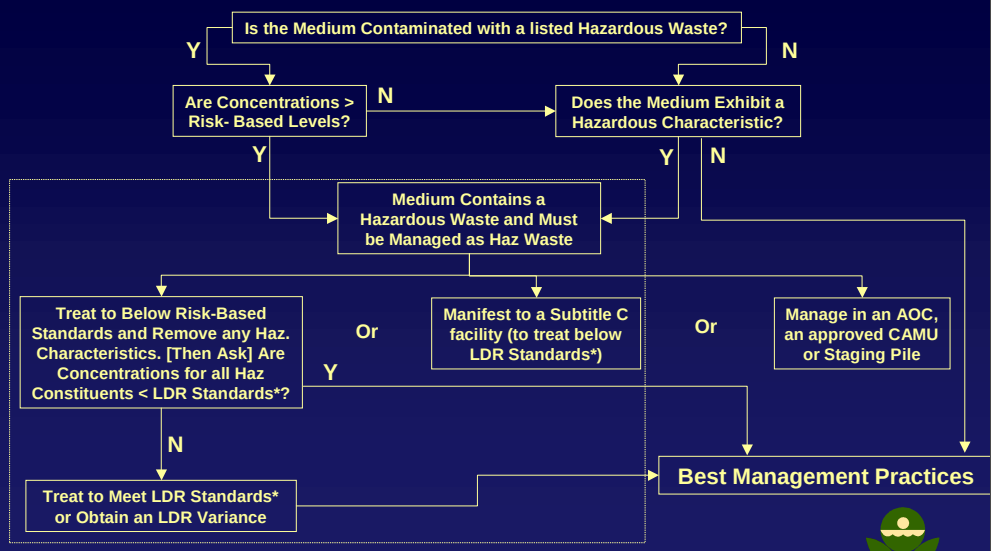
For a detailed discussion of application of LDRs to contaminated environmental media (in the context of contaminated soil) see the preamble to the Soil Treatment Standards Regulations, 63 FR 28671 – 28620 (May 26, 1998).

Alternative LDR Treatment Standards

If LDRs	And If LDRs	And If	Then you
Applied to the listed waste when it contaminated the soil*.	Apply to the listed waste now	.....	Must comply with LDRs.
Didn't apply to the listed waste when it contaminated the soil*.	Apply to the listed waste now	The soil is determined to contain the listed waste when the soil is first generated.	Must comply with LDRs.
Didn't apply to the listed waste when it contaminated the soil*.	Apply to the listed waste now	The soil is determined not to contain the listed waste when the soil is first generated.	Needn't comply with LDRs.
Didn't apply to the listed waste when it contaminated the soil*.	Don't apply to the listed waste now	.....	Needn't comply with LDRs.

* For dates of LDR applicability, see 40 CFR Part 268 Appendix VII. To determine the date any given listed hazardous waste contaminated any given volume of soil, use the last date any given listed hazardous waste was placed into any given land disposal unit or, in the case of an accidental spill, the date of the spill.

Management of Contaminated Media – EPA Region 4



14

* LDR Standards may be Universal Treatment Standards or, when applicable, the Alternate LDR Treatment Standards for Contaminated Soil (40 CFR 268.49

Area where LDR Applies

Review

- Cleanup sites will typically generate remediation waste
- Not all remediation waste is hazardous, even at a TSDF
- To figure out if remediation waste is hazardous, it helps to divide it into media and non-media
- LDRs generally apply only to hazardous remediation waste
- Early identification of the subset of remediation waste that's hazardous at any given site is important

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You've Got Hazardous Remediation Waste - Now What

- Waste can be managed in certain types of units that limit or tailor RCRA requirements
- Special LDRs for some hazardous remediation waste, and LDR treatment variences
- Permit waivers and other special forms of permits and approvals are available

16

Area of Contamination (AOC) Policy

- Equates areas of dispersed contamination with a RCRA unit
- Consolidation and/or *in situ* treatment of hazardous waste within an AOC are not "placement" under RCRA

17

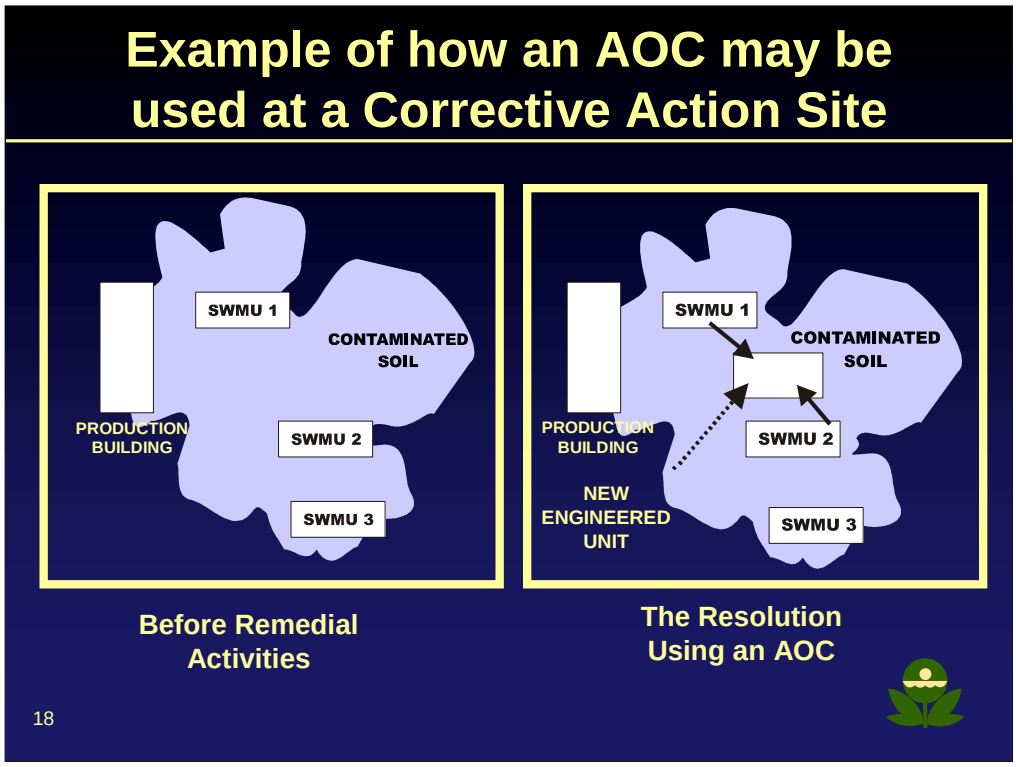
Notes:

The "Area of Contamination Policy" equates areas of dispersed contamination with a RCRA unit.

Consolidation of waste within an AOC and treatment of waste *in situ* within an AOC are not considered "placement" of hazardous waste, therefore a duty to comply with LDRs is not triggered.

Many people confuse the AOC policy with the regulations for Corrective Action management units (CAMU). Generally, wastes must be managed in situ to be covered by the AOC policy. With CAMUs wastes may be treated in non-land-based units, then placed or replaced in a CAMU. The differences between CAMUs and AOCs will be covered in more detail later.

References: The AOC policy was first articulated in the National Contingency Plan (NCP). See 53 FR 1444 for detailed discussion in proposed NCP preamble; 55 FR 8758-8760, March 8, 1990 for final NCP preamble discussion. See also, most recent EPA guidance, March 13, 1996 EPA memo, "Use of Area of Contamination Concept During RCRA Cleanups."



Notes:

Before remedial activities:
Remediation waste, in the form of old, weathered sludges, is distributed among three solid waste management units. Each unit has an apron of contaminated soil. There is also contaminated soil outside of the process building. This soil contamination overlaps with the contamination from some of the solid waste management units, creating a large area of dispersed soil contamination by various organic constituents, from various sources, at various concentrations.

The remediation goal at the facility is to consolidated all contaminated soil and other remediation waste into a land-based, lined unit, cap, and leave in place.

The resolution using AOC:
A land-based, lined unit is constructed within the area of soil contamination. Sludges from SWMUs 1, 2, and 3 are consolidated into the unit. Contaminated soil is also consolidated into the unit.
The unit is capped.

Corrective Action Management Unit (CAMU)

- A specific type of land-based unit that can be used to treat, store, or dispose of hazardous remediation wastes
- Minimum technological requirements may be tailored to site- and waste-specific circumstances

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Notes:

The CAMU rules went into effect in 1993.

CAMUs may be approved at any cleanup site where hazardous remediation waste will be treated, stored, or disposed. EPA recently clarified the CAMU definition to emphasize that CAMUs are available for all hazardous remediation waste.

CAMUs do not have to meet the existing minimum design, operating, closure, and post-closure requirements for hazardous waste units; instead, they have to meet design, operating, closure, and post-closure performance standards in the CAMU rule.

Corrective Action Management Unit (Cont.)

- Placement of waste in a CAMU does not trigger a duty to comply with LDR treatment standards
- CAMUs must be approved by EPA or a State in a permit, order, or other enforceable document

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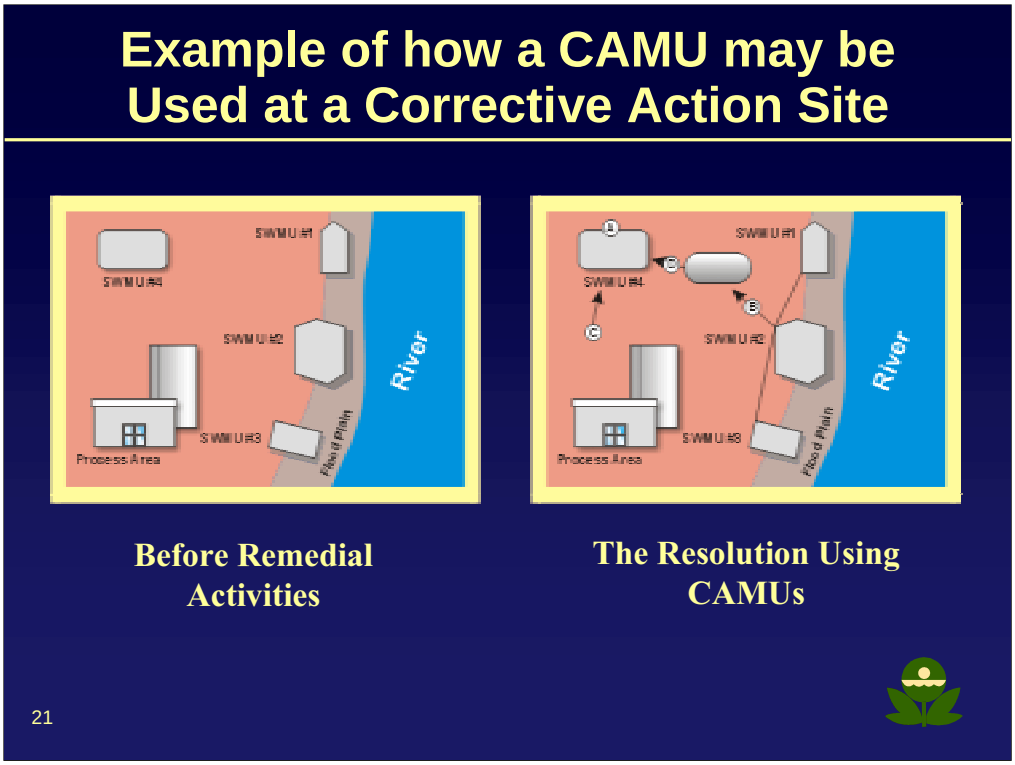
Notes (Cont'd):

Although there is a preference for use of CAMUs to facilitate treatment, placement of remediation waste into a CAMU does not trigger a duty to comply with land disposal restriction treatment standards.

CAMUs must be approved by EPA or a State in a permit, order, or other enforceable document. For example, the CAMU requirements can also be applied as applicable, relevant, and appropriate requirements under CERCLA and approved in records of decision or applied as ARARs under a State cleanup program similar to CERCLA and approved in enforceable State documents.

References: See 58 FR 8677, February 16, 1993; appropriate use of RCRA Section 7003 orders and comparable state orders are discussed in an EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2. CAMU regulations are at 40 CFR 264.552, promulgated February 16, 1993 (58 FR 8658). The differences between CAMUs and AOCs are discussed in more detail in the March 13, 1996 EPA guidance memo, "Use of the Area of Contamination Concept During RCRA Cleanups."



Notes:

Before Remedial Activities

The remedial goal at this facility is to treat the waste in each of the solid waste management units and consolidate the wastes from the SWMUs in the flood plain to a more protective location.

The Resolution Using CAMUs

(A) The Regional Administrator or State Director designates SWMU #4 as a CAMU.

(B) The remediation waste from the four SWMUs are then removed and treated in a temporary on-site treatment unit.

(C) SWMU #4 is retrofitted with a liner.

(D) The treatment residuals can be placed in the CAMU without meeting the land disposal restrictions. Specific treatment standards and other design, operation, closure, and post-closure requirements for CAMU would be specified according to the criteria in the CAMU regulation. EPA strongly encourages use of CAMUs for treatment.

Reference: Fact Sheet, "EPA Issues Final Rules for Corrective Action Management Units and Temporary Units" (Washington, D.C.: United States Environmental Protection Agency, EPA/530-F93-001, 1993), p.4.

What is a Corrective Action Temporary Unit (TU)

- A specific type of RCRA unit for non-land-based treatment or storage of hazardous remediation waste
- Allows tailoring of the design and operating requirements for tanks and containers (e.g., secondary containment)
- Must be approved by EPA or a State in a permit, order, or other enforceable document

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Notes:

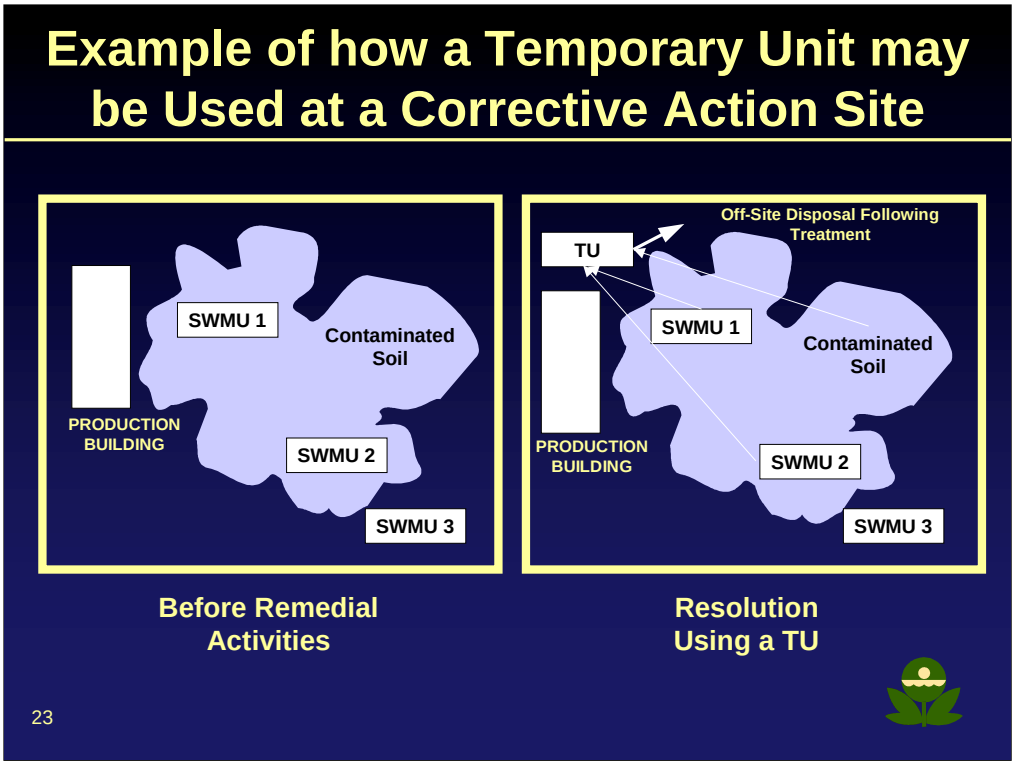
The TU regulations were published with the CAMU regulations and went into effect in 1993.

TUs may be approved at any site where hazardous remediation waste will be stored in tanks or containers.

A Temporary Unit (TU) is a tank or container storage unit used for treatment or storage of remediation wastes.

EPA or a State may determine that a design, operating, or closure standard normally applicable to a tank or container storage unit does not apply to a TU provided they replace the requirement with an alternative requirement that is protective of human health and the environment.

References: See, 58 FR 8677, February 16, 1993; appropriate use of RCRA Section 7003 orders and comparable state orders is discussed in an EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2. The TU regulations are at 40 CFR 264.553, promulgated February 16, 1993 (58 FR 8658).



Notes:

Before remedial activities:
Remediation waste, in the form of old, weathered sludges, is distributed among three solid waste management units. Each unit has an apron of contaminated soil. There is also contaminated soil outside of the process building. This soil contamination overlaps with the contamination from some of the solid waste management units, creating a large area of dispersed soil contamination by various organic constituents, from various sources, at various concentrations.

The remediation goal at the facility is to treat all contaminated soil and other remediation waste on-site in a tank until the applicable land disposal restriction treatment standards have been achieved, then to send the treated remediation waste off-site for disposal.

The resolution using TU:
A tank-based treatment unit is constructed in an area of the site that is already contaminated.
Contaminated soil and other remediation wastes are treated, by batch, in the treatment unit. The treatment results in compliance with applicable LDR treatment standards.
Following treatment the material is manifested and sent off-site for final disposal.

Generator 90-Day Units

- Generator 90-day units do not need interim status or a hazardous waste permit
- Generator 90-day units include:
  - Tanks
  - Containers
  - Containment buildings
  - Drip pads
- Hazardous waste removed from generator 90-day units must meet applicable land disposal restriction treatment standards prior to land disposal

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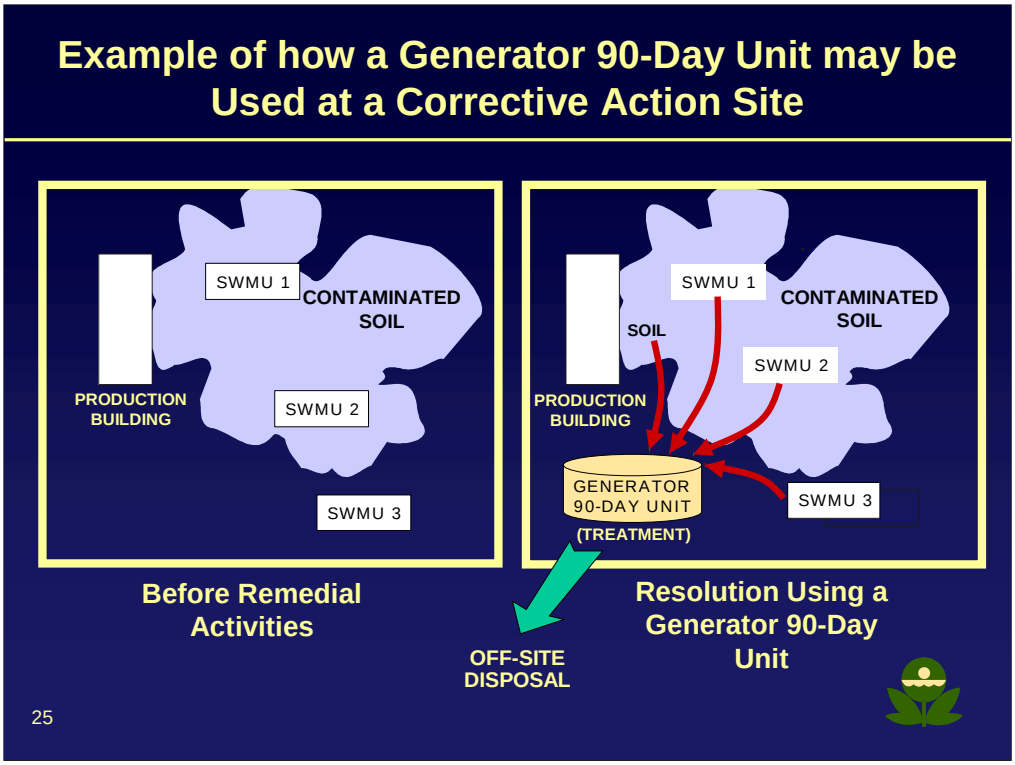
Notes:

Generators of hazardous waste may accumulate (treat, store) hazardous waste on-site in such units for up to 90 days without interim status or a hazardous waste treatment storage or disposal permit.

Because they are not considered land disposal units, placement of hazardous waste, including hazardous remediation waste, into a generator 90-day unit does not constitute land disposal. Therefore, wastes may be placed in generator 90-day units without first being treated to comply with land disposal restriction treatment standards.

If hazardous waste is removed from generator 90-day units it must be treated to comply with applicable land disposal restriction treatment standards prior to land disposal.

Reference: 40 CFR 262.34, associated preamble at 51 FR 10168 (March 24, 1986).



Notes:

<u>Before Remedial Activities</u>

The remedial goal at this facility is to treat material on-site and ship off-site for disposal at a Subtitle D facility.

<u>The Resolution Using a Generator 90-Day Unit</u>

(A) A soil washing unit is constructed using a tank that meets the requirements for a generator 90-day unit.

(B) Remediation waste from throughout the facility is sent to the unit in batches. Each batch is treated for 90 days or less.

(C) Following treatment, the remediation waste is determined no longer to contain hazardous waste and to comply with LDR treatment standards.

(D) Treated material is sent off-site as non-hazardous waste for disposal in Subtitle D facility.

Staging Piles

- Staging piles may be used for short-term storage of remediation waste
- Staging piles must meet specified performance standards for design and operation
- Because they are not land disposal units, placement of remediation waste in staging piles does not trigger a duty to comply with LDR treatment standards

26

Notes:
The HWIR-Media Rule established a new type of unit for remediation waste – the staging pile. Staging piles may be used for short-term, land-based storage of remediation waste.

A staging pile is defined as an accumulation of solid, non-flowing remediation waste that is not a containment building and is used only during remediation.

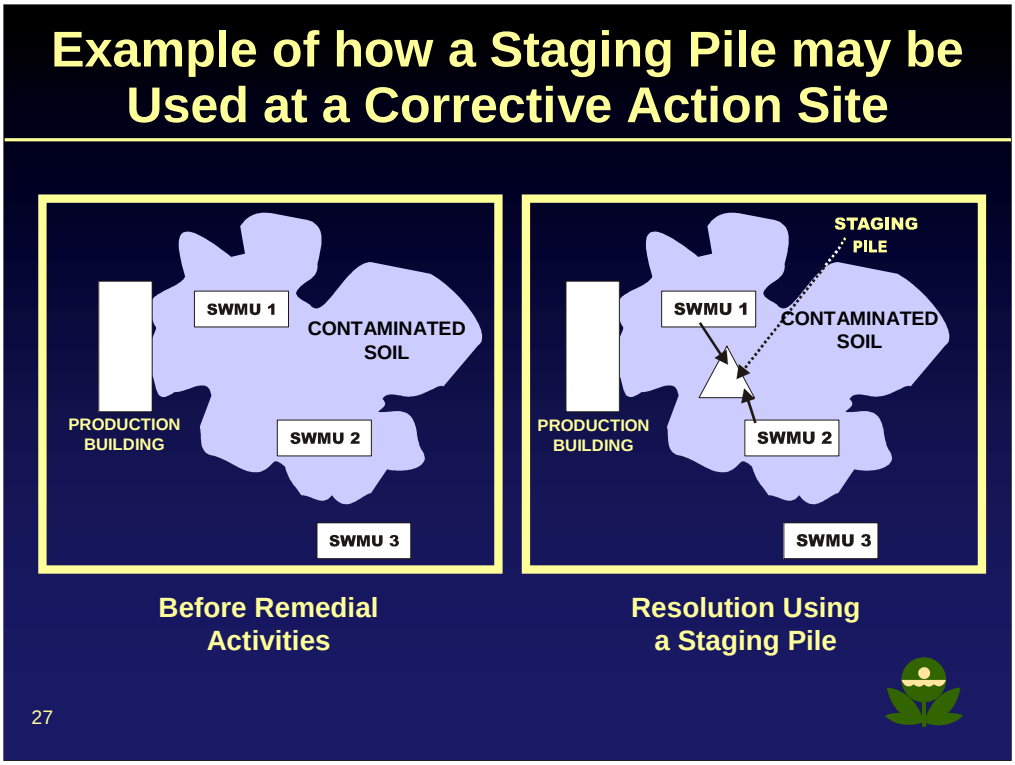
Because staging piles are not considered land disposal units, placement of remediation waste in a staging pile does not trigger a duty to comply with land disposal restriction treatment standards.

Staging piles do not have to meet the existing minimum technology requirements for hazardous waste units (e.g., groundwater monitoring requirements); instead, they have to meet design, operating, and closure performance standards established in the HWIR-Media rule. Staging piles must be clean closed.

Staging piles may be used only for storage. They cannot be used for treatment.

Staging piles may be used for up to 2 years, with an opportunity for one 180-day extension.

References: The regulations for staging piles are at 40 CFR 264.554 promulgated on November 30, 1998 (63 FR 65909).



Notes:

<u>Before Remedial Activities</u>

The remedial goal at this facility is to treat material on-site and ship off-site for disposal at a Subtitle D facility.

<u>The Resolution Using a Staging Pile</u>

(A) A Staging Pile is constructed within the area of contaminated soil.

(B) Remediation wastes from throughout the site are consolidated into the staging pile.

(C) A soil washing unit is constructed using a tank that meets the requirements for a generator 90-day unit.

(D) Remediation waste from the staging pile is treated in batches in the generator 90-day unit.

(E) Following treatment, the remediation waste is determined no longer to contain hazardous waste and to comply with LDR treatment standards.

(F) Treated material is sent off-site as non-hazardous waste for disposal in Subtitle D facility.

Some Differences Between CAMUs, TUs, Generator Accumulation Units and AOCs

Some Differences Between CAMUs, TUs, Generator Accumulation Units and AOCs.

	CAMU	TU	Gen. Acc. Unit	AOC
Advance Agency approval required.	X	X		
Land-based unit for treatment, storage, or disposal.	X			
Tank or container unit for treatment or storage.		X	X	
Material is located in different areas of a facility and not connected by contiguous contamination and will be consolidated on-site.	X	X	X	
Material is located in contiguous area of contamination and will be consolidated on-site.				X
Material was generated on-site and will be treated in tank or container.	X	X	X	
Material will be treated on-site *in situ*.	X			X
Material was generated off-site and will be treated, stored or disposed at your site.				
Material was generated on-site and treated in a tank or container on-site and will be returned to the land on-site.	X	X	X	
Treatment or storage limited to 90 days or less			X	
Operation of unit (and treatment and storage) limited to 1 year or less with opportunity for one extension of an additional year.		X		
Treatment, storage, and disposal timeframe unlimited.	X			

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Notes:

This table illustrates some differences between:

Corrective Action Management Units (CAMU): land-based unit that can be used to treat, store, or dispose of hazardous remediation waste.

Temporary Units (TU): tanks and container storage units used for the treatment and storage of remediation wastes.

Generator Accumulation Units: tanks, containers, containment buildings, and drip pads used for accumulation (including treatment) of hazardous waste, including remediation waste.

Areas of Contamination (AOC): areas of generally dispersed contamination that can be used for consolidation and other *in situ* management approaches.

LDR Treatment Standards – Debris

- Established in 1992
- Optional
- Based on application of common extraction, destruction, and containment debris treatment technologies
- Expressed as specific technologies rather than numeric criteria

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See regulations at 40 CFR 268.45, promulgated August 18, 1992 and associated preamble discussion at 57 FR 37194 and 27221.

LDR Treatment Standards – Soil

- Established 1998
- Optional
- Based on performance of remediation technologies
- Achieve either 90% reduction from initial concentrations of hazardous constituents or 10 times the universal treatment standard, whichever is higher

30

See regulations at 40 CFR 268.49 promulgated May 26, 1998 and associated preamble discussion at 63 FR 28602 - 28622.

Establishment of Site-Specific LDR Treatment Variances

When can site specific LDR treatment variances be established?

- When the nationally applicable treatment standard is unachievable or physically or environmentally inappropriate
- For contaminated soil only, when compliance with the nationally applicable treatment standard would result in treatment beyond the point at which threats are minimized

31

Notes:
Site-specific LDR treatment variances allow establishment of an LDR treatment standard that is site- and waste-specific. Site-specific LDR treatment variances can be approved only if the following eligibility criteria are met: the nationally applicable treatment standard must be either unachievable for the waste in question or must be physically or environmentally inappropriate for the waste in question.

Alternative treatment standards established through site-specific LDR treatment variances must meet the statutory standard of minimizing short- and long-term threats to human health and the environment. Site-specific LDR treatment standards may be risk- or technology-based.

For contaminated soil only, a site-specific LDR treatment variance can be approved if application of the nationally applicable treatment standard will result in treatment beyond the point at which short- and long-term threats to human health and the environment are minimized. This is commonly known as the "site-specific minimize threat variance."

Site-specific LDR treatment variances can be used to bring LDR treatment requirements into closer harmony with other remediation requirements. The site-specific minimize threat variance for soil is especially helpful since it can be used to cap LDR treatment requirements for soil at health-based levels.

References: Regulations governing site-specific LDR treatment variances are at 40 CFR 268.44(h), promulgated August 17, 1988 (53 FR 31199) and clarified December 5, 1997 (62 FR 64504).

Process for Approval of a Site-Specific LDR Variance

- Non-rulemaking variance
- Approval process should be streamlined, and integrated into ongoing cleanup processes
- Public notice/opportunity for comment required
- Documentation that alternative LDR treatment standard "minimizes threats"

32

Notes:
Decisions to approve site-specific LDR treatment variances must undergo public notice and an opportunity for public comment.

The application process for a site-specific LDR treatment variance, if any, should be as streamlined as possible. The public notice and comment associated with LDR treatment variances should be combined with other public notices and opportunities for comment that are associated with cleanups.

References: The most recent EPA guidance on site-specific LDR treatment variances, which includes information on establishing alternative LDR treatment standards, is in the January 8, 1997 guidance memo, "Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups." In 1996, EPA clarified its policy on state authorization for site-specific LDR treatment variances and began encouraging states to become authorized to approve variances. See, HWIR-Media proposal, 61 FR 18828 (April 29, 1996).

EPA's Policy on Groundwater Reinjection

Contaminated groundwater can be reinjected without meeting LDR treatment standards if:

- Reinjection is part of a CERCLA cleanup or RCRA Corrective Action, and
- The groundwater is substantially treated prior to reinjection, and
- Upon completion, the cleanup is protective of human health and the environment

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Notes:

Generally, disposal of hazardous waste (including ground water that contains hazardous waste) by underground injection into or above formations which contain an underground source of drinking water is prohibited by RCRA Section 3020(b)

Contaminated groundwater that contains hazardous waste may be reinjected into the aquifer from which it was withdrawn without first being treated to meet LDR treatment standards if it meets the above requirements.

RCRA Section 3020(b) can be especially useful for groundwater pump and treat sites.

Approval of reinjection under RCRA Section 3020(b) can be included in approval of other cleanup activities, for example, as part of approval of a RCRA Statement of Basis or CERCLA Record of Decision.

References: See, RCRA Section 3020(b), established as part of the 1984 HSWA amendments. See also, OSWER Directive 9234.1-06, "Application of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26," November 27, 1989.

Two Commonly Used Federal Permit Waiver Authorities

- CERCLA Section 121(e)
- RCRA Section 7003
- Permit waivers are good for streamlining cleanups by avoiding application of a duplicative administrative process

34

Notes:

Two types of permit waivers are most commonly used: the CERCLA permit waiver under CERCLA Section 121(e) and RCRA Section 7003.

Under CERCLA Section 121(e), EPA does not have to obtain permits for CERCLA actions. The Agency does have to ensure that the substantive requirements that would have been imposed through permits are met.

Under RCRA Section 7003, in situations which may present imminent and substantial endangerment to human health or the environment, EPA can waive both the requirement to obtain a permit and any substantive requirement that would have been imposed through a permit (EPA, however, seldom waives substantive requirements).

References: See, "Guidance on the Use of Section 7003 of RCRA," U.S. EPA, Office of Enforcement and Compliance Assurance, October 1997. See, EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2.

State Permit Waivers

States that have permit waiver authorities similar to CERCLA Section 121(e) and RCRA Section 7003 may waive permits if:

- the State is authorized for the RCRA permitting program, and
- the State applies its permit waiver authorities in a manner no less stringent than that allowed under corresponding Federal authorities

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Notes:
States that have a State Superfund-like program or other State program with a permit waiver authority analogous to CERCLA Section 121(e) and that are authorized to implement the RCRA permitting program can exercise their State permit waiver authority to waive the requirement to obtain a RCRA permit, provided the State uses its CERCLA 121(e)-like permit waiver authority in a manner no less stringent than the manner in which EPA uses CERLA Section 121(e).

Similarly, States that have a State authority analogous to RCRA Section 7003 and are authorized to implement the RCRA permitting program can exercise their RCRA Section 7003-like authority, provided the State uses its authority in a manner no less stringent than the manner in which EPA uses RCRA Section 7003.

References: See 58 FR 8679 (February16, 1993); EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2.

Streamlined Permit / Remedial Action Plan (RAP)

- In final HWIR-Media Rule, EPA established a new type of RCRA permit for remediation waste treatment, storage, and disposal
- This new type of RCRA permit is called a Remedial Action Plan or RAP
- RAP approval process is more streamlined than the generally applicable RCRA permitting process

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Notes:
RAPs may be used only to permit treatment, storage, and disposal of remediation waste. They cannot be used for non-remediation hazardous wastes.

RAPs are a type of RCRA permit. For that reason, RAPs must comply with the minimum statutory requirements for RCRA permits, most notably, the statutory public participation requirements. EPA or the authorized State must publish a notice of its intent to approve or deny a RAP in a major local newspaper of general circulation; broadcast its intention to approve or deny a RAP over a local radio station; and send a notice of its intention to approve or deny a RAP to each unit of local government having jurisdiction over the are in which the facility is located, to each State agency having any authority under State law with respect to any construction or operations at the site, and to the applicant. The public notice/comment period must be at least 45 days. If a hearing is requested, it must be held. See 40 CFR 270.145.

RAPs do not provide an opportunity to waive applicable RCRA requirements. They provide only a streamlined permitting mechanism for imposing/defining applicable RCRA requirements.

The information submission requirements for RAP applications are reduced compared to the information submission requirements for other RCRA permits. Generally, RAP applications must only: (1) identify the facility and remediation wastes that the RAP will cover; (2) describe the treatment, storage, and disposal practices that the RAP will cover; and, (3) include information demonstrating that facility operations will comply with applicable RCRA requirements. RAPs can be used to approve Corrective Action management units, temporary units, and staging piles and can be used to record site-specific land disposal restriction treatment variances and contained-in determinations. Any document that meets RAP requirements can function as a RAP. RAPs can be included in any cleanup document or can be stand-alone documents.

References: Regulations governing RAPs are at 40 CFR 270.2, 270.68, and 270.80 – 270.230, promulgated November 30, 1998 (63 FR 229).

Other Approvals

- Changes during interim status to comply with corrective action requirements 40 CFR 270.72(a)(5)
- Emergency permits 40 CFR 270.61
- Temporary authorization at permitted facilities 40 CFR 270.42(e)
- Treatability studies 40 CFR 261.4(e)

Review

- When treating, storing, or disposing of hazardous remediation waste you generally need a unit (AOC, CAMU, e.g.) and an approval (permit, permit waiver, order, e.g.)
- LDRs can be tailored. LDR treatment variences can be approved without rulemaking
- You generally have many options, try to work backwards from your desired remedial action to find the RCRA compliance approach that best supports your cleanup

Practice/Case Study

- You will now have an opportunity, working in your table group, to practice deciding whether remediation waste is hazardous and developing a remediation waste management strategy
- As a table, decide whether you are going to work on an example from someone's experience or a case study. You may have time to do both.
- Tomorrow, each table will report to the group and we'll discuss.

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Tips

- Not all remediation waste is hazardous
- Good decisions about remedy selection should drive cleanups. When thinking about hazardous remediation waste management options work backwards from desired result.

Tips (Cont.)

- These are site-specific choices that will be influenced by:
  - Regulatory and policy factors
  - Owner/operator concerns and preferences
  - Community concerns and preferences
- Consider “radical” options/approaches if you need to support timely implementation of good remedies

Administrative Approaches

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

Objectives

Participants will be able to:

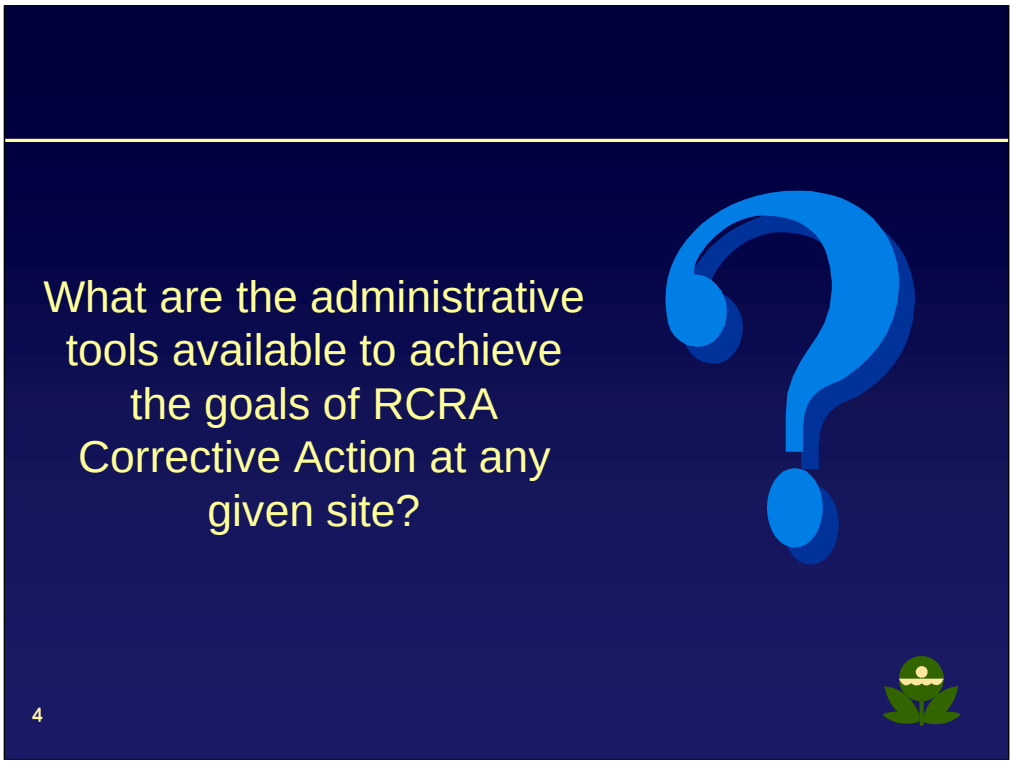
- Recognize the menu of potential State and/or Federal administrative/enforcement approaches (including facility-lead) for implementing Corrective Action
- Make an informed selection from that menu for a particular site
- Learn of successful approaches that have been used to encourage efficient Corrective Action
- Share approaches that are being used in the Regions

2

Introduction

- Objectives for Corrective Action should be the same whether implementation occurs through:
  - A permit
  - Enforcement mechanism
  - Other approach
- No matter which approach you choose, EPA believes public participation is critical

3



Notes:

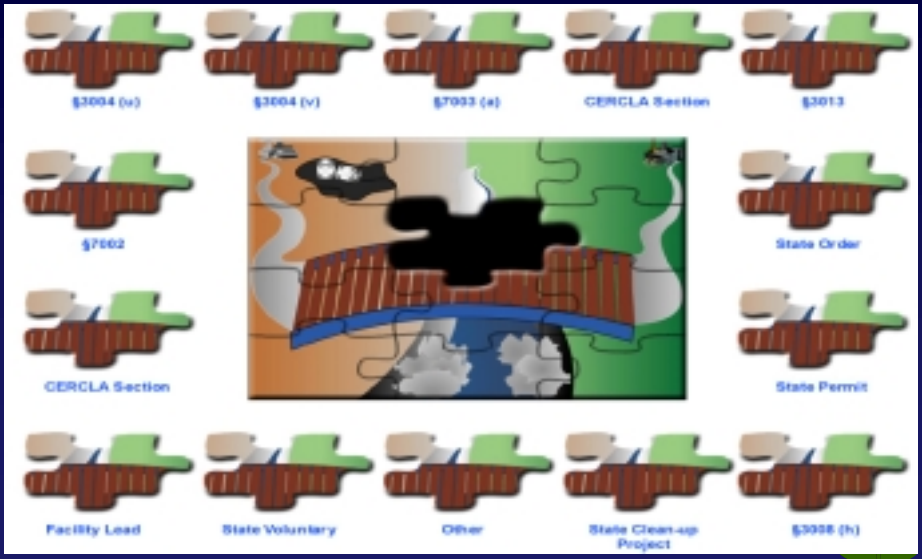
The Corrective Action program faces challenges over the next several years to meet GPRA goals for the high priority sites identified across the country. Regions should continue to use traditional regulatory tools (permits and administration orders) flexibly to require corrective action, and in appropriate cases use innovative approaches such as Facility-lead Corrective Action to achieve Corrective Action completion.

The goal of protecting human health and the environment from the effects of releases of hazardous waste or constituents may also be achieved, in appropriate circumstances, by tools outside the statute such as:

- Coordination with other Federal cleanup programs (e.g., Superfund);
- Coordination with analogous State cleanup programs; and
- Facility lead Corrective Action

There are advantages and disadvantages to each of these tools that should be weighed in any given decision.

Picking the Right Implementation Approaches & Authorities for Site Cleanup



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Administrative Tools Available

- RCRA Corrective Action permit
- RCRA Corrective Action order
- CERCLA
- State-lead
- Facility-lead

6

Region I Program Structure and Focus

- Performance standard based letters of agreement
- All project managers involved
- Used at any site matching “criteria;” no designated target group*
- Currently the mechanism governing Corrective Action at 18% of active facilities (anticipate it will always be around 20-25%)

7

Notes:

* We do use to help meet the needs of beneficial reuse sites that are not on the GPRA baseline.

Region III – Program Structure and Focus

- Performance standards based letters of agreement
- New Position created to address the Region III non-addressed high priority facilities
- Assistance from Army Corps or Engineers, States, and other RPMs

8

Notes:

- In March, 1998, there were 170 non-addressed sites in Region III
- Accelerated inspection schedule has addressed 70 of these sites with the remainder being addressed in FY 2000 and FY 2001

Region III – Program Structure and Focus continued…

- 30% unaddressed facilities do not need Corrective Action, already addressed
- 10% unaddressed facilities transferred to CERCLA
- 60% need Corrective Action
- Facility-lead used at high priority sites meeting criteria
- Currently facility-lead governing Corrective Action at 10% of high priority facilities (anticipated to be 20% by FY 2001)

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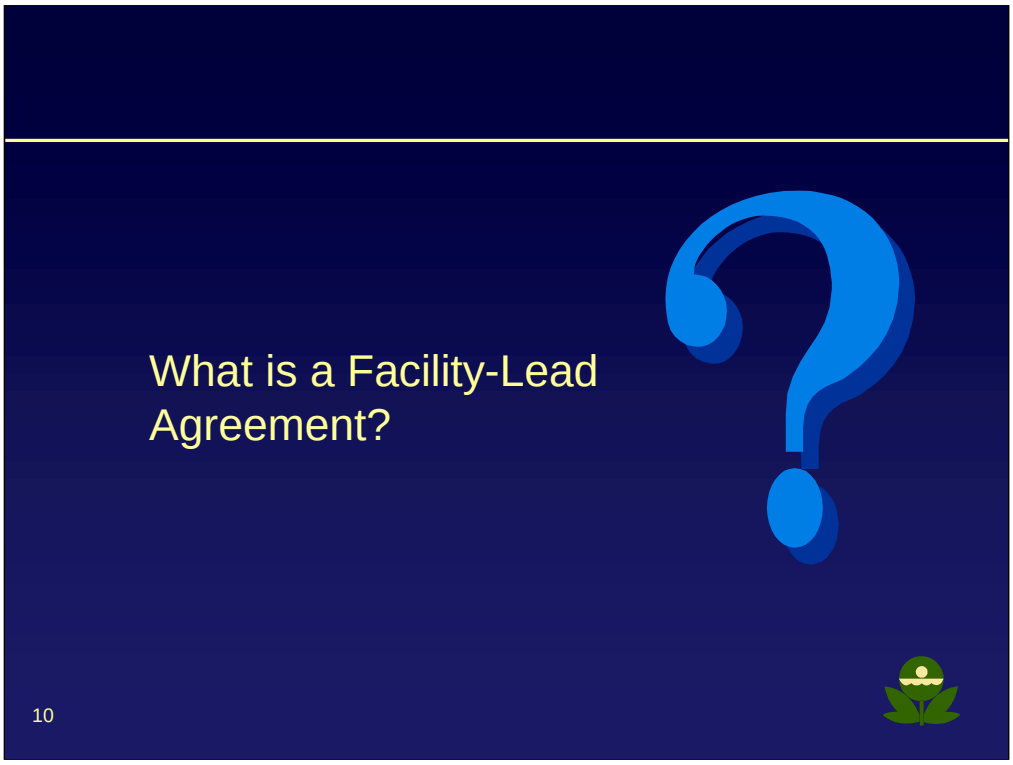
Notes:

- Corrective Action permits/orders for 10% of facilities needing Corrective Action
- State-lead should account for 25% of facilities needing Corrective Action
- Facility-lead should account for the remaining 25% of facilities needing Corrective Action



Notes:

Facility-lead Corrective Action agreements are simple letters of intent containing broad performance standards to provide the framework for guiding Corrective Action. The agreements express EPA's expectations regarding the facility's self-directed cleanup activities. These expectations are generally issued in the form of a letter from EPA and responded to by a facility's return letter of commitment. Model agreements currently in use in Regions I and III are included in the workshop handbook. The major topics covered in these agreements are:

- investigation performance standards,
- guidance sources to be utilized,
- public involvement expectations,
- interim measure and final remedy decision making criteria,
- stabilization and final remedy measures of success,
- project schedule expectations,
- reporting and coordination expectations, and
- reservation of rights.

Comparison of Mechanisms

- Facility-Lead Agreements
  - Set goals
  - Process flexible
  - Authority & penalties implicit
  - Discuss actual data gaps during updates
  - More focus on EIs
- Typical Permits and Orders
  - Set process
  - Process controlled
  - Authority & penalties explicit
  - Discuss potential data needs at start
  - No focus on EIs

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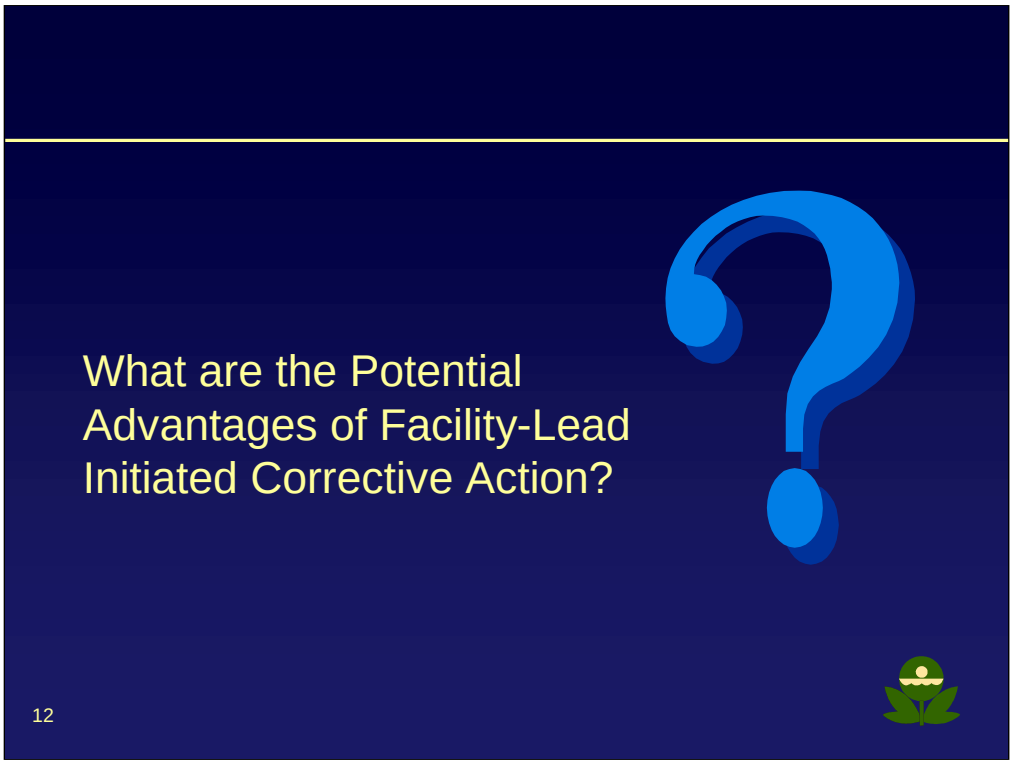
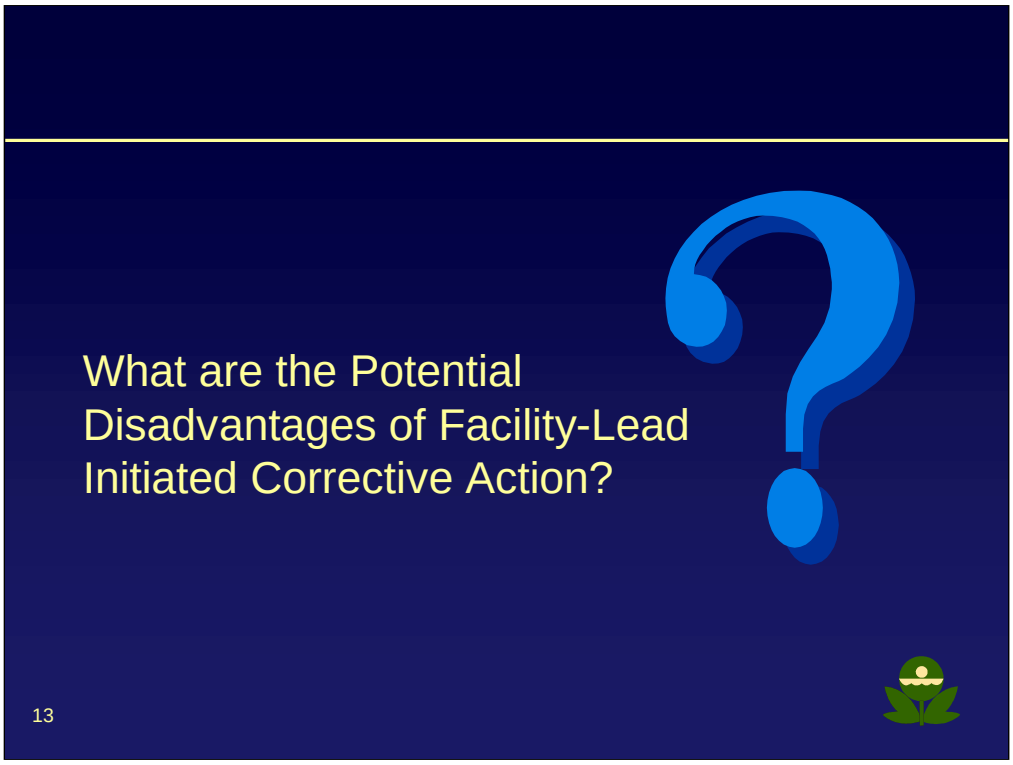
Notes:

Identification of issues, recommended criteria for selecting remedies, data to support decision making, and data quality control is generally the same.



Notes:

- Reduced administrative burden
- Field work focused oversight
- Greater schedule flexibility
- Greater budget control
- Opportunity to be pro-active and co-operative
- Creates positive common goals
- Reduced time and cost



Notes:

- Agreement will not survive a property transfer
- Agreement may not survive bankruptcy
- No ability to enforce quickly with direct financial disincentives
- May pose problems in taking advantage of some regulatory flexibility (e.g., need an order to create a Corrective Action management unit)
- Facility incentive may change and is difficult to accurately gauge
- The current owner may need an enforceable document to negotiate with former owner responsible for environmental problems
- Facility may need enforceable document to receive funding
- Difficulty for EPA to convert numerous non-performers to permits/orders

Recommended Factors to look for in Facility-Lead Corrective Action – Region I

- Good enforcement record
- Financial capability
- Technical capability
- Motivation

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Recommended Factors to Look for in Facility-Lead Corrective Action – Region III

- Corrective Action started
- Good enforcement record
- State approval
- Financial capability
- Technical capability
- Limited releases
- Small number of Solid Waste Management Units (SWMUs)
- Motivation

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Additional Information

Region I:

- Ernie Waterman (617) 918-1369, or waterman.ernest@epa.gov

Region III:

- Denis Zielinski (215) 814-3431, or zielinski.denis@epa.gov
- www.epa.gov/reg3wmcd/correctiveaction.htm

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Improving Pace of Cleanups

- Corrective Action enforcement authorities provide tools to compel and enforce remediation of hazardous releases
- Authorized States have their own enforcement authorities

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Notes:

The RCRA Corrective Action program is designed to identify and remediate releases of RCRA hazardous wastes or hazardous constituents. The Corrective Action enforcement authorities are tools for remediating such releases depending on the type, location, and character of the release and the type of site involved.

In addition to EPA's enforcement authorities, authorized States have their own regulations and enforcement authorities that can be used, in appropriate circumstances, to require Corrective Action. For authorized States, both Regional and State personnel should look at those regulations and authorities in considering the appropriate Corrective Action enforcement vehicle. For example, some States have imminent and substantial endangerment authorities that may be used to require interim measures.

Improving Pace of Cleanups (Cont.)

- Enforcement authorities can accelerate the pace of a cleanup under two general scenarios:
  - Encouraging/compelling a reluctant/recalcitrant party to perform investigative and/or cleanup work
  - Expediting cleanup where awaiting issuance of a permit would slow a cleanup that would otherwise be proceeding rapidly

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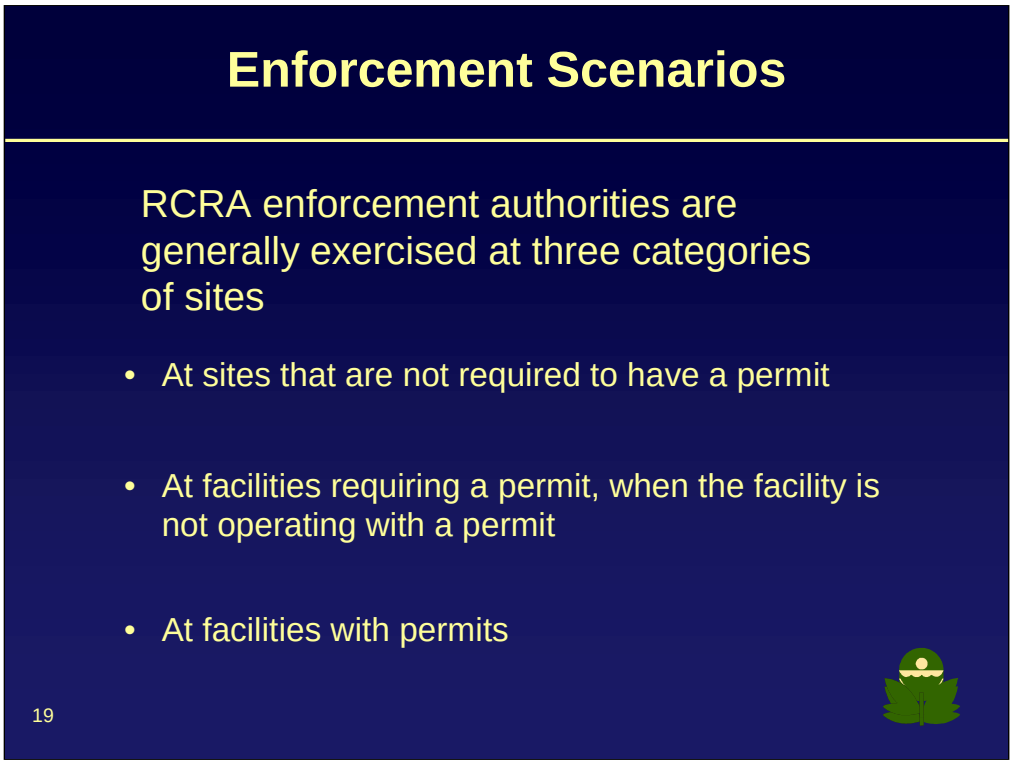
Notes:

The Corrective Action enforcement authorities are used to address releases sooner rather than later and the enforcing agency should proceed with that objective in mind. In particular, with a noncooperative party, EPA and/or the authorized State should act quickly to gather necessary information and make decisions regarding the appropriate enforcement vehicle(s) for ensuring a timely cleanup.



Notes:

In general, the first category involves any sites where hazardous waste and, in some cases, solid waste are handled (e.g., generator sites).

The second category involves facilities "authorized to operate" in interim status—facilities that have interim status, facilities that should have had interim status, and some facilities that had interim status at one time.

The third category includes treatment, storage, or disposal facilities that have a permit containing Corrective Action conditions.

Site Categories

- Waste Generators or Handlers
- Interim Status Facilities
- TSDFs with Permit

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Waste Generators or Handlers

- §3007 - Information gathering
- §3013 - Information and investigation
- §7003 - Imminent and substantial endangerment

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Notes:

§3007 provides a broad information-gathering and investigation authority allowing inspections and sampling at most past or present hazardous waste handlers. Its foremost limitation is that it cannot be used to require cleanup activities.

§3013 provides a broad information-gathering and investigation authority allowing monitoring, testing, analysis, and reporting, and can be used at most past or present hazardous waste handlers.

The primary advantages of using §3013 are that it: (a) has a very low threshold for obtaining relief — a situation that "may present a substantial hazard," and (b) provides EPA with broad discretion to require activities as necessary to evaluate the hazard.

The primary disadvantage is that §3013 cannot be used to require actual cleanup.

Notes (Cont.):

§7003 provides a broad cleanup authority applicable to all solid or hazardous waste handlers. The advantages of the §7003 authority are that it:

(a) applies to any person who is or has contributed to waste handling;

(b) has a low threshold for obtaining relief — a situation "may present an imminent and substantial endangerment;"

(c) applies to both hazardous and solid waste;

(d) applies "notwithstanding" any other RCRA provision; and

(e) provides EPA with broad discretion to both restrain and require actions, including activities necessary to evaluate or monitor or protect against a hazard.

These authorities may also be used at interim status or permitted facilities and are discussed in more detail in the background materials.

Interim Status Facilities

- Subpart F* - Regulatory groundwater monitoring requirements
- §3008(h) - Statutory corrective action authority
- §3007, §3013 and §7003 may also be used

* States may be authorized for implementing analogous statutes and programs

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Notes:

Subpart F - groundwater monitoring requirements applicable to all "regulated units" at interim status facilities.

§3008(h) has been the most commonly used Corrective Action authority and is used to clean up releases from interim status facilities. The primary advantages of §3008(h) are that: (a) there need only be a determination of a release into the environment, not a finding of a violation; and (b) there is broad discretion to order Corrective Action as necessary to protect human health and the environment.

The primary limitation of §3008(h) is that it applies only to facilities "authorized to operate" in interim status.

These authorities are discussed in more detail in the background materials.

Treatment, Storage, and Disposal Facilities (TSDFs) With Permits

- §3004 (u)&(v)* - Statutory corrective action requirements
- Subpart F* - Regulatory groundwater monitoring and cleanup requirements
- §3008 (a) - Statutory enforcement/cleanup authority
- §3007, §3013 and §7003 may also be used

* States may be authorized for implementing analogous statutes and programs

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Notes:

§3004(u) & (v) - cleanup authority used to impose permit conditions requiring facilities to address releases.

§3008(a) - authority used to require compliance with a RCRA Subtitle C permit requirement when a violation occurs. The advantage of using §3008(a) is that there is broad authority to require any actions necessary to ensure compliance. The primary limitation is that there is a higher threshold for requiring corrective action, a finding of a violation.

Subpart F - groundwater monitoring requirements for regulated units and cleanup requirements applicable to solid waste management units (SWMUs).

These authorities are discussed in more detail in the background materials.

Parting Thought

"You don't screw nails and you don't hammer screws. Think about what you are trying to do and <u>choose the right tool for the job</u>."

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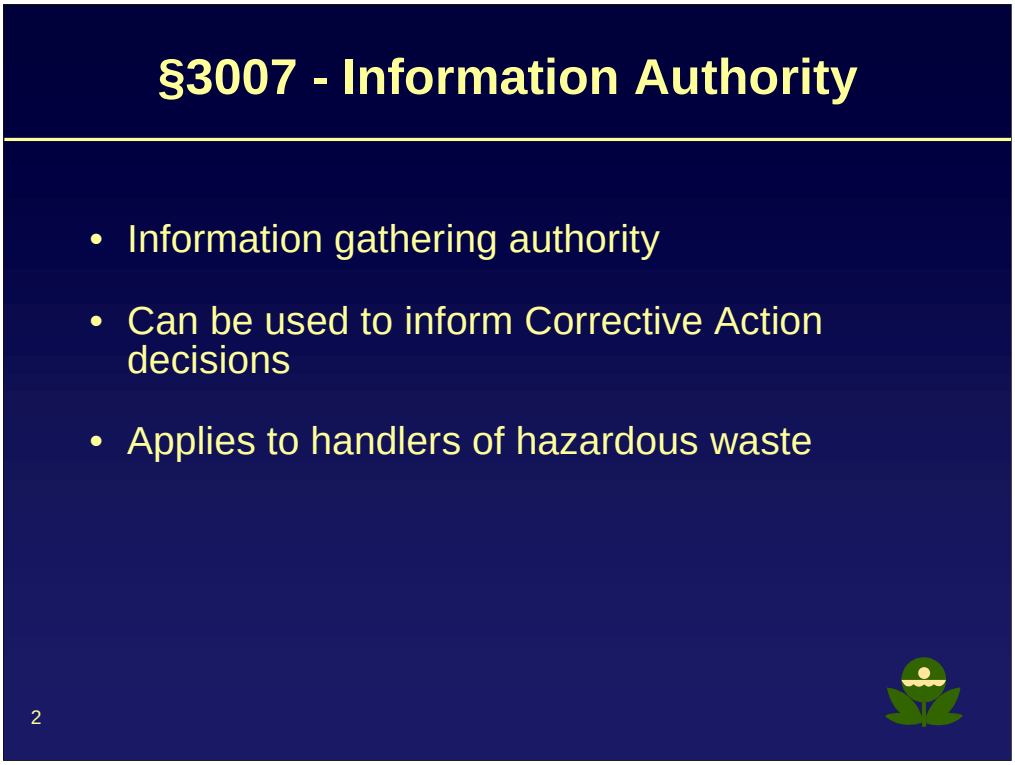
Background for Group Exercise

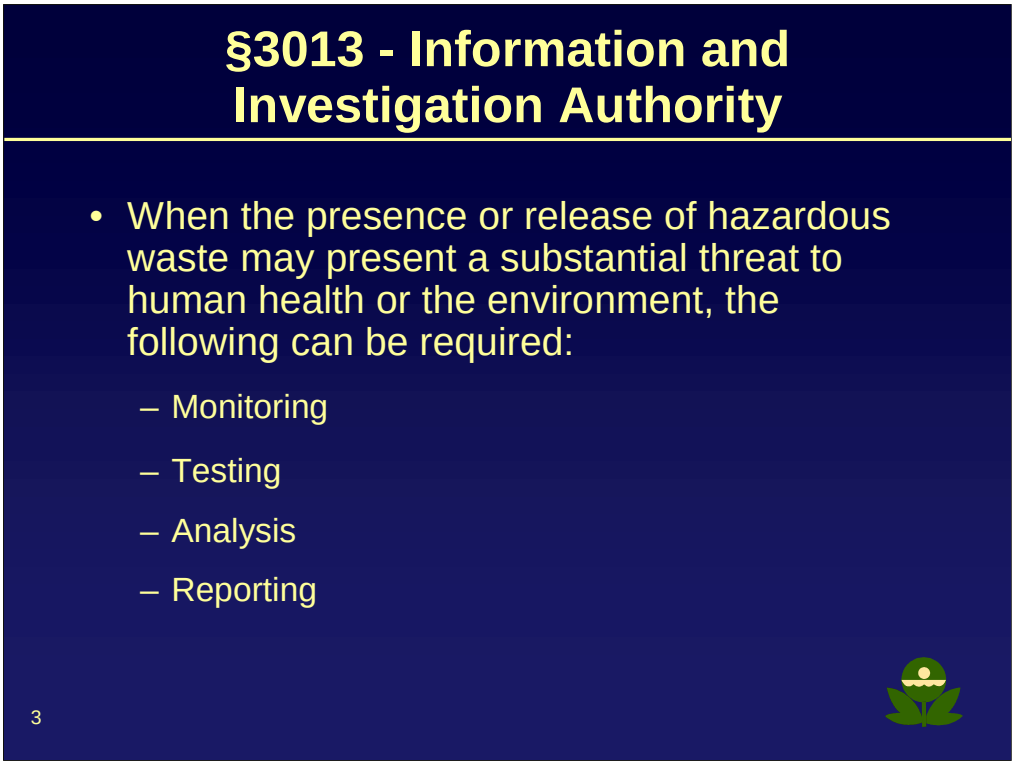


Notes:

For purposes of enforcing RCRA requirements, EPA may obtain information from "any person" who handles hazardous waste, including generators and transporters.

Authority allows inspection and sampling related to the hazardous waste handling activities.

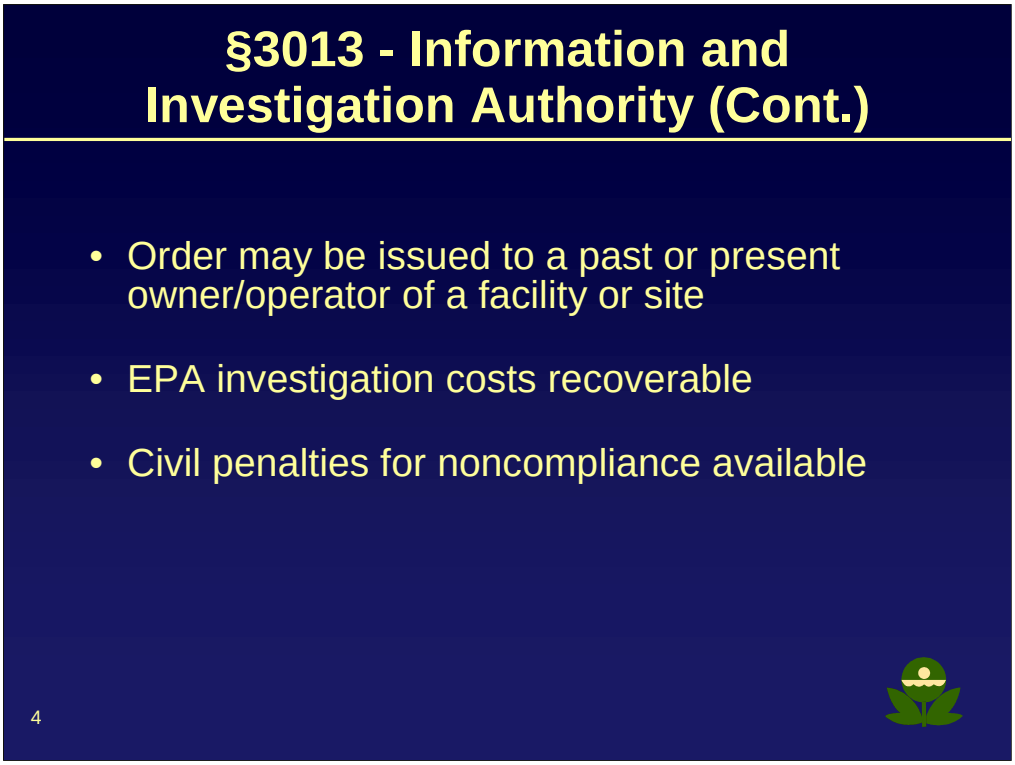
Background for Group Exercise



Notes:

§3013 provides EPA with the authority to require investigation where the presence or release of hazardous waste may present a substantial hazard to human health or the environment.

§3013 may be used at either RCRA generator sites or RCRA TSDFs. It is not a full blown "remediation" authority - a §3013 Order can require monitoring, testing, analysis, and reporting, but not actual cleanup. Nonetheless, it is an important tool for investigations (e.g., RFIs) and studies (e.g., CMSs).



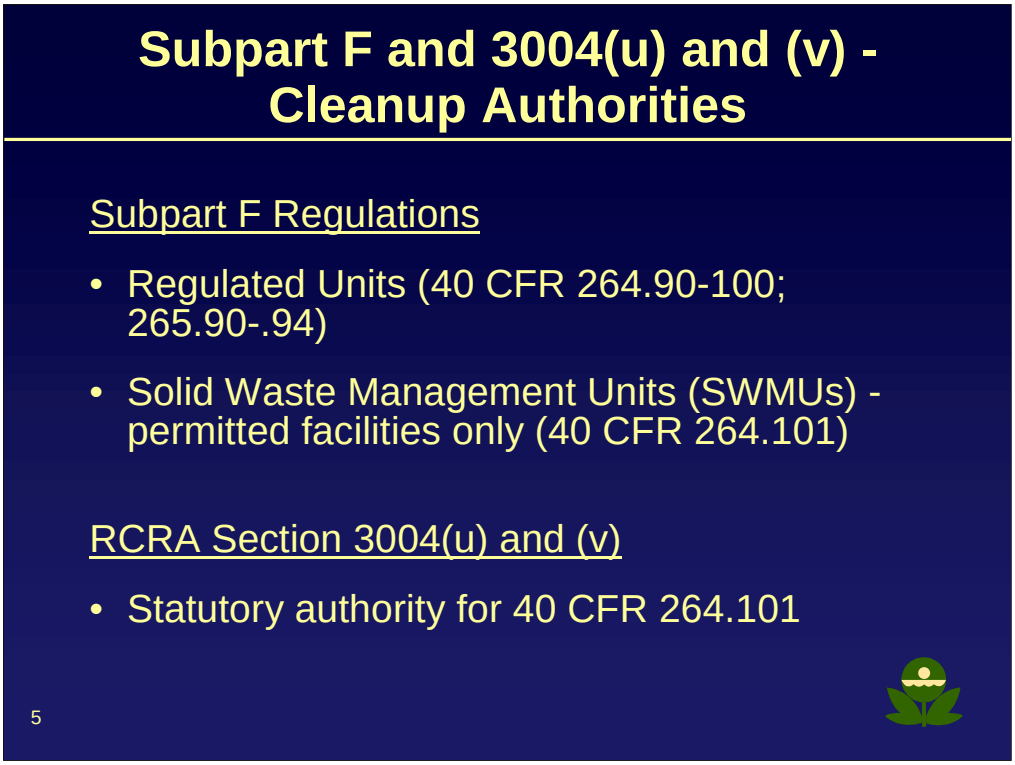
Notes:

§3013 is a convenient tool to require confirmatory sampling/analysis to determine if environmental indicators have been met.

Either the EPA or the facility can perform the investigation study, although a past or present facility owner/operator should be provided the opportunity to perform the work before EPA undertakes the work. If EPA performs, §3013 can be used to seek recovery of such costs from the respondent.

References: EPA issued guidance entitled "Issuance of Administrative Orders Under Section 3013 of the Resource Conservation and Recovery Act." [September 26, 1984. EPA Memorandum from Courtney M. Price (Assistant Administrator for Enforcement and Compliance Monitoring) and Lee M. Thomas (Assistant Administrator, Office of Solid Waste and Emergency Response).]

Background for Group Exercise



Notes:

The majority of 40 CFR Part 264 Subpart F applies only to surface impoundments, waste piles, land treatment units or landfills that received hazardous waste after July 26, 1982 and require groundwater monitoring and remediation (if necessary).

All permitted TSDFs must perform Corrective Action to address any releases from SWMUs (regardless of when the waste was placed in SWMUs). SWMUs include regulated units. See 40 CFR Section 264.101.

Sections 3004(u) & (v) require permitted facilities to remediate releases of hazardous waste or hazardous constituents from SWMUs regardless of when waste was placed in the units and remediation may be required within (u) or beyond (v) the facility boundaries.

RCRA Subtitle C permits must require Corrective Action "as necessary to protect human health and the environment." Additionally, remediation may be required pursuant to EPA's "omnibus" permit authority. See RCRA Section 3005(c)(3).

Interim status (Part 265) Subpart F regulations apply to any surface impoundment, land treatment unit, or landfill that is either seeking a permit or is operating under interim status or intends to close under interim status.

§3008(a) - Enforcement/Cleanup Authority

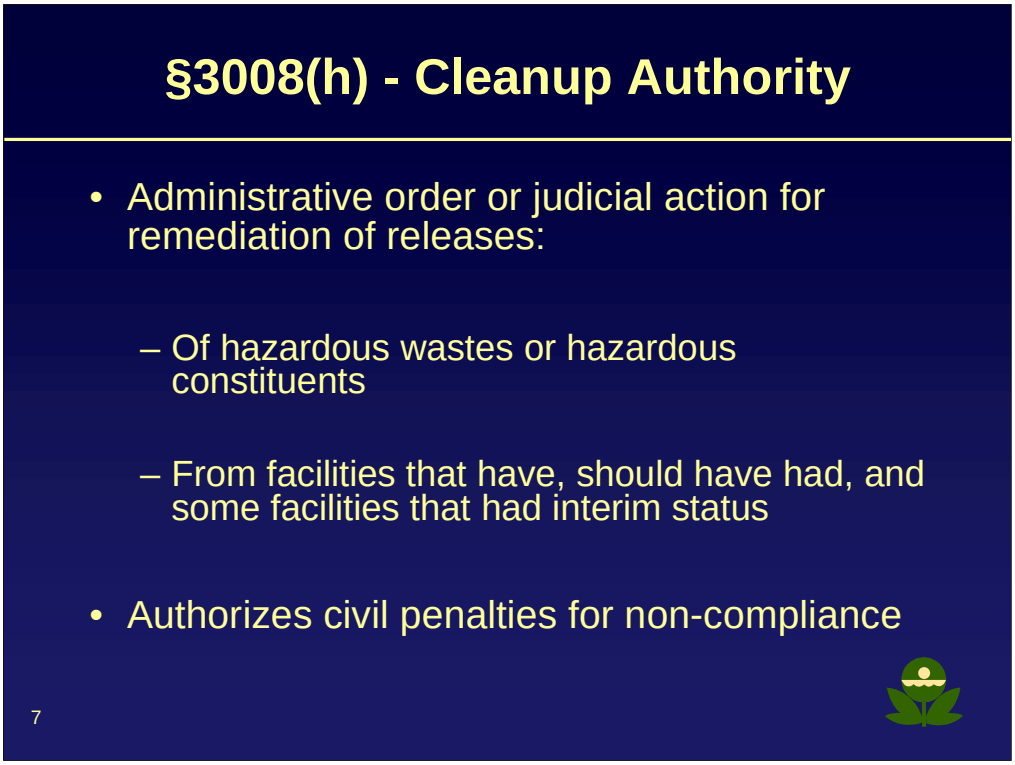
- Administrative order or judicial actions
- Violations of RCRA Subtitle C, RCRA regulations, authorized State regulations, or permit conditions
- Civil penalties for noncompliance

6

Notes:

When RCRA has been violated, §3008(a) provides EPA with the authority to issue an administrative order requiring compliance, including compliance with Corrective Action regulatory requirements, authorized states' RCRA regulations, and Corrective Action permit conditions. In the alternative, EPA can initiate a court action seeking a court order requiring compliance with applicable Corrective Action requirements.

States may use analogous authorities to take enforcement actions for violations of Corrective Action requirements, including Subpart F.



Notes:

Where there is or has been a release of hazardous waste or hazardous constituents, §3008(h) provides EPA with the authority to issue an administrative order, or initiate a court action to require an owner/operator to perform a Corrective Action or take other measures EPA deems necessary to protect human health or the environment.

§3008(h) Orders may be issued to Loss of Interim Status (LOIS) facilities.

§3008(h) is the most commonly used RCRA Corrective Action enforcement authority.

References: EPA issued a final RCRA §3008(h) Model Consent Order on December 15, 1993 (OSWER Directive #9902.5A) and an Interim Final Model 3008(h) unilateral order on January 23, 1989 (OSWER Directive #9902.5).

§7003 - Cleanup Authority

- Administrative order or judicial action
- Solid or hazardous waste
- Past or present handling "may present an imminent and substantial endangerment to health or the environment"
- Any handler of these wastes

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Notes:

Section 7003 provides the enforcement authority to issue an administrative order, or initiate a court action, where past or present solid or hazardous waste handling practices may present an imminent and substantial endangerment to human health or the environment.

The authority is broader in scope than other RCRA enforcement options because it can be used to require Corrective Action by RCRA generators and transporters as well as at RCRA treatment, storage or disposal facilities, and can address solid waste (not just hazardous waste).

References: A comprehensive §7003 guidance document is available for additional information on this authority. The guidance was issued on October 20, 1997 from the Office of Enforcement and Compliance Assurance.

"Guidance on the Use of Section 7003 of RCRA," U.S. EPA, October 1997.

Background for Group Exercise

Notes:

Facility Lead Agreements are a convenient tool for rapidly implementing Corrective Action at self-motivated, technically capable facilities.

Analogous State Programs

- Many States have cleanup programs with goals similar to Corrective Action and structural differences from Corrective Action which may offer specific advantages or disadvantages in achieving Corrective Action goals at a given facility

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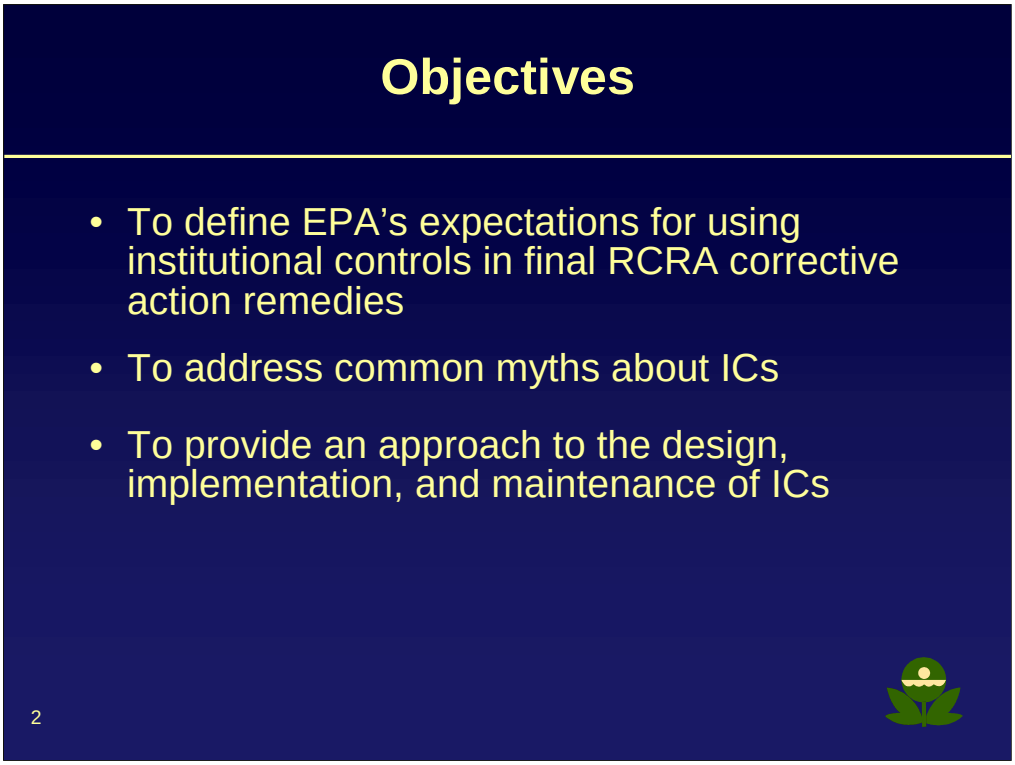
Analogous State Programs

- The questions we need to ask at every site include:
- Which partner in the State/EPA partnership should manage Corrective Action at this site?
- Which of the tools available to the partnership should we use?

11

Institutional Controls For Final Remedies

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.



References:

"Institutional Controls: A Remedial Project Manager's Guide to Identifying, Evaluating, and Selecting Institutional Controls." Draft Fact Sheet, October 1999.

"Institutional Controls: A Reference Manual." USEPA Workgroup on Institutional Controls, Draft, March 1998.

Two main messages of this module are:

1. Institutional controls are generally a component of a remedy that are used to supplement other controls to achieve protection of human health and the environment. They are seldom, if ever, a sole remedy.

2. Institutional controls should be evaluated using the same approaches and criteria as other parts of a remedy.

This module is based on draft EPA institutional control guidance and is not intended to be a legal primer on different controls, nor is it designed to teach which controls are most appropriate given a site-specific situation. Rather, the guidance summarizes key aspects of thinking about ICs from a project manager's perspective.

What are Institutional Controls?

- Non-engineering measures, usually legal controls, that minimize the potential for exposure to contamination by limiting land or resource use
- Example types
  - Government controls
  - Proprietary controls
  - Enforcement tools
  - Informational Devices

3

Notes:

Please see attached matrix for more information.

Government controls -- Existing or future state or local authorities that restrict property use (traditional police powers). Examples include zoning, laws regarding well drilling or water usage, and legal authorities involving licensing or permitting processes.

Proprietary ICs – Legal instruments placed in the chain of title for the subject real property that convey a property interest from the owner to a second party, for the purpose of imposing restrictions on land and/or water use. Examples include restrictive easements and covenants. These property interests often include the right of access to inspect and monitor the restrictions.

Enforcement tools – Federal, state and local governments can, in some circumstances, direct a property owner (usually a responsible party or "RP") to refrain from using a property in specific ways. Also, contractual agreements can be reached with property owners either through an enforcement settlement process if owner is a RP or in a separate agreement with non-RPs. Agreements can also be reached between federal, state or local authorities to ensure enforcement of ICs.

Notes (Cont'd)…

Informational Devices – Notice of land use restrictions (sometimes referred to as a deed notice) may be placed in land records by the owner of the subject property. Also, some states provide for notices to be placed in a statewide registry. Such notices are usually not enforceable long-term proprietary controls, but have informational value for persons searching the appropriate records. Generally, unless statutory authority exists, a governmental body should not place a notice of land use restrictions in the land records without the owner's consent, as such action may give rise to a takings claim.

* Fences that restrict access to sites are often mistaken as ICs. Because fences are physical barriers instead of administrative or legal measures, they are not considered to be ICs.

* "Deed restriction" is not a traditional property law term, but rather is used in the NCP as a shorthand way to refer to types of ICs. To avoid confusion, site managers should avoid the term and instead be specific about the types of ICs under consideration and their objectives.

Important Role of Institutional Controls

- Inevitable part of many waste-in-place remedies
- May also be needed until final, unrestricted release conditions are in place
- However, not a substitute for active measures (e.g., to address principal threat wastes)
- Should work in combination with treatment and engineering approaches

5

Notes:

• Whenever wastes remain in place as part of a remedy in concentrations above a restricted resource use, some form of ICs are likely to be needed to complement other controls. That is, ICs should be used at all sites where contamination is left in place as part of a final remedy that does not allow for unrestricted use and unlimited exposure. ICs are compared to the most restrictive criteria (residential)—not present or future use.

• Even when unrestricted resource use is planned, ICs may be part of an interim approach until the desired conditions are achieved.

•EPA expects active measures often to be needed. For example, EPA expects treatment of principal threat wastes and Ics would not be an appropriate control for these wastes.

Thinking About ICs in Corrective Action

- Mix of institutional controls may be needed to meet the desired objectives ("layering" is the commonly used term)
- ICs vary temporally, geographically, and by the type of action being taken (interim, final)
- Implementation of ICs may differ between RCRA and CERCLA

6

Notes:

Examples of ICs available to use in RCRA Corrective Action:

-Restricting groundwater use by stopping use of a municipal well field until MCLs have been met

-Creating an easement or permit program to prohibit well-drilling on the property

-Prohibiting residential development in an area of contamination through use of a zoning restriction

Institutional controls may be part of both for short and long-term periods, be applied to a portion or an entire site, and be part of interim or final actions. All aspects of these choices should be thought through in line with the approach outlined in this presentation

What is Allowable Under RCRA

-Under RCRA the permitting authority can itself be used as an IC. Prohibitions on certain land uses or activities can be made a condition of the permit. But care should be taken to ensure that the ICs will survive property transfer and/or permit termination.

-Because there is no federal mechanism allowing the Agency to acquire an interest in property to implement an IC under RCRA, EPA must rely on third parties (typically, the relevant state or local government) to exercise its authority to hold the property interest. Because the third parties will hold the interest, they will be able to enforce the IC.

Thinking About ICs in Corrective Action (Cont'd)…

- You should start considering ICs as soon as you think about any remedial options that would leave waste in place greater than an acceptable, conservative, direct exposure level (i.e., residential)
- ICs are actions (they don't actively clean up waste, but they do control exposure)
  - Subject to same criteria used to evaluate engineering controls

7

Notes:

The need for institutional controls may be anticipated as early as facility investigations when problems are defined and initial evaluations of technologies are initiated. At this time, the focus should be on identifying any information that will be necessary to determine what controls may be appropriate and key data needed to support their selection.

As evaluation of technologies proceeds, instititutional controls should be similarly considered. If a corrective measures study (or equivalent document) is prepared, institutional controls should be evaluated similar to engineering options.

The Statement of Basis must clearly outline the purpose of the IC and identify expected standards of performance.

The basis for evaluating institutional controls as part of a remedy is the same performance standard and balancing/evaluation criteria used for other types of final remedies. These are outlined in more detail in the Quick Reference Tables and the next module, Remedy Selection.

Common Myths About ICs

1) The lawyers can deal with ICs later

2) Don't sweat the cleanup standards; ICs can always address residual contamination

3) The project manager promised to implement ICs later; that's good enough for now

4) I'll just use a model IC; after all, if it works at a site in one State, it should work at another

8

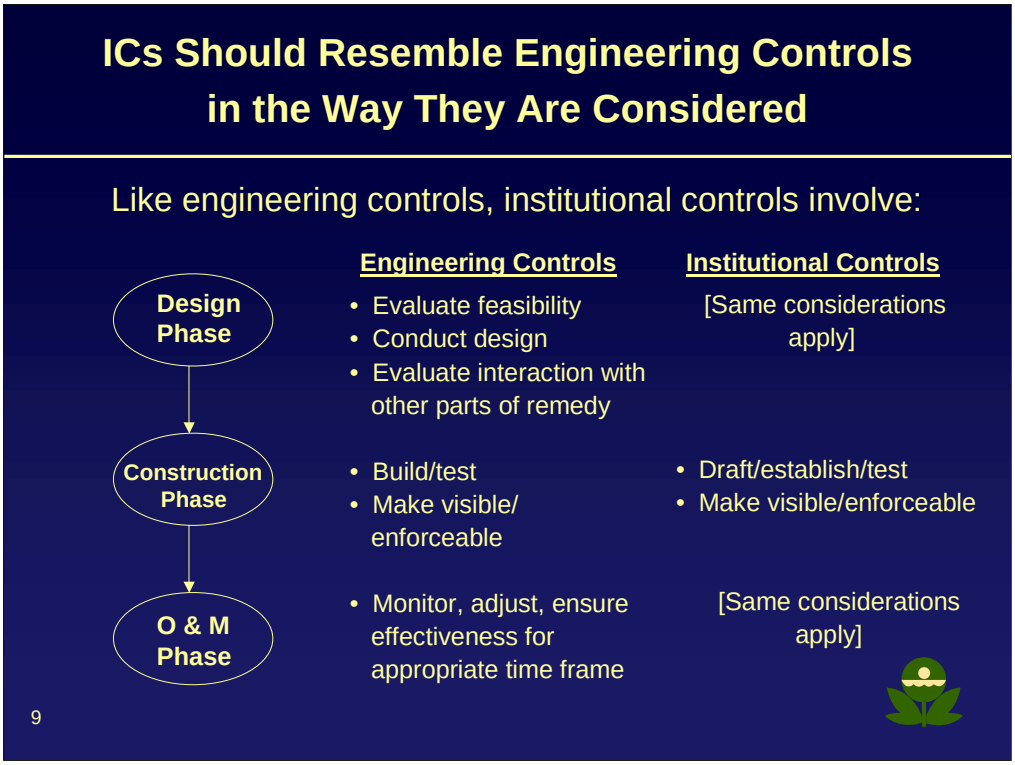
Notes:

1) Wrong – Just like engineering controls, ICs need to be carefully designed, constructed and implemented. Early consideration of these details is critical. Remember, Agency attorneys don't charge by the hour; call them early in the process!

2) Wrong – While there is a time and a place for ICs, they are not a catch-all that can be relied upon to address all concerns about long-term exposure pathways.

3) Wrong – Many project managers do not realize that there must be two parties (and EPA does not count) to create an effective, enforceable IC (other than informational notices). To create a valid real property interest, there must be a conveyance by one property owner (grantor) to another entity (the grantee). The conveyance results in the property owner agreeing to do or refrain from doing specific activities and granting a right of enforcement to the grantee. Unlike Superfund, EPA cannot purchase the property interest. So even the project manager's good faith pledge is useless without the cooperation of an appropriate third party.

4) Wrong – The terminology, enforceability and effect of each real property interest is largely dependent on state common law of real property. For example, in most states, in order for an easement to bind subsequent purchasers, the grantor and grantee must be adjacent property owners (with one parcel getting the benefit of the easement and the other the burdens). This may have negative implications for restrictions placed on property for protection of public health and the environment since the grantee is not typically an adjacent property owner.



Notes:

Design Phase – Involves evaluating the need for and appropriateness of an institutional control, determining the type of control needed, and identifying the third parties necessary to successfully implement IC.

Construction Phase – Involves negotiating, drafting, and recording legal documents to transfer property interest from property owner to third party (i.e., creating industrial use only easement held by the state environmental agency).

O & M Phase – Involves implementing visibility measures to ensure that the community is informed about the IC (i.e., recording with Dig Safe, adding to state web page, etc.) and inspecting and enforcing IC.

Like engineering controls, ICs can work well, work somewhat, or not work.

Elements When Developing ICs

- ICs often may need to be "layered" (i.e., more than one type of IC used simultaneously) or used in a series depending on site-specific conditions
- To evaluate use of ICs, the project manager should look at four elements:
  - Objective of the IC
  - Mechanism(s) available
  - Timing (when and for how long IC is needed)
  - Responsibility (who will make it work)

10

Notes:

Objective—Clearly state the goals and what will be accomplished through the use of ICs.

Example: Restrict the use of ground water as a drinking water source until the MCLs are met.

Mechanism—Determine the specific types of ICs required to meet the objective (i.e., access is often a contractual right whereas land use restrictions are a property right).

Example: Choose several types such as an easement, a zoning change and a deed notice to simultaneously restrict land use and provide notification on the limitation of a site for a specific use ("layering").

Timing—Investigate when the IC needs to be implemented and/or secured.

Example: A deed notice may be required in the short-term and a formal petition for a zoning change may be necessary in the long-term.

Responsibility—Think about who will be responsible for securing and maintaining the control.

Example: Compel the potentially responsible party to ensure appropriate land use on their site through an enforceable agreement in addition to relying on local policing of zoning requirements.

Notes:

Some Rules of Thumb About Proprietary Controls

1) Is a property right (as opposed to a mere contractual right) really necessary
   Generally, proprietary controls are advisable when the restrictions will be:

   a) Long-term (15-30 years)
   b) Permanent (contaminants will be let in place that prevent unrestricted use),
   OR
   c) Other controls are deemed unreliable
   If duration is more short-term (4-5 years to treat soil), restrictions may not need to "run with the land."

2) When should property restrictions be implemented/secured?
   Timing should be evaluated as part of the remedy selection process

3) Who will be responsible for securing and maintaining the controls?
   a) Party responsible for the cleanup at the site
   b) Other parties such as federal, state, or local government, if appropriate

4) Who should be the grantee?
   Unlike CERCLA, RCRA does not authorize EPA to hold property interests. Thus, EPA should look towards other potential grantees such as states, stable companies (Fortune 500), local government organizations, conservation organizations, etc.

5) How should potential holder be evaluated?
   a) Is entity likely to be in existence for the duration of the remedy?
   b) Would entity be willing and/or capable of enforcing?

Uncertainty Management in Institutional Controls

- Like engineering or treatment approaches, ICs will result in uncertainties that need to be managed
- In many cases, the effectiveness of the control and issues about responsibility and enforceability will be long-term uncertainties
- In general, any IC will require active uncertainty management (continuous monitoring)

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Notes:

- Layering of controls is an uncertainty management strategy.

•Controls can be established early in the process and revised later to become more or less restrictive as data are collected and risks to human health and the environment are better understood

Summary Slide

- ICs will be a part of many RCRA interim and final remedies
- ICs should be evaluated in terms similar to those of engineering controls (effective design, good operation, long-term monitoring)

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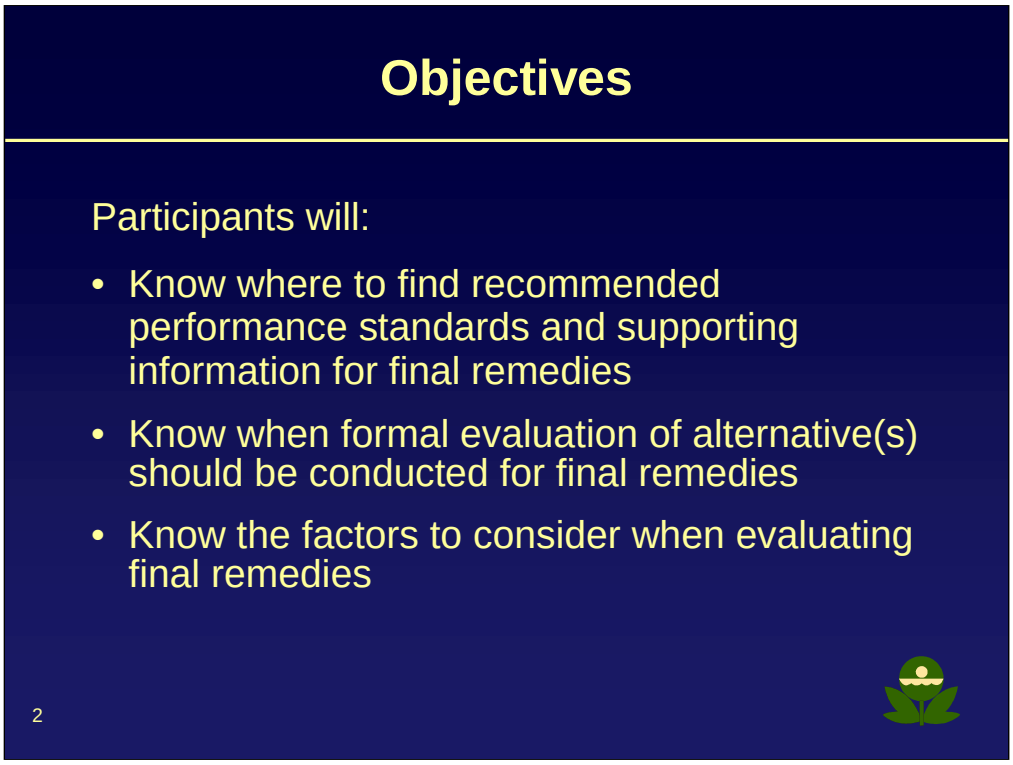
Final Remedy Selection

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.



Notes:

This module describes remedy selection processes, criteria, and tools for final remedies at RCRA Corrective Action sites.

This module also provides some tools that project managers can use to organize and assess the information they need to consider when documenting and implementing remedies.

This module does not provide guidance on how to conduct detailed technical evaluations of different potential remedies, however, the toolbook provides helpful exercises dealing with remedial technologies.

Regulator Choices for Remedy Selection

- Review remedy recommendation (see case study at end of module)
- Given owner/operator recommendation, would you:
  - approve it?
  - request modifications? If so, which ones?
  - request an additional approach be considered? If so, what approach?

3

Key Questions to Address

- What are lead agency roles and responsibilities?
- Against what performance standard and criteria do you evaluate a remedy?
- What are expectations for the number of remedial alternatives to evaluate?
- What administrative process should you use to evaluate a final remedy?

4

Notes:

A major cross-cutting factor in addressing several of these questions is how certain do you need to be in the data you have, and how much uncertainty can you live with now and manage when the remedy is being implemented?

Summary of Roles and Responsibilities

- Owner/operator should recommend a remedy; lead agency evaluates it
- Number of alternatives can vary
- Lead agency role(s) vary from review/approval of the details of remedy selection to review/approval of performance basis

5

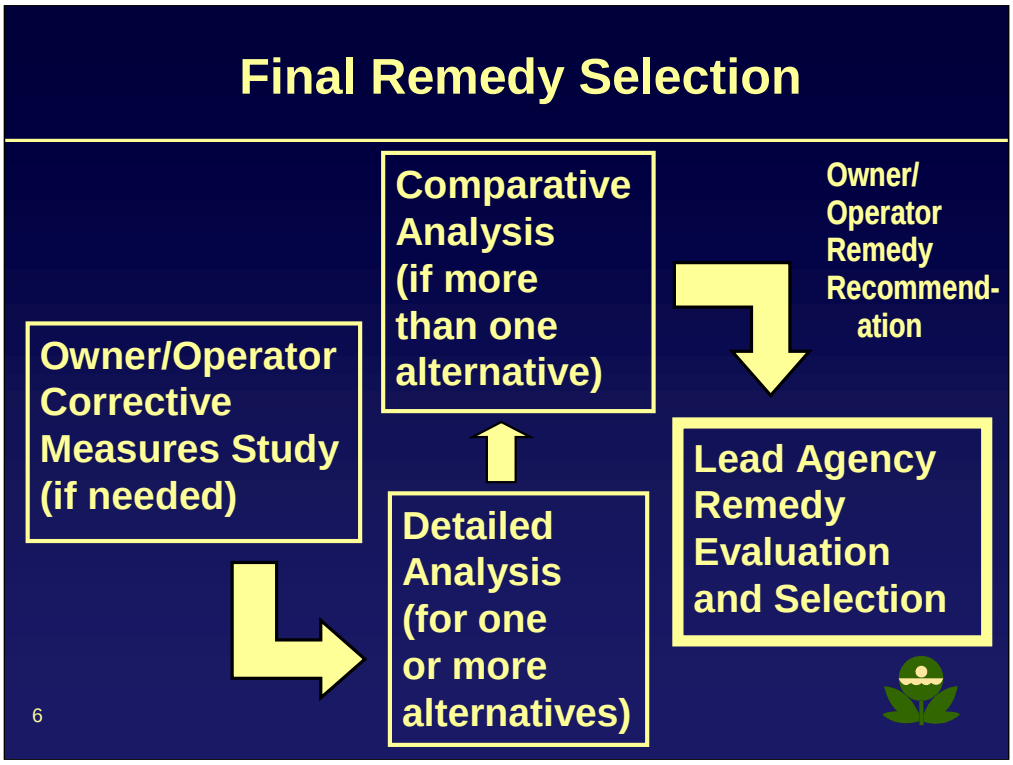
Notes:

Owner/operator should prepare a remedy recommendation, based on data that are submitted as part of the corrective measures summary (CMS), or are sufficient in their own right to be submitted without a formal CMS.

For some sites (e.g., low priority), paperwork supporting the remedy recommendation may remain in site files unless the lead agency requests to see it.

Lead agency evaluates the remedy recommendation using criteria that will be discussed in more detail later. The number of alternatives an owner/operator evaluates may vary with:

- size/complexity of site
- ability of a single technology to adequately meet criteria



Notes:

Remedy Selection Fact Sheet, found in the back of this module, describes each of these elements in more detail.

Summary of Responsibilities and Elements for Final Remedies

		Owner/Operator Remedy Recommendation		
	Owner/ Operator Corrective Measures Study (CMS) (if necessary)	**Detailed Analysis (for one or more alternatives)**	**Comparative Analysis (if more than one alternative)**	**Lead Agency Remedy Evaluation and Selection**
Key Elements	Identification and sufficient description of corrective measure alternative(s) to determine whether it meets overall remedy performance standards and remedial expectations Provides key information to compare the corrective measure alternative(s) to appropriate threshold remedy selection criteria	Evaluation of alternative against each performance standard and evaluation/balancing criterion	Evaluation of each remedy against evaluation/balancing criteria to determine "best" remedy (if multiple alternatives are proposed) or evaluation against each balancing criteria to ensure a single remedy would meet remedy performance standards	Select and provide documented rationale for remedy recommendations
Roles/ Responsibilities	Owner/Operator prepares CMS or equivalent documentation as part of another document EPA/State reviews CMS or equivalent against elements to determine adequacy	Owner/Operator prepares remedy recommendation EPA/State reviews remedy recommendation for completeness and sufficiency to be able to determine advantages and disadvantages of each alternative against each criterion	Owner/Operator prepares necessary comparative analysis to identify preferred alternative or to show acceptability of a single alternative EPA/State reviews comparison of alternatives or acceptability analysis	Owner/Operator provides support and input to remedy selection process EPA/State, after reviewing public input, makes final remedy decision

7

Notes:

Corrective measures studies (CMS) provide, to the degree necessary, the evaluation of remedial alternatives against the appropriate criteria. They also serve to design the alternative(s) to a sufficient degree to allow remedy review and approval.

CMSs are initiated early on in concept, although much of the site-specific documentation may not be available until some investigation steps are conducted.

Where problems are definable early in site planning activities and a problem statement can be written, the major focus of the investigation may be what is traditionally thought of as the CMS. That is, the investigation can focus on data needs relating to evaluating and recommending/approving technologies to remediate the problem.

The degree of lead agency oversight may vary depending on the priority of the site, the desire of the regulators to be involved, and cooperation by the owner/operator.

Expectations for Remedy Evaluation (CMS or Equivalent)

- Evaluate only appropriate, implementable approaches, consistent with expected future land uses
  - Scope and substance of CMS tailored to the extent, nature, and complexity of problems
- Overlap with site characterization
- Limited agency oversight, as appropriate, if releases and performance measures are well defined
- Evaluation of multiple alternatives not required if single alternative meets performance standard

8

Notes:

The CMS obviously should provide the data and evaluation to support the decision-making criteria. This includes Corrective Action Results, performance standards, criteria, and media cleanup objectives.

Where technical impracticability (TI) recommendations are made by owner/operators, lead agency role may include evaluation of possible technologies that could be effective.

Primary references on the use of institutional controls include: "Institutional Controls: A Reference Manual," US EPA Workgroup on Institutional Controls, Draft, March 1998.

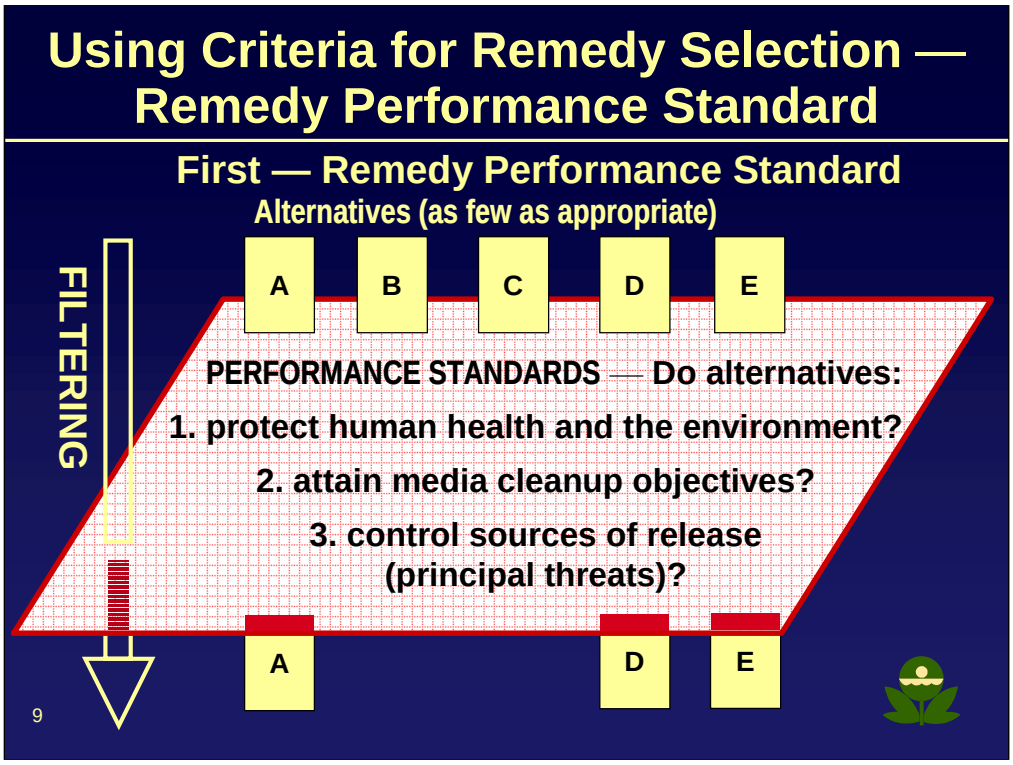
Establish Performance Monitoring Systems as Part of the Remedy

Data collection decisions do not stop with characterization (pre-remedy). Performance monitoring plans are a part of the remedy recommendation, and should be able to answer whether or not the remedy is implemented:

– The remedy is working as desired (short term);

– The remedy has met performance standards; and

– Whether new conditions affect long-term achievement of Corrective Action Results.



Notes:

The criteria for evaluation of remedies have evolved. Three performance standards now comprise the threshold that any remedy proposed or selected should meet, and seven criteria comprise the evaluation/balancing criteria.

The concept of the performance standard as a "filter" and the evaluation/balancing criteria as a "scale" is an appropriate analogy. That is, remedies should meet all three performance standards. Those that provide the best balance among the other criteria are preferred.

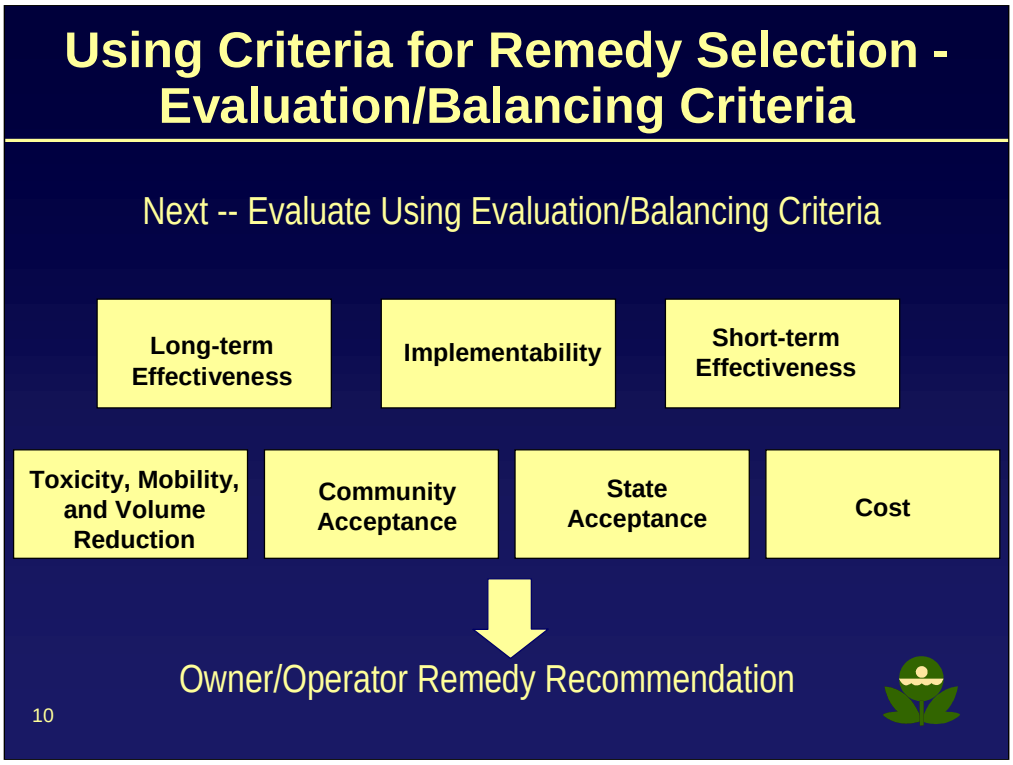
<u>For a single alternative</u>, these criteria:

•Serve as basis to determine if EPA judges the remedy recommendation adequate

•Result is approval, recommended modification, or request that the owner/operator to develop additional alternatives

<u>For multiple alternatives</u>:

•Allows identification of "recommended" or "best" approach



Notes:

EPA intends to place small emphasis in selecting remedies on the long-term effectiveness criterion, that is the ability of any remedial approach to provide adequate protection of human health and the environment over the long term. Thus, source control technologies that involve treatment of contamination, or that otherwise do not rely on containment structures or systems to ensure against future releases, will be strongly preferred to those that offer more temporary, or less reliable, controls. Long-term effectiveness should consider reasonably anticipated future land uses.

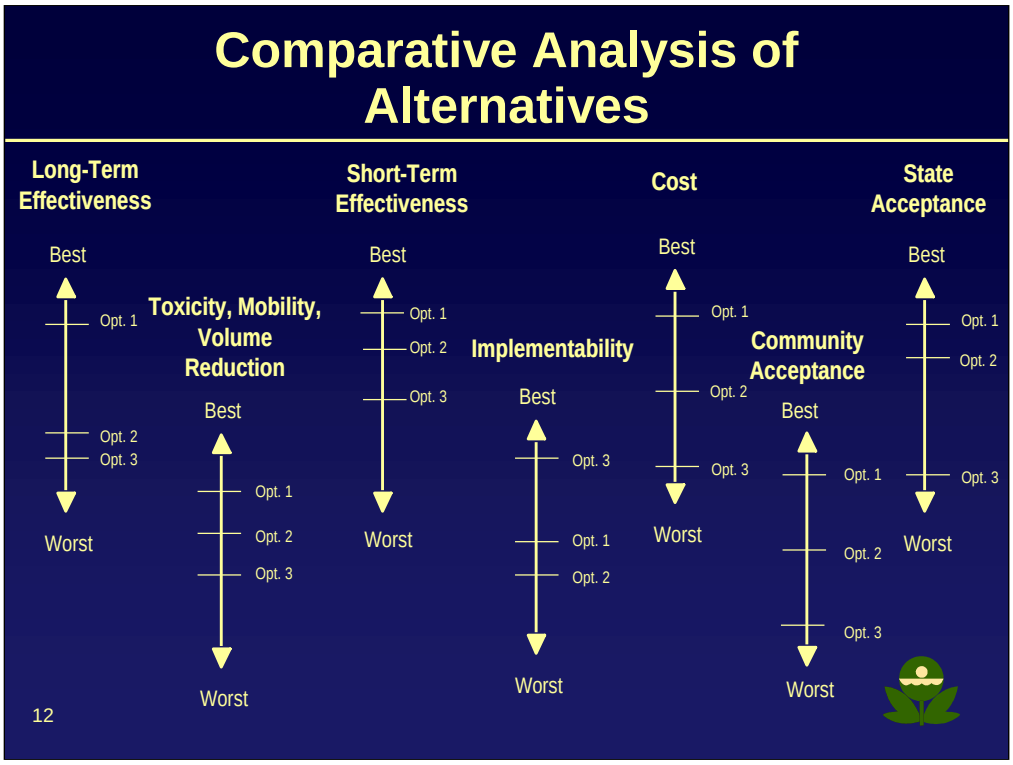
Reduction of toxicity, mobility, or volume is directly related to the concept of long-term reliability of remedies. As a general goal, remedies are preferred that employ techniques that are capable of permanently reducing the overall degree of risk posed by the wastes and constituents at the facility. Reduction of toxicity, mobility or volume is this a means of achieving the broader objective of long-term reliability.

Short-term effectiveness may address factors such as magnitude of reduction of existing risk, and time until full protection is achieved. It also addresses risks that might be posed to community, workers, or the environment during implementation.

Notes (Cont.):

Implementability will often be a determining variable in shaping remedies. For example, some technologies will require State or local permits prior to construction, which may increase the time needed to implement the remedy. Also, the evaluation should include an assessment as to whether the remedy is implementable with respect to future land use.

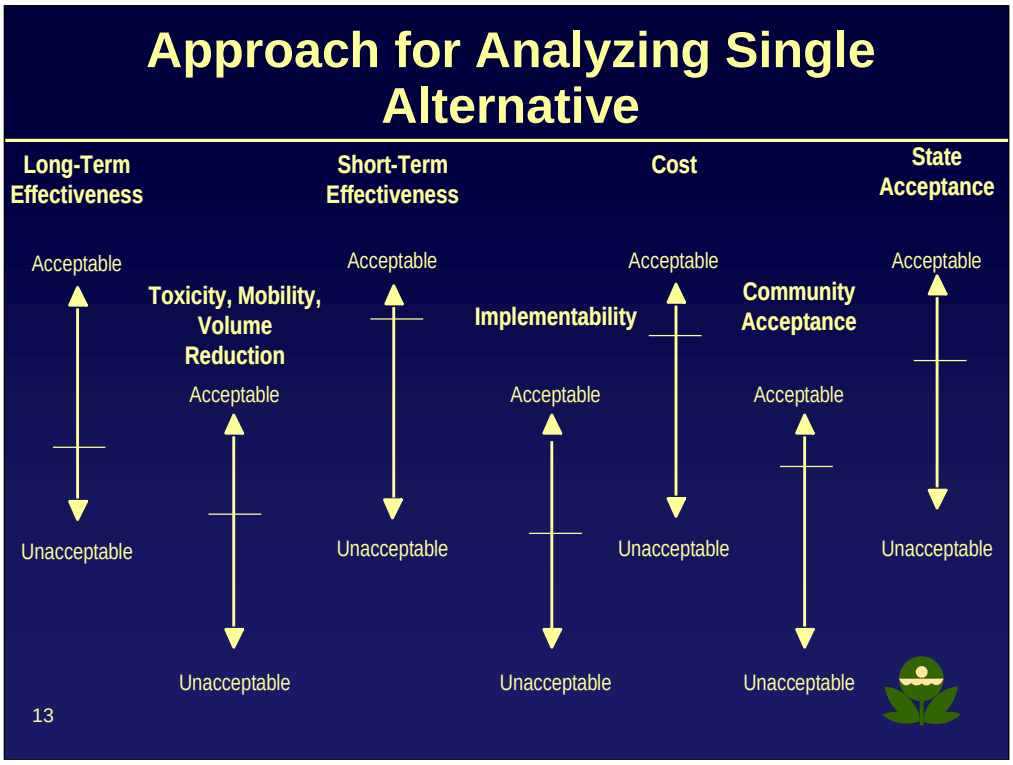
Community acceptance should include an analysis of the local planning agency's plan for potential reuse of the property.



Notes:

This tool portrays a qualitative use of the balancing criteria when more than one alternative is being considered.

The intent is to determine whether one alternative or option offers an overall "better" balance of the seven criteria.



Notes:

This tool portrays a qualitative evaluation of how acceptable a single alternative is against the seven criteria. The outcome can be a judgement that certain modifications to the remedy might make it more acceptable.

The Statement of Basis/Response to Comments

- The purpose is to document and communicate the proposed and selected final remedy to the public
- It is a combination of existing information from planning, investigations, and evaluations
  - Problem statements
  - Residual uncertainty management strategies
  - Alternative analysis tools

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Notes:

The Statement of Basis/Response to Comments summarizes the:

- Facility background
- Environmental setting for the site
- Problems for the site
- Corrective Action activities already conducted (e.g., interim measures and stabilization techniques)
- EPA's public participation activities (communication blueprint)
- Applicable Corrective Action Results
- Type and concentration of contaminants present
- Exposure pathways, including those based on current as well as reasonable expected future uses
- Carcinogenic and non-carcinogenic risks to be addressed
- Ecological risks to be addressed
- Cleanup levels or goals
- Innovative technology considerations

Notes (Cont'd):

The Statement of Basis/Response to Comments also identifies other information including:

- Remedy selection
- Residual uncertainties
- Final remedy

References: "*RCRA Corrective Action Decision Documents: the Statement of Basis and Response to Comments. Directive No. 9902.6*," April 29, 1991.

Remedy Completion

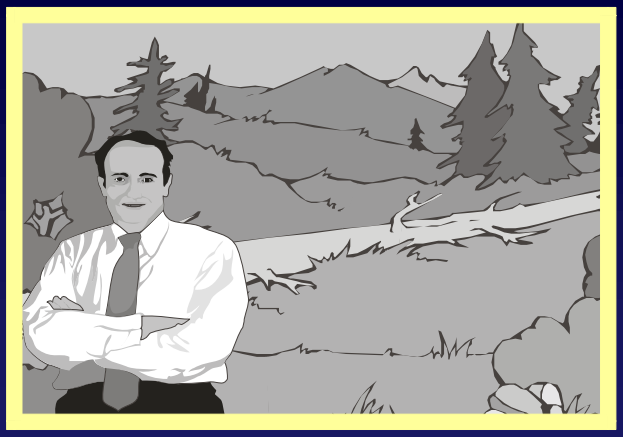
This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

Objectives

Participants will be able to:

- Incorporate remedy completion considerations early in cleanups
- Apply EPA's guidance on when remedies are complete
- Efficiently use administrative processes to seek public participation in and record remedy completion decisions

Remedy Completion is the Ultimate Goal of Corrective Action

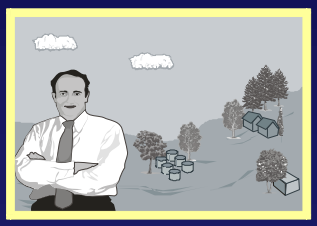


3

Remedy Completion

Remedy Completion can be for...

an entire Facility...



or an Individual Unit.

a portion of a Facility...

4

What Constitutes Remedy Completion?

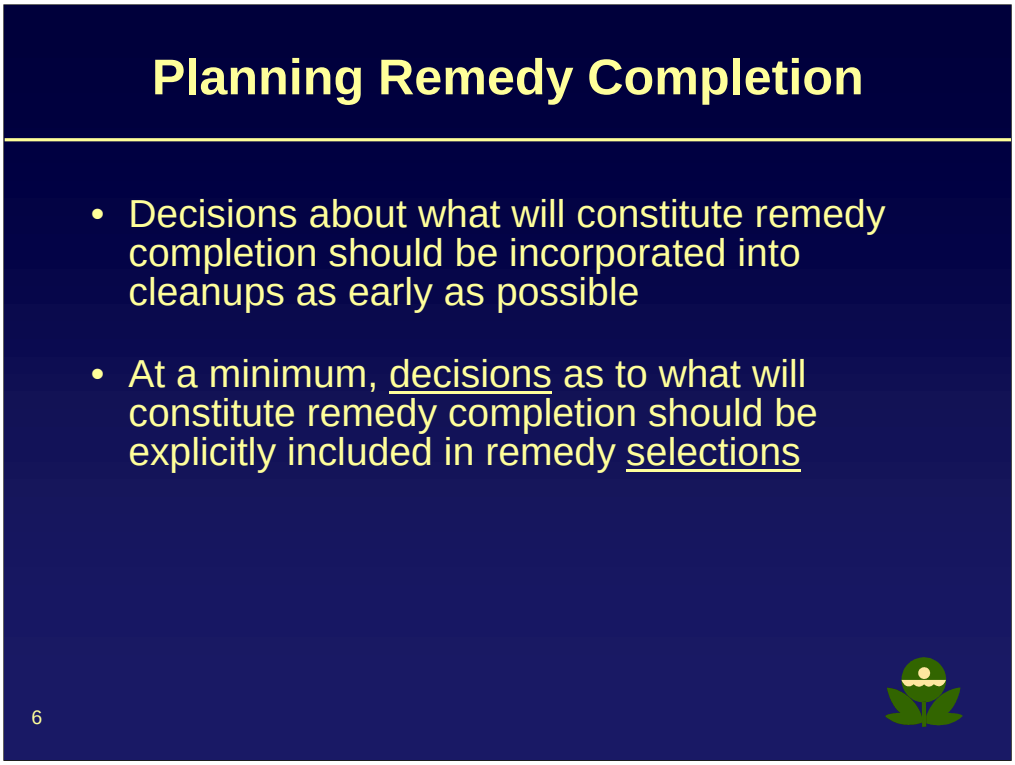
- The elements of remedy completion depend on the remedy selected for:
  - a facility;
  - portion of a facility; or
  - individual unit
- For all remedies, EPA believes a remedy should be considered complete only when certain conditions are met

5

Notes:

EPA believes that for remedies to be considered complete the lead agency should have necessary and sufficient information about a facility and remedy to:

- Document the facility, portion of facility, or unit for which the decision is made;
- Document that the remedy was selected and implemented properly;
- Document any land use assumptions or restrictions used to inform the remedy selection and document any associated long-term care requirements for the facility, portion, or unit;
- Ensure that remedy is consistent with anticipated future land use; and
- Document that cleanup standards or other remedial goals are achieved.



Notes:

Making early decisions about what will constitute remedy completion is important so the public, the facility owner/operator, and the project manager all will understand and agree on what the cleanup is going to accomplish.

Examples:

1. For a groundwater cleanup, remedy completion might be monitoring that shows cleanup standards are achieved at the point of compliance in groundwater for 3 consecutive years;
2. For a soil cleanup, remedy completion might be sampling that confirms all soil above site-specific cleanup standards has been removed or that confirms cleanup standards have been achieved;
3. For a remedy that includes capping or containment, remedy completion might be construction of the containment system, documentation that the containment system is functioning properly, notification of the containment system, and that remaining hazardous wastes and hazardous constituents are included on the property deed.

Three Suggested Steps to Determine Remedy Completion

- Gather and assess data and information necessary to make a tentative decision as to whether a remedy is complete
- Make a tentative decision and provide that decision to the public, including the facility owner/operator, for review and comment
- Respond to public comments and make a final decision as to whether a remedy is complete

Step 1: Gathering and Assessing Data and Information

- Information can come from facility owners/operators, State and Federal regulators, and contractors
- Facility owners/operators' final documentation of remedy completion should be certified by an independent registered professional
- Information gathered by State and Federal regulators should be shared with the facility owner/operator

8

Notes:

Part of remedy completion decisions will generally be a determination of whether cleanup levels have been achieved at points of compliance. This will typically require application of a statistical methodology.

There are many statistical methods that may be used. It is important for project managers and facility owners/operators to discuss and make clear which the statistical methods will be used to support remedy completion decisions. This should be done when remedy completion criteria are set.

Step 2: Making a Tentative Decision for Public Review and Comment

- Evaluate information/data to determine if the conditions established at remedy selection are met
- Make a tentative decision about whether the remedy meets the conditions
- Invite public review and comment on tentative remedy completion decision, and the information supporting the decision

9

Notes:

If Corrective Action is occurring under a RCRA permit, EPA recommends that public notice be accomplished through a Class III permit modification. The procedures for Class III permit modifications are found at 40 CFR 270.42(c).

Class III permit modification requires that a notice of the modification be sent to all people on the facility mailing list and to appropriate units of State and local governments. Notice must also be published in a local newspaper of general circulation. A 60-day public comment period and a public meeting are required.

If Corrective Action is occurring under an order or other nonpermit mechanism, public notice should be accomplished using a process that is similarly inclusive.

If a remedy completion decision is based, in part, on any assumptions about nonresidential future land use, the land use assumptions should be highlighted in the public notice so the community can evaluate and comment on the validity of the assumptions. Also check with appropriate land use planning agency to ensure that remedy is consistent with community development plans.

Step 3: Responding to Public Comments and Final Decision

- Carefully evaluate public comments
- Make necessary adjustments to the tentative remedy completion decision
- Final decision about remedy completion should:
  - include a response to all significant comments; and
  - be made available to the public

10

Notes:

Examples of modifications to remedies in response to public comment:

1. Public does not agree with the amount of waste that would be left in place—asks for additional removal.
2. Public does not agree with the long-term care mechanisms in place to maintain land use assumptions—asks for more long-term care or more conservative land use.
3. Public does not agree with the amount of restoration the remedy provides—asks for additional landscaping/plantings.

Remedy Completion Decisions

- Modify facility permit simultaneously with remedy completion decision if facility is operating/ conducting post-closure care under a permit.
- Terminate interim status using permit denial procedures simultaneously with remedy completion decision if:
  - Remedy completion decision is for entire facility; and
  - Closure/post-closure care are complete for entire facility

11

Notes:

For Federal actions under RCRA, permit denial procedures are generally set forth in 40 CFR Part 124.

For permit denial, 40 CFR Part 124 regulations require that EPA publish a notice of intent to deny a facility permit in accordance with 40 CFR 124.6(b). A notice of intent to deny a permit is a type of draft permit and must follow the same administrative procedures as other draft permits. A notice of intent to deny a facility permit must be accompanied by a statement of basis (40 CFR 124.7) or a fact sheet (40 CFR 124.8) and must be based on the administrative record for the facility in question (40 CFR 124.9). A notice of intent to deny a facility permit must be published for public comment and an opportunity for a public hearing is required (40 CFR 124.10 through 124.12). After public notice and comment on a notice of intent to deny a facility permit, final decisions must be made in accordance with 40 CFR 124.15 and opportunities for appeal of final decision provided in accordance with 40 CFR 124.19.

States that are authorized to implement the RCRA permitting program will have equivalent administrative procedures that must be used for permit denial.

Remedy Completion Decisions (Cont.)

- If a remedy completion decision is not for an entire facility, make clear exactly what:
  - portions of the facility; or
  - units at the facility

  are covered by the decision

Remedy Completion Decisions (Cont.)

Remedy completion decisions are:

- Based on information available at the time; and
- Do not preclude future additional cleanup actions, as appropriate, in response to new information

13

Decisions About Remedy Completion Can Be Complicated

- Complications caused by the administrative status of individual facilities and the authorization status of a State in which a facility is located
- Complications caused by future land use/institutional controls issues

14

Notes:

Complications caused by the administrative status of a facility or the authorization status of a State.

- Who makes completion decisions?
- What administrative processes apply?

States should work with Regions to resolve these issues.

Complications caused by future land use/institutional controls issues:

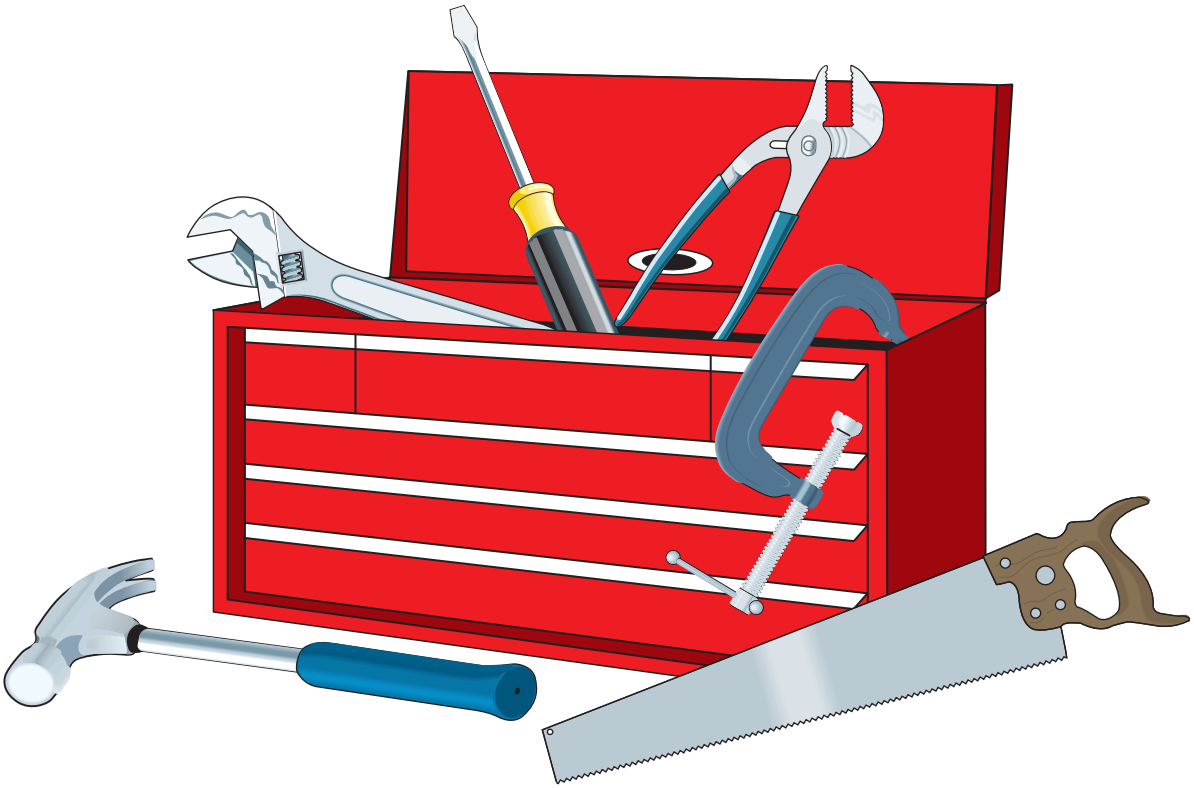
- Responsibility for recording future land use assumptions
- Responsibility for monitoring/enforcing future land use limitations/institutional controls

TOOLBOOK

RCRA Corrective Action Workshop On Results-Based Project Management

Tools for Accelerating Schedules, Improving Efficiency, and Focusing Implementation on Protective Results

Developed by the Corrective Action Programs Branch
Office of Solid Waste



RCRA Corrective Action Workshop
on Results-Based Project Management

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  - ! Interim-Final Documentation of Environmental Indicator Determination; RCRA Corrective Action Environmental Indicator (EI) RCRIS Code (CA 725): "Current Human Exposures Under Control"
  - ! Current Human Exposures Under Control Flow Chart
  - ! Interim-Final Documentation of Environmental Indicator Determination; RCRA Corrective Action Environmental Indicator (EI) RCRIS Code (CA 750): "Migration of Contaminated Ground Water Under Control"
  - ! Migration of Contaminated Groundwater Under Control Flow Chart
  - ! EPA Memo 2/5/99: Interim-Final Guidance for RCRA Corrective Action Environmental Indicators
- **Reference List**

"Dynamic Workplans and Field Analytics: The Keys to Cost Effective Site Characterization and Cleanup" . . . . . Dynamic Workplans and Field Analytics

- **Tools**
  - ! EPA Memo 1/28/98: Documented Savings Using Field Analytical Technologies
  - ! EPA Efforts to Promote Improved Processes for Site Characterization and Monitoring
  - ! Reference Lists courtesy of The Nielson Environmental Field School, Inc.

- EPA Innovations in Site Characterization; Case Study: Hanscom Air Force Base, Operable Unit 1 (Sites 1, 2, and 3), Case Abstract
- EPA Memo 8/7/98: Clarification Regarding Use of SW-846 Methods
- EPA Fact Sheet: Field Sampling and Analysis Technology Matrix and Reference Guide
- EPA Fact Sheet: Field Analytical and Site Characterization Technologies, Summary of Applications
- EPA Fact Sheet: Environmental Technology (ETV) Program, Site Characterization and Monitoring Technologies Pilot
- EPA Fact Sheet: Site Characterization Library, Volume 1, Release 2; National Exposure Research Laboratory (NERL) - Las Vegas
- EPA CLU-IN: Hazardous Waste Cleanup Information World Wide Web Site
- EPA TechDirect: Technology Information Service
- EPA CERCLA Education Center Technology Innovation Office: Field-Based Site Characterization Technologies Short Course Information
- EPA CERCLA Education Center Technology Innovation Office: Field-Based Site Characterization Technologies Course Information
- EPA CERCLA Education Center Technology Innovation Office: Strategies for Field-Based Analytical and Sampling Technologies Course Information

Managing Remediation Waste . . . . . Managing Remediation Waste

- **Tools**
  - EPA Management of Remediation Waste Under RCRA
  - EPA Memo 10/15/98: Summary Chart of October 14, 1998 Memorandum "Management of Remediation Waste Under RCRA"
  - EPA Fact Sheet: Final HWIR-Media Rule
  - Reference List for Managing Remediation Waste
- **Reference List**

Administrative Approaches . . . . . Administrative Approaches

- **Tools**
  - EPA Memo 10/20/97: Transmittal of "Guidance on the Use of Section 7003 of RCRA"
  - Letter from Waterman, EPA, to Lavine, Whyco/Model Facility Agreement, May 1996
  - Letter from Waterman, EPA, to Lavine, Whyco regarding Voluntary Corrective Action, November 1996
  - Letter from Hyner, Whyco, to Waterman, EPA regarding Voluntary Corrective Action/Stabilization Criteria, January 1997
- **Reference List**

Final Remedy Selection . . . . . Final Remedy Selection

- **Tools**
  - Federal Remediation Technologies Roundtable Remediation Case Studies: Fact Sheet and Order Form
  - EPA Citizens' Guide to Understanding Innovative Treatment Technologies
  - The Federal Remediation Technologies Roundtable Remediation Technologies Screening Matrix and Reference Guide, 3rd Edition

- EPA CERCLA Education Center Technology Innovation Office Innovative Treatment Technologies Short Course
- EPA CERCLA Education Center Technology Innovation Office Innovative Treatment Technologies Course
- EPA Expediting Cleanup Through Contingent Removal Actions

• **Reference List**

Remedy Completion . . . . . Remedy Completion

• **Tools**
- EPA Memo 9/24/96: Coordination Between RCRA Corrective Action and Closure and CERCLA Activities
- EPA Memo 3/16/98: Risk-Based Clean Closure

• **Reference List**

Recent Developments in Innovative Treatment Technologies (ITT) . . . Recent Developments in ITT

• **Tool**
- EPA Directive: Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites

Post Closure . . . . . Post Closure

• **Tools**
- EPA Fact Sheet: Post-Closure Permit Amendment Addresses Corrective Action
- Post Closure Module

Glossary/Acronyms . . . . . Glossary/Acronyms

INTRODUCTION

FACT SHEET #1

HISTORY OF
RCRA CORRECTIVE ACTION

Congress, the general public, EPA, and State agencies believe the rate and pace of RCRA cleanups should be increased. Speaking at the RCRA National Program meeting on January 12, 1999, Acting Assistant Administrator Tim Fields indicated that Corrective Action progress was the RCRA program's highest priority in 1999. One of the efforts designed to improve Corrective Action progress is a new workshop titled, "RCRA Corrective Action Workshop on Results-Based Project Management." This is the first in a series of fact sheets supporting the Workshop.

WHAT IS THE PURPOSE OF THIS FACT SHEET?

This fact sheet [1] provides an overview of the main events that have shaped the current RCRA Corrective Action Program. It also provides a brief history of the statutory authorities, regulations, and policy that form the framework for the program. A misconception concerning the Corrective Action Program through the years has been that implementation can only be accomplished through an inflexible, prescriptive, step-by-step process. This fact sheet points out that since1990, the Program has emphasized site-specific flexibility aimed at achieving both interim and final Corrective Action results. Today' s Corrective Action Program continues to emphasize flexibility and results!

WHAT DOES THE CORRECTIVE ACTION PROGRAM DO?

The RCRA Corrective Action Program evaluates releases of hazardous wastes and hazardous constituents at hazardous waste treatment, storage and disposal facilities, and develops and implements remedial measures to protect human health and the environment. Currently, EPA believes that there are approximately 6,400 facilities subject to RCRA Corrective Action. Of these, approximately 3,600 facilities have Corrective Action already underway or will be required to implement Corrective Action as part of the process to obtain a permit to treat store or dispose of hazardous waste.

WHY IS THE RCRA CORRECTIVE ACTION PROGRAM IMPORTANT?

The program addresses risk-reduction and final cleanup at facilities that treat, store, or dispose of hazardous waste. EPA has identified rapid remediation of RCRA Corrective Action facilities as one of its highest priorities.

HOW DOES EPA IMPLEMENT THE CORRECTIVE ACTION PROGRAM?

EPA implements the program principally through permits and orders issued under statutory authorities established by the Hazardous and Solid Waste Amendments of 1984 (HSWA). Prior to HSWA, EPA' s authority to compel remediation of RCRA facilities was limited to:

- Section 3004(a) - required the Agency to promulgate regulations establishing standards for hazardous waste treatment, storage and disposal facilities (TSDFs); the Agency promulgated regulations under this statutory authority that requires cleanup of certain releases from hazardous waste treatment, storage, and disposal units.
- Section 3013 - monitoring, testing, analysis and reporting of information for facilities that may present a substantial hazard to human health or the environment; and
- Section 7003 - cleanups of situations that may present an imminent and substantial endangerment to human health and the environment.

HSWA added statutory provisions to RCRA that gave EPA substantial authority to develop a broader Corrective Action Program than previously existed; however, the pre-HSWA authorities are still available for use where appropriate. Corrective Action provisions added to RCRA include:

- Section 3008(h) - provides authority to require Corrective Action, as necessary to protect human health and the environment, at facilities authorized to operate under interim status;
- Section 3004(u) - requires that when Corrective Action, as necessary to protect human health and the environment cannot be finished before permits are issued, permits contain Corrective Action schedules of compliance.
- Section 3004(v) - requires corrective action for releases migrating beyond the facility boundary;
- Section 3005(c)(3) - requires that permits contain all conditions EPA or the State determines is necessary to protect human health and the environment. This provision is often referred to as EPA' s " omnibus" authority and has been used, for example, to require Corrective Action at " areas of concern" (AOCs).

Note: Direct quotes of the relevant statutory language are attached to this fact sheet.

EPA expects that the States will be the primary implementers of the Corrective Action Program. Currently, 33 States have already received authorization for RCRA Corrective Action and use their own Statutory and regulatory authorities to implement the program. A number of additional States are also in the process of receiving Corrective Action authorization.

WHAT ARE THE MAJOR DEVELOPMENTS THAT HAVE SHAPED THE PROGRAM SINCE 1984?

1990 - SUBPART S PROPOSAL (55 FR 30798, July 27): EPA proposed detailed regulations to govern the technical (e.g., cleanup levels, site characterization, etc.) and procedural (definitions, permitting, oversight, etc) elements for implementing RCRA Corrective Action. The 1990 proposal was intended to be similar to the Superfund Program' s National Contingency Plan (NCP) in scope and level of detail. However, the proposal also emphasized the need for site-specific **flexibility** stating "EPA believes a flexible approach, based on site-specific analysis is necessary. No two cleanups will follow exactly the same course, and therefore, the program has to allow significant latitude

to the decision maker in structuring the process, selecting the remedy, and setting cleanup standards appropriate to the specifics of the situation." (55 FR 30802.)

The 1990 Subpart S proposal encouraged project managers to focus on cleanup results and emphasized procedural flexibility. At the same time it also provided substantial detail on common cleanup elements. These common elements are identified in Highlight 1 along with corresponding elements from the EPA' s Superfund cleanup program. After considering many significant and diverse public comments, EPA decided not to immediately finalize the majority of the proposal (e.g., see discussion below on CAMUs and TUs which were finalized in 1993). It is the Agency' s current intention not to finalize comprehensive Corrective Action Regulations. A Federal Register notice formally withdrawing the 1990 proposal is anticipated in the near future. In the absence of detailed Corrective Action regulations, since 1990, EPA has issued guidance, policy directives and related regulations all of which were designed to increase the effectiveness, efficiency and pace of Corrective Action.

HIGHLIGHT 1
Common Elements of RCRA Corrective Action as Described In 1990 Proposal

- RCRA Facility Assessment (RFA) - similar to Superfund's Preliminary Assessment/Site Inspection (PA/SI)
- RCRA Facility Investigation (RFI) - similar to Superfund's Remedial Investigation (RI)
- Corrective Measures Study (CMS) - similar to Superfund's Feasibility Study
- Statement of Basis (SB) and Response to Comments (RTC) - similar to Superfund Record of Decision (ROD)
- Remedy evaluation and selection based on four proposed standards for all remedies and six decision or balancing factors - similar in scope to Superfund remedy selection criteria
- Corrective Measures Implementation (CMI) - similar to Superfund's Remedial Design/Remedial Action (RD/RA)

1991 - Stabilization Initiative (October 25): The stabilization initiative encouraged program implementers to use flexible approaches aimed at near-term activities to control or abate threats to human health and the environment and prevent/minimize movement of existing contamination at many facilities rather than only focusing on final, facility-wide, cleanups for relatively few facilities.

1991 - National Corrective Action Prioritization System (NCAPs): NCAPs established a ranking system for facilities subject to Corrective Action. Using NCAPs, facilities subject to Corrective Action are divided into high, medium, and low priority categories to help implementers focus resources on the worst facilities first. Of these 3600 facilities mentioned previously, the division among high, medium and low priority based on NCAPs scoring is 1500, 1100, and 1000, respectively.

1993 - Corrective Action Management Unit and Temporary Unit Regulations (55 FR 8658, February 16): The regulations, which were promulgated based on the 1990 Subpart S proposal, created two new types of units designed to increase flexibility in the way remediation wastes are managed.

1994 - Environmental Indicators: EPA established two environmental indicators as results-based measures for Corrective Action to aid the site decision maker in focusing on cleanup outcomes rather than process. These two indicators focused on preventing unacceptable exposure to humans and preventing the continued migration of contaminated ground water.

1994 - RCRA Corrective Action Plan (CAP, EPA 520-R-94-004): The CAP provides guidance to program implementers on a comprehensive menu of possible elements for implementing Corrective Action. For example, the CAP provides an extensive list of activities that might be associated with facility investigations. The intent is to select the elements of an actual facility investigation on a site-specific basis.

1994 - Subpart S Initiative: The Subpart S Initiative was created in response to concerns about the slow pace of RCRA Corrective Action. This initiative centered around 5 major objectives: create a consistent, holistic approach to cleanups; establish protective, practical cleanup expectations; shift more responsibility to the regulated community; streamline cleanups and reduce costs; and increase opportunities for meaningful public involvement throughout cleanups. The major product of the Subpart S Initiative was the May 1, 1996 Advance Notice of Proposed Rulemaking (ANPR, see below).

1996 - Advance Notice of Proposed Rulemaking (61 FR 19432, May 1): The three primary purposes of the ANPR were to: discuss improvements to the Corrective Action Program that were underway; update the 1990 proposal and other documents by providing the Agency's current guidance on Corrective Action implementation; and, request comments on many issues that could affect future corrective action rulemakings and policies. The ANPR also conveyed seven implementation principles (see Highlight 2) that continue to reflect the Agency' s most recent guidance for implementing the RCRA Corrective Action Program. Subsequent to issuing the ANPR, the Agency issued a memorandum (January 17, 1997) emphasizing the expectation that the ANPR should be used as guidance for implementing the RCRA Corrective Action Program.

HIGHLIGHT 2
Corrective Action Operating Principles from May 1, 1996 ANPR

- Corrective Action decisions should be based on risk.
- Program implementation should focus on results.
- Interim actions and stabilization should be used to reduce risks and prevent exposures.
- Activities at Corrective Action facilities should be phased.
- Program implementation should provide for meaningful inclusion of all stakeholders.
- Corrective Action obligations should be addressed using the most appropriate tool for any given facility.
- States should be the primary implementers of the Corrective Action Program

1998 - Post-Closure Regulations (63 FR 56709): This regulation provides flexibility to EPA and authorized States agencies by removing the requirements to obtain a permit for the post-closure period. It also allows EPA or authorized State agencies to use other available authorities to address post-closure needs under certain circumstances, thus removing impediments that have been encountered when one unit is subject to Post-Closure and other units are subject to Corrective Action.

1998 - Hazardous Waste Identification Rule for Contaminated Media (HWIR - Media, November 30, 63 FR 65874): This regulation makes it faster and easier to obtain permits for treating, storing, and disposing of hazardous remediation wastes. It allows facility owner/operators to seek a streamlined permit called a " Remedial Action Plan" to address remediation wastes. In addition, it removed the requirement that " cleanup only" TSDF' s conduct facility-wide Corrective Action. Other key concepts addressed in the rule include the creation of a special type of unit called a " staging pile" , exemption from RCRA Subtitle C for certain dredged materials, and streamlined authorization procedures for revisions to State RCRA programs.

1998 - Management of Remediation Waste Under RCRA (October 14, EPA 530-F-98-026): This guidance provides a very useful consolidation of existing statutes, regulations, policies and guidance which can be used to tailor RCRA hazardous waste requirements when applied to remediation waste. Some examples of the 18 different approaches addressed in the guidance include: area of contamination, CAMUs, permit waivers, contained-in policy, and exemptions for less-than 90 day accumulation of hazardous waste.

1999 - Interim Final Guidance for RCRA Corrective Action Environmental Indicators (February 5): This guidance updated the 1994 guidance (see above) for evaluating sites to determine whether they meet the RCRA Corrective Action Program' s two environmental indicators. Specifically, these indicators are called, " Current Human Exposures Under Control" and " Migration of Contaminated Ground Water Under Control." These two EIs represent the primary goals for the RCRA Corrective Action Program. Furthermore, they are serving as the measures for tracking the Program' s performance in accordance with the Government Performance and Results Act of 1993.

The Corrective Action Program' s goals are by the year 2005 to have 95% of the high priority facilities to achieve the human exposure indicator, and 70% of high priority facilities to achieve the contaminated ground water indicator. The percentages are based upon a baseline established in 1999 of 1712 facilities which is comprised of approximately 1500 high priority facilities plus approximately 200 other Regional and State priorities. The importance of this guidance was further emphasized in a February 11, 1999 EPA memo requesting EPA Regions to provide a commitment to the national EI goals, along with details as to how they intend to meet the goals.

1999 - Improving the Accuracy of RCRA Corrective Action Program Data (February 11): This EPA memo was issued to the Regions to emphasize the importance of accurately reflecting program achievements at 1700 high priority facilities in the RCRA Corrective Action Information System database. Accuracy in this database is important because it is being used by interested stakeholder to judge the progress of the program.

WHAT DOES "FOCUS ON RESULTS" MEAN?

As emphasized in the ANPR, EPA believes that program implementation should focus on results rather than on any one prescriptive linear process. For example, EPA is most interested in knowing that the two Environmental Indicators have been achieved at facilities, as opposed to the number or sequence of events and reports leading up to

achieving the EIs or the Federal or State authority under which cleanup requirements are imposed or overseen. Therefore, it is imperative that program implementers have a clear understanding of the " interim" and " final" results that the Corrective Action program seeks to achieve. **While interim measures are particularly important to achieve the Environmental Indicator goals, Corrective Action obligations remain until final remedial measures are complete.**

Interim (or near-term) remedial measures should be used to control, minimize or eliminate releases(es) and potential releases that pose an actual or potential threat to human health and the environment. Common examples of interim measures include actions designed to cut-off an exposure pathway (e.g., temporary cover of contaminated soil), or installation of a containment system designed to prevent the further spread of contaminated groundwater. To the extent practicable, interim measures should be consistent with final remedies.

Final remedial measures should (1) protect human health and the environment; (2) attain media cleanup objectives; and (3) remediate the sources of releases to eliminate or further reduce threats to human health and the environment, and use treatment to address principal threats , unless alternative approaches are determined to be appropriate by the Regional Administrator. The following evaluation/balancing criteria were developed to help program implementers determine the optimum alternative: (1) long-term reliability and effectiveness; (2) reduction of toxicity, mobility and volume through treatment; (3) short-term effectiveness; (4) implementability; (5) cost; (6) community acceptance; and (7) State acceptance (in states not authorized for Corrective Action). As an additional tool to aid in remedy evaluation and selection, the Agency has developed a series of expectations for final remedies. These expectations are described in Corrective Action Workshop Fact Sheet #2.

WHERE DO I GET MORE INFORMATION?

For more information about RCRA Corrective Action and the Results Based Site Management Workshop, visit the Corrective Action Internet Home Page at http://www.epa.gov/correctiveaction.

Notes:

1. This document provides guidance to EPA and States on how best to implement RCRA Corrective Action. It also provides guidance to the public and the regulated community on how EPA intends to exercise its discretion in implementing its regulations. The document does not, however, substitute for EPA' s regulations, nor is it regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future as appropriate.

Statutory References (exerpts)

RCRA Section 3013(a): "If the Administrator determines, upon receipt of any information that (1) the presence of any hazardous waste at a facility or site at which hazardous waste is, or has been, stored, treated, or disposed of; or (2) the releases of any such waste from such facility or site may present a substantial hazard to human health or the environment, he may issue an order requiring the owner or operator of such facility or site to conduct such monitoring, testing, analysis, and reporting with respect to such facility or site as the Administrator deems reasonable to ascertain the nature and extent of such hazard."

Under certain circumstances, EPA can use RCRA Section 3013 to issue orders to the "most recent previous owner or operator. . .who could reasonable be expected to have [knowledge of the presence of hazardous waste at the facility or site]."

RCRA Section 7003(a): "Notwithstanding any other provision of this Act, upon receipt of evidence that the past or present handling, storage, treatment, transportation, or disposal of any solid waste or hazardous waste may present an imminent and substantial endangerment to health or the environment, the Administrator may bring suit on behalf of the United States in the appropriate district court against any person (including any past or present generator, past or present transporter, or past or present owner or operator of a treatment, storage, or disposal facility) who has contributed or who is contributing to the alleged disposal to restrain such person from such handling, storage, treatment, transportation, or disposal to order such person to take such other action as may be necessary, or both. . .."

RCRA Section 3004(u): "Standards promulgated under this section shall require, and a permit issued after the date of enactment of the Hazardous and Solid Waste Amendments of 1984 by the Administrator or a State shall require, corrective action for all releases of hazardous waste or constituents from any solid waste management unit at a treatment, storage, or disposal facility seeking a permit under this subtitle, regardless of the time at which waste was placed in such unit. Permits issued under section 3005 shall contain schedules of compliance for such corrective action (where such corrective action cannot be completed prior to issuance of the permit) and assurances of financial responsibility for completing such corrective action."

RCRA Section 3004(v): "As promptly as practicable after the date of enactment for the Hazardous and Solid Waste Amendments of 1984, the Administrator shall amend the standards under this section regarding corrective action required at facility for the treatment, storage, or disposal of hazardous waste listed or identified under section 3001 to require that corrective action be taken beyond the facility boundary where necessary to protect human health and the environment unless the owner or operator of the facility concerned demonstrates to the satisfaction of the Administrator that, despite the owner' s or operator's best efforts, the owner or operator was unable to obtain the necessary permission to undertake such action."

RCRA section 3005(c)(3) : " Any permit under this section shall be for a fixed term, not to exceed 10 years in the case of any land disposal facility, storage facility, or incinerator or other treatment facility. Each permit for a land disposal facility shall be reviewed 5 years after date of issuance or reissuance and shall be modified as necessary to assure that the facility continues to comply with the currently applicable requirements of this section and section 3004. Nothing in this subsection shall preclude the Administrator from reviewing and modifying a permit at any time during its term. Review of any application for a permit renewal shall consider improvements in the state of control and measurement technology as well as changes in applicable regulations. Each permit issued under this section shall contain such terms and conditions as the Administrator (or the State) determines necessary to protect human health and the environment."

RCRA section 3008(h)(1): " Whenever on the basis of any information the Administrator determines that there is or has been a release of hazardous wastes into the environment from a facility authorized to operate under section 3005(e) of this subtitle, the Administrator may issue an order requiring corrective action or such other response measure as the Administrator deems necessary to protect human health or the environment or the Administrator may commence a civil action in the United States district court in the district in which the facility is located for appropriate relief, including a temporary or permanent injunction."

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 11 1999

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Meeting RCRA Corrective Action GPRA Goals

FROM: Timothy Fields, Jr., Acting Assistant Administrator

TO: Regional Administrators
Regions 1-10

Achievement of the 2005 Government Performance and Results Act (GPRA) Corrective Action goals is my highest priority for the national RCRA Program. With this memorandum I am seeking a commitment from each region to fulfill its share of our important goals for significantly reducing human exposure and controlling groundwater releases at RCRA facilities. I would like the Regions to provide me with their specific commitments, along with details of how they will be achieved, by March 22, 1999. A related request concerning improving the accuracy of our GPRA baseline will be coming to you shortly.

I know that co-implementation of the RCRA program by EPA and the States makes planning and coordination to meet the GPRA goals especially challenging. I would therefore appreciate your including in your plan a description of issues pertaining to oversight coordination and work sharing with the States in your Region.

I am also aware that many regions have examined and significantly overhauled their corrective action programs to speed cleanups and eliminate procedural barriers. I am particularly interested to hear about innovative and successful approaches that you believe are making a difference, and that can be shared with other regions and the States.

My request for your strategy or plan is detailed in the attachment along with the annual targets each Region must achieve to reach the national 2005 goals. The 2005 goals require that human exposures be controlled at 95% of our highest *priority facilities and that contaminated* groundwater be controlled at 70% of our highest priority facilities. After we receive your plans, my staff and I will be negotiating with you to ensure that we are collectively making the strongest

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and most realistic efforts to further the RCRA corrective action program. Once the specific regional commitments are agreed to, my office will be closely tracking regional progress towards those commitments. Thank you in advance for your efforts to help the corrective action program meet its commitments for human health and environmental protection.

If you have any questions or would like to discuss this request further, please let me know, or your staff may contact Robert Hall of the Corrective Action Programs Branch of the Office of Solid Waste at (703) 308-8432.

cc: RCRA Senior Policy Advisors and RCRA Program Contacts (via electronic mail)

Attachments

U.S. ENVIRONMENTAL PROTECTION AGENCY
RCRIS NATIONAL OVERSIGHT DATABASE

HANDLERS IN THE CORRECTIVE ACTION GPRA UNIVERSE

EPA REGION: 05
STATE: ILLINOIS

EPA ID	HANDLER NAME	CITY
ILD055409940	ABBOTT LABORATORIES	NORTH CHICAGO
ILD006278170	ALLIED CORP METROPOLIS WORKS	METROPOLIS
ILD980503106	AMOCO OIL CO RIVERFRONT	WOOD RIVER
ILD980700967	AMOCO OIL CO WOOD RIVER REFINERY	WOOD RIVER
ILD043369446	ASHLAND CHEMICAL CO	CALUMET CITY
ILD980700538	ASHLAND CHEMICAL CO	WILLOW SPRINGS
ILD005238159	AUBREY MFG INC	UNION
ILD000819946	BEAZER EAST INC	CARBONDALE
ILD980700751	BFI OF ILL INC OGLE CTY LANDFILL	DAVIS JUNCTION
ILD009033341	BIGARD OIL & MFG INC	NEWTON
ILD980700728	BROWNING FERRIS IND OF ILLINOIS INC	ZION
ILD042075333	CABOT CORP	TUSCOLA
ILD052664604	CATERPILLAR INC	EAST PEORIA
ILD005141726	CCL CUSTOM MFG INC	DANVILLE
ILD048843809	CHEMETCO INC	HARTFORD
ILD010284248	CID LANDFILL	CALUMET CITY
ILD000608471	CLEAN HARBORS OF CHICAGO	CHICAGO
ILD074411745	CWM LARAWAY RDF	ELWOOD
ILD980700710	ENSIGN-BICKFORD CO	WOLF LAKE
ILD087157251	ENVIRONMENTAL WASTE RESOURCES INC	COAL CITY
ILD005078126	EQUISTAR CHEMICAL LP	TUSCOLA
ILD000672139	ESCAST INC	ADDISON
ILD005109525	GILBERT & BENNETT MFG CO	BLUE ISLAND
ILR000007203	ILLIANA HEAT TREATING INC	DANVILLE
ILD990783995	J AND M PLATING INC	ROCKFORD
ILD000781591	JONES & LAUGHLIN STEEL CORP HENNEPIN WKS	HENNEPIN
ILD020367561	KERR MCGEE CHEMICAL CORP	MADISON
ILD000714881	KEYSTONE GROUP BARTONVILLE PLT	PEORIA
ILD006280606	LACLEDE STEEL CO ALTON WORKS	ALTON
ILD005476882	MARATHON ASHLAND PETROLEUM LLC	ROBINSON
ILD005092135	METHODE ELECTRONICS INC	CHICAGO
ILD005172325	MODERN PLATING CORP	FREEPORT
ILD006536239	MOTOR WHEEL CORP	MENDOTA
IL0000060392	NORTH BRANCH CHICAGO RIV RESERVIOR 29A	NORTHBROOK
ILD006271696	OLIN CORP	EAST ALTON
ILD062480850	PHIBRO TECH INC	JOLIET
ILD041539230	PIERCE CHEMICAL CO	ROCKFORD
ILD048296180	QUANTUM CHEMICAL/USI DIVISION	MORRIS
ILD001756675	ROCKFORD POWER MACHINERY	ROCKFORD
ILD093862811	SAFETY KLEEN CORP 5 136 01	PEKIN
ILD000805911	SAFETY KLEEN SYSTEMS INC	ELGIN
ILD000805929	SAFETY-KLEEN CORP	ARLINGTON HEIGHTS
ILD005456439	SHERWIN WILLIAMS KENSINGTON DSC	CHICAGO

RCRIS NATIONAL OVERSIGHT DATABASE

HANDLERS IN THE CORRECTIVE ACTION GPRA UNIVERSE

EPA ID	HANDLER NAME	CITY
IND005460209	MASON CORP	SCHERERVILLE
IND000646950	METALWORKING LUBRICANTS	INDIANAPOLIS
IND016584641	MIDWEST STEEL CO	PORTAGE
IND052959640	ML KS BEARINGS INC	GREENSBURG
IN1210022272	NEWPORT CHEMICAL DEPOT	NEWPORT
IND072051394	PURDUE UNIVERSITY	WEST LAFAYETTE
IND000199653	QUEMETCO INC	INDIANAPOLIS
IND005477021	RADIO MATERIALS CORP	ATTICA
IND006061477	RAYBESTOS PRODUCTS CO	CRAWFORDSVILLE
IND004320032	REA MAGNET WIRE CO	FT WAYNE
IND984894527	RECLAIMERS INC	KENDALLVILLE
IND000718130	REFINED METALS CORP	INDIANAPOLIS
IND001859032	RHODIA INC	HAMMOND
IND077042034	SAFETY KLEEN OIL RECOVERY CO	EAST CHICAGO
IND005447537	SLATER STEELS CORP	FT WAYNE
IND005213715	STEWART WARNER	INDIANAPOLIS
IND072081169	ULRICH CHEMICAL INC	TERRE HAUTE
IN9210020443	US ARMY INDIANA ARMY AMMO PLT	CHARLESTOWN
IN5170023498	US NAVAL SURFACE WARFARE CTR CRANE DIV	CRANE
IND047030226	USS LEAD REFINERY INC	EAST CHICAGO
IND005444062	USSC GARY WORKS	GARY
IND016627333	VAN WATERS AND ROGERS S BEND	SOUTH BEND
IND054101415	WOLF LAKE TERMINALS INC	HAMMOND

STATE: MICHIGAN

MID080358351	AGREVO USA CO	MUSKEGON
MID005379607	ALPENA PLANT LAFARGE CORP	ALPENA
MID006026793	AMWAY CORP	ADA
MID047173653	ASHLAND CHEMICAL CO	LANSING
MID048223986	BASF CORP	HOLLAND
MID064197742	BASF CORP	WYANDOTTE
MID060197662	BLUE COW INC	MIDDLEVILLE
MID005044813	BUCKEYE PRODUCTS CORP	ADRIAN
MID096963194	CHEM MET SERVICES INC	BROWNSTOWN TWP
MID005510805	DEARBORN REFINING CO	DEARBORN
MID005356647	DELPHI ENERGY & ENGINE MGMT SYSTEMS	FLINT
MID017079625	DELPHI ENERGY & ENGINE MGMT SYSTEMS	GRAND RAPIDS
MID099114704	DETROIT COKE CORP	DETROIT
MID005356803	DETROIT DIESEL CORP	DETROIT
MID000724724	DOW CHEMICAL CO THE	MIDLAND
MID000809632	DOW CORNING CORP MIDLAND PLT	MIDLAND
MID017422304	DSC LTD TRENTON PLANT	TRENTON
MID088754668	EDWARDS OIL SERVICE INC	DETROIT
MID005363114	ELF ATOCHEM NORTH AMERICA	RIVERVIEW
MID072589328	FENSKE ENTERPRISES	GRAND RAPIDS

RCRIS NATIONAL OVERSIGHT DATABASE

HANDLERS IN THE CORRECTIVE ACTION GPRA UNIVERSE

EPA ID	HANDLER NAME	CITY
MID005057005	FORD MOTOR CO MONROE PLT	MONROE
MID006407597	GENERAL DYNAMICS LAND SYSTEMS	MUSKEGON
MID005356902	GM TRUCK GROUP PONTIAC EAST ASSEM.	PONTIAC
MID005356886	GMC CPC PONTIAC	PONTIAC
MID005356860	GMC DELPHI INTERIOR & LIGHTING SYSTEMS	FLINT
MID005356712	GMC NAO FLINT OPERATIONS	FLINT
MID041793340	GMC POWERTRAIN SAGINAW METAL CASTINGS OP	SAGINAW
MID082771700	GRANGER LAND DEVELOPMENT CO	LANSING
MID058723867	HENKEL SURFACE TECHNOLOGIES	MORENCI
MID099124299	JOHNSON CONTROLS INC	FOWLERVILLE
MID006020895	KHI INC	HOLLAND
MID006025217	KURDZIEL IRON INDUSTRIES INC OF ROTHBURY	ROTHBURY
MID006014666	LACKS INDUSTRIES INC	GRAND RAPIDS
MID080359433	LACKS INDUSTRIES INC	SARANAC
MID006017966	LAMINA INC LAMINA BRONZE PROD DIV	BELLAIRE
MID000809665	LEVY EDW C CO PLT 3	ECORSE
MID094549425	LEVY EDW C CO PLT 6	DETROIT
MID981192347	MICHIGAN MARINE TERMINAL INC	RIVER ROUGE
MID060975844	MICHIGAN RECOVERY SYSTEMS	ROMULUS
MID082767591	MICHIGAN SPECIALTY TUBE	SOUTH LYON
MID053343976	MICHIGAN STATE UNIVERSITY	EAST LANSING
MID980825632	MIDNR STORAGE FACIL ROSCOMMON	ROSCOMMON
MID005380134	MOTOR WHEEL CORP	LANSING
MID005069257	NATIONAL STANDARD NILES CITY COMPLEX	NILES
MID006014906	OCCIDENTAL CHEMICAL CORP	MONTAGUE
MID006013643	PARKE DAVIS & CO	HOLLAND
MID047153077	PRODUCTION PLATED PLASTICS INC	RICHLAND
MID020087128	REICHHOLD CHEMICALS INC	FERNDALE
MID087738431	ROUGE STEEL COMPANY	DEARBORN
MID981000359	SAFETY KLEEN SYSTEMS INC	MASON
MID980499735	SEALED POWER DIV DANA CORP SANFORD ST	MUSKEGON
MID099113128	SELFRIDGE AIR NATIONAL GUARD ANGB	SELFRIDGE AFB
MID094553419	ST MARYS PEERLESS CEMENT CO	DETROIT
MID006407597	TELEDYNE ADVANCED MATERIALS	MUSKEGON
MID005358130	TOTAL PETROLEUM INC ALMA REFINERY	ALMA
MID000820381	UPJOHN CO THE	KALAMAZOO
MID005477773	WHIRLPOOL CORP ST JOSEPH DIV PLT 3-6	ST JOSEPH
MID004508628	WYCOFF STEEL INC	PLYMOUTH

STATE: MINNESOTA

MND081138604	ALLIANT TECHSYSTEMS INC PROV GRND	ELK RIVER
MND006449649	CYPRUS NORTHSHORE MINING	SILVER BAY
MND006161756	IBM INTL BUSINESS MACHINES CORP	ROCHESTER
MND000823914	LOCKHEAD MARTIN TACTICAL DEF	EAGAN
MND006162820	MARATHON ASHLAND PETROLEUM LLC	ST PAUL PARK

RCRIS NATIONAL OVERSIGHT DATABASE

HANDLERS IN THE CORRECTIVE ACTION GPRA UNIVERSE

EPA ID	HANDLER NAME	CITY
OHD000817312	GENERAL ELECTRIC CO AIRCRAFT ENGINE	EVENDALE
OHD020632998	GM N A O LORDSTOWN ASSEMBLY	WARREN
OHD041063074	GM NORTH AMERICAN TRUCK PLATFORMS MORAIN	MORAINE
OHD005050273	GMC POWERTRAIN DIV GMC	DEFIANCE
OHD004462131	HOOVER CO THE PLT 1	NORTH CANTON
OHD001926740	HUKILL CHEM CORP	BEDFORD
OHD004495545	INDUSTRIAL RECOVERY CAPITAL CO OF OHIO	MARYSVILLE
OHD987048733	LAFARGE CORP PAULDING PLANT	PAULDING
OHD004290078	MALTA CO DIVISION OF TOMKINS INDUSTRIES	MALTA
OHD043730209	MEAD CORP MEAD STORAGE DEPOT	CHILLICOTHE
OHD004289450	MERITOR HEAVY VEHICLE SYSTEMS	HEATH
OHD980569388	MORAINE ENGINE PLANT POWERTRAIN GMC	MORAINE
OHD000724138	MORTON INTERNATIONAL INC	CINCINNATI
OHD045566098	MORTON INTERNATIONAL INC	WEST ALEXANDRIA
OH3800015379	NASA LERC PLUM BROOK STATION	SANDUSKY
OHD001876267	NCR CORP E AND M CAMBRIDGE	CAMBRIDGE
OHD990747859	OCCIDENTAL CHEMICAL CORP	KENTON
OHD039992516	OWENS CORNING SCIENCE & TECH CTR	GRANVILLE
OHD097537609	PLM PROPERTIES LLC	SPRINGFIELD
OHD004198917	PPG INDUSTRIES INC	BARBERTON
OHD004304689	PPG INDUSTRIES INC	CIRCLEVILLE
OHD080930050	R AND D CHEMICAL CO	MANSFIELD
OHD004228003	REPUBLIC ENGINEERED STEELS INC	CANTON
OHD055522429	REPUBLIC ENVIRONMENTAL SYSTEMS	BEDFORD
OHD004178612	RESEARCH OIL CO RESEARCH TRANSPORATION C	CLEVELAND
OHD980793384	RESERVE ENVIRONMENTAL SERVICES	ASHTABULA
OHD000384248	RICHLAND COUNTY LANDFILL	MANSFIELD
OHD004187035	RIVER RECYCLING INDUSTRIES INC	CLEVELAND
OHD980683544	RMI TITANIUM CO EXTRUSION PLANT	ASHTABULA
OHD000810242	RMI TITANIUM CO SODIUM PLT	ASHTABULA
OHD048415665	ROSS INCINERATION SERVICES INC	GRAFTON
OHD980587364	SAFETY KLEEN SYSTEMS INC	HEBRON
OHD990834483	SCOTT O M AND SONS CO	MARYSVILLE
OHD004343117	SHELL CHEMICAL CO	BELPRE
OHD000816629	SPRING GROVE RESOURCE RECOVERY	CINCINNATI
OHD004461711	STARK CERAMICS	EAST CANTON
OHD068901610	TELEDYNE MONARCH RUBBER PLANT 1	HARTVILLE
OHD000821348	TELEDYNE MONARCH RUBBER PLANTS 2 AND 5	HARTVILLE
OHD077755213	THOMAS STEEL STRIP CORP	WARREN
OHD043736644	THOMSON CONSUMER ELECTRONICS INC	CIRCLEVILLE
OHD077752566	U S CERAMIC TILE CO	EAST SPARTA
OHD004209094	UNION CAMP CORP	DOVER
OHD004153854	UNITED MUSICAL INSTRUMENTS USA INC	EASTLAKE
OHD020273819	WASTE MANAGEMENT OF OHIO	VICKERY
OHD060409521	WCI STEEL INC	WARREN
OHD041081548	WEAR EVER	CHILLICOTHE

RCRIS NATIONAL OVERSIGHT DATABASE

HANDLERS IN THE CORRECTIVE ACTION GPRA UNIVERSE

STATE: WISCONSIN

EPA ID	HANDLER NAME	CITY
WID006125215	ANSUL INC STANTON ST	MARINETTE
WID053689196	ASHLAND CHEMICAL INC	MILWAUKEE
WID980615439	COOK COMPOSITES AND POLYMERS CO	SAUKVILLE
WID006144737	CURWOOD INC	NEW LONDON
WID086686003	GENERAL ELECTRIC CO	WEST MILWAUKEE
WID006075352	HACCO INC	RANDOLPH
WID000808824	HYDRITE CHEMICAL CO	COTTAGE GROVE
WID006091425	JOHNSON S C AND SON INC	STURTEVANT
WID076171008	KESTREL HAWK PARK LANDFILL	RACINE
WID006073225	KOHLER CO	KOHLER
WID006179493	KOPPERS INDUSTRIES INC	SUPERIOR
WID098547854	METRO RECYCLING AND DISPOSAL FACILITY	FRANKLIN
WID023350192	MILWAUKEE SOLVENTS AND CHEMICALS CORP	MENOMONEE FALLS
WID988643169	MPM INC	FREDERIC
WID059972935	PPG INDUSTRIES INC	OAK CREEK
WID980896641	SAFETY KLEEN CORP 5 046 21	LA CROSSE
WID000668822	SAFETY KLEEN SYSTEMS INC	SHAWANO
WID980896633	SAFETY KLEEN SYSTEMS INC	MADISON
WID981097769	SAFETY KLEEN SYSTEMS INC	WAUKESHA
WID020488011	STRESAU LABORATORY INC	SPOONER
WI9210020054	US ARMY BADGER ARMY AMMO PLT	BARABOO
WI3210020563	US ARMY GARRISON FORT MCCOY	FORT MCCOY
WID046536231	VULCAN MATERIALS CO	PORT EDWARDS
WID000808568	W M W I OMEGA HILLS LANDFILL	GERMANTOWN
WID006133441	WAUPACA FOUNDRY INC	WAUPACA
WID063379796	WEISENBERGER TIE AND LUMBER CO INC	MARATHON
WID094361458	WITCO CORP	JANESVILLE
WID990829475	WRR ENVIRONMENTAL SERVICES CO INC	EAU CLAIRE

United States
Environmental
Protection Agency
Washington, D.C. 20460

Solid Waste
and Emergency
Response (5101)

EPA 500 -F-98-273
November 1998
www.epa.gov/brownfields/

Brownfields Economic Redevelopment Initiative

Outreach and Special Projects Staff (5101) Quick Reference Fact Sheet

***EPA's** Brownfields Economic Redevelopment Initiative is designed to empower states, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields. A brownfield is a site, or portion thereof, that has actual or perceived contamination and an active potential for redevelopment or reuse. EPA's Brownfields Initiative strategies include funding pilot programs and other research efforts, clarifying liability issues, entering into partnerships, conducting outreach activities, developing job training programs, and addressing environmental justice concerns.*

Many areas across the country that were once used for industrial and commercial purposes have been abandoned—some are contaminated. Because lenders, investors, and developers fear that involvement with these sites may make them liable for cleaning up contamination they did not create, they are more attracted to developing sites in pristine areas, called "greenfields." The result can be blighted areas rife with abandoned industrial facilities that create safety and health risks for residents, drive up unemployment, and foster a sense of hopelessness. These areas are called "brownfields."

OBJECTIVE

EPA's Brownfields Economic Redevelopment Initiative is designed to empower States, cities, Tribes, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields.

ACTIVITIES

EPA's Brownfields Initiative identifies and addresses barriers to cleanup and redevelopment. It recommends swift, aggressive measures for change within the context of the existing Superfund law. Four broad activities serve as the cornerstones of EPA's Brownfields Initiative:

Brownfields Assessment Demonstration Pilots—To date, EPA has awarded more than 220 Brownfields Assessment Demonstration Pilots that are funded through cooperative agreements of up to $200,000 each for a twoyear period. The pilots are exploring innovative approaches to solving brownfields problems and providing a growing knowledge base to help direct the Brownfields Initiative. These pilots have been testing redevelopment models, directing efforts at removing regulatory barriers, and bringing together community groups, investors, lenders, developers, and other affected parties to address brownfields issues. EPA expects to award up to 100 Assessment Pilot grants during fiscal year 1999.

Clarification of Liability Issues—EPA has developed a number of tools to address the liability concerns of lending institutions, municipalities, property owners, developers, prospective purchasers, and others. For example, EPA may enter into agreements with prospective purchasers of property, providing a covenant not to sue for existing contamination. EPA also issues comfort letters to parties clarifying, among other things, the Agency's involvement at a particular site. In addition, EPA has archived approximately 30,000 sites from the Superfund site inventory (CERCLIS) indicating that there is no further Federal Superfund interest, thereby removing the stigma of potential contamination and liability associated with these sites.

Partnerships and Outreach—EPA is building partnerships with Federal agencies, States, Tribes, cities, and other organizations to ensure a coordinated approach to addressing brownfields. In July 1996, the Interagency Working Group on Brownfields was established as a forum for Federal agencies to exchange information on brownfieldsrelated activities and to establish a national coordinated strategy for addressing brownfields. This strategy led to the development of the National Partnership Action Agenda, the centerpiece being the Showcase Communities initiative.

National Partnership Action Agenda—The Clinton Administration has launched a landmark effort to improve communities by building partnerships between public and private organizations to link environmental protection with economic development and community revitalization. The Brownfields National Partnership Action Agenda includes more than 100 commitments from more than 25 organizations, including more than 15 Federal agencies. These commitments represent a $300 million investment in brownfields communities by the Federal government and an additional $165 million in loan guarantees. The participating Federal agencies include the following:

Executive Office of the President
Federal Deposit Insurance Corporation
Federal Housing Finance Board
General Services Administration
Office of Management and Budget
U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Defense
U.S. Department of Education
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Housing and Urban Development
U.S. Department of Interior
U.S. Department of Justice
U.S. Department of Labor
U.S. Department of Transportation
U.S. Department of Treasury
U.S. Department of Veterans Affairs
U.S. Environmental Protection Agency
U.S. Small Business Administration

Brownfields Showcase Communities—In March 1998, as part of the National Partnership Action Agenda, the Federal partners designated 16 Brownfields Showcase Communities that will serve as models to demonstrate the benefits of collaborative activity on brownfields. The communities are

distributed across the country and vary by size, resources, and community character. This multi-agency partnership will provide a wide range of support depending on the particular needs of each Showcase Community. The goals of the project are to: promote environmental protection and restoration, economic redevelopment, job creation, community revitalization, and public health protection through the assessment, cleanup, and sustainable reuse of brownfields; link Federal, State, local and non-governmental action supporting community efforts to restore and reuse brownfields; and develop national models demonstrating the positive results of public and private collaboration in addressing brownfields challenges. The Showcase Communities will provide a pattern for future interagency cooperative efforts in addressing environmental and economic issues.

Workforce Development—EPA is working with community colleges and others to foster workforce development in brownfields communities through environmental education, recruitment of students from disadvantaged communities, and quality worker training. In July 1998, EPA awarded 11 Job Training and Development Demonstration Pilots. The goals of the Job Training Pilots are to facilitate cleanup of brownfields sites contaminated with hazardous substances and prepare trainees for employment in the environmental field, including training in alternative or innovative treatment technologies. EPA expects to award up to 10 Job Training Pilot grants in fiscal year 1999.

MILESTONES AND OTHER ACTIVITIES

Brownfields Tax Incentive—On August 5, 1997, President Clinton signed the Taxpayer Relief Act (PL 10534/HR 2014), which included a new tax incentive to spur the cleanup and redevelopment of brownfields in distressed urban and rural areas. Under the tax incentive, environmental cleanup costs for properties in targeted areas are fully deductible in the year in which they are incurred, rather than having to be capitalized. The tax incentive will help bring thousands of abandoned and underused industrial sites back into productive use, providing the foundation for neighborhood revitalization, job creation, and the restoration of hope in our nation's cities and distressed rural areas. EPA is providing technical assistance to the States as they implement the new tax incentive.

Brownfields Cleanup Revolving Loan Fund Pilots—EPA's Brownfields Cleanup Revolving Loan Fund (BCRLF) Demonstration Pilot program is designed to enable eligible States, cities, towns, counties, and Tribes to capitalize revolving loan funds that will be used to safely clean up brownfields so as to facilitate their sustainable reuse. EPA provides financial assistance to an eligible entity (e.g., a municipality) to establish its own revolving loan fund that will be used to make loans for authorized purposes (i.e., brownfields cleanups). A revolving loan fund charges interest on the loans, generally at a low rate. This fund is termed revolving because it uses loan repayments to make new loans for the same authorized purposes. EPA awarded 23 BCRLF Pilots in fiscal year 1997. Each BCRLF Pilot was funded at $350,000. EPA expects to award up to 60 BCRLF Pilot grants in fiscal year 1999 at up to $500,000 each.

Clean Air/Brownfields Pilots Partnership—EPA has partnered with the U.S. Department of Commerce's Economic Development Administration (EDA) to fund the Clean Air/Brownfields Partnership Pilots. The project is designed to demonstrate the effectiveness of innovative strategies designed to enhance both air quality and economic vitality. The Clean Air Pilots will study the relationship between clean air, brownfields assessment and cleanup, and economic development issues. The project also seeks to quantify the air quality and other environmental and economic benefits of redeveloping brownfield sites within a city instead of developing new sites in the suburbs, and to make it easier for urban developers to offset emissions from new development by reducing it elsewhere in the city. Once the pilot objectives are met, the partners will develop plans, specific to

each city, that satisfy both EPA Clean Air Act requirements and restoration and reuse needs. These plans may be used as models by other cities to protect the health of their citizens while revitalizing their economies.

Targeted Brownfields Assessments—EPA's Targeted Brownfields Assessments (TBA) program is designed to help States, Tribes, and municipalities—especially those without EPA

Brownfields Assessment Demonstration Pilots—minimize the uncertainties of contamination often associated with brownfields. Under the TBA program, EPA provides funding and/or technical assistance for environmental assessments at brownfields sites throughout the country. Targeted Brownfields Assessments supplement and work with other efforts under EPA's Brownfields Initiative to promote cleanup and redevelopment of brownfields.

Fiscal Year 1999 Brownfields Funding—For fiscal year 1999, Congress appropriated $91 million to EPA for the brownfields program. This includes $20 million to award up to 100 additional Assessment Pilots, $35 million to award up to 60 BCRLF Pilots, $3 million for targeted brownfields assessment work, $10 million for States to support voluntary cleanup programs, and $5 million for job training and workforce development. In fiscal year 1999, HUD will have available $25 million for its Brownfields Economic Development Initiative (BEDI) grants. These grants are awarded on a competitive basis and must be used to enhance projects financed with Section 108 loan guarantees. BEDI grants and Section 108 loan guarantees provide communities with a source of financing for economic development, public facilities, and large-scale physical development projects. For more information on HUD programs, visit www.hud.gov/bfields.html

Contact

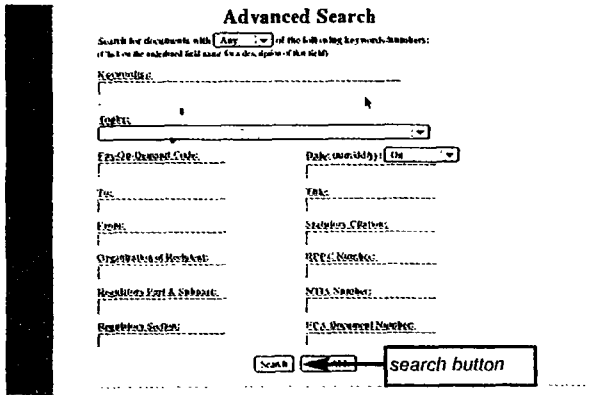
U.S. EPAOSWER Outreach and Special Projects Staff (202) 2604039

For additional information on EPA's Brownfields Economic Redevelopment Initiative, contact the RCRA/Superfund Hotline at: (800) 4249346 or visit the EPA Brownfields web site at:

http://www.epa.gov/brownfields/

HOW DO I USE ADVANCED SEARCH?

Using the advanced search function allows you to search the database using specific criteria. You may locate documents by date, author, recipient, title, regulatory part and subpart, regulatory section, statutory citation, fax-on-demand code, RCRA Permit Policy Compendium (RPPC) number, National Technical Information Service (NTIS) number, or EPA Document Number.



The advanced search also allows searches by keyword or keywords. When using the keyword field, the advanced search provides the option to search for word variants and for word synonyms. The database will display a list of all the documents that meet the search parameters. To view detailed information on a particular document, simply click on the document title.

HOW CAN I GET ADDITIONAL HELP FINDING DOCUMENTS CONTAINED IN RCRA ONLINE?

For more information, call the RCRA Hotline at (800) 424-9346 or 703-412-9810 (from the Washington, DC area). The Hotline is open Monday though Friday, 9:00 a.m. to 6:00 p.m. eastern time.

WHERE CAN I DIRECT SUGGESTIONS AND PROBLEMS?

Please direct technical problems about RCRA Online to the RCRA Online Administrators.

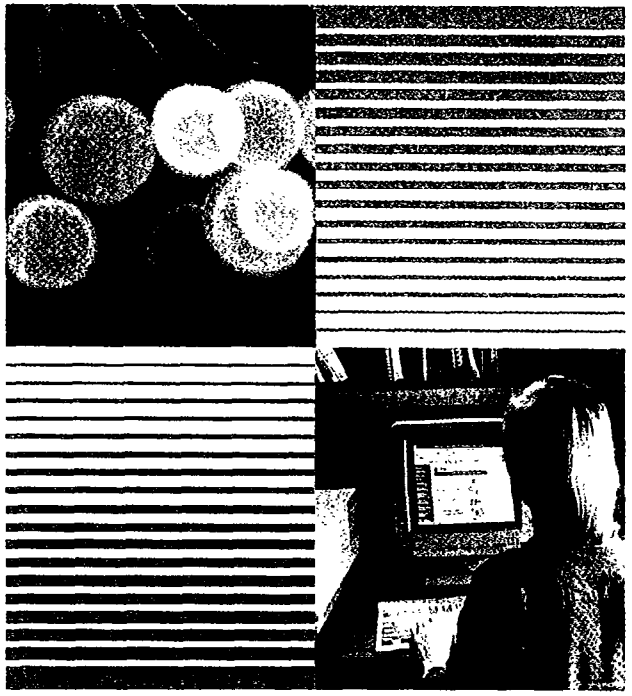
Simply click, "RCRA Online Administrators" at the bottom of the page under "How To Use."

United States Environmental Protection Agency
EPA 530-F-98-022
September 1998
www.epa.gov/osw
Solid Waste and Emergency Response (5305W)

EPA

RCRA ONLINE

A Quick Reference Guide



WHAT IS RCRA ONLINE?

RCRA Online is an electronic database of selected letters, memoranda, and questions and answers written by the Environmental Protection Agency's (EPA) Office of Solid Waste since 1980. These documents cover the management of non-hazardous, hazardous, and medical waste regulated by the Resource Conversation and Recovery Act (RCRA). Regular updates are planned.

HOW DO I ACCESS IT?

RCRA Online can be accessed using Netscape Navigator 2.1 or Microsoft's Internet Explorer 3.0. Simply run the browser and connect to RCRA Online directly by entering the URL:

http://www.epa.gov/rcraonline

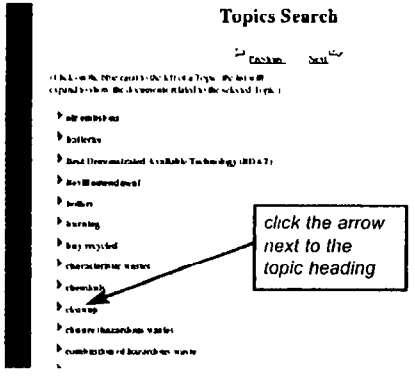
The first page is the Welcome Page. Click on "Continue" to display the RCRA Online Menu. From the Menu you can navigate to one of the three different Search screens to begin your document search.

RCRA Online provides users with the capability to view and print the actual text of the documents identified in a search.

HOW DO I SEARCH TOPICS?

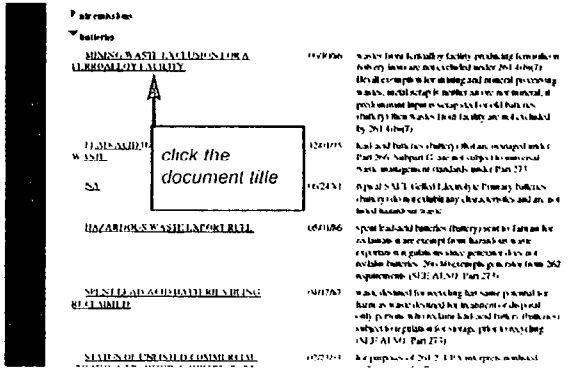
RCRA Online allows users to locate documents though topical, full, and advanced search functions. Using the topic search function is the simplest way to locate documents in the database.

The topics cover a wide range of RCRA subjects. To search the database by topic,



choose the topic search icon on the tool bar.

Click on the blue arrow next to the desired topic. To view detailed information on a particular document, simply click on the document title.



Helpful Hint

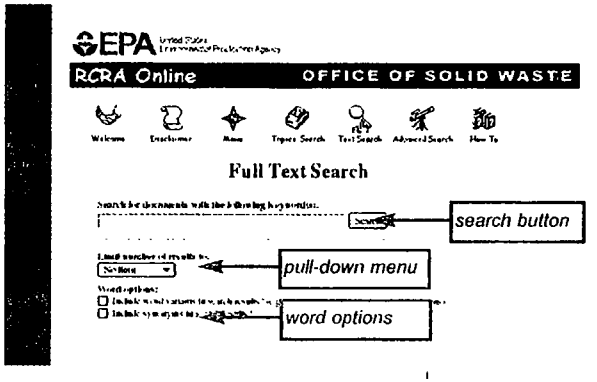
*To search for a word using only the first few characters of the word, use the * (asterisk) as a wild card (e.g., if searching for battery or batteries type "batt*").*

HOW DO I SEARCH FULL TEXT?

Type the keyword or keywords into the search field, separating each word with a space (e.g., "battery lead plate"). To search for a string of words in a particular order, or to search for exact phrases, group the words within quotation marks (e.g., "solid waste").

You can limit the number of documents the database will find by using the pull down menu and choosing the desired limit.

The full text search also gives you the option to search for word variants (e.g., "battery" will show references to "battery" and "batteries") and for synonyms or related words (e.g., the word "gas" will also show the words "vapor," "fumes," and "helium.")



To perform the search, click on the "Search" button adjacent to the keyword field. The database will display a list of all the documents that meet the search parameters. To view detailed information on a particular document, simply click on the document title.

References for Introduction

Module References

! Progress Under Corrective Action is Limited, but New Initiatives May Accelerate Cleanups, GAO/RCED-98-3, October 1997.

! Remediation Waste Requirements Can Increase the Time and Cost of Cleanups, GAO/RCED-98-4, October 1997.

! History of Corrective Action, Fact Sheet #1, RCRA Corrective Action Workshop on Results-Based Project Management: Fact Sheet Series, March 1999.

Supplemental References and Resources

! Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Advanced Notice for Proposed Rulemaking (ANPR), May 1, 1996 (61 FR 19432). Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm

! EPA Implementation of Government Performance and Results Act (GPRA), U.S. EPA Available to download from the Internet: http://www.epa.gov/oigearth/gprasum.htm

! GPRA: Available to download from the Internet: http://www.epa.gov/ooaujeag/notebook/gpranew.htm

! OSW Waste Cleanup Website: http://www.epa.gov/epaoswer/osw/cleanup.htp

! RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction

! Hazardous Waste Clean-Up Information (CLU-IN) Website: http://www.clu-in.org

! CLU-IN Electronic Bulletin Board System (BBS) - (301) 589-8366

! Superfund Hazardous Waste Clean-Up Website: http://www.epa.gov/superfund/

! EPA/OSW - Corrective Action Home Page: http://www.epa.gov/epaoswer/hazwaste/ca/index.htm

! Brownfields Economic Redevelopment Initiative, Quick Reference Fact Sheet. OSWER Directive No. EPA500-F-98-273, November 1998.

! General information is available on the Agency's Brownfields home page on the Internet at http://www.epa.gov/brownfields/. The Agency's Brownfields Action Agenda is located at http://www.epa.gov/swerosps/bf/aa.htm and the text of the Action Agenda can be found at http://www.epa.gov/swerosps/bf/ascii/action.txt.

! Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities: Proposed Rule

! Introduction to: CRA Corrective Action. RCRA, Superfund & EPCRA Hotline Training Module, U.S. EPA, Office of Solid Waste, EPA530-R-97-065, July 1997. (Available to download from the Internet: http://www.epa.gov/epaoswer/hotline/modules.htm)

References for Introduction

! RCRA Hotline Phone Number - (800) 424-9346

! RCRIS User Support Phone: (800) 767-7274

! Resource Conservation and Recovery Information System (RCRIS), U.S. EPA, 1998. Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/data/#rcris

! RCRIS Hazardous Waste Reports: Corrective Action Sites. Available for download from the Internet at http://www.epa.gov/epaoswer/hazwaste/data/ca.htm

CORRECTIVE ACTION PRINCIPLES/REFERENCES TABLES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 17 1997

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Use of the Corrective Action Advance Notice of Proposed Rulemaking as Guidance

FROM: Elliott P. Laws
Assistant Administrator
Office of Solid Waste and Emergency Response

Steven A. Herman
Assistant Administrator
Office of Enforcement and Compliance Assurance

TO: RCRA/CERCLA Senior Policy Managers
Regions I - X

On May 1, 1996 we published an advance notice of proposed rulemaking ("ANPR") for corrective action for releases from solid waste management units at hazardous waste management facilities (61 FR 19432). The ANPR has several purposes: it introduces our strategy for improving the corrective action program (the Subpart S Initiative), requests information to assist in identifying and developing program improvements, provides a status report on the corrective action program and guidance on program implementation, and highlights areas of flexibility within the program and program improvements currently underway. This memorandum emphasizes our expectation that the ANPR will be used as guidance.

Background

In the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA), Congress directed EPA to require corrective action for all releases of hazardous waste or constituents from solid waste management units at facilities seeking RCRA permits (i.e., hazardous waste treatment, storage or disposal facilities) regardless of the time at which waste was placed in the units. When corrective action cannot be completed prior to permit issuance, the statute directs EPA to specify corrective action schedules of compliance and financial assurance, as necessary to protect human health and the environment, in all permits

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issued under RCRA § 3005. In addition, EPA is directed to require that corrective action, as necessary to protect human health and the environment, be taken beyond facility boundaries unless facility owners/operators demonstrate to the Agency's satisfaction that, despite their best efforts, they were unable to obtain the necessary permission to undertake off-site corrective action. See, RCRA §§ 3004(u) and (v), 42 U.S.C. 6924(u) and (v). At the same time, Congress enacted the RCRA permit omnibus provision directing that, "each permit issued under [RCRA Section 3005] shall contain such terms and conditions as the Administrator determines necessary to protect human health and the environment." See, RCRA § 3005(c)(3), 42 U.S.C. 6925(c)(3). EPA is also authorized to require corrective action at interim status facilities by issuing orders under RCRA § 3008(h), 42 U.S.C. 6928(h).

In July 1985, EPA codified corrective action requirements at 40 CFR 264.90(a)(2), 264.101, 270.60(b), and 270.60(c). These regulations essentially reiterated the statutory language of RCRA Section 3004(u). In December 1987, EPA promulgated additional corrective action regulations to address the requirements of RCRA Section 3004(v). Because the regulatory language governing the corrective action program is minimal, program implementation has largely been addressed in guidance. Over the years, EPA has published a number of major corrective action guidance documents and, in 1990, proposed detailed corrective action regulations. See, 55 FR 30798, July 27, 1990. As discussed in the ANPR, many of these documents, including the 1990 proposal, continue to provide useful information and guidance for corrective action implementation. However, the ANPR updates our position on many of the issues discussed in the 1990 proposal, and should be considered the primary corrective action implementation guidance.

Content of the ANPR

The ANPR introduces our strategy for identifying and developing improvements to the corrective action program, provides guidance, and requests public comments on a variety of corrective action issues and concepts. Section I identifies the statutory and regulatory basis of the corrective action program. Section II includes discussions of major corrective action program guidance and policy milestones that have occurred since 1990. Section III focuses on corrective action implementation. It describes how certain program elements have evolved since 1990, offers guidance on corrective action implementation, and highlights approaches some program implementers and facility owners/operators have used to expedite cleanups. Section IV builds on the discussions in Section III by summarizing our corrective action implementation goals and strategies. Section V requests comments and data that will help us identify and implement improvements to the corrective action program.

Most important, the ANPR articulates our corrective action program management philosophy. As you know, more than 5,000 facilities are subject to corrective action. To account for the variety of corrective action facilities and site-specific circumstances, EPA has consistently emphasized a flexible, facility-specific approach to corrective action. Because of site- and community-specific circumstances, few cleanups will follow exactly the same course; therefore,

program implementers and facility owners/operators should be allowed significant latitude to structure the corrective action process, develop cleanup objectives, and select appropriate remedies. At the same time, a number of basic operating principles should guide corrective action implementation and program development. As discussed in the ANPR (61 FR 19440 - 41), these principles are:

- Corrective action decisions should be based on risk.
- Corrective action implementation should focus on results rather than process.
- Interim actions and stabilization should be used to reduce risks and prevent exposure
- Corrective action activities should be phased to focus resources on the areas or pathways of highest concern.
- Corrective action implementation should provide for meaningful inclusion of all stakeholders through full, fair, and equitable public participation.
- Corrective action requirements should be addressed using the most appropriate authority, including state authorities, for any given facility.
- States will be the primary implementers of the corrective action program.

Section III of the ANPR provides guidance on our goals and expectations for various elements of corrective action, such as the initial investigation and remedy selection. It also summarizes our approach to the corrective action process, emphasizing that the various elements of the corrective action process "should not become ends in themselves...EPA continues to encourage program implementors and facility owners/operators to focus on the desired result of a cleanup rather than a mechanistic cleanup process." (61 FR page 19443, column 3.) Section III also includes information on a number of corrective action concepts that have evolved in recent years and highlights approaches or activities that some program implementors and facility owners/operators have successfully used to expedite or improve cleanups. For example, it emphasizes that current and reasonably expected future land use should be considered when selecting corrective action remedies. (61 FR page 19452, column 1.) It encourages use of innovative site characterization techniques to expedite site investigations. (61 FR page 19445, column 1.) And, it recognizes that, in appropriate cases, states may rely on non-RCRA state authorities to satisfy corrective action requirements. (61 FR pages 19441 - 19442.)

The ANPR as Guidance

The ANPR is our effort to compile over ten years of corrective action implementation experience and represents our most recent thinking on corrective action. It was developed by a workgroup that included representatives from each of the regions, interested states, and other

offices here at headquarters. We expect program implementors to become familiar with our positions on corrective action as recorded in the ANPR, and, excluding Section V which is a request for comment, to use the information in the ANPR as guidance.

Disclaimer

This memorandum and the ANPR provide guidance to EPA personnel on how to best implement RCRA corrective action requirements. It is not a regulation, and it does not substitute for applicable statutes or regulations. Therefore, it cannot impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based on consideration of specific circumstances. EPA may change this guidance in the future.

Additional Information

Each month, regional and headquarters personnel have an opportunity to discuss corrective action implementation on the Corrective Action Conference Call. We encourage you to use this call as a forum to share your experiences with using the ANPR as guidance and discuss the continuing evolution of the corrective action program. For more information on the corrective action conference call, please contact Colin Apse, in the Office of Solid Waste, at (703) 308-6081.

You also have an opportunity to participate in identification and development of improvements to the corrective action program through your continued support of the Subpart S Initiative. As discussed in the ANPR, the Subpart S Initiative includes both rulemaking and non-rulemaking (e.g., guidance, training) aspects of improving the corrective action program. For more information on the ANPR or the Subpart S Initiative please contact Hugh Davis, also in the Office of Solid Waste, at (703) 308-8633.

For questions on legal issues, please contact Dawn Messier, in the office of General Counsel, at (202) 260-9733.

cc: Susan Bromm, OSRE
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Regional RCRA Branch Chiefs
Regional CERCLA Branch Chiefs
Tom Kennedy, Association of States and Territorial Solid Waste Management Officials

federal register

Wednesday
May 1, 1996

Part V

Environmental Protection Agency

40 CFR Ch. I

Corrective Action for Releases From Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Ch. I

[FRL–5460–2]

RIN 2050–AB80

Corrective Action for Releases From Solid Waste Management Units at Hazardous Waste Management Facilities

AGENCY: Environmental Protection Agency (EPA).

ACTION: Advance notice of proposed rulemaking.

SUMMARY: Today's action has three purposes. First, it introduces EPA's strategy for promulgating regulations governing corrective action for releases from solid waste management units at hazardous waste management facilities under the Resource Conservation and Recovery Act (RCRA) and requests information to assist in identification and development of potential improvements to the protectiveness, responsiveness, speed or efficiency of corrective actions. The Agency originally proposed corrective action regulations on July 27, 1990. Second, to provide context for potential revisions to the corrective action program, today's Notice includes a general status report on the corrective action program and how it has evolved since the 1990 proposal, and provides guidance on a number of topics not fully addressed in 1990. Third, it emphasizes areas of flexibility within the current program and describes program improvements currently underway or under consideration.

DATES: To ensure consideration, information and data must be received on or before July 30, 1996.

EPA will hold a public hearing on this Notice on June 3, 1996.

ADDRESSES: Written comments responding to today's Notice should be addressed to: Docket Clerk, U.S. Environmental Protection Agency, RCRA Docket (OS–305), 401 M Street SW, Washington, D.C. 20460. Comments sent by special delivery, such as overnight express services, should be addressed to: RCRA Docket Information Center (RIC), Crystal Gateway One, 1235 Jefferson Davis Highway, First Floor, Arlington, VA 22202. Electronic comments should be addressed to: RCRA-Docket@epamail.epa.gov.

The June 3, 1996 public hearing will be held at the Key Bridge Marriott, located at 1401 Lee Highway, Arlington, VA 22209. Advance requests to speak at the hearing should be submitted, in writing, to: Hugh Davis (5303W) U. S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460.

For important additional instructions on submitting comments or making a request to speak at the public hearing, see Supplementary Information.

FOR FURTHER INFORMATION CONTACT: For general information, contact the RCRA Hotline at (800) 424–9346 (toll-free) or (800) 553–7672 (hearing impaired), or (703) 412–9810 (locally), Monday–Friday, 8:00–5:00 eastern standard time. For technical information, contact Hugh Davis, Office of Solid Waste (5303W), U.S. Environmental Protection Agency, 401 M Street SW, Washington, D.C. 20460. Phone, (703) 308–8633. E-mail address, davis.hugh@epamail.epa.gov.

SUPPLEMENTARY INFORMATION:

Instructions for Submitting Comments and Requests To Speak at the Public Hearing

Commenters should place the docket number (F–96–CA2P–FFFFF) on all comments and submit an original and two copies. Comments also may be submitted electronically, through the Internet. Comments submitted electronically should be in ASCI to avoid the use of special characters and encryptions.

The official record for this action will be kept in paper form. EPA will transfer all comments received electronically into paper form and place them, with comments submitted directly in writing, in the official record. EPA responses to comments will be recorded in a notice in the Federal Register or in an official record for this action. EPA will not immediately reply to electronic comments other than to seek clarification of comments that may be garbled in transmission or during conversion to paper form.

Confidential business information (CBI) may be included in comments, however, to ensure continued confidentiality, it must be submitted under separate cover. If including CBI, commenters should submit an original and two copies to: U.S. Environmental Protection Agency, RCRA CBI Document Control Officer, OSW (5303W), 401 M Street SW, Washington, D.C. 20460. Place the docket number (F–96–CA2P–FFFFF) on the CBI and include a reference to any non-CBI comments submitted. Do not submit CBI electronically.

Docket materials may be reviewed by appointment by calling (703) 603–9230. The docket is located on the first floor of the Crystal Gateway building at 1235 Jefferson Davis Highway in Arlington, Virginia and is open from 9:00 a.m. to 4:00 p.m., Monday through Friday, excluding Federal holidays. A maximum of 100 pages of material may be copied at no cost from any one regulatory docket. Additional copies are $0.15 per page. The main switchboard number for the hotel is (703) 524–6400.

Individuals interested in directions to the June 3, 1996 public hearing at the Key Bridge Marriott or room reservations should contact the hotel directly at (703) 524–6400. Registration for the hearing will begin at the hotel at 8:30 am. The hearing will begin at 9:00 am. and end at 5:00 pm unless concluded earlier. Oral and written statements may be submitted at the public hearing. Time for the public hearing is limited; oral presentations will be made in the order that requests are received and will be limited to 15 minutes, unless additional time is available. Advance requests to speak at the public hearing should be clearly marked as a request to speak at the public hearing and include the scheduled date of the hearing (June 3, 1996) and the docket number for this action (F–96–CA2P–FFFFF). Requests to speak at the public hearing may also be made on the day of the hearing, by registering at the door; request to speak by individuals who choose to register at the door on the day of the hearing will be granted in the order received, as time permits. All individuals who choose to speak at the public hearing are requested to provide a paper copy of their testimony for the record.

Internet Access

This notice is available on the Internet. To access today's Notice electronically:

Gopher: gopher.epa.gov
WWW: http://www.epa.gov
Dial-up: (919) 558–0353

From the main EPA Gopher menu, select: EPA Offices and Regions/Office of Solid Waste and Emergency Response (OSWER)/Office of Solid Waste (RCRA)/Hazardous Waste/Corrective Action.

FTP: ftp.epa.gov
Login: anonymous
Password: your Internet address
Files are located in /pub/gopher/oswrcra

Glossary of Commonly Used Acronyms

ASTM—American Society for Testing and Materials
ASTSWMO—Association of State and Territorial Solid Waste Management Officials
CAMU—Corrective Action Management Unit
CAP—Corrective Action Plan
CERCLA—Comprehensive Environmental Response, Compensation and Liability Act
CMI—Corrective Measures Implementation

CMS—Corrective Measures Study
CSGWPP—Comprehensive State Groundwater Protection Program
DQO—Data Quality Objective
EAB—Environmental Appeals Board
FACA—Financial Assurance for Corrective Action
HSWA—Hazardous and Solid Waste Amendments
LDR—RCRA Land Disposal Restrictions
MCL—Maximum Contaminant Limit
MTR—RCRA Minimum Technology Requirements
NCAPS—National Corrective Action Prioritization System
NPL—National Priorities List
NCP—National Oil and Hazardous Substances Pollution Contingency Plan
OSW—EPA Office of Solid Waste
OSWER—EPA Office of Solid Waste and Emergency Response
POC—Point of Compliance
RBCA—Risk Based Corrective Action (refers to ASTM standard E1739–95)
RCRA—Resource Conservation and Recovery Act
RFA—RCRA Facility Assessment
RFI—RCRA Facility Investigation
RU—Regulated Unit
SWMU—Solid Waste Management Unit
SSG—EPA Soil Screening Guidance
TI—Technical Impracticability
TSDF—Treatment, Storage, or Disposal Facility
UST—Underground Storage Tank

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I. Background

A. Statutory and Regulatory Requirements

In the 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA), Congress directed EPA to require corrective action for all releases of hazardous waste and hazardous constituents from solid waste management units at facilities seeking RCRA permits (i.e., hazardous waste Treatment, Storage or Disposal Facilities or TSDFs) regardless of the time at which waste was placed in the units. When corrective action cannot be completed prior to permit issuance, the statute directs EPA to specify corrective action schedules of compliance and financial assurance in all permits issued under RCRA section 3005. In addition, EPA is directed to require that corrective action be taken beyond facility boundaries unless facility owners/operators demonstrate to the Agency's satisfaction that, despite their best efforts, they were unable to obtain the necessary permission to undertake off-site corrective action. (See, RCRA section 3004 (u) and (v), 42 U.S.C. 6924 (u) and (v).) At the same time, Congress enacted the RCRA permit omnibus provision directing that, ''each permit issued under [RCRA Section 3005] contain such terms and conditions as the Administrator determines necessary to protect human health and the environment.'' (See, RCRA sections 3005(C)(3), 42 U.S.C. 6925(c)(3).) EPA is authorized to require corrective action

at interim status facilities under RCRA section 3008(h), 42 U.S.C. 6928(h).

At the time the new corrective action provisions were enacted, corrective action for releases to groundwater from RCRA regulated units was already required under 40 CFR part 264, subpart F. RCRA regulated units are defined in 40 CFR 264.90 as surface impoundments, waste piles, land treatment units, and landfills that received hazardous waste after July 26, 1982; they are a subset of the universe of solid waste management units. The 1984 HSWA amendments extended corrective action authority at TSDFs to all waste management at units that received solid or hazardous waste at any time. In the legislative history of RCRA section 3004(u), Congress noted that one purpose of the new corrective action requirements was to ensure that RCRA facilities did not become Superfund cleanup sites. The legislative history records that, ''Unless all hazardous constituents released from solid waste management units at permitted facilities are addressed and cleaned up the Committee is deeply concerned that many more sites will be added to the future burdens of the Superfund program with little prospect for control or cleanup. The responsibility to control such releases lies with the facility owner and operator and should not be shifted to the Superfund program, particularly when a final permit has been requested by the facility.'' (See, H.R. Rep. No. 198, 98th Cong., 1st Sess., part 1, 61 (1983).)

In July 1985, EPA codified corrective action requirements at 40 CFR 264.90(a)(2); 264.101; 270.60(b) and 270.60(c). (See, 50 *FR* 28702, July 15, 1985.) These regulations reiterate the statutory language of RCRA section 3004(u) by requiring facility owners/operators seeking RCRA permits to institute corrective action, as necessary to protect human health and the environment, for all releases of hazardous waste and constituents from solid waste management units at the facility. When corrective action cannot be completed prior to permitting, EPA requires that all permits contain corrective action requirements, schedules of compliance, and financial assurance. In 40 CFR 270.60(b) and 270.60(c), EPA clarified that corrective action is also required for some facilities with RCRA permits-by-rule, including hazardous waste management facilities with permits issued under the Underground Injection Control program and the National Pollution Discharge Elimination System (NPDES) permitting program.

In December 1987 (52 *FR* 45788, December 1, 1987), EPA promulgated additional corrective action regulations to codify the statutory language of RCRA § 3004(v), requiring corrective action for releases beyond the facility boundary. EPA also established permit application requirements necessary to support corrective action implementation, and modified the corrective action requirements for underground injection wells with RCRA permits-by-rule.

On July 27, 1990 (55 *FR* 30798), EPA proposed detailed regulations to govern the RCRA corrective action program. The 1990 proposal was designed to be the analogue to the CERCLA program's National Oil and Hazardous Substances Pollution Contingency Plan (NCP). As such, it addressed both technical (e.g., cleanup levels, remedy selection, points of compliance) and procedural (e.g., definitions, permitting, reporting) elements of the corrective action program. In the 1990 proposal, EPA emphasized the need for site-specific flexibility in cleanup programs. The Agency stated, ''Because of the wide variety of sites likely to be subject to corrective action, EPA believes that a flexible approach, based on site-specific analyses is necessary. No two cleanups will follow exactly the same course, and therefore, the program has to allow significant latitude to the decision maker in structuring the process, selecting the remedy, and setting cleanup standards appropriate to the specifics of the situation.'' (See, 55 *FR* 30802.)

The 1990 proposal was the subject of significant public comment. Although EPA has finalized only a few sections of the 1990 proposal,[1] the bulk of the proposal is routinely used as guidance during corrective actions.

B. Summary of Today's Notice

Today's Notice introduces EPA's strategy for promulgation of corrective action regulations and requests public input on a variety of issues and concepts associated with corrective action. To provide context for potential revisions to the corrective action program and because the Agency's philosophy and strategies have evolved in many respects since 1990, today's Notice also includes a general status report on the corrective action program and how it has grown since the 1990 proposal, and provides guidance on a number of topics not fully addressed in 1990. Finally, today's Notice emphasizes the flexibility inherent in the existing corrective action program, discusses steps EPA is already taking to improve corrective actions and requests comments on new approaches to expedite and simplify facility cleanups.

In Section I of today's Notice, EPA identifies the statutory and regulatory basis of the corrective action program.

Section II of today's Notice introduces EPA's Subpart S Initiative. Through the Subpart S Initiative the Agency intends to identify and implement improvements to the protectiveness, responsiveness, speed and efficiency of the corrective action program. Section II includes discussions of the Subpart S Initiative objectives, outreach, and schedule. It also includes discussions of major corrective action program guidance and policy milestones that have occurred since 1990, and the relationship of the Subpart S Initiative to other agency rulemakings and initiatives.

In Section III, EPA discusses corrective action implementation, describes how certain program elements have evolved since 1990, and provides guidance on a number of topics that were not fully addressed in the 1990 proposal. This section emphasizes areas of flexibility in the current corrective action program and highlights innovative approaches some program implementors and facility owners/operators have used to expedite cleanups. Readers are urged to pay particular attention to Section III in order to gain an overall understanding of the Agency's latest thinking on corrective action implementation.

Section IV of today's Notice builds on the detailed discussions in Section III by providing concise statements of EPA's corrective action implementation goals and strategies.

In Section V of today's Notice, EPA requests comments and data on a variety of issues to assist it in identifying and developing improvements to the corrective action program. In some cases, the Agency raises new concepts that would likely warrant re-proposing regulations or developing new guidance documents; in other cases, concepts were addressed in the 1990 proposal but are included in Section V because the Agency is requesting additional comment and data at this time.

II. Subpart S Initiative

EPA and the states have made considerable progress in implementing the corrective action requirements; however, despite this progress, the overall implementation of the corrective action program has been subject to considerable criticism. States,

[1] See 58 *FR* 8658, February 16, 1993, ''Corrective Action Management Units'' where EPA finalized regulations addressing the creation, management, and closure of units created specifically for purposes of managing remediation wastes.

environmental groups and the regulated community have raised many concerns, including: slow progress in achieving cleanup or other environmental results; an emphasis on process and reports over actual work in the field; unrealistic, impractical or overly conservative cleanup goals; excessive and detailed oversight; reluctance to authorize or recognize the work of state cleanup programs; and, lack of meaningful public participation. EPA believes that many of these concerns have been overstated; however, at the same time, it recognizes that improvements to the corrective action program are necessary. EPA and the states now have more than ten years experience in implementing the corrective action requirements. EPA believes the time has come to reevaluate the RCRA corrective action program to identify and implement improvements to the program's speed, efficiency, protectiveness and responsiveness, and to focus the program more clearly on environmental results. The reevaluation effort is known as the Subpart S Initiative.

As part of the Subpart S Initiative, EPA has been working with states and other stakeholders to develop a comprehensive strategy to identify and develop improvements to the corrective action program and promulgate final corrective action regulations. The Subpart S Initiative involves assessment of the current corrective action program, outreach to stakeholders, finalization of some elements of the 1990 proposal, development of new proposals and guidance documents, and today's Notice.

EPA is committed to substantive consistency among its cleanup programs. For that reason, the Subpart S Initiative is being coordinated closely with the Superfund program, including the Superfund administrative improvements efforts and Superfund reauthorization activities.

A. Objectives

Taking into consideration corrective action implementation experience, recent feedback from stakeholders, and the comments received on the 1990 proposal, EPA has developed five objectives for the Subpart S Initiative:

(1) Create a consistent, holistic approach to cleanups at RCRA facilities;

(2) Establish protective, practical cleanup expectations;

(3) Shift more of the responsibilities for achieving cleanup goals to the regulated community;

(4) Focus on opportunities to streamline and reduce costs; and,

(5) Enhance opportunities for timely, meaningful public participation.

Implementation of these five objectives will involve new approaches to corrective action and may necessitate significant revisions to the existing corrective action program. In adopting any new approach, EPA will not sacrifice protection of human health and the environment or the meaningful involvement of the public and affected communities.

B. Outreach

EPA believes the experiences of states, the regulated community, other Federal agencies, and environmental and public interest groups will be tremendously valuable as it works to identify and develop improvements to the corrective action program. Today's Notice reflects the involvement of interested stakeholder groups, as discussed below. EPA is committed to a continuing and meaningful dialogue with these groups as the Subpart S Initiative develops. As the Subpart S Initiative progress, EPA will continue to identify interested stakeholder groups and invite their input and involvement.

1. States

In December and January 1995, EPA met twice with interested state representatives to solicit their early input in the Subpart S Initiative. In general, these state representatives advised that the corrective action program: Retain considerable flexibility; emphasize results over process; be generally consistent with the CERCLA program; address consistency issues within the RCRA program (e.g., between cleanups at SWMUs and regulated units); address risk assessment and risk management, including ecological risk; empower states and expedite state authorization; and, encourage stabilization without discouraging final cleanups. State representatives also strongly advised against finalizing corrective action regulations in pieces, favoring the comprehensive approach reflected in today's Notice. The ongoing role of the states in the Subpart S Initiative is discussed below.

2. Environmental and Public Interest Community

EPA wrote nine environmental and public interest groups requesting their early involvement in the Subpart S Initiative. To date, EPA has met with one environmental group, the Environmental Defense Fund (EDF). The Environmental Defense Fund expressed support for changes in the corrective action program to improve the speed and efficiency of cleanups and increase opportunities for meaningful public participation. Their suggestions include: tailoring the level of public participation to the level of community interest; including opportunities for public participation throughout the cleanup process; using risk goals and clearly defined cleanup standards to make cleanups more efficient; maintaining a throughout-the-plume/unit boundary cleanup point of compliance; and, using deed restrictions at non-residential cleanups. While EDF expressed general support for consistency in technical matters between RCRA and CERCLA, they also expressed the opinion that operating hazardous waste management facilities, such as those typically addressed by RCRA corrective action, have an ongoing responsibility to their communities and should, perhaps, be held to higher cleanup standards than abandoned (i.e., Superfund) sites. EPA welcomes the continued involvement of EDF in the Subpart S Initiative and will continue to look for opportunities to involve other environmental and public interest groups.

3. Regulated Community

EPA met with and received written materials from a variety of industry groups which offered their suggestions for improvements to the corrective action program. In general, industry groups expressed frustration with the pace and cost of corrective actions and what they perceive as overly stringent cleanup criteria. Their suggestions include increased reliance on performance standards, more emphasis on non-residential future land use scenarios, and improved coordination with other applicable cleanup authorities (e.g., the Superfund program and state cleanup programs). EPA welcomes the continued involvement of the regulated community in development of the Subpart S Initiative.

4. Other Federal Agencies

During Spring and Summer 1995, EPA held a series of meetings with other Federal agencies, including, the Department of Defense (DOD), the Department of Energy (DOE), the Department of Agriculture, the Council on Environmental Quality (CEQ), and the Office of Management and Budget (OMB). Many of these agencies own or operate facilities which are subject to RCRA corrective action. During these meetings, EPA and the other Federal agencies discussed potential improvements to the RCRA corrective action and Superfund programs. EPA will continue these discussions during development of the Subpart S Initiative.

The Department of Defense and the Department of Energy reviewed and

provided comments on a draft version of today's Notice and EPA met with DOD and DOE representatives to discuss their comments and suggested changes.

C. On-Going Role of the States

The states are the primary implementors of the corrective action program. Because of this, EPA has actively solicited state input and participation in the Subpart S Initiative and is developing the Initiative in full partnership with the states. As of today's Notice, thirteen states [2] have agreed to participate in the Subpart S Initiative as co-regulators. During the co-regulation process, state representatives participate actively in development of policy and regulatory options and analyses. As discussed above, EPA has held two meetings with state representatives to discuss development of the Subpart S Initiative; three additional meetings and a fifty-state review of any regulatory proposals are planned. In addition, representatives of interested states participated actively in development of today's Notice and reviewed and provided comment on numerous drafts.

D. Strategy and Schedule

The Subpart S Initiative will include development of guidance and policy documents and rulemaking. EPA intends to publish rule language in fall 1997. In order to present the Agency's visions for the corrective action program and regulations in totality, the 1997 publication will promulgate elements of the 1990 proposal that the Agency believes do not need additional public review and will re-propose other program elements. Based in part on comments received in response to Section V.B of today's Notice, EPA will determine which elements of the 1990 proposal will be finalized without further comment and which elements will be re-proposed.

Guidance and policy development will play an important role in the Subpart S Initiative. The balance between guidance and policy development and rulemaking will be determined, in part, by comments received on today's Notice. Section V.A of this Notice requests specific recommendations for additional policy or guidance development.

E. Major Corrective Action Program Developments Since 1990

The Subpart S Initiative builds on several recent and important developments in the corrective action program. Many of these program developments are addressed in the EPA guidance documents discussed below; other program developments were associated with promulgation of the Corrective Action Management Unit (CAMU) regulations, also discussed below. A complete list of corrective action guidance documents is available in the ''RCRA Corrective Action Plan,'' EPA/520–R–94–004, OSWER Directive 9902.3–2A, May 1994, included in the docket for today's Notice.

1. Stabilization Initiative

EPA's early implementation of the corrective action program focused on final, comprehensive cleanups at a limited number of facilities. As EPA and states gained more experience, it became clear that, at many sites, final cleanups were difficult and time-consuming to achieve and that an emphasis on final remedies at a few sites could divert limited resources from addressing ongoing releases and environmental threats at many other sites. As a result, in 1991, the Agency established the Stabilization Initiative as one of the primary implementation objectives for the corrective action program. The goal of the Stabilization Initiative is to increase the rate of corrective actions by focusing on near-term activities to control or abate threats to human health and the environment and prevent or minimize the further spread of contamination. Through the Stabilization Initiative, the Agency is seeking to achieve an increased overall level of environmental protection by implementing a greater number of actions across many facilities rather than following the more traditional process of pursuing final, comprehensive remedies at a few facilities.

Controlling exposures or the migration of a release may stabilize a facility, but does not necessarily mean that a facility is completely cleaned up. At some stabilized facilities, contamination is still present and additional investigations or remediation may eventually be required; however, as long as the stabilization measures are maintained, stabilized facilities should not present unacceptable near-term risks to human health or the environment and program implementors and facility owners/operators have the opportunity to shift their resources (either at the stabilized facility or among facilities) to additional health or environmental concerns. Stabilization actions should be a component of, or at least consistent with, final remedies. More information on the Stabilization Initiative is available in the 1991 guidance memorandum ''Managing the Corrective Action Program for Environmental Results: The RCRA Facility Stabilization Effort'' and in Section III.C.3 of today's Notice.

2. Environmental Indicators for Corrective Action

Critics of the corrective action program have often charged that EPA focuses too much on administrative processes rather than actual cleanups. As an example of this problem, critics cite Agency management systems which often track the number of paperwork deliverables (e.g., work plans approved) rather than achievement of environmental results. In response to these concerns and the Government Performance and Results Act of 1993, EPA is moving the corrective action program away from more traditional management systems and, consistent with a broader Agency-wide effort, now focuses management of the corrective action program on environmental indicators. Two specific environmental indicators have been developed for the corrective action program. These indicators are: Human Exposures Controlled Determination and Groundwater Releases Controlled Determination. The environmental indicators are facility-wide measures. Human Exposures Controlled is attained when there are no unacceptable risks to humans due to releases of contaminants at or from the facility subject to RCRA corrective action. Groundwater Releases Controlled is attained when the migration of groundwater contamination at or from the facility across designated boundaries (these boundaries may be facility boundaries or specified boundaries within a facility) is controlled.

The environmental indicators are not tied to specific program activities or paperwork deliverables. In the course of implementing final remedies, the environmental indicators will be achieved; however, the implementation of stabilization measures can also result in achieving the environmental indicators. EPA is striving to make the corrective action program more performance based. Because the environmental indicators focus on results, they can serve well as performance measures for remedial activities. Further guidance on the environmental indicators is available in the July 29, 1994 memorandum ''RCRIS Corrective Action Environmental Indicator Event Codes CA725 and CA750,'' which has been placed in the docket for today's Notice.

[2] These states are: Wisconsin, Texas, Georgia, Idaho, Florida, Colorado, New York, California, Utah, Oklahoma, North Carolina, Delaware, and Missouri.

EPA is committed to using the corrective action environmental indicators to increase the efficiency of the corrective action program by focusing on results. Although EPA has developed only two environmental indicators for corrective action to date, additional indicators may be developed to address factors such as ecological risk or source control. EPA requests comments on the development of additional environmental indicators in Section V.C.1 of today's Notice.

3. Corrective Action Plan

Another concern in the corrective action program has been consistency. While no two cleanups will follow the exact same course, EPA recognizes that some level of consistency in cleanup processes can help to ensure that all cleanups will achieve the same overall level of protection. The RCRA Corrective Action Plan or CAP (OSWER Directive 9902.3–2A, May 1994), provides guidance which program implementors and facility owners/operators can use to develop and direct the specific corrective action activities which might be necessary at any given facility. The CAP provides an overall program implementation framework and model scopes of work for site characterizations, interim actions, evaluation of remedial alternatives and remedy implementation. Program implementors and facility owners/operators can use these model scopes of work when developing site-specific strategies, work plans, and schedules of compliance.

The CAP is not meant to be a cleanup prescription. The model scopes of work in the CAP present a range of activities which might be necessary at a corrective action facility. Program implementors and facility owners/operators should choose carefully from this range when developing facility specific work plans.

4. CAMU Rule

Program implementors and facility owners/operators have long recognized that certain RCRA Subtitle C hazardous waste requirements can significantly complicate or delay cleanups when applied to remediation wastes. To address this problem, EPA promulgated regulations for corrective action management units (58 FR 8658, February 16, 1993). The CAMU rule provides relief from specific RCRA standards that can preclude desirable remediation options or unnecessarily add to the cost of remedies (e.g., the RCRA land disposal restrictions when applied to remediation waste) by creating a new type of RCRA unit. EPA and authorized states may choose to designate a CAMU for management of remediation waste during RCRA corrective actions and other cleanups. When designating CAMUs, EPA and authorized states have the flexibility to establish site-specific design, operating, closure and post-closure requirements instead of using the existing RCRA requirements for land-based units. Remediation wastes (i.e., media and debris which contain hazardous waste or exhibit a hazardous waste characteristic) may be consolidated into a CAMU before or after treatment. In addition, remediation wastes may be treated in a CAMU or moved (again, before or after treatment) between CAMUs at the same facility without automatically triggering otherwise applicable RCRA land disposal restrictions or minimum technology requirements.

The CAMU rule was challenged in 1993; however, the challenge has been stayed pending publication of the final Hazardous Waste Identification Rule for Contaminated Media (HWIR-Media). EPA expects that the HWIR-Media rule will largely obviate the need for the CAMU rule, and is planning to propose withdrawal of the CAMU regulations as part of the HWIR-Media proposal (for a discussion of the HWIR-Media proposal, see Section II.F.1 of today's Notice). In the meantime, CAMUs may be used to support efficient and protective cleanups.

5. Other Developments

In addition to the examples discussed above, program implementors and facility owners/operators are using the existing flexibility in the corrective action program to explore a range of new approaches in an effort to improve the corrective action process and expedite cleanups at a facility-specific level. These include: using performance standards to set goals for site investigations and cleanups; encouraging innovative technical approaches; facilitating voluntary or accelerated cleanups, when a facility owner/operator wants to move ahead of a regulatory agency; the use of third-party oversight; expanded public participation, including use of citizen advisory boards; innovative coordination with or deferral to other programs, including state cleanup programs; and, many other efforts. In accordance with EPA's emphasis on consistency of results between the RCRA and CERCLA programs, many of these approaches are being developed in cooperation with the Superfund program or state remedial programs.

EPA encourages program implementors and facility owners/operators to continue to explore new approaches to corrective action and to share their successes and failures. Some of the innovative approaches which have proved most successful at individual facilities are discussed later in today's Notice; EPA is looking forward to receiving information on other new approaches in response to today's Notice. One of the purposes of today's Notice is to gather information on successful facility-specific approaches to corrective action so EPA can build on implementation experience as it identifies and develops improvements to the national program during the Subpart S Initiative.

F. Relationship to Other Agency Initiatives and Rulemakings

EPA is involved in several rulemakings and other activities which will have particular impact on the Subpart S Initiative. Coordination with these other rulemakings and activities is ongoing.

1. HWIR Media

The Hazardous Waste Identification Rule for Contaminated Media (HWIR-Media) is a regulatory reform proposal that reexamines the application of many of the RCRA hazardous waste treatment and management standards to contaminated environmental media (e.g., soil and groundwater) managed during Agency or authorized state overseen cleanups. Under current regulations, environmental media that contain (or are contaminated by) hazardous wastes must be managed as hazardous waste (this is known as the ''contained-in policy''). In developing the HWIR-Media proposal, EPA, in partnership with the states, is examining a number of reforms designed to allow program implementors to tailor treatment and management requirements for contaminated media to site- and media-specific conditions. EPA is proposing several types of reforms and seeking comment on a number of alternatives. The Agency may finalize any one or combinations of these reforms or alternatives.

The first major area of reform that EPA is considering would revise the Land Disposal Restrictions (LDRs) Minimum Technological Requirements (MTRs) and permitting requirements that apply to contaminated media currently subject to hazardous waste management requirements, to make them more appropriate for the types of contaminated media and concerns typically addressed at cleanup sites. Currently, large volumes of contaminated media are subject to

hazardous waste requirements, notably LDR, MTR and permitting, that were originally designed for newly generated or process wastes, where the concerns are different from those at cleanup sites.

More broadly, EPA is also proposing to exempt some contaminated media from RCRA Subtitle C hazardous waste management requirements. This reform would allow authorized states or EPA to determine contaminated media management standards for those exempted media on a site-specific basis. EPA is considering two exemption options. First, EPA is considering exempting media by determining, often based on management conditions, that the media do not contain hazardous wastes (this is commonly known as the ''contained-out'' approach); second, EPA is considering exempting media only if certain conditions were met (this is commonly known as the ''conditional exclusion'' approach). Under the options that would exempt only some contaminated media from hazardous waste management requirements, EPA is proposing to use a set of constituent concentrations known as a ''Bright Line'' to divide the media that would and would not be eligible for exemption. Media with concentrations of constituents below Bright Line concentrations would be eligible for exemption; media with constituent concentrations above the Bright Line would not be eligible. Finally, in the HWIR-Media proposal, EPA is requesting comment on exempting all cleanup wastes, including contaminated media, sludges, debris, and other wastes managed during the course of a cleanup, based on a conditional exclusion. Under this option, authorized states or EPA would set all management and treatment requirements for cleanup wastes on a site-specific basis.

The HWIR-Media proposal in particular will complement the Subpart S Initiative by potentially providing program implementors with the flexibility to tailor requirements for management of contaminated media to the risks posed by any given medium and the circumstances at any given corrective action facility.

2. Post-Closure Rule

EPA has long recognized the need to more effectively integrate corrective action and closure activities. Toward this end, the Agency proposed a rule entitled ''Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities; Post-Closure Permit Requirement; Closure Process; State Corrective Action Enforcement Authority'' (59 *FR* 55778, November 8, 1994). In this notice, the Agency proposed revisions to the current requirements applicable to facilities with closed and closing land disposal units, and revisions to the requirements for state authorization for corrective action. These provisions, described in more detail below, were proposed as part of the Agency's efforts to create a consistent approach to cleanups at RCRA facilities.

a. The Post-Closure Permit Requirement. The current regulations at 40 CFR Part 270.1(c) require owners and operators of surface impoundments, landfills, land treatment units, and waste pile units that received wastes after July 26, 1982, or that certified closure after January 26, 1983 to obtain a post-closure permit for the facility, unless they demonstrate closure by removal at those units. For facilities that did not receive an operating permit, and closed under interim status standards, this post-closure permit serves to impose several critical statutory and regulatory requirements, including the requirements for corrective action.

The November 8, 1994 proposal would allow a regulatory agency (e.g., EPA or an authorized state) to address these facilities using the best available regulatory or enforcement authority, instead of requiring that agencies issue post-closure permits in all cases. While the proposal would not otherwise modify the applicable cleanup requirements at these facilities, it would remove the requirement that they be imposed through the post-closure permitting process. Under the proposal, a regulatory agency could require post-closure care (including corrective action) at the facility under an enforcement mechanism, a state cleanup authority, or Federal Superfund authority. This flexibility contributes to the Agency's efforts in the Subpart S Initiative.

b. Applicability of 40 CFR Parts 264 and 265 to Regulated Units Requiring Corrective Action. Under the current regulations, the requirements that apply to closed and closing land disposal units depend on their legal status. Regulated units, defined in 40 CFR 264.90 as surface impoundments, waste piles, land treatment units, or landfills that received waste after July 26, 1982, are subject to the fairly specific closure, post-closure, financial assurance, groundwater monitoring and corrective action requirements of 40 CFR Parts 264 and 265. Non-regulated solid waste management units are not subject to 40 CFR Parts 264 and 265; consequently, environmental risks at those units are determined and addressed on a site-specific basis through the corrective action process.

Despite this regulatory distinction, these units are often indistinguishable in terms of environmental risk. EPA is concerned that this dual regulatory scheme can, in some cases, limit its authority to determine the best remedy at regulated units. In the November 8, 1994 proposal, the Agency expressed this concern, and solicited comment on whether the regulations should be modified to give overseeing agencies the discretion to remove or modify all or part of the Part 264 and 265 requirements described above at a facility that is undergoing cleanup using the RCRA corrective action process.

c. State Corrective Action Enforcement Authority. Under the current Federal authorization process, states are required to obtain authorization for implementing provisions of HSWA, such as Section 3004(u), to address corrective action at permitted facilities. However, states have never been required to obtain authority to address corrective action at interim status facilities. On November 8, 1994, EPA proposed that states be required to upgrade their judicial or administrative enforcement authority to respond to releases of hazardous waste or hazardous constituents at interim status facilities as provided by Section 3008(h). This provision was designed to provide consistent and complete delegation of the corrective action program to states.

EPA is completing its review of comments on the proposed provisions and plans to proceed with promulgation of the final rule in the near future.

3. RCRA Statutory Reform

On March 16, 1995 the President committed to identify high cost, low benefit provisions of the Resource Conservation and Recovery Act (RCRA) for legislative reform. After an extensive stakeholder outreach process, the Administration selected two issues. The first issue for legislative reform, an exemption for certain low risk wastes from costly regulation under RCRA's land disposal restrictions program, was signed into law—the Land Disposal Flexibility Act—by the President on March 26, 1996.

The second topic identified for legislative reform was the application of RCRA hazardous waste management requirements to cleanup wastes. The Administration currently is discussing with stakeholders and Congress the possible development of bipartisan legislation to expedite the safe and cost-effective management of cleanup wastes that are currently subject to RCRA

hazardous waste management requirements. In addition to RCRA cleanup sites, the type of reform being discussed would benefit site cleanups under Superfund, Brownfield and State voluntary programs.

4. Improvements to the Procedures for Authorization of State Hazardous Waste Program Revisions

Under RCRA Section 3007, EPA is charged with authorizing equivalent state hazardous waste programs including corrective action programs. Authorized states administer and enforce the RCRA program within the state in lieu of the Federal program (see 40 CFR Part 271); authorized states have primary enforcement responsibility, although EPA retains enforcement authority under RCRA sections 3008, 7003, and 3013.

Following their initial authorization, states are required to periodically revise their hazardous waste programs to remain equivalent to the Federal program. Since EPA is continually revising the RCRA program in response to statutory changes, court ordered deadlines and evolving priorities, states are continually updating their authorized programs. Preparation, review and approval of changes to authorized state hazardous waste programs represents a significant workload for states and EPA. In addition, states have often expressed the concern that EPA review of changes to authorized hazardous waste programs is too detailed, resource intensive, and time consuming. To increase the pace and efficiency of authorization of state program revisions and respond to state concerns, EPA proposed changes to the regulations for processing state program revision applications in the Land Disposal Restrictions Phase IV rule (60 *FR* 43654, August 22, 1995). Additional provisions to streamline authorization of state program revisions are under consideration for inclusion in the HWIR-Media rule, currently under development. Improvements proposed in the LDR Phase IV rule and under consideration for the HWIR-Media rule include: creating a tiered approach to tailor authorization to the complexity and impact of the program revisions at issue; increasing reliance on state certifications; and placing more emphasis on time-frames for processing of authorization applications. Improvements to the procedures for state program revisions would apply to all state program revisions, including revisions made necessary by promulgation of corrective action regulations.

5. Superfund Reauthorization

As a general philosophy, EPA believes that the RCRA and CERCLA remedial programs should operate consistently and result in similar environmental solutions when faced with similar circumstances. Currently, Congress is considering legislation to reauthorize CERCLA. If CERCLA is amended, EPA believes that parallel changes in the corrective action program should generally be adopted. Changes to the CERCLA program which might impact the RCRA corrective action program include new approaches to setting cleanup standards and factoring risk into remedial decision making.

6. Superfund Administrative Improvements and Reforms

Independent of reauthorization of the CERCLA statute, EPA's Superfund program has undertaken a number of administrative initiatives to streamline the Superfund program and increase the fairness, effectiveness, and efficiency of CERCLA cleanups. Several of the proposals developed as part of the administrative reform and improvement efforts also apply to RCRA cleanups, as discussed below.

a. Guidance on Land Use. On May 25, 1995, EPA issued a Directive titled, ''Land Use in the CERCLA Remedy Selection Process.'' The directive has two primary objectives. First, to promote early discussions between EPA and local land use planning authorities, local officials, and the public regarding reasonably anticipated future land uses. Second, to promote the use of the information from those discussions to formulate realistic assumptions regarding future land use, and to clarify how land use assumptions influence risk assessment, development of remedial alternatives, and remedy selection.

The directive was developed primarily to address land use considerations under the CERCLA program; however, the principle of early and complete involvement of stakeholder groups to develop realistic land use assumptions is equally applicable to the RCRA corrective action program. EPA recognizes that RCRA facilities are often industrial properties that are actively managed, rather than the abandoned sites typically addressed under CERCLA. Because of this consideration, the directive stated that non-residential use considerations might be especially appropriate at many RCRA corrective action facilities. Consideration of non-residential land use in RCRA corrective actions was addressed in the 1990 proposal and is discussed further in Sections III.C.5.j and V.E.1 of today's Notice.

b. Soil Screening Guidance. In December 1994, EPA issued a draft ''Superfund Soil Screening Guidance,'' (SSG) for public review and comment. The SSG was developed to accelerate decision making at CERCLA and other cleanup sites by focusing investigations on exposure pathways and contaminated areas of concern and eliminating certain pathways, areas, and contaminants not of concern from more detailed assessments. The SSG provides a framework for developing site-specific screening levels for residential-based exposure scenarios.

Specific soil screening levels (SSLs), derived in accordance with the SSG, are defined as contaminant concentrations in soil below which no further action or study would generally be warranted under CERCLA. They are not intended to be cleanup levels. According to the SSG, where soil contaminant concentrations equal or exceed SSLs, further assessment, but not necessarily a cleanup, would likely be warranted.

EPA is evaluating comments on the draft guidance and intends to issue final soil screening guidance in the near future. The Agency anticipates that the SSG may also be used to develop action levels for certain RCRA corrective action facilities. For more information on the role of action levels during corrective actions, see Section III.C.2.e of today's Notice.

c. Presumptive Remedies. The Superfund program began developing presumptive remedy guidance in 1991, to use past experience to streamline cleanups. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The Agency expects that presumptive remedies will be used at all appropriate sites, including RCRA facilities, to help ensure consistency in remedy selection and implementation and to reduce the cost and time required to investigate and remediate similar types of sites. Several presumptive remedy guidance documents are available and have been placed in the docket for today's Notice, including: Presumptive Remedies: Policies and Procedures; Presumptive Remedy for CERCLA Municipal Landfill Sites; Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils; and, Presumptive Remedies for Soils, Sediments and Sludges at Wood Treating Sites. Future presumptive

remedy guidance documents may address sites with groundwater contamination, sites contaminated with polychlorinated biphenyl compounds (PCBs), and manufactured gas sites.

d. Community Based Remedy Selection. In an effort to increase community involvement, EPA plans to pilot a new community-based Superfund remedy selection process. Under this process, EPA will assist community groups, local governments and other stakeholders in developing consensus and becoming more directly involved in remedy selection at select Superfund sites.

During the first half of fiscal year 1996, EPA will develop guidelines and options for community-based remedy selection pilot programs at specific sites. These pilot programs will empower affected parties to play a direct role in finding a protective, cost-effective remedy for a Superfund site in their community, inform affected parties of the applicable statutory and regulatory requirements, and improve community understanding and acceptance of Superfund remedies. EPA will use the results of the Superfund community-based remedy selection pilot programs as it works to improve public participation at RCRA corrective action facilities.

7. Brownfields Initiative

EPA developed the Brownfields Economic Redevelopment Initiative to help communities revitalize abandoned, idled, or under-used industrial and commercial sites where expansion or redevelopment is complicated by environmental contamination. Through the Brownfields Action Agenda, the Agency committed to fund up to 50 Brownfield Pilot Programs to explore brownfield characterization and redevelopment strategies at the local level. The brownfields pilots will test redevelopment models, direct special efforts toward removing regulatory barriers without sacrificing protectiveness, and facilitate coordinated environmental cleanup efforts at the Federal, state and local levels. The Pilots are intended to provide EPA, states, tribes, municipalities, and communities with useful information and strategies as they continue to seek new methods to promote a unified approach to site assessment, environmental cleanup, and redevelopment. To date, EPA has awarded 40 pilots.

EPA anticipates that many approaches to cleanup and site redevelopment evolving from the Brownfields Initiative will have direct application to the corrective action program and the Subpart S Initiative.

8. Environmental Justice

Executive Order 12898, ''Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations,'' directs each Federal Agency to ''. . . make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental effects of its programs, policies and activities on minority populations and low income populations.'' In response to the Executive Order and to concerns voiced by many groups outside the Agency, EPA issued a Directive on September 21, 1994 which required that environmental justice issues be considered at all stages of policy, guidance and regulation development.

EPA has identified four main areas of environmental justice concerns within the Subpart S Initiative: (1) outreach to stakeholders, including members of affected communities, during the rulemaking process; (2) public participation on a site-specific level during the corrective action process; (3) public participation in future land-use and associated remedial decisions; and (4) ensuring the continued effectiveness of any institutional controls. The Agency recognizes that discussions of streamlining, such as those in today's Notice, often raise concerns in environmental justice communities. The Agency remains committed to identifying and addressing environmental justice concerns and to expanding public participation in the corrective action process, and would welcome the involvement of the environment justice community in development of the Subpart S Initiative.

9. Permits Improvement Team

In July 1994, EPA organized a group of state, tribal and local government officials to examine and propose improvements to EPA's permit programs. This group is known as the Permits Improvement Team. The Permits Improvement Team is examining ways to streamline the permitting process, exploring alternatives to individual permits, and evaluating ways to enhance public participation in permitting. For RCRA corrective action, the emphasis is on addressing RCRA and non-RCRA facilities in order of environmental priority, rather than having a state's priorities skewed by the RCRA permit process. For example, the RCRA permit could include a general provision to require compliance with the state's existing environmental cleanup program. Any changes to the RCRA permitting program that result from the Permits Improvement Team's efforts will be considered as EPA implements the Subpart S Initiative.

III. Corrective Action Implementation

As discussed in Section II of today's Notice, EPA generally uses the 1990 corrective action proposal, supplemented by later guidance, as a guideline for corrective action implementation. The 1990 proposal was intended to support a flexible approach to corrective action. Unfortunately, EPA believes the proposal has at times been interpreted too narrowly, and much of the intended flexibility has been under used. In addition, the nature of the corrective action program and some of EPA's positions have evolved since 1990.

For the benefit of those involved with the corrective action program, and to provide context for the requests for comment in Section V of today's Notice, this section provides a general status report on the corrective action program, and how it has evolved since the 1990 proposal and includes guidance on a number of topics not fully addressed in 1990. It also emphasizes the flexibility inherent in the current corrective action program and encourages program implementors and facility owners/operators to take advantage of this flexibility to improve the corrective action process and expedite cleanups.

A. Program Management Philosophy

More than 5,000 facilities are subject to RCRA corrective action, over three times the number of sites on CERCLA's National Priorities List (NPL). The degree of investigation and subsequent corrective action necessary to protect human health and the environment varies significantly across these facilities. Some facilities may require no cleanup at all or only minor corrective action, while others are as complex and highly contaminated as any Superfund site. To account for the variety of corrective action facilities and site-specific circumstances, EPA has emphasized a flexible, facility-specific approach to corrective action. Few cleanups will follow exactly the same course; therefore, program implementors and facility owners/operators must be allowed significant latitude to structure the corrective action process, develop cleanup objectives, and select remedies appropriate to facility-specific circumstances. At the same time, a number of basic operating principles

guide corrective action program implementation and development.

(1) Corrective Action Decisions Should Be Based on Risk

As in most EPA programs, the Agency's fundamental goal in the corrective action program is to control or eliminate risks to human health and the environment. Risk-based decision making is especially important in the corrective action program, where it should be used to ensure that corrective action activities are fully protective given reasonable exposure assumptions and consistent with the degree of threat to human health and the environment at a given facility.

(2) Program Implementation Should Focus on Results

The purpose of the corrective action program is to stabilize releases and clean up RCRA facilities in a timely manner, not to ensure compliance with or fulfillment of a standardized process. Program implementors and facility owners/operators should focus on environmental results rather than process steps and ensure that each corrective action related activity at any given facility directly supports cleanup goals at that site. In focusing on results, program implementors are encouraged to use innovative approaches to management and oversight.

(3) Interim Actions and Stabilization Should Be Used To Reduce Risks and Prevent Exposures

A primary implementation strategy of the corrective action program is to focus resources first on stabilizing continuing releases and controlling exposure at facilities undergoing corrective action. Once a facility is stabilized, Agency oversight at that facility can be reduced and resources shifted to other facilities of concern. By focusing on stabilizing many facilities, rather than pursuing a final cleanup at a few facilities, EPA can achieve a greater overall level of human health and environmental protection in the near-term.

(4) Activities at Corrective Action Facilities Should Be Phased

Significant efficiencies can be gained by phasing corrective action at individual facilities to focus on areas of the facility that represent the greatest risk to human health and/or the environment. Phasing allows information obtained from previous phases to be used for planning and refining subsequent investigations or responses. Using a phased approach, response actions can be taken at some high-priority areas of the facility while other lower-priority areas are addressed at a later time.

(5) Program Implementation Should Provide for Meaningful Inclusion of All Stakeholders

EPA is committed to including all stakeholders in the corrective action process. Stakeholders are included in both facility-specific decision making through public participation activities and in the development of the national corrective action program. The Agency believes stakeholder involvement is essential in all corrective action cleanups, regardless of the oversight mechanism used (e.g., order, permit, state authority, voluntary action).

(6) Corrective Action Obligations Should Be Addressed Using the Most Appropriate Tool for Any Given Facility

EPA recognizes that there are many mechanisms or tools which can be used to ensure appropriate corrective action at any given facility, including RCRA orders or permits, state cleanup orders, and voluntary cleanup programs. Each mechanism has advantages and disadvantages when applied to individual facilities. Program implementors and facility owners/operators should carefully consider these advantages and disadvantages when choosing a corrective action mechanism.

(7) States Will Be the Primary Implementors of the Corrective Action Program

Since corrective action requirements will be, predominantly, implemented by states, EPA is committed to full and meaningful state involvement in development of corrective action implementation strategies, policy, guidance and regulations.

B. Scope and Definitions

Corrective action requirements apply at hazardous waste treatment, storage and disposal facilities (TSDFs). These include permitted facilities and facilities that have, have had, or should have had RCRA interim status. This collection of facilities is typically referred to as the ''corrective action universe.'' Corrective action may be required for releases of hazardous waste or hazardous constituents from these facilities, as necessary to protect human health and the environment. EPA does not generally require corrective action at facilities which are issued land treatment demonstration permits, emergency permits, permits-by-rule for ocean disposal, or research, development and demonstrations permits unless these facilities otherwise become subject to RCRA operating or post-closure permitting requirements.

The 1990 proposal established EPA's views on the scope and applicability of RCRA corrective action authorities. Although EPA's views have largely remained unchanged in this area, there have been several important refinements or developments, as discussed below.

1. Concept of Parity

Most facilities in the RCRA corrective action universe are potentially subject to cleanup under numerous cleanup authorities, including state or Federal Superfund authorities. The potential for overlapping application of these authorities can cause confusion and concern in the regulated community and among state and Federal regulators. In the 1990 proposal, EPA stated that one of the Agency's primary objectives was ''to achieve substantial consistency with the policies and procedures'' of the Superfund remedial program. The logic behind this concept is that, since both programs address cleanup of potential and actual releases, both programs should arrive at similar remedial solutions. EPA's position is that any procedural differences between RCRA and CERCLA should not substantively affect the outcome of remediation.

Generally, cleanup of any given site or area at a facility under RCRA corrective action or CERCLA will substantively satisfy the requirements of both programs. We believe that, as a general matter, RCRA and CERCLA program implementors can defer cleanup activities from part or all of a site to one program with the expectation that no further cleanup will be required under the other program. For example, when investigations or studies have been completed under one program, there should be no need to review or repeat those investigations or studies under another program. Similarly, a remedy that is acceptable to one program can be presumed to meet the standards of the other.[3] The same principle should apply to authorized state corrective action programs and state CERCLA analogous programs. Over half the states have Superfund-like authorities. In some cases, these authorities may be substantively equivalent in scope and effect to the Federal CERCLA program, and therefore are likely to be substantially equivalent to the RCRA corrective action program.

[3] In some cases specific releases or constituents are not ''solid wastes'' under RCRA. For example, RCRA excludes from the definition of solid waste certain source, special nuclear, or byproduct material as defined by the Atomic Energy Act 42 U.S.C. § 2011.

EPA emphasized the concept of parity in a recently issued policy for deleting RCRA facilities from the NPL and deferring their cleanup to the RCRA corrective action program (60 *FR* 14641), available in the docket for today's Notice.[4] EPA is planning to issue additional guidance on RCRA and CERCLA parity in an upcoming policy memo, ''Coordination of RCRA/CERCLA Activities'' and through the inter-agency and state ''Lead Regulator Workgroup.''

2. Voluntary Cleanup

EPA strongly encourages voluntary corrective actions. As discussed in the 1990 proposal, voluntary cleanups have a number of advantages, including timeliness, flexibility, and efficient use of facility owner/operator and Agency resources. Unfortunately, representatives of the regulated community have, on occasion, complained that procedural barriers have delayed cleanups they were willing to undertake voluntarily. Over the last few years, EPA and the states have taken significant steps to address this concern and to further encourage and facilitate voluntary actions. For example, EPA is planning to issue guidance on the use of state voluntary cleanup programs to address contamination at sites that may be subject to cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act including hazardous waste generators, unregulated by RCRA corrective action requirements. The Guidance for Development of Memoranda of Agreement (MOA) Language Concerning State Voluntary Cleanup Programs is being developed in partnership with interested states and will outline general principles which EPA will use when deciding whether to endorse a state voluntary cleanup program and to assure private parties that subsequent Federal action under CERCLA will not be taken except under limited circumstances.

The same general principles established in the CERCLA MOA guidance may apply to the use of state voluntary cleanup programs at facilities subject to RCRA corrective action; however, because of distinctions in statutory requirements, consideration of additional factors may be required of those programs. Issues associated with voluntary cleanups at facilities subject to RCRA corrective action, including the use of state voluntary cleanup programs, are discussed in Section V.D.3 of today's Notice.

3. Definitions

The 1990 proposal included definitions for a number of terms which help to further define the applicability of RCRA corrective action. Pending final action on the proposal, EPA has generally continued to interpret these terms consistently with the proposal; however, as EPA has gained experience with applications in particular cases, it has refined its interpretations in some respects. The following discussion highlights the way in which these issues have been addressed in some specific situations (e.g., cases decided by the EPA Environmental Appeals Board (EAB)).

a. Facility. Under RCRA § 3004(u), corrective action is required for releases form solid waste management units at facilities seeking RCRA permits. The 1990 proposal defined ''facility'' as ''all contiguous property under the control of the owner or operator seeking a permit under Subtitle C of RCRA.'' This definition was finalized when the rule on corrective action management units (CAMUs) was promulgated (58 *FR* 8658, February 16, 1993) and is now codified at 40 CFR 260.10. For reasons discussed in the 1990 proposal, the term ''facility'' for corrective action purposes is separate and substantively different from the facility definition for other RCRA purposes.

A number of issues continue to arise regarding the application of the facility definition. A common issue is whether or not a certain parcel is considered ''contiguous'' for purposes of the corrective action facility definition. One such situation is the case of two parcels under common ownership but separated by a road or public right of way. In the 1990 proposal, EPA indicated it would interpret such parcels to constitute a single facility for purposes of corrective action. This approach was recently accepted by the EAB, which held that two parcels were a single facility where they were separated by a privately owned railroad line (*In re Exxon Co., USA*, RCRA Appeal No. 94–8 (EAB May 17, 1995)).

Another common scenario involves two geographically separated parcels under common ownership that are connected by ditches, bridges, or other links under the control of the facility owner/operator. In the *Exxon* permit appeal, the EAB noted the fact that the two parcels (which it found to be ''contiguous'' in any case) were also connected by a sewer system collecting waste water from different parts of the facility. It pointed out that in an earlier case, evaporation ponds three miles from a refinery were treated as part of the same facility because they were linked to the refinery by a drainage ditch controlled (although not owned) by the same party. (See, *In re Navajo Refining Co.*, RCRA Appeal No. 88–3 (Adm'r June 27, 1989)). In a separate final RCRA section 3008(h) order, EPA has determined that two parcels on opposite sides of a river, but connected by a trestle, constitute a single facility for corrective action purposes. (See, *In re Sharon Steel Corp.*, Docket No. RCRA III–062–CA (Region III).)

The 1990 proposal requested comment on how the definition of facility should apply where a large parcel is owned by one party who leases a small portion to another party for a RCRA-permitted facility. In the proposal, EPA indicated that it would consider corrective action requirements to extend to SWMUs throughout the larger parcel. At the same time, EPA recognizes that there are differing views as to the policy merits of this interpretation and invites further comment in section V.C.2 of today's Notice.

b. Release. The definition of release for corrective action was first discussed in the 1985 HSWA codification rule (50 *FR* 28702, July 15, 1985). In the 1985 rule, EPA wrote that the definition of release for corrective action should, at a minimum, be as broad as the definition of release under CERCLA. Accordingly, EPA has interpreted the term release to mean ''any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping or disposing into the environment.'' (See, 50 *FR* 28713, July 15, 1985.) In the 1990 proposal, EPA clarified that the definition of release also includes abandoned or discarded barrels, containers, and other closed receptacles containing hazardous wastes or constituents and that it could include releases that are permitted under other authorities, such as the Clean Water Act. EPA continues to adhere to these interpretations of the term ''release.''

c. Solid Waste Management Unit. In 1990, EPA proposed to define the term ''solid waste management unit'' or ''SWMU'' to mean, ''Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released.'' Pending resolution of the 1990 proposal, EPA has used this definition in

[4] The RCRA deletion policy does not pertain to Federal Facilities, even if such facilities are also subject to RCRA Corrective Action; however, program implementors and facility owners/operators are encouraged to use interagency agreements to eliminate duplication of effort, including oversight, at Federal facilities.

corrective action implementation. The inclusion of units not specifically intended for the management of solid or hazardous waste is supported by the legislative history of RCRA sections 3004 (u) and (v), and this point has been applied in decisions by the EAB. (See, e.g., *In re General Motors Corp.*, RCRA Appeal No. 90–24 (EAB Nov. 6, 1992).)

As discussed in the 1990 proposal, not all areas where releases have occurred are considered SWMUs. In the 1990 proposal, EPA indicated a one-time spill which had been adequately cleaned up would not constitute a SWMU; on the other hand, a location at which wastes or other materials were released in a routine and systematic manner (such as a loading area where minor spills or leaks occurred routinely over time) would be a SWMU. The 1990 proposal indicated that industrial sewers used for collecting wastes would constitute SWMUs. This interpretation, which was based in part on earlier decisions in permit appeals, has been affirmed by the EAB in *In re Amoco Oil Co.*, RCRA Appeal No. 92–21 (EAB Nov. 23, 1993).

The definition of a SWMU is often a point of disagreement when corrective action permits or orders are issued. Facility owners/operators and representatives of the regulated community often argue that Congress intended the RCRA corrective action program to be focused on waste management units (i.e., SWMU) and that non-waste-management related releases (e.g., spills) should be addressed by other cleanup programs or authorities. EPA notes that authority exists for requiring corrective action for releases that are not attributable to SWMUs. Given the legislative history of RCRA section 3004(u), which emphasizes that RCRA facilities should be adequately cleaned up, in part, to prevent creation of new Superfund sites, EPA believes that corrective action authorities can be used to address all unacceptable risks to human health or the environment from RCRA facilities. In the permitting context, remediation of non-SWMU related releases may be required under the ''omnibus'' authority (see 40 CFR 270.32(b)(2)) which allows EPA to impose such permit conditions as are necessary to protect human health and the environment. In other contexts, orders under RCRA sections 3008(h) or 7003 may require remedial action to address releases regardless of whether a SWMU is present. Therefore, extended debate or litigation over a particular SWMU designation will in many cases be unproductive for all parties and, as a general principle, EPA discourages debate on these issues, believing that discussions should more properly focus on whether there has been a release that requires remediation.

To reflect a more holistic approach, permits and orders often use the term ''area of concern'' to refer to releases which warrant investigation or remediation under the authorities discussed above, regardless of whether they are associated with a specific SWMU as the term is currently used. For example, when an overseeing agency believes one-time spills of hazardous waste or hazardous constituents have not been adequately cleaned up, these releases are often addressed as areas of concern.

d. Hazardous Waste and Hazardous Constituent. RCRA section 3004(u) requires corrective action for releases of ''hazardous wastes or constituents.'' As discussed in the 1990 proposal, EPA interprets the term ''hazardous waste,'' as used in RCRA section 3004(u) to include all wastes that are hazardous within the statutory definition in RCRA section 1004(5), not just those that are either listed or identified by EPA pursuant to RCRA section 3001.

EPA also used the 1990 proposal to discuss use of the phrase ''or constituents'' in RCRA section 3004(u). EPA views this phrase as significant in two ways. First, it indicates that Congress was particularly concerned that, within the broad category of wastes that might be ''hazardous'' within the statutory definition, the corrective action authority should be used to address the specific subset of ''hazardous constituents.'' Second, it indicates that the corrective action authority was not intended to be limited to hazardous waste, and extends to hazardous constituents regardless of whether they also fall within the term ''hazardous waste,'' or whether they were derived from hazardous waste. Under this interpretation, constituents that were contained within nonhazardous solid wastes may be addressed through corrective action.

C. Corrective Action Process

The corrective action process discussed in the 1990 proposal was structured around five elements common to most cleanup activities: initial site assessment, site characterization, interim actions, evaluation of remedial alternatives, and implementation of the selected remedy. These elements typically occur, to one degree or another, during most cleanups. As discussed in the 1990 proposal, EPA emphasizes that no one approach to implementing these cleanup elements is likely to be appropriate for all corrective action facilities; therefore, a successful corrective action program must be procedurally flexible. In addition, these cleanup elements should not become ends in themselves; EPA continues to encourage program implementors and facility owners/operators to focus on the desired result of a cleanup rather than a mechanistic cleanup process. These five elements should be viewed as evaluations necessary to make good cleanup decisions, not prescribed steps along a path.

1. Initial Site Assessment

The first element in most cleanup programs is an initial site assessment. During the initial site assessment information is gathered on site conditions, releases, potential releases, and exposure pathways to determine whether a cleanup may be needed and to identify areas of potential concern. Overseeing agencies may also use initial site assessments to set relative priorities between sites and allocate oversight and other resources.

In the CERCLA program, the initial site assessment is called a Preliminary Assessment/Site Investigation, or PA/SI; in the corrective action program, it is referred to as a RCRA Facility Assessment or RFA. During an RFA, an overseeing agency typically compiles existing information on environmental conditions at a given facility and, as necessary, gathers additional facility-specific information on solid waste management units and other areas of concern, releases, potential releases, release pathways, and receptors. Information gathered during an RFA usually forms the basis for initiating full scale site characterization

a. Facility Owners/Operators May Gather RFA Information. At the time to today's Notice, EPA and the states have completed 3,534 RFAs at RCRA facilities. In the past, EPA has been reluctant to allow facility owners/operators to conduct RFAs because of concern over the adequacy of the facility submissions; however, by now the RFA is a well developed process and EPA believes it may be more reasonable to accept the work of facility owners/operators. Where RFAs have not yet been completed, facility owners/operators may choose to conduct their own site assessment and submit the report to EPA for review. If EPA believes the site assessment is adequate, the site assessment may be approved and adopted as the RFA for the facility. In the same way, when an RFA was completed some years ago, a facility owner/operator might conduct a site assessment to update the RFA and submit it to EPA for review, approval

and adoption as an RFA update. Facility owners/operators who choose to conduct or update their own RFAs should ensure that they address all solid waste management units and other areas of concern at the facility. Guidance on the scope of RFAs is available in ''RCRA Facility Assessment (RFA) Guidance'' EPA/530/SW–86/053, PB87–107769, October 1986, which has been placed in the docket for today's Notice. Facility owners/operators who want to obtain a copy of the RFA conducted for their facility should contact the appropriate EPA Regional Office or their authorized state.

b. Release Assessment. Release assessments (sometimes referred to as Phase 1 assessments) are used to confirm or reduce uncertainty about solid waste management units, areas of concern, and potential releases identified during the initial site assessments. Under the corrective action process as originally conceived, program implementors and facility owners/operators would typically move directly from the initial site assessment to full scale site characterization. As program implementors and facility owners/operators have gained experience in corrective action implementation, they have often found it advantageous to conduct a limited release assessment after the RFA but before full scale site characterization, to focus subsequent investigations or eliminate certain units or areas from further consideration. Release assessments can be especially helpful in cases where the RFA is old or where the overseeing agency and the facility owner/operator disagree about inclusion of one or more units, areas, or releases in the site characterization.

Information collected during a release assessment can be used to focus site characterizations on the areas and releases and exposure pathways which constitute the greatest risks or potential risks to human health and the environment and to eliminate areas from consideration during site characterization. For example, an initial site assessment could identify an old waste pile as a solid waste management unit. The facility owner/operator might present information showing that the waste in the pile had been removed; however, there may be little or no information to confirm that releases from the unit (if any) were adequately addressed during waste removal. The facility owner/operator could, during a release assessment, conduct highly focused sampling at the unit to confirm that releases either had not occurred or were adequately remediated.

c. National Corrective Action Prioritization System. Implementing agencies often use initial site assessments to set priorities for limited oversight resources. In the corrective action program, EPA sets priorities using the National Corrective Action Prioritization System (NCAPS). NCAPS priorities are generally based on information gathered during the RFA. Because of the number of facilities subject to corrective action, the variety of facility-specific conditions, and the limitations on Agency oversight resources, careful prioritization is essential. The Agency's policy is to focus its corrective action resources first on facilities and areas at facilities which present the greatest relative risk to human health and the environment. Accordingly, NCAPS considers the environmental setting of a facility and potential receptors, actual and potential releases of hazardous wastes or constituents from the facility, and the toxicity of constituents of concern to group facilities into high, medium and low priority groups.

NCAPS rankings are based on risk, but NCAPS does not involve a traditional site-specific risk assessment. NCAPS is a resource management tool that EPA and authorized states use to set relative priorities among corrective action sites to focus limited agency resources. Currently 40% of facilities subject to corrective action are considered high priority, 30% medium, and 30% low.

2. Site Characterization

Before cleanup decisions can be made, some level of characterization is necessary to ascertain the nature and extent of contamination at a site and to gather information necessary to support selection and implementation of appropriate remedies. In the CERCLA program, this step is referred to as the Remedial Investigation or RI; in the RCRA program, the RCRA Facility Investigation or RFI.

Carefully designed and implemented RFIs are critical to accurately characterize the nature, extent, direction, rate, movement, and concentration of releases at a given facility; this information is needed to determine potential risks to human health and the environment and support development and to implementation of corrective measures should they prove necessary. It can also be used to eliminate facilities which are shown not to present unacceptable risks from further consideration. A successful RFI will identify the presence, movement, fate, and risks associated with environmental contamination at a site and will elucidate the chemical and physical properties of the site likely to influence contamination migration and cleanup.

The 1990 proposal outlines the types of information which may be required during a remedial investigation. As discussed in the 1990 proposal, program implementors and facility owners/operators should gather the information necessary to support cleanup decisions; collection of all the information discussed in the 1990 proposal will not be necessary at most facilities.

Experience in corrective action implementation has demonstrated that poorly focused investigations can become a drain on time and resources and, in some cases, unnecessarily delay remedial actions. EPA emphasizes that remedial investigations should be tailored to the specific conditions and circumstances at the facility and focused on the units, releases, and exposure pathways of concern. For example, in delineating the extent of contamination it may not be necessary to delineate to background concentrations in all cases. In some cases, information adequate to support cleanup decisions can be obtained through delineation to risk-based concentrations or other investigation endpoints. For example, an investigation endpoint might be based on the presence or absence of a competent confining layer rather than constituent concentrations.

EPA has found a number of approaches to be particularly helpful in developing focused site investigations, as discussed below.

a. Conceptual Site Models. Site investigations and remedy implementation are often most successful when based on a ''conceptual site model.'' A conceptual site model is a three-dimensional picture of site conditions that conveys what is known or suspected about the sources, releases and release mechanisms, contaminant fate and transport, exposure pathways and potential receptors, and risks. The conceptual site model is based on the information available at any given time and will evolve as more information becomes available. The conceptual site model may be used to present hypotheses that additional investigations could confirm or refute, to support risk-based decision-making, and to aid in identification and design of potential remedial alternatives.

The conceptual site model is not a mathematical or computer model, although these tools often prove helpful in visualizing current information and predicting future conditions. The conceptual site model can be

documented by written descriptions of site conditions and supported by maps, cross sections, analytic data, diagrams of the site that illustrate actual or potential receptors, and other descriptive tools.

The conceptual site model is dynamic and should be tested and refined from the very first stages of corrective action to the point at which the site has been remediated and no longer presents a threat to human health or the environment. The RCRA Facility Assessment often forms the basis for the first conceptual model of the site. At this stage, the model should be used as a tool to compile available and relevant information and to identify the urgency and scope of subsequent investigations as well as interim actions. One use of the conceptual site model could be to ensure that site conditions are consistent with the underlying assumptions that were used to develop standardized action levels (see Section III.C.2.e). The model can also be used to support phasing of site investigations to ensure data collection efforts address the most important information needs. In addition, a conceptual site model can be a critical tool for evaluating remedy performance.

More detailed guidance on the development and use of the conceptual site model is available in ''Guidance for Evaluating the Technical Impracticability of Ground Water Restoration'' (EPA/540–R–93–080). Additional guidance on using conceptual models will be included in the upcoming Soil Screening Guidance (see, Section II.F.6.b).

b. Innovative Site Characterization Technologies. In the 1990 proposal, EPA recommended a focused approach to site characterization activities. EPA continues to support data collection approaches that focus on information needed to support decisions. The Agency has seen tremendous improvements in site characterization efficiency when innovative approaches are used, especially those that rely on rapid sample collection (e.g., direct-push technologies) and on-site analytical techniques (e.g., sensor technologies, assay kits, field gas chromatography/mass spectrometry (GC/MS), X-ray fluorescence). Depending on the data quality objectives for a particular site, confirmatory laboratory analyses may also be necessary. Data quality objectives are discussed in Section III.C.2.c, below.

The benefits of using innovative site characterization technologies are magnified when a work plan is used only to convey strategies, methods, data quality objectives, and general areas subject to investigation, and exact sample locations are left to be determined based on iterative on-site data collection and analysis. Some of the benefits of using innovative characterization techniques along with iterative decision-making include: Rapid sample collection and analysis allowing for on-site decision making and optimization of the investigation effort; enhanced three-dimensional understanding of the site because of the greater number of data points available for a given commitment of resources; better identification of actual or potential risks to human health and environmental receptors; and, more rapid assessment of the need for interim actions.

Program implementors and facility owners/operators should take advantage of innovative characterization technologies. Likewise, EPA encourages implementing officials to be receptive to innovative approaches which can significantly improve the quality as well as the cost- and time-effectiveness of site characterization.

c. Tailored Data Quality Objectives. Program implementors and facility owners/operators should tailor data gathering strategies to the purpose for which the data will be used. The overall degree of data quality or uncertainty that a decision maker is willing to accept is referred to as the Data Quality Objective (DQO) for a decision. The DQO is used to specify the quality of the data, usually in terms of precision, bias, representativeness, comparability and completeness. The DQO approach applies to the entire measurement system (e.g., sampling locations, methods of collection and handling, field analysis, etc.), not just to laboratory analytical operations. In general, EPA has found that DQOs can and should be used to ensure that environmental data are scientifically valid, defensible, and of an appropriate level of quality given the intended use for the data.

Program implementors and facility owners/operators using innovative site characterization and assessment approaches should pay particular attention to DQOs. For example, an objective of the early stages of an investigation could be to identify the presence of gross contamination. In this context, a DQO could include a higher method detection limit (e.g., part per million) that could be obtained with cost-effective field screening technologies. In contrast, a very low method detection limit (part per billion or even trillion) could be an appropriate DQO to determine if groundwater is fit for human consumption.

EPA encourages program implementors and facility owners/operators to use the DQO approach to define adequate data collection for corrective action decisions. EPA has found that site investigations can be expedited considerably when DQOs are carefully established. For additional information on incorporating DQOs in the decision-making process at RCRA facilities, see Chapter One of SW–846 (Chapter One of SW–846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition as amended by Update I, July 1992); ''Final Guidance for the Data Quality Objective Process'' EPA QA/G–4, September 1994; and, ''Quality Assurance Project Plans for RCRA Ground-Water Monitoring and Corrective Action Activities'' EPA, Sylvia Lowrance and H. Matthew Bills, July 1993, available in the docket for today's Notice.

d. Use of Existing Information to Streamline the Remedial Investigation. Many RCRA facility owners/operators have collected information on physical characteristics or on the nature and extent of contamination at the facility outside of the RCRA corrective action process. Information on site conditions may have also been obtained by entities other than the facility owner/operator. As a general principle, information that is not time dependent should not be collected again; EPA encourages the incorporation of pertinent existing information into the corrective action process. For example, many states have required facilities to conduct groundwater investigations under state laws for units that are not regulated units under RCRA; this information can often be easily incorporated into a corrective action investigation. Similarly, information collected through a state Superfund process is also generally of appropriate quality to be directly useable to support corrective action decisions.

Information that is relevant to corrective action may exist in reports or formats that are not traditionally used for RCRA corrective action. For example, engineering boring logs may have been generated on the facility by local utility companies, or by the facility itself during building construction. Provided data and information are submitted in a usable format, state or Federal agencies overseeing RCRA corrective actions should not require adequate information to be recollected or reformatted.

Facility owners/operators who are developing site characterization or other information independently are urged to document the quality of their information carefully. Thorough

documentation of data quality will increase its usefulness in the corrective action process. Use of existing information can reduce costs of conducting investigations and increase the speed of corrective action cleanups.

To determine whether existing data is appropriate for corrective action decisions, the nature and quality of the information should be assessed in view of the goals of the corrective action investigation. Where DQOs have been established, existing data can be assessed against DQOs to determine their adequacy. For example, the DQO for a specific corrective action decision could be a minimum analytical detection limit that is considerably lower than that used in an existing study. In this case, non-detects in the existing data could not be used to justify no action; however, the existing data could be used to determine ''hot-spots'' and to plan a second phase study using a more sensitive analytical method. On the other hand, if the detection limits were below an acceptable risk level and no constituents were detected, re-sampling would not typically be required—even if more sensitive methods were available.

EPA regions and states are currently incorporating existing information into ongoing corrective actions. If the regulatory agencies are aware of pertinent existing information at the time of issuance of a permit or order, they have the option of explicitly referencing the relevant information in the facility investigation requirements of the permit or order or, if the data are of sufficient quality and quantity, stating that the data fulfill site investigation needs. In some cases, the facility owner/operator will inform the overseeing agency of existing information; EPA or the states have the option of redirecting any investigations based upon the relevance of this information.

e. Role of Action Levels. At certain facilities subject to corrective action, contamination will be present at concentrations that may not justify further action. For this reason, EPA has, in some cases, used the concept of ''action levels'' as a trigger mechanism for conducting additional corrective action activities (e.g., additional investigations, evaluation of remedial alternatives, site-specific risk assessments). Under this approach, contamination found in a particular medium below an appropriate action level would not generally be subject to remediation or further study.

Action levels are health- or environmental-based concentrations derived using chemical-specific toxicity information and standardized exposure assumptions. Action levels are often established at the more protective end of the risk range (e.g., 10^{-6}) using conservative exposure and land use assumptions; however, action levels based on less conservative assumptions could be appropriate based on site-specific conditions. For example, if the current and reasonably anticipated future uses of a site are industrial, an action level based on industrial exposure scenarios could be appropriate.

Action levels can be developed on a facility-specific basis or can be taken from standardized lists. Currently, some states and EPA Regions have developed standardized lists of action levels or cleanup levels (standardized cleanup levels can serve as action levels) for RCRA corrective action facilities and other cleanup sites. One of the earlier and more widely distributed lists of action levels was developed by EPA and included in Appendix A of the preamble to the 1990 proposal. Since 1990, toxicity research has progressed; accordingly, some of the action levels included in the 1990 proposal may no longer be appropriate. In addition, the action levels in the 1990 proposal were based on residential land-use assumptions which may not be appropriate at all corrective action facilities. Program implementors and facility owners/operators should ensure that action levels used at RCRA corrective action facilities reflect up-to-date toxicity information and that action level assumptions are consistent with the physical conditions and current or reasonably anticipated exposure assumptions at any given facility. For example, risk to ecologic receptors is not accounted for in the action levels included in the 1990 proposal. If ecologic risks are a concern at a given corrective action facility, program implementors and facility owners/operators should consider developing facility-specific action levels to account for ecologic risk issues.

EPA has found that action levels are most beneficial when they are available during the planning stages of site investigations. In the 1990 proposal, the Agency indicated that it would be advantageous to include action levels in corrective action permits to give facility owners/operators and the public an indication of contaminant concentrations that would likely trigger additional study or corrective measures. At the same time, the Agency recognized that, in some cases, including action levels in corrective action permits would not be necessary (e.g., when available information establishes the need for an analysis of remedial alternatives). Program implementors and facility owners/operators have the flexibility to determine whether or not to include action levels in corrective action permits and orders.

In Section V of today's Notice, EPA requests comments on the use of action levels and the role of the Federal government in promoting national consistency by developing, maintaining, and distributing action levels (as well as media cleanup levels) or standardized protocols for developing site-specific levels.

f. Integration With the Evaluation of Remedial Alternatives. At most sites, likely remedial strategies will become clear during the initial site assessment and subsequent site characterization. To expedite the corrective action process, EPA encourages program implementors and facility owners/operators to focus data gathering during site characterization on information needed to support plausible remedies. This strategy is discussed more fully in Section III.C.4.a of today's Notice.

3. Interim Actions

Since the 1990 proposal, EPA has increasingly emphasized the importance of interim actions and site stabilization in the corrective action program. Many cleanup programs, including RCRA and CERCLA, recognize the need for interim actions while site characterization is underway or before a final remedy is selected. Typically, interim actions are used to control or abate ongoing risks to human health or the environment in advance of final remedy selection. For example, actual or potential contamination of drinking water supplies might necessitate an interim action to provide alternative drinking water sources. Similarly, hazardous waste or constituents stored in poorly maintained or damaged drums or tanks might require an interim action to stabilize (e.g., by overpacking) or remove the damaged containers. The concept of interim actions is especially appropriate to facilities subject to RCRA corrective action, since many facilities in the corrective action universe are operating industrial facilities, where a final facility cleanup might not be completed for many years.

One of EPA's overriding goals in managing the corrective action program is to expedite risk reduction by emphasizing early implementation of interim actions to control or minimize ongoing threats to human health or the environment. The importance of interim actions at RCRA corrective action facilities is further emphasized in the Agency's Stabilization Initiative

discussed in Section II.E.1 of today's Notice.

Interim actions at RCRA facilities can include a wide range of activities such as source removal, installation of a pump and treat system, and institutional controls. In accordance with the Stabilization Initiative, interim actions should be employed as early in the corrective action process as possible, consistent with the environmental objective and priorities for the site; as further information is collected, program implementors and facility owners/operators should continue to look for opportunities to conduct additional interim actions. Generally, interim actions should be compatible with, or a component of, the final remedy.

4. Evaluation of Remedial Alternatives

Contamination at most cleanup sites can be addressed using a number of remedial alternatives, each of which would present advantages and disadvantages. Before choosing a cleanup approach, program implementors and facility owners/operators will typically analyze a range of alternatives and evaluate their advantages and disadvantages relative to site-specific conditions. In the CERCLA program the identification and evaluation of remedial alternatives is referred to as the Feasibility Study or FS; in the RCRA corrective action program, the Corrective Measures Study or CMS.

The purpose of a Corrective Measures Study is to identify and evaluate potential remedial alternatives for facilities undergoing corrective action. During the CMS, program implementors and facility owners/operators typically evaluate one or more remedial alternatives based on site-specific conditions and select a preferred remedial alternative as the remedy. The CMS does not necessarily have to address all potential remedies for every corrective action facility. EPA advises program implementors and facility owners/operators to focus corrective measures studies on realistic remedies and to tailor the scope and substance of studies to the extent, nature and complexity of releases and contamination at any given facility. For example, some potential remedies should not be considered because they are simply implausible. In cases where EPA has identified a presumptive remedy (presumptive remedies are discussed in Section II.F.6.c of today's Notice), the purpose of the CMS will be to confirm that the presumptive remedy is appropriate to facility-specific conditions. In cases where EPA or a state is using performance standards or a similar approach, the Agency might not require submission or approval of a formal CMS at all. EPA continues to emphasize that it does not want studies to be undertaken simply for the purpose of completing a perceived step in a perceived process. While, for a complex site, review of a full range of remedial alternatives may be required, at many sites, the preferred remedial approach will be apparent early in the cleanup process and the analysis of remedial alternatives should be highly focused.

In implementing the corrective action program, EPA has found a number of opportunities to significantly increase the efficiency of corrective measures studies, as discussed below.

a. Integration With Site Characterization. EPA continues to emphasize that the components of corrective action (e.g., release assessment, RFI, CMS) should not be viewed as isolated steps in a linear process. In the Agency's experience, it is generally more efficient to focus data collection on information needed to support an appropriate, implementable remedy than to attempt to complete separate evaluations at each step. As remedial alternatives are considered during a CMS, the facility owner/operator might find additional site characterization necessary. Similarly, the earlier in the corrective action process potential remedies can be identified, the more effectively information gathering can be focused. For example, in a situation where the contamination being addressed involves a large mixed fill landfill, the remedial alternatives will likely involve physical and institutional controls. These alternatives should be identified early in the RFI enabling the facility owner/operator to tailor the RFI toward collection of information necessary to support development of appropriate physical controls. In other cases, a facility may have relatively limited soil contamination or old solid waste management units which the facility owner/operator desires to remove all contaminated material for treatment and disposal off-site. In these cases, the RFI might be focused on removal options and analysis of other alternatives would not be necessary. Other benefits associated with combination of the RFI and CMS can include cost savings associated with consolidation of reports and other documents, and time savings associated with concurrent rather than sequential analysis. The 1990 proposal and the 1990 RCRA Corrective Action Plan discuss other situations where the CMS could be combined with site characterization, including:

(1) ''Low risk'' facilities. These are facilities where environmental problems are relatively small and where releases present minimal exposure concerns. Such facilities might have limited on-site soil contamination;

(2) Facilities where removal remedies have been proposed by the owner/operator. For example, at a facility where there is contaminated soil and the owner/operator proposes to excavate all the contaminated soil for subsequent off-site recycling, treatment or disposal;

(3) Facilities with straightforward remedial solutions or where presumptive remedies, as discussed in Section II.F.6.c of today's Notice, can be applied. These are facilities where standard engineering solutions, which have proven effective in similar situations, may be appropriately applied;

(4) Facilities where few remedial options are available. This includes situations where there are few practicable remedial solutions; and,

(5) Facilities where the remedy is phased.

b. Formal Evaluation Not Always Necessary. At some facilities the CMS does not have to be submitted to an overseeing agency for review and approval in favor of a performance-based approach. In these scenarios, the overseeing agency (e.g., EPA or a state) might oversee the facility investigation to ensure that all releases and potential releases from the facility are adequately identified and characterized and that adequate remedial goals are developed for the facility. After the remedial goals undergo public review and comment and are approved by the overseeing agency, the facility owner/operator would design and implement a remedy sufficient to meet the remedial goals without direct agency oversight.

For example, the remedial investigation at a facility may reveal widespread groundwater contamination caused by a release from an old surface impoundment. The remedial goals for the facility might be to control the source contaminating the groundwater, contain the groundwater plume, and restore groundwater quality to specified cleanup levels. Media cleanup levels would be included in the remedial goal and the facility owner/operator would be required to conduct remedial activities in a manner which involves the affected public in a meaningful and timely way. The facility owner/operator would then design and implement a remedy (and a public participation plan). In this example, while the facility owner/operator might analyze a number of alternatives, the overseeing agency would not ordinarily second-guess the

remedial choice (since the agency had been involved in developing the performance standards). Instead, the overseeing agency would monitor compliance with the remedial goals. If the remedial goals or milestones were not met in the required performance period, additional remediation measures would likely be required. EPA favors performance-based approaches provided that the remedial goals for the facility are clear, the oversight during remedy implementation is appropriate to the complexity of the facility-specific circumstances, and the public is substantively involved. Many states, in particular the State of Georgia, attribute the success of their corrective action programs, in part, to eliminating Agency review and approval of the CMS as a step in the corrective action process in favor of a performance-based approach.

c. Facility Owner/Operator Should Recommend a Preferred Remedy. EPA emphasizes that it expects facility owners/operators to develop and recommend remedies or remedy performance standards (if a performance-based model is being used), including proposed media cleanup levels, points of compliance and compliance time frames, that address the proposed threshold criteria and present an advantageous combination of the proposed balancing criteria. During remedy selection, EPA will consider the facility owner/operator's preferred remedial alternative, other remedial alternatives and public comment. Although it is the responsibility of the facility owner/operator to develop and recommend a preferred remedial alternative or remedy performance standard, the Agency can reject any alternative and require further analysis or prescribe a different remedial alternative or remedy performance standard.

5. Remedy Selection

Remedies should be protective of human health and the environment, and maintain protection over time. In meeting this remedial goal, EPA has learned that certain combinations of facility-specific circumstances are often addressed by similar approaches. Based on this experience, the Agency has developed certain expectations for remedies. Remedy expectations are not binding requirements; rather, they reflect collective experience and guide development of remedial alternatives. For example, the fact that remedies for highly mobile contaminants often involve some form of treatment does not preclude a non-treatment option; however, expectations developed from past experience can focus program implementors and facility owners/operators on the more generally acceptable remedial options. In effect, the remedial expectations allow program implementors and facility owners/operators to profit from prior EPA experience and focus resources on the most plausible remedial alternatives. Many of these expectations were first articulated in the discussion of remedy selection at CERCLA sites in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 430(a)(1)). The remedial expectations discussed below express EPA's experiences to date given our current remedial goals and remedy selection strategies; however, the Agency recognizes that issues associated with remedial goals and strategies are currently the subject of considerable public debate, i.e., in Congressional discussions of Superfund reauthorization. Since EPA is committed to consistency of results between the RCRA corrective action and Superfund remedial programs, any revisions to the CERCLA remedial expectations or the CERCLA remedy selection process will likely be incorporated into RCRA corrective action. Currently, EPA has the following remedial expectations:

(a) EPA expects to use treatment to address the principal threats posed by a site whenever practicable and cost-effective.[5] Contamination that represents principal threats for which treatment is most likely to be appropriate includes contamination that is highly toxic, highly mobile, or cannot be reliably contained, and that would present a significant risk to human health and the environment should exposure occur.

(b) EPA expects to use engineering controls, such as containment, for wastes and contaminated media which can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable.

(c) EPA expects to use a combination of methods (e.g., treatment, engineering and institutional controls), as appropriate, to achieve protection of human health and the environment.

(d) EPA expects to use institutional controls such as water and land use restrictions primarily to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous wastes and constituents. EPA does not expect that institutional controls will often be the sole remedial action.

(e) EPA expects to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, less adverse impact, or lower costs for acceptable levels of performance when compared to more conventional technologies.

(f) EPA expects to return usable groundwaters to their maximum beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of groundwater is not practicable, EPA expects to prevent or minimize further migration of the plume, prevent exposure to the contaminated groundwater and evaluate further risk reduction. EPA also expects to control or eliminate surface and subsurface sources of groundwater contamination.

(g) EPA expects to remediate contaminated soils as necessary to prevent or limit direct exposure of human and environmental receptors and prevent the transfer of unacceptable concentrations of contaminants (e.g., via leaching, runoff or air borne emissions) from soils, including subsurface soils, to other media.

In addition to experiences recorded in the remedial expectations, EPA routinely encounters a number of issues associated with remedy selection, as discussed below.

a. Balancing Treatment and Exposure Control. Risk is a function of toxicity and exposure; therefore, risk reduction can be accomplished by reducing toxicity (e.g., through treatment to reduce toxicity, mobility or volume) and/or preventing exposure (e.g., through engineering and institutional controls). Program implementors and facility owners/operators often struggle to find an appropriate balance between these approaches.

While preventing exposure may appear to be the most direct near-term means of reducing risk, permanent reduction of the toxicity, mobility and/or volume of contaminated material might be the most cost-effective means of reducing risk over time. For example, at a facility where the remedy relies, in part, on engineering controls to prevent exposure there could be: associated operation and maintenance costs; the need to maintain the RCRA facility permit for the life of the remedy; increased Agency involvement to monitor the continued effectiveness of the remedy; and, need for institutional controls. When treatment to reduce toxicity, mobility or volume is chosen, EPA does not necessarily expect the remedy to involve treatment alone. For

[5] The term ''cost-effective'' does not necessarily imply least costly.

example, highly toxic contaminated material could be treated so that the concentrations of hazardous constituents, while still above media cleanup levels, would support a reliable containment remedy.

The exact balance between reduction in toxicity, mobility or volume and exposure control will best be established on a case-by-case basis in consideration of site-specific conditions; however, all things being equal, permanent reductions in toxicity, mobility or volume are preferred to exposure control because it is protective of human health and the environment in the long-term and removes the risks associated with the potential failure of engineering or institutional controls. Program implementors and facility owners/operators are cautioned against too great a reliance on exposure control remedies when alternatives which include permanent reduction in toxicity, mobility or volume are available, affordable and practical. Additional information on the balance between toxicity reduction and exposure control is available in ''A Guide to Principal Threat and Low Level Threat Wastes,'' Superfund Publication 9380.3–06FS, November 1991, which is available in the docket for today's Notice.

b. Remedy Selection Criteria. The 1990 proposal, like the Superfund NCP, established a two-phased evaluation for remedy selection. During the first phase, potential remedies are screened to see if they meet ''threshold criteria''; remedies which meet the threshold criteria are then evaluated using various ''balancing criteria'' to identify the remedy that provides the best relative combination of attributes. While the CERCLA remedy selection criteria are not identical to the RCRA corrective action criteria proposed in 1990, they address the same types of considerations and should generally result in similar remedies when applied to similar site-specific conditions.

The 1990 proposal identified four remedy threshold criteria and five balancing criteria. The four threshold criteria proposed in 1990 were that all remedies must: (1) be protective of human health and the environment; (2) attain media cleanup standards; (3) control the source(s) of releases so as to reduce or eliminate, to the extent practicable, further releases of hazardous waste (including hazardous constituents) that might pose threats to human health and the environment; and (4) comply with applicable standards for waste management. EPA believes these threshold criteria remain appropriate as general goals for cleanup and screening tools for potential remedies.

There has been some confusion regarding the proposed threshold criterion that remedies attain media cleanup standards. Attaining media cleanup standards does not necessarily entail removal or treatment of all contaminated material above specific constituent concentrations. Depending on the site-specific circumstances, remedies may attain media cleanup standards through various combinations of removal, treatment, engineering and institutional controls. For example, in situations where waste is left in place in an engineered landfill or under a cap, media cleanup standards would be attained, in part, through long-term engineering and institutional controls.

The 1990 proposal identified five balancing criteria for choosing among remedies that meet the threshold criteria. The five balancing criteria proposed in 1990 were: (1) Long-term reliability and effectiveness; (2) reduction of toxicity, mobility or volume of wastes; (3) short-term effectiveness; (4) implementability; and (5) cost. The balancing criteria were not ranked in terms of relative importance. As discussed in the 1990 proposal, any one of the balancing criteria might prove to be the most important at a particular site. For example, a remedy at a certain site might be protective in the short term but not necessarily reliable in the long term (e.g., capping of a highly contaminated area). In this case, the need for long term reliability and the potential for long-term operation and maintenance costs would tend to point toward a remedy which presented a more advantageous combination of the balancing criteria (e.g., removal or treatment of hot spots, capping residual contamination, and implementing an institutional control).

The proposed balancing criterion of cost has caused some confusion. Cost can and should be considered when choosing among remedies which meet the threshold criteria. As discussed in the 1990 proposal, EPA believes that many potential remedies will meet all the threshold criteria. In that situation, cost becomes an important consideration in choosing the remedy which most appropriately addresses the circumstances at the facility and provides the most efficient use of Agency and facility owner/operator resources. For cost comparisons between alternatives to be accurate, they should include capital and operation and maintenance costs for the anticipated life of the remedy.

Pending resolution of the 1990 proposal, program implementors and facility owners/operators should use the threshold and balancing criteria proposed in 1990 as guidance when selecting facility-specific remedies; however, as discussed in Section V of today's Notice, EPA is also considering and requesting comment on a number of alternatives for corrective action remedy selection, including focusing on remedy performance standards. These alternatives are based, in part, on innovative approaches already used in some states and EPA Regions.

c. Media Cleanup Standards. The term ''media cleanup standards'' typically refers to broad cleanup objectives; it often includes the more specific concepts of ''media cleanup levels,'' ''points of compliance,'' and ''compliance time frames.'' The more specific term, ''media cleanup levels'' typically refers to site- and media-specific concentrations of hazardous constituents, developed as part of the overall cleanup standards for a facility. Media cleanup standards (and levels) should reflect the potential risks of the facility and media in question by considering the toxicity of the constituents of concern, exposure pathways, and fate and transport characteristics.

Consistent with the CERCLA program, in the RCRA corrective action program EPA intends to clean up sites in a manner consistent with available, protective, risk-based media cleanup standards (e.g., MCLs and state cleanup standards) or, when such standards do not exist, to clean up to protective media cleanup standards developed for the site in question (e.g., through a site-specific risk assessment). Both approaches require a site-specific risk-based decision. When available media cleanup standards are used (e.g., MCLs, state cleanup standards), the assumptions used to develop the standardized cleanup values should be consistent with the site-specific conditions at the facility in question.

As discussed in the NCP and the 1990 proposal, EPA's risk reduction goal is to reduce the threat from carcinogenic contaminants such that, for any medium, the excess risk of cancer to an individual exposed over a lifetime generally falls within a range from 10^{-6}, in other words, an exposed individual will have an estimated upperbound excess probability of developing cancer of one in one-million, to 10^{-4}, or an exposed individual will have an estimated upperbound excess probability of developing cancer of one in ten-thousand. For non-carcinogens, the hazard index should generally not

exceed one (1).[6] Available risk-based media cleanup standards are considered protective if they achieve a level of risk which falls within the 10^{-6} to 10^{-4} risk range.

EPA's preference, all things being equal, is to select remedies that are at the more protective end of the risk range. Therefore, program implementors and facility owners/operators should generally use 10^{-6} as a point of departure when developing site-specific media cleanup standards. Use of 10^{-6} as a point of departure does not establish a strict presumption that all final cleanups will necessarily attain that level of risk reduction. Given the diversity of the corrective action universe and the emphasis on consideration of site-specific conditions such as exposure, uncertainty, or technical limitations, the Agency expects that other risk reduction goals may be appropriate at many corrective action facilities. As discussed in the 1990 proposal, EPA endorses ''* * * an approach [to remedy selection] that allows a pragmatic and flexible evaluation of potential remedies at a facility while still protecting human health and the environment. This approach emphasizes the overall goal of 10^{-6} as the point of departure, while allowing site or remedy-specific factors, including reasonable foreseeable future uses, to enter into the evaluation of what is appropriate at a given site.'' (See, 55 *FR* 30826.)

d. Points of Compliance. As proposed in 1990, the point of compliance (POC) is the location or locations at which media cleanup levels are achieved. In the absence of final corrective action regulations specifically addressing points of compliance, program implementors and facility owners/operators develop POCs on a site-specific basis. For air releases, program implementors and facility owners/operators have generally used the location of the person most exposed, or other specified point(s) of exposure closer to the source of the release. For surface water, program implementors and facility owners/operators have routinely established the POC at the point at which releases could enter the surface water body; if sediments are affected by releases to surface water, a sediment POC is also established. Points of compliance for soils are generally selected to ensure protection of human and environmental receptors against direct exposure and to take into account protection of other media from cross-media transfer (e.g., via leaching, runoff or airborne emissions) of contaminants. For groundwater, program implementors and facility owners/operators generally set the POC throughout the area of contaminated groundwater or, when waste is left in place, at and beyond the boundary of the waste management area encompassing the original source(s) of groundwater contamination. This approach to the groundwater POC is generally referred to as the ''throughout the plume/unit boundary POC.'' This approach is consistent with the groundwater POC described in the preamble to the Superfund program's National Oil and Hazardous Waste Contingency Plan (NCP, pages 8713 and 8753, Federal Register March 8, 1990). EPA recommends consideration of the following factors when developing a site-specific groundwater POC: proximity of sources of contamination; technical practicability of groundwater remediation; vulnerability of the groundwater and its possible uses; and, exposure and likelihood of exposure and similar considerations.

In 1990, EPA proposed specific POCs for groundwater, air, surface water, and soil. These proposals, especially the proposed POC for groundwater, generated a substantial number of comments. Developing site-specific points of compliance generally continues to be an area of discussion and debate. In Section V.E.2 of today's Notice, EPA requests additional comment regarding POCs for corrective action.

e. Compliance Time Frame. The compliance time frame is the time period and schedule according to which corrective actions are implemented. In the 1990 proposal, EPA expressed a preference for the expeditious stabilization of releases, followed by timely completion of corrective actions and full restoration of contaminated media; however, a number of factors may influence the time frame within which media cleanup standards are attained, including: the extent and nature of contamination at the facility; risks to human health and the environment before and during remedy implementation; practical capabilities of remedial technologies; the availability of treatment or disposal options; and, the desirability of utilizing emerging technologies.

Remedy implementation schedules developed at the time of remedy selection should, to the extent possible, specify the compliance time frame; however EPA recognizes that uncertainties associated with remediation may make it impossible to specify when a remedy must be completed. For example, due to complexities associated with contaminant occurrence in the subsurface and with groundwater remediation in general, the time needed to remediate groundwater at some sites cannot be accurately predicted. In these circumstances, the Agency recommends the use of performance measures or milestones monitored over time to track progress toward attaining remedial goals. These performance measures should be specified in the remedy implementation plans or performance standards. In cases where it is not practical to determine a precise compliance time frame, estimated compliance time frames may be used to help evaluate remedial alternatives and the technical practicability of site-specific remedial goals.

EPA emphasizes that, at many sites, the primary focus should be on near-term stabilization of releases. At these sites, it may be appropriate to focus the compliance time frame and corrective measures implementation schedule on the stabilization action; the remaining compliance time frame and corrective measures implementation schedule (if any are necessary) could then be developed during selection of the facility-wide remedy.

f. Site-Specific Risk Assessments. EPA's strategy for corrective action implementation incorporates risk-based decision-making throughout the corrective action process. At some sites, risk-based decisions can be made using standardized risk considerations, such as standardized exposure assumptions. At other sites, a site-specific risk assessment will be desirable. When a site-specific risk assessment is needed, EPA, in some cases, has directed the facility owner/operator to perform the risk assessment; in other cases EPA has chosen to do the risk assessment itself based on data submitted by the owner/operator. Site-specific risk assessments conducted at RCRA facilities may be based on CERCLA's extensive guidance in this area (e.g., ''Risk Assessment Guidance for Superfund,'' Volumes I and II, Interim final EPA/540/1–89/001 and 002, December 1989 and March 1989). Additional information on the Agency's approach to risk-based decision-making is available in the Agency's recent memorandum on risk characterization. (See, 3/21/95 memorandum from Carol Browner, ''EPA Risk Characterization Program'' in the docket for today's Notice.) The

[6] The hazard index is a measurement of non-carcinogenic risks. It is calculated by summing two or more hazard quotients for multiple substances and/or multiple exposure pathways. A hazard quotient is the ratio of a single substance exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period.

Administrator stated, ''* * * we must improve the way in which we characterize and communicate environmental (human health and ecologic) risk.'' The key values conveyed in the 1995 Risk Characterization guidance are: (1) ''transparency'' in the decision making process (i.e., full and open discussion of supporting analyses, uncertainties, assumptions, etc.); (2) ''clarity'' in communication within the Agency and the public regarding environmental risk and the uncertainties associated with our assessments; (3) consistency; and (4) reasonableness in our use of scientifically defensible risk assessments. It is EPA's policy to incorporate these values in all risk-based considerations, including site-specific risk assessments at corrective action facilities.

g. Ecological Risk. Corrective action remedies must protect both human health and the environment. Some form or ecological assessment will generally be necessary at all corrective action facilities; at some corrective action facilities, a formal ecological risk assessment will be necessary. When an ecological risk assessment is needed, EPA, in some cases, has directed the facility owner/operator to perform the risk assessment; in other cases EPA has chosen to do the risk assessment itself based on data submitted by the owner/operator. The use of ecological risk assessment is an important component of the corrective action program. Often, environmental receptors are sensitive to contamination at lower concentrations than humans are, and the exposure is usually longer and more intense. In order to fulfill EPA's mandate, the program must be implemented in a manner that is protective of both human health and the environment. This includes the selection of media cleanup standards and the implementation of remedial activities that are protective or ecologic receptors. In the process of selecting stabilization measures or implementing final remedies, program implementors and facility owner/operators should be aware of how different remedial activities may affect ecological systems, especially sensitive populations, either on or adjacent to the facility.

Ecological risk assessment may be even more important when non-residential land use assumptions are used. Action or cleanup levels based on human health exposure scenarios or land use assumptions might not be protective of ecological receptors; therefore, consideration of the ecological exposure pathway may, in certain settings, be the driving factor in selection of action or cleanup levels.

CERCLA's National Contingency Plan (55 FR 8666, March 8, 1990) designates certain key Federal agencies, state agencies and Indian tribes as natural resource trustees. Section 300.600 of the NCP indicates that trustees act on behalf of the public in regards to protection of natural resources. Under CERCLA, trustees should be notified when contamination threatens natural resources. As a matter of policy, EPA recommends that trustees also be notified when RCRA corrective action identifies a release that threatens natural resources. In addition, trustee agencies have a great deal of experience in their respective areas and can be used as a valuable resource when conducting ecological assessments.

h. Determinations of Technical Impracticability. Remediation of contaminated media to a desired media cleanup standard can, in certain situations, be technically impracticable. Congress formally recognized technical impracticability (TI) in the CERCLA statute and EPA incorporated the concept in the National Contingency Plan and the 1990 Subpart S proposal (proposed 40 CFR 264.525(d) and 264.531).

Technical impracticability decisions may be made for any medium; however, contaminated groundwater has received in the most TI-related attention. The single greatest cause for technical impracticability determinations during groundwater restoration has been the presence of dense non-aqueous phase liquids (DNAPLs).[7] The Superfund program estimates that DNAPLs are likely present at approximately 60 percent of NPL sites. While EPA has not conducted an overall assessment of the presence of DNAPLs at RCRA facilities, it believes the percentage of DNAPLs at high priority corrective action facilities is likely comparable to the Superfund estimate for NPL sites. To provide a framework for addressing technical impracticability, the Agency issued ''Guidance for Evaluating the Technical Impracticability for Ground-Water Restoration'' (EPA/540–R–93–080). EPA encourages program implementors and facility owner/operators to refer to this guidance for a more detailed description of technical impracticability and a discussion of related issues, including: a description of DNAPLs and why they are difficult to remediate; factors to consider when making a technical impracticability determination; and, appropriate and practicable remedial options in situations where complete restoration is technically impracticable.

The possibility that certain remedies may be technically impracticable should be considered throughout the remediation process—from the early stages of developing a conceptual site model through all stages remedy implementation. When possible, determinations of technical impracticability should be made early in the remediation process and included in RCRA corrective action remedial decision documents (permits and orders). In some cases, program implementors and facility owner/operators might not have enough information to justify a determination of technical impracticability at the time of the site characterization or, even, when the remedy is selected. At the same time, there may be strong indications that restoration of a particular medium will be difficult and may prove technically impracticable (e.g., complicated groundwater remedies). In such situations, program implementors and facility owner/operators may choose not to establish a fixed media cleanup level, point of compliance or compliance time-frame, since achieving full restoration may prove technically impracticable. Instead, the remedy might proceed using interim goals and performance measures which could be revisited as more information became available. To avoid creating unrealistically high remedial expectations in these situations, the corrective action permit or order should discuss the possibility that full restoration of a particular medium may prove technically impracticable.

By recognizing technical impracticability, EPA is not in any way scaling back the general goal of returning contaminated groundwater to beneficial uses. Where technical impracticability is determined, the Agency would expect to require an alternative remedial strategy that is: (1) technically practicable; (2) consistent with the overall objectives of the remedy; and (3) controls the source(s) of contamination, and human and environmental exposures. A determination of TI does not release a facility owner/operator from corrective action obligations.

i. Natural Attenuation. EPA's three major remedial programs (i.e., Superfund, RCRA Corrective Action Program, and the Underground Storage

[7] Liquid contaminants that do not readily dissolve in water are known as non-aqueous phase liquids (NAPLs). NAPLs are divided into two classes: light NAPLS (LNAPLs), such as gasoline, are less dense than water; dense NAPLs (DNAPLs), such as the common solvent trichloroethylene, are more dense than water. NAPLs in the subsurface can cause long-term groundwater contamination, can be difficult to locate and, in many circumstances, technically impracticable to remove.

Tank Program) recognize that natural attenuation, in certain circumstances, can be an acceptable component of remedial actions for contaminated groundwater. As discussed in the NCP, a natural attenuation remedy uses natural processes such as biodegradation, dispersion, dilution, and/or adsorption to achieve remedial goals. (See, 55 *FR* 8734, March 8, 1990.)

Natural attenuation remedies are not ''no action'' remedies. Natural attenuation should be evaluated, where it might be applicable, along with and in a manner similar to other potential remedial approaches. In some cases, natural attenuation might be only one aspect of an overall approach to achieving remedial goals. As in any other remedial approach, a proposed remedy involving natural attenuation will have to be protective of human health and the environment and satisfy remedy selection criteria. Program implementors and facility owner/operators should provide a complete description of natural attenuation remedies and emphasize that, by approving a natural attenuation remedy, an overseeing agency is not allowing a responsible party to avoid its remedial obligations. Remedies involving natural attenuation should include: a thorough site characterization; source control or removal where appropriate; documentation or evidence of attenuation processes and the ability of these processes to achieve remedial objectives; an appropriate long-term monitoring plan; and, in certain circumstances, a contingency plan for a more active remedial measure (e.g., pumping).

j. Land Use. As discussed in the 1990 proposal, EPA's policy is that current and reasonable expected future land use and corresponding exposure scenarios should be considered in both the selection and timing of remedial actions. In the 1990 proposal, the Agency stated, ''* * * contaminated soil at an industrial site might be cleaned up to be sufficiently protective for industrial use but not residential use, as long as there is reasonable certainty that the site would remain industrial.'' (See, 55 *FR* 30803.) Recently, EPA issued additional guidance on incorporating reasonable future land use assumptions in remedial decision making in the guidance document ''Land Use in the CERCLA Remedy Selection Process'' (OSWER Directive No. 9355.7–04, May 25, 1995; see Section II.F.6.a of today's Notice).

Reasonable future land use assumptions should be assessed when developing remedial goals for any given facility and used to focus all aspects of the corrective action process; however, EPA cautions against automatically restricting assumptions of future land use to extrapolation of the current use or relying only on designated zoning or industrial use codes to establish land use assumptions. A large industrial facility could include office areas, parking areas, a child care area or on-site residences. Highly industrial sites are sometimes located adjacent to residential properties. All of these factors should be considered when making land use assumptions.

EPA recognizes the complexities associated with developing reasonably anticipated land use assumptions and the need for caution when basing remedial decisions on assumptions of future use; however, the Agency believes that non-residential land use assumptions are appropriate for many corrective action facilities. When remedies based on non-residential exposure scenarios involve a combination of treatment and engineering or institutional controls, program implementors and facility owner/operators should use currently available tools to ensure that the remedy continues to achieve its objectives over time and the land use assumptions remain valid. For example, many implementing agencies allow facility owner/operators to use institutional controls to ensure that exposure scenarios at the facility remain consistent with those used at the time of remedy selection.

EPA requests comments on these and other land use issues in Section V.E.1 of today's Notice.

6. Remedy Implementation

Remedy implementation typically involves detailed remedy design, remedy construction, remedy operation and maintenance, and remedy completion. In the CERCLA program, remedy implementation is known as ''remedial design/remedial action, operation and maintenance''; in the corrective action program, it is known as ''corrective measures implementation'' or CMI. As proposed in 1990, corrective measures implementation is generally conducted in accordance with an approved CMI plan. Components of corrective measures implementation might include: conceptual design, operation and maintenance, intermediate design plans and specifications, final design plans and specifications, construction work plan, construction completion report, corrective measure completion report, health and safety plan, public participation plan and progress reports; however, in many cases, only a subset of these documents will be required for individual corrective measures implementations.

EPA has found a number of useful strategies for improving the efficiency of corrective measures implementation, as discussed below.

a. Performance Based Corrective Measures Implementation. Similar to the performance-based approach discussed for evaluation of remedial alternatives in Section III.C.4.b of today's Notice, some states and EPA regions have developed a performance-based approach to corrective measures implementation. When using a performance-based approach to corrective measures implementation, the overseeing agency generally works with the facility owner/operator during remedy selection to develop remedial goals for the facility. Following public review and comment and approval of a remedy and remedial goals, the facility owner/operator is tasked with designing and implementing the chosen remedy in a manner which would meet the remedial goals. For example, if the remedy chosen for a particular facility included some form of groundwater treatment, an accompanying remedial goal might be to achieve hydrologic containment of the groundwater plume and continuous reduction of the concentrations of hazardous constituents. While the overseeing agency would review and approve the remedy and remedial goals and be involved in developing monitoring systems or other means of measuring compliance with the remedial goals, it would not necessarily be involved with the details of remedy design, construction and implementation. Rather, the overseeing agency would monitor compliance with the remedy implementation milestones and remedial goals and become involved in the details of remedy design and implementation only if a facility owner/operator was having trouble meeting the remedial goals. A performance-based approach to remedy implementation emphasizes that the facility owner/operator, not the overseeing agency, is responsible for designing and implementing a successful remedy.

b. Performance Monitoring. Evaluation of the performance of a chosen remedy is necessary to measure progress toward remedial goals and ensure that remedial objectives are achieved. Program implementors and facility owner/operators have recognized that appropriately designed performance monitoring programs can maximize efficiency and cost-effectiveness and ensure protection of potential human or ecologic receptors.

Properly designed performance monitoring programs are especially important for groundwater remediation because the concentration and distribution of contamination in the subsurface often change with time. Likewise, the ability of remediation systems to prevent migration of contaminated groundwater can be influenced by natural and human factors (e.g., seasonal precipitation or nearby agricultural groundwater usage). For groundwater remediation systems, performance monitoring can assess changes in subsurface conditions so that the remedy can be modified to ensure maximum efficiency in terms of both the location and pumping rate at individual extraction wells.

Performance monitoring is also a critical aspect of a remedial alternative that relies on engineering controls (e.g., liners, barrier walls). Poorly designed monitoring programs for engineered remedies can potentially fail to detect releases from the ''contained'' areas.

While EPA recognizes the importance of performance monitoring, it also acknowledges that long-term routines of sample collection and analysis carry significant financial burdens. The Agency encourages program implementors and facility owner/operators to design monitoring programs with effectiveness and efficiency as fundamental considerations. For example, due to subsurface heterogeneities, it may be more effective and efficient to monitor a greater number of discrete locations for a subset of mobile contaminants, than to monitor fewer locations for an exhaustive list of analytical parameters and contaminants.

Properly designed performance monitoring programs are integral to remedy success and should be considered throughout the corrective action process, including in remedy selection and design. Detailed guidance regarding performance monitoring and designing monitoring programs in general is available in ''RCRA Ground-Water Monitoring: Draft Technical Guidance'' (EPA/530/R–93/001) and ''Methods for Monitoring Pump-and-Treat Performance'' (EPA/600/R–94/123).

c. Completion of Corrective Measures. Documents specifying corrective measures implementation should include methods to determine when remedial goals have been achieved. For example, statistical procedures are often appropriate for determining that concentrations of hazardous constituents measured in groundwater samples meet a remedial goal. Other remedies might require that certain tests be undertaken to determine that engineering standards have been achieved. Decisions regarding completion of corrective measures may be made for the entire facility, for a portion of the facility, or for a specified unit or release. The public and affected community should be given an opportunity to review and comment on all proposals to complete corrective measures.

In 1990, EPA proposed that corrective measures be considered complete based on a three-part evaluation: the corrective measure had to have complied with all media cleanup standards; all required source control actions would have to be completed; and all specified procedures for removal and decontamination of units, equipment, devices and structures would have to be complete. In addition to certifying compliance with the three criteria, the Agency proposed that the owner/operator's certification be signed by an independent registered professional ''skilled in the appropriate technical discipline(s).'' The Agency chose not to propose that all certifications be signed by an independent qualified registered professional engineer because it believed that engineering certifications would not be appropriate in all cases (e.g., for a remedy largely addressing groundwater, the Agency believed that certification by a hydrogeologist might be more appropriate). In the absence of final regulations addressing completion of corrective measures, program implementors and facility owner/operators should use the requirements for completion of corrective measures proposed in 1990 as guidance when developing site-specific procedures for completion of corrective measures. At a minimum, the public and affected community should be given notice and an opportunity to comment before corrective action implementation is terminated and a facility is released from its RCRA obligations.

D. Incorporation of Corrective Action in RCRA Permits

RCRA Section 3004(u) mandates that corrective action and schedules of compliance be required for facilities seeking a permit, when corrective action cannot be completed prior to permit issuance. Approximately half the states are authorized to implement state RCRA corrective action programs in lieu of the Federal program. In authorized states, the state issues the RCRA permit including the corrective action component (using any of the options discussed above). In states not authorized for the corrective action program, the state typically issues most of the RCRA permit and EPA issues the corrective action portion. Although any given facility may be issued a portion of its RCRA permit by an authorized state and a portion by EPA, this should not lead to the perception that any given facility has more than one RCRA permit. Program implementors and facility owner/operators should remember that any given facility has only one RCRA permit; when joint permitting is necessary, EPA will coordinate permitting schedules and priorities with authorized states.

Corrective action requirements and schedules can be included in RCRA permits in a number of ways. In some cases, the RCRA permit will contain detailed corrective action provisions, work plan requirements, and schedules. In other cases, the RCRA permit may incorporate corrective action requirements by referencing another document (e.g., a state or Federal corrective action order). Finally, in certain cases, RCRA permits may defer to corrective action activities being conducted under another authority or by another program. In many cases, incorporation of corrective action requirements into any given permit will use a combination of these strategies. For example, at a corrective action facility where the facility owner/operator has chosen to address a subset of the releases voluntarily, a corrective action permit could defer action at the areas being addressed by the voluntary cleanup while incorporating detailed corrective action conditions for the remaining releases or areas of concern.

E. Corrective Action Orders

Although the 1990 proposal focused primarily on corrective action under RCRA permits, EPA and the states frequently use orders to initiate or oversee corrective actions. EPA intends for equivalent environmental results to be achieved whether corrective action requirements are dictated in an order or a permit. As a matter of EPA policy, the substantive corrective action requirements and public participation requirements imposed under either mechanism are generally the same.

RCRA, as amended by HSWA, includes several enforcement authorities which can be used to issue corrective action orders. The most commonly used authority is RCRA section 3008(h). EPA's longstanding interpretation is that corrective action may be required under RCRA section 3008(h) at facilities which have or should have had interim status, as well as some facilities that had interim status at one time but no longer do (e.g., facilities that have lost interim status under RCRA interim status section 3005(e)(2) and facilities which

have clean closed under interim status), or have failed to properly obtain interim status. In addition, the 1990 proposal explained that issuance of a permit does not automatically terminate the effectiveness of a previously issued 3008(h) order.

Other enforcement authorities which can be used to issue corrective action orders include RCRA sections 3013 and 7003. RCRA section 7003 provides EPA the authority to take enforcement actions to compel corrective action where solid or hazardous waste may present an imminent and substantial endangerment to human health or the environment. RCRA section 3013 provides EPA the authority to require investigations and studies where the presence or release of hazardous waste may present a substantial hazard to human health or the environment. All corrective action orders may be issued unilaterally by the Agency or as consent agreements between the respondent and the Agency.

F. Public Participation and Environmental Justice

EPA is committed to providing meaningful public participation in all aspects of the RCRA program, including RCRA corrective action. In 1993, the Agency released a detailed guidance manual on public participation (RCRA Public Involvement Manual, EPA 530–R–93–006). EPA followed this guidance in December 1995 with the RCRA Expanded Public Participation rule (60 *FR* 63417, December 11, 1995). EPA is also committed to the principles of environmental justice and equitable public participation. One of the Agency's central goals in the RCRA program is to provide equal access to information and an equal opportunity to participate. EPA continues to regard public participation as an important activity that empowers all communities, including minority and low-income communities, to become actively involved in local waste management activities. EPA strives to provide adequate public participation opportunities to all communities, putting forth additional effort, where appropriate, to reach communities that have not been involved in the past.

When corrective action is part of the RCRA permitting process, it follows the procedural requirements set forth in 40 CFR Parts 124 and 270. Under these requirements, the corrective action provisions in any permit application are available for public review throughout the permitting process and the public can comment on them at the draft permit stage.

The RCRA Expanded Public Participation rule creates more opportunities for public participation in the RCRA permit process.[8] Additional opportunities of public participation include: (1) A prospective applicant must advertise and hold an informal public meeting before submitting an application for a RCRA permit; (2) the permitting Agency must mail a notice to the facility mailing list when the facility submits its permit application, telling members of the public where they can examine the application during Agency review; and (3) giving the permitting Agency the authority to require a facility owner/operator to set up an information repository at any time during the permitting process or the permit life. EPA anticipates that these provisions, combined with existing public participation requirements, will provide community members with significant opportunities for early input and access to information.

In addition to the new requirements in the RCRA public participation rule, EPA is using guidance to help facility owner/operators meet the Agency's public participation goals. In the preamble to the RCRA Expanded Public Participation rule, EPA encourages agencies and facilities to use all reasonable means to ensure equal opportunities for participation and equal access to information. These means may include, but are not limited to, multilingual notices and fact sheets, as well as translators, in areas where the affected community contains significant numbers of people who do not speak English as a first language. The Agency expects all those involved in implementing corrective action to make good faith efforts to meet these objectives in all permitting processes, including corrective action. In the near future, EPA will issue further guidance to assist facilities and permitting agencies in providing full and equitable public participation in corrective action activities.

EPA's policy is for corrective actions imposed or overseen using a non-permit mechanism to have the same level of public participation as that associated with permits. Although EPA typically has less control over public participation during voluntary corrective actions, it strongly encourages the use of public participation and will take into account the level of public participation conducted by the facility owner/operator when evaluating the acceptability of voluntary actions. In the absence of final regulations specifically addressing public participation during corrective action, program implementors and facility owner/operators should develop public participation strategies on a site-specific basis, consistent with existing public participation requirements and the program goal of full, fair, and equitable public participation. At a minimum, information regarding corrective action activities (e.g., RFI and CMS reports) should be available to the public and the public should be given an opportunity to review and comment on proposed corrective action remedies.

G. Financial Assurance

RCRA section 3004(u) requires that, when corrective action cannot be completed prior to permitting, RCRA permits contain corrective action schedules of compliance and financial assurance. Financial assurance is also typically included in corrective action orders. On October 24, 1986, EPA proposed detailed regulations to govern financial assurance for corrective action (FACA). The October 1986 proposal would require owners or operators seeking an RCRA permit to demonstrate financial assurance for completion of remedies. Proposed acceptable mechanisms included trust funds, surety bonds guaranteeing performance, letters of credit, the financial test, and the corporate guarantee. These are similar to the mechanisms used to assure closure and post-closure costs. In a subsequent memorandum, EPA clarified that insurance would also be an acceptable mechanism. In addition to permissible mechanisms, the October 1986 proposal provided that financial assurance demonstrations would ordinarily be required at the time of remedy selection (e.g., rather than at the time an RFI is required). The proposal also discussed cost-estimating procedures, including the periodic adjustment of cost estimates, for determining the amounts of required financial assurance.

In the absence of final rules, program implementors and facility owner/operators have the flexibility to tailor financial responsibility requirements to facility-specific circumstances. In some instances, however, industry has expressed concern with EPA's implementation of the financial

[8] The RCRA public participation rule is generally effective only in states which have amended their authorized hazardous waste programs to adopt the public participation rule requirements. At a minimum, all authorized states are scheduled to make such amendments by July 1, 1997. The exceptions are the following states and territories where EPA implements the entire RCRA hazardous waste program, including the public participation rule: Alaska, Hawaii, Iowa, Puerto Rico, the Northern Mariana Islands, the Virgin Islands and American Samoa.

assurance requirements. Representatives of the regulated community have also expressed concern that the costs of providing financial assurance divert resources from actual cleanup activities, and that it may be difficult for facility owners/operators to provide assurance for future work while simultaneously performing current work.

In Section V of today's Notice, EPA requests comments on these concerns and on corrective action financial assurance in general. In the interim, EPA emphasizes that program implementors should apply financial assurance requirements flexibly and that their main goal should be to ensure that remedies proceed expeditiously.

IV. Corrective Action Program Priorities

In the absence of detailed regulations, EPA and authorized states have implemented the corrective action program based on guidance and policies developed over the past ten years. EPA stresses that implementation of the corrective action requirements must continue even as the Agency considers improvements to the corrective action program. EPA's key goals and implementation strategies for the corrective action program are outlined below.

1. Prioritize the corrective action universe:

a. Meet the goal of assessing and prioritizing all hazardous waste treatment, storage or disposal facilities by end of FY96.

b. Focus resources on high priority areas at high priority facilities.

2. Increase the amount of corrective action:

a. Continue to authorize states for corrective action.

b. Do not duplicate work already performed by another Federal or state program.

c. Encourage alternate state authorities to conduct analogous work at RCRA facilities.

d. Utilize the expertise of other Federal/state agencies where appropriate (e.g., the U.S. Fish and Wildlife Service for ecological, wetlands issues).

e. Increase the number of voluntary actions, including actions at facilities without a permit or an order, actions outside of an existing permit or order, and actions required under permit or order but with no Agency oversight.

f. Disinvest or substantially reduce oversight at lower priority facilities and high priority facilities where the owner/operator has proven his or her capability.

3. Continue to implement the stabilization initiative:

a. Implement stabilization actions as early in the process as possible.

b. Phase and focus RFIs to collect any information needed to implement stabilization actions.

c. Use existing corrective action program environmental indicators as stabilization performance measures.

d. Include meaningful opportunities for public participation throughout the process including during extensive or long-term stabilization actions.

4. Streamline the corrective action process where possible:

a. Implement stabilization actions where possible, then disinvest and move on to other facilities.

b. Focus RFI data collection and tailor investigations to specific site conditions.

c. Use existing pertinent data.

d. Communicate remediation expectations to facility owners/operators early in the process.

e. Use innovative technical tools, including new site characterization techniques and treatment technologies when appropriate and beneficial.

f. Avoid unnecessary procedural steps whenever feasible (e.g., eliminate the CMS if a desirable remedy can be identified without one).

g. Use presumptive remedies when appropriate.

h. Focus on plausible remedies, if a CMS is necessary.

i. Conduct CMS concurrent with RFI when possible.

j. Utilize site-specific performance standards instead of detailed review of work plans and remedy designs when possible.

k. Consider non-residential land use scenarios when appropriate, while recognizing that ecological risks may end up driving media cleanup standards and remedy designs when using industrial land use assumptions.

5. Continue to involve the public in all stages of the corrective action process.

V. Request for Comment and Data

EPA has the benefit of more than ten years experience in corrective action implementation as it begins the Subpart S Initiative. The Agency is committed to using this experience to identify, develop, and implement improvements to the speed, efficiency, protectiveness and responsiveness of the corrective action program as part of the Subpart S Initiative. Today, EPA requests information, comments and data to assist in this process. Some of the topics discussed in this section raise new concepts that would likely warrant re-proposing regulations or developing new guidance documents; others were addressed in the 1990 proposal but are included in this section of today's Notice because the Agency is requesting additional comment and data at this time. EPA requests that commenters be as specific as possible in their responses to today's requests. The Agency is particularly interested in comments which rely on actual experience in corrective action implementation and include specific suggestions for improvement to the corrective action program. The Agency also requests that commenters keep in mind the objectives of the Subpart S Initiative: create a consistent, holistic approach to cleanups at RCRA facilities; establish protective, practical cleanup expectations; shift more of the responsibilities for achieving cleanup goals to the regulated community; focus on opportunities to streamline and reduce costs; and, enhance opportunities for timely, meaningful public participation.

EPA emphasizes that its purpose in requesting comments at this time is to take advantage of information and experience gained through program implementation to aid in identification and development of new proposals and to determine which portions of the 1990 proposal should be promulgated immediately. EPA will consider all comments submitted in response to today's Notice in development of the Subpart S Initiative. Comments submitted during the 1990 comment period will be considered before the Agency takes final action on any part of the 1990 proposal. If EPA later proposes new corrective action regulations, full public notice and opportunity for comment will be provided at that time.

A. General

EPA requests general comment on its implementation of the corrective action program to date and on the strategy, goals and schedule of the Subpart S Initiative as discussed in Sections II and IV of today's Notice. The Agency is especially interested in comments which include suggestions for specific improvements to the corrective action program based on actual implementation experiences. The Agency is also interested in examples of situations where the existing flexibility in the corrective action program has been used to expedite facility cleanups and in examples of the corrective action program providing too much or too little flexibility. Since the Subpart S initiative includes policy, guidance and rule development, commenters should include specific recommendations for

additional policy or guidance development and address the balance between guidance/policy documents and regulations (e.g., in 1990 EPA proposed detailed regulations to address most aspects of the corrective action program perhaps some of that information could be presented more effectively in policy or guidance documents).

B. Resolution of the 1990 Proposal

EPA believes there may be elements of the 1990 proposal which have been largely non-controversial or for which the issues have been fully aired; accordingly, going through additional notice and comment on all the issues raised by the 1990 proposal would not be necessary or, from an efficiency standpoint, desirable. On the other hand, many issues raised by the 1990 proposal have evolved during the past six years of corrective action implementation, necessitating additional opportunities for public notice and comment. In the discussions to follow, EPA identifies the issues on which it believes further public input is most needed. EPA also requests that commenters identify any other issues, or elements of the 1990 proposal, on which they believe it would be inappropriate for the Agency to take final action without re-proposal. At the same time, EPA requests that commenters identify specific elements of the 1990 proposal which could be promulgated without additional public review and the advantages or disadvantages of immediately promulgating such provisions. Comments submitted in response to this request will be considered part of the administrative record for the 1990 proposal; however, commenters should keep in mind that EPA's intent is not to request new comment on the specifics of the 1990 proposal. Comments submitted during the 1990 comment period will be considered before the Agency takes final action on any part of the 1990 proposal.

C. Focusing the Corrective Action Program on Results

As discussed earlier in today's Notice, the goal of the corrective action program is to appropriately stabilize and clean up RCRA facilities in a timely way. EPA believes that too often program implementors and facility owners/operators may lose sight of this goal and become distracted by processes. On the other hand, the purpose of a standardized cleanup process is to ensure that the program is implemented consistently and that all facilities appropriately meet cleanup goals. The Agency is interested in improving the corrective action program's focus on cleanup goals and requests general comment on the balance between focusing on results and ensuring an appropriate level cleanup at all facilities. In addition, EPA is specifically interested in comments which address:

1. Performance Standards

EPA believes that focusing the corrective action program on compliance with clear measurable performance standards rather than a prescriptive corrective action process could significantly increase the pace and quality of corrective action cleanups. Corrective action performance standards could be part of a larger Agency effort to develop results-based measures. The Government Performance and Results Act of 1993 (GPRA) requires EPA to develop and implement results-based measures across its programs by 1998. For example, the corrective action environmental indicators (discussed below), were developed, in part, in response to the GPRA. The Agency will consider any performance-based approaches developed as part of the Subpart S Initiative as it develops its implementation plan for the GPRA.

Reliance on performance standards, however, can raise a number of implementation issues. For example, some stakeholders have suggested that using performance standards in lieu of detailed review and approval of work plans may increase the risk that individual facility owners/operators will attempt to obscure or avoid legitimate corrective action obligations. Stakeholders have also expressed concern about potential reductions in public participation when corrective action activities occur with reduced Agency oversight. In addition, some elements of corrective action may be difficult to specify as performance standards, and measuring, documenting compliance with, and enforcing performance standards can be difficult for facility owners/operators and overseeing agencies. EPA requests general comment of the use of performance standards in the corrective action program. The Agency is particularly interested in comments which address the details of documenting and measuring compliance with performance standards and in approaches to ensure adequate public involvement in performance-based corrective action activities. In addition, as discussed in Section II.E.2 of today's Notice, the corrective action program currently has two environmental indicators covering human exposures controlled and groundwater releases controlled. The Agency requests comments on the development of additional environmental indicators; the Agency is specifically interested in indicators targeted at ecological risks.

2. Less Focus on Solid Waste Management Units

Use of the solid waste management unit (SWMU) concept as discussed in the 1990 proposal has led to numerous unsuccessful permit appeals. These permit appeals slow corrective action implementation and increase the transaction costs. In certain cases, the SWMU concept may also deter program implementors and facility owners/operators from addressing contamination on a site-wide basis by focusing corrective action resources unit-by-unit instead of more holistically.

In general, EPA believes that a holistic approach to corrective action, as opposed to a unit-by-unit approach, could increase cleanup efficiency and reduce transaction costs. EPA requests general comment on focusing the corrective action program less on individual solid waste management units and more on holistic approaches. The Agency requests that commenters who support a less unit oriented corrective action program also address whether there is any need for clarifications to the corrective action jurisdiction language and/or the SWMU definition in order to use such an approach.

D. Using Non-RCRA Authorities for Corrective Action

EPA recognizes that there are many authorities which could be used to impose or oversee corrective action at any given facility. Typically, these authorities include RCRA orders and permits, state cleanup orders, and voluntary and independent actions. In some cases, CERCLA authorities are also available. The Agency is concerned that, to date, it has not taken full advantage of the work of other programs in the RCRA corrective action program. In principle, EPA believes that when a facility is being adequately addressed it should not matter what authority is used or what Agency is overseeing the cleanups. In support of this principle, the Agency requests general comment on the use of non-RCRA authorities to satisfy corrective action requirements. Commenters should address the scope and stringency of non-RCRA authorities as compared to corrective action requirements and the ability of non-RCRA authorities to adequately involve the public and affected communities.

The Agency is also specifically interested in comments which address:

1. State Cleanup Programs

Over half the states have independent Superfund-like authorities and cleanup programs; typically, these authorities and cleanup programs are modeled after the Federal Superfund program. In many cases, EPA believes these independent state authorities are substantively equivalent in scope and effect to the RCRA corrective action program.

The use of state cleanup programs can offer a number of advantages to state and regional personnel as well as to the regulated, environmental and public interest communities. EPA believes these advantages include: providing states the ability to recover the costs of their program oversight; expanded opportunities for public participation; the ability to recover damages associated with contamination caused by previous owners or operators who would likely not be considered liable under RCRA sections 3004(u) and 3004(v); and, opportunities for voluntary or independent cleanups.

Many states are already using their independent Superfund-like authorities to address releases of hazardous waste and hazardous constituents at facilities subject to corrective action, especially at facilities operating under interim status. The Agency is interested in exploring the relationship between independent state Superfund-like authorities and the corrective action program and, if appropriate, providing some level of assurance that facility owners/operators who complete cleanups under independent state authorities have satisfied RCRA corrective action obligations.

EPA requests general comment on the use of state Superfund-like cleanup programs to compel or conduct cleanups at facilities subject to RCRA corrective action. EPA is especially interested in comments which address:

(a) Scope. Whether the scope and effect of state Superfund-like cleanup programs are substantively equivalent to the scope and effect of the RCRA corrective action program.

(b) Advantages/Disadvantages. Advantages and disadvantages which might be associated with using a state Superfund-like cleanup authority, rather than, or in addition to, an RCRA corrective action authority, at an operating hazardous waste management facility.

(c) Compliance with Federal Standards. The degree to which compliance with state Superfund-like authorities should be assumed to meet corrective action requirements, including procedural requirements such as public participation and permitting.

(d) Coordination with RCRA Permits. Issues which might be associated with coordination of state Superfund-like cleanup orders with RCRA permits and Federal RCRA corrective action orders.

2. Enhanced Flexibility for States With EPA-Endorsed CSGWPPs

Current EPA policy is to provide states greater flexibility for the management and protection of their groundwater resources. This policy was stated formally in a report titled, ''Protecting the Nation's Ground Water: EPA's Ground Water Strategy for the 1990s'' (Publication 21Z–1020, July 1991). The 1991 report indicated that, to the extent authorized by EPA statute and consistent with Agency program implementation objectives, EPA will defer to state policies, priorities, and standards once a state has developed an adequate groundwater protection program. EPA provided a definition of an adequate state groundwater protection program in a December 1992 guidance titled, ''Final Comprehensive State Ground Water Protection Program Guidance'' (EPA 100–R–93–001). The focal point of the 1992 guidance was the creation of Comprehensive State Ground Water Protection Programs (CSGWPPs). As discussed in the 1992 guidance, CSGWPPs are intended to provide a more efficient, coherent, and comprehensive approach to protecting the nation's groundwater resources.

Developing a CSGWPP is a three-stage process. First, a state develops a ''core CSGWPP'' and submits it to EPA for review and endorsement. The core CSGWPP is only required to include one groundwater protection or remediation program to demonstrate whether the state's CSGWPP approach inconsistent with EPA guidance. Second, after the core CSGWPP is endorsed by EPA, joint state-EPA discussions are held to develop a ''multi-year planning agreement.'' The multi-year planning agreement will establish methods and a schedule for incorporating other state groundwater programs into the CSGWPP. Third, at the completion of the multi-year planning process, all groundwater protection and remediation programs conducted in the state, including Federal remediation programs, are included in a ''fully integrating CSGWPP.''

At the time of today's Notice, EPA has endorsed five state core CSGWPPs; endorsement of thirteen more is anticipated by June 1996. EPA is committed to taking actions within its own programs to provide states with endorsed CSGWPPs greater flexibility in protecting their groundwater resources. The Agency has recently affirmed this commitment in, ''EPA's Commitments to Support Comprehensive State Ground Water Protection Programs'' EPA, 100/R–94/002, date. In the RCRA corrective action program, EPA committed to considering state groundwater classification when making groundwater use assumptions, selecting groundwater cleanup levels, and setting cleanup priorities.

EPA is interested in evaluating additional opportunities to provide states with endorsed CSGWPPs enhanced flexibility in implementation of the RCRA corrective action program. EPA requests comments and suggestions on specific areas of flexibility that should be available in states with endorsed CSGWPPs. The Agency is also interested in suggestions and comments addressing areas where a distinction in the amount of flexibility afforded to states with an EPA-endorsed CSGWPPs would not be appropriate. For example, should states with EPA-endorsed CSGWPPs be provided greater flexibility than states without endorsed CSGWPPs in specifying groundwater cleanup levels, points of compliance or compliance time-frames based on state determination of current and future groundwater uses as recorded in an EPA-endorsed CSGWPP? Similarly, should states with EPA-endorsed CSGWPPs be given additional flexibility to prioritize oversight resources or facility-specific corrective action schedules?

3. Voluntary Corrective Action

EPA requests comments on the use of state voluntary cleanup programs to accelerate cleanups at facilities subject to RCRA corrective action and the roles of EPA and states in such situations. EPA is specifically interested in comments which address:

(a) Use of state voluntary cleanup programs at RCRA corrective action facilities. Over half the states have developed voluntary cleanup programs; these state voluntary cleanup programs vary significantly in program design, the degree to which the state offers guidance and oversight during the cleanup process and the review, if any, of the final cleanup. EPA is interested in comments which address the use of state voluntary cleanup programs to accelerate corrective action at RCRA facilities including the level of Federal review or endorsement, if any, necessary for such programs. Commenters who support Federal review or endorsement should address program criteria (e.g., protectiveness,

public participation) that EPA should use to evaluate state voluntary cleanup programs used to satisfy corrective action obligations.

(b) Incentives for private parties to accelerate corrective actions. EPA recognizes that many facility owners/operators who might be inclined to accelerate corrective action voluntarily at their facilities may choose not to because of concerns that the Agency might ''second-guess'' the cleanup conducted and impose additional requirements. EPA requests comments on incentives which can be offered to encourage facility owners/operators to voluntarily accelerate corrective action at their facilities including approaches which could be used to provide comfort or assurance to facility owners/operators who complete corrective action under a state voluntary program. In addition, the Agency requests comments on the degree to which accelerated corrective action should be based on compliance with general performance standards or, alternatively, more detailed guidance documents or regulations. Commenters who support the use of guidance should specify whether guidance should be developed at the state or Federal level, and list the existing documents that they believe would be applicable.

(c) Specific site eligibility for accelerated corrective action. In some state voluntary cleanup programs, site eligibility for voluntary cleanup is limited to sites which are considered low risk (e.g., sites where the contamination is not highly concentrated or highly toxic). EPA requests comments on site eligibility for accelerated corrective action and whether eligibility should in any way be limited based on the degree of health or environmental threat present at any given facility. The Agency is specifically interested in comments which address whether, or to what extent, facilities already under real-time Agency oversight should be allowed to switch to an accelerated action pursuant to a state voluntary cleanup program.

(d) Public participation. EPA believes that meaningful opportunities for public participation are essential to a successful corrective action program; it requests comments on the specific opportunities and procedures for public participation which should be included in any voluntary corrective action program.

(e) Review of accelerated actions. EPA anticipates that some level of review by the implementing state agency will be necessary to ensure that accelerated corrective actions are of sufficient quality to fulfill corrective action requirements. The Agency requests comments on the level of review by the implementing state agency, if any, necessary to ensure the quality of accelerated corrective actions. Commenters who believe some level of review is necessary should address the timing and substance of the review (e.g., audits of facility actions and records, review of milestone documents), and the role, if any, of EPA in the review process.

(f) Third-party oversight. Several states have established cleanup programs which rely on a licensed third-party overseer, rather than implementing agency staff, to ensure compliance with cleanup requirements at certain facilities. One state requires an independent third-party overseer to monitor compliance with all phases of the cleanup process at facilities and certify to the implementing agency when cleanup at a facility is complete. EPA believes such approaches may reduce the risks associated with voluntarily accelerated cleanups and provide necessary relief to state regulators. While development of a third-party oversight system is not currently under consideration at the Federal level, EPA requests comments on the use of state third-party oversight programs for oversight of cleanups at facilities subject to RCRA corrective action.

4. Corrective Action at Interim Status Facilities

In 1990, EPA proposed that corrective action regulations be included in 40 CFR Part 264 (the permitting standards). The only changes proposed to 40 CFR Part 265 (the interim status standards) were to address the need to coordinate corrective action and closure activities at closing interim status units and facilities. EPA's longstanding view has been that the requirements to address facility-wide corrective action at interim status facilities are consistent with those for permitted facilities. For this reason, the Agency requests comments on whether the corrective action regulations should be developed under 40 CFR Part 265 as well as under Part 264. The Agency is especially interested in comments which address the trigger for initiation of corrective action activities at interim status facilities, the degree to which any corrective action requirements included in 40 CFR Part 265 would be independent or self-implementing (see, discussion of independent or self-implementing corrective action, below), and the incorporation of corrective action activities conducted while facilities are under interim status into final facility permits. In addition, EPA requests comments on further modifying the interim status requirements to include provisions for the cleanup of releases to groundwater from regulated units equivalent to those at 40 CFR 264.100.

5. Independent or Self-Implementing Corrective Action

EPA believes that the 1990 corrective action proposal appropriately emphasized the need for flexibility and site-specific decisions; however, the administrative framework proposed in 1990 relies on intensive oversight by a regulatory agency. In general, corrective action facility owners/operators initiate a cleanup only after being compelled to do so by a regulatory agency (e.g., in an order or permit). The regulatory agency then reviews and approves intermediate steps, such as work plans and reports, ultimately selects the remedy, and ensures that the remedy is implemented and achieves cleanup objectives. This command and control approach reduces risks associated with all phases of cleanup at a facility; however, it is resource intensive and may discourage facility owners/operators from undertaking voluntary or accelerated cleanup actions.

Due to limited oversight resources, many of the lower risk facilities which are believed to require some form of corrective action have remained unaddressed. This issue has raised concerns about the pace and quantity of corrective action cleanups. In order to address these concerns and shift more of the responsibility for conducting corrective action activities to the regulated community, EPA is examining approaches to independent or self-implementing corrective action. By ''independent'' or ''self-implementing'' the Agency is referring to activities required by regulation to meet certain standards of performance within specified time periods without direct, real-time, oversight by a regulatory agency. For example, the RCRA regulations for hazardous waste characterization require generators of solid waste to determine if such wastes are considered hazardous wastes and, if hazardous, to manage them appropriately. Generators notify overseeing agencies of their waste determinations and management (through the biannual reporting and manifesting systems) and overseeing agencies periodically audit or inspect generator compliance. Similarly, EPA believes some corrective action activities could be sufficiently prescribed by regulation and carried out independently by facility owners/operators subject to auditing by an overseeing agency, rather than being

specified in facility specific order or permit conditions. For example, facility owners/operators could be required, upon identification of a release of hazardous waste or hazardous constituents at or from the facility, to conduct an initial screening investigation and take appropriate steps to control the release. In another example, facility owners/operators could be required to take whatever steps are necessary to certify compliance with EPA's two environmental indicators for corrective action. (As discussed in Section II.E.2 of today's Notice, the two environmental indicators for corrective action are human exposures controlled and groundwater releases controlled.)

EPA believes that applying the concept of self-implementation to a cleanup scenario raises many issues. For example, the complexity and site-specific nature of corrective action, coupled with the fact that it requires the exercise of professional judgement (e.g., hydrogeologic, engineering) throughout the process, may make self-implementation problematic. These same factors may make compliance monitoring and enforcement difficult. The Agency's experience with the self-implementing groundwater monitoring requirements in the interim status standards (i.e., Part 265, Subpart F) is indicative of the difficulties that may be associated with ensuring full compliance with self-implementing standards. The Agency is interested in general comment on the concept of independent or self-implementing corrective action; it is specifically interested in comments which address:

(a) Scope. EPA requests that commenters specifically identify the elements of the corrective action process which they believe are amenable to self-implementation.

(b) Public participation. Meaningful public participation is essential to the corrective action process. EPA requests that commenters address incorporation of public participation opportunities and activities in self-implemented corrective action.

(c) Detailed guidance. An argument can be made that, without detailed guidance for self-implemented activities, quality will vary across actions. EPA requests that commenters address the degree to which self-implementation should rely on detailed guidance and whether the Agency should issue new guidance for self-implemented corrective action or if EPA can rely on guidance already available at the state and Federal level. Commenters suggesting that EPA rely on existing guidance should indicate the guidance documents they believe would be applicable. The Agency is also interested in comments which address approaches to ensure that facility owners/operators have access to and use current and appropriate guidance documents.

(d) Record keeping and reporting. Facility owners/operators might be required to submit information certifying and documenting their compliance with self-implementing requirements. Information and documentation which EPA could use to assess the quality of self-implemented actions might also be necessary. EPA requests that commenters address whether or not Record keeping and reporting requirements should be part of self-implementing corrective action. Commenters who support Record keeping and reporting requirements should address the specific requirements they believe are necessary.

(e) Compliance Monitoring and Enforcement. Compliance with self-implementing requirements might be monitored through regular inspections or periodic auditing. EPA requests comments on the ability of state or Federal overseeing agencies to adequately monitor and enforce self-implementing requirements. EPA requests that commenters specifically address its ability to accurately assess the quality of self-implemented corrective actions without ongoing Agency oversight.

(f) Risks. Any reduction in real-time agency oversight increases the risks that individual facility owners/operators might attempt to avoid or obscure legitimate corrective action obligations. EPA requests comments on the potential risks associated with self-implementation of certain corrective action provisions and suggestions of actions that the Agency could take to eliminate or mitigate such risks.

6. Consistency with the CERCLA Program

As discussed in Section III.B.1 of today's Notice many facilities subject to corrective action are also subject to cleanup under the Federal CERCLA program. At some of these facilities, RCRA corrective actions are proceeding concurrently with CERCLA cleanups (e.g., the RCRA corrective action is addressing SWMUs while the CERCLA cleanup is focusing on other releases). At other facilities, cleanup is being addressed by one authority but final action under the other authority is being deferred (e.g., a site undergoing RCRA corrective action but still on the NPL). In general, EPA believes coordination of cleanup activities at facilities with overlapping RCRA and CERCLA liability is appropriate; however, the Agency continues to hear concerns over duplication of procedural and substantive cleanup requirements, including oversight. Recently, EPA established a multi-agency and state workgroup to examine issues associated with overlapping cleanup obligations. Through the ''Lead Regulator Workgroup'' the Agency hopes to identify specific strategies for expediting cleanups though reducing or eliminating the transaction costs that may be associated with overlapping cleanup obligations. The Agency requests comments on the issue of coordination of overlapping RCRA and CERCLA cleanup requirements and suggestions for improvement to the Agency's current policy and regulatory approaches to coordination. For example, would using of the same terms for remedial activities, such as investigations or remedy selection, improve coordination at sites with overlapping RCRA corrective action and CERCLA cleanup obligations? Similarly, should the remedy selection criteria between the two programs be explicitly conformed?

While EPA's focus is on coordination between the RCRA and CERCLA programs, it also requests comments on coordination of overlapping state and Federal cleanup obligations.

7. ASTM RBCA Standard

EPA expects the number of identified releases from underground storage tanks (USTs) to increase to more than 400,000 as the 1998 deadline for upgrading, replacing, or closing UST systems approaches. To meet the challenge of addressing these releases in a timely manner, EPA is working with states to streamline their administrative processes and to encourage the use of expedited site assessment and alternative cleanup technologies. The Agency is also encouraging state and local agencies to incorporate risk-based decision-making into their corrective action programs.

Risk based decision-making is a process UST implementing agencies can use to: focus site assessment data gathering; conduct initial response actions; categorize or classify sites; determine what, if any, further action is necessary to remediate a site; help establish cleanup goals; and decide on the level of oversight provided to cleanups conducted by UST owners and operators. To provide support for the use of risk-based decision-making, EPA's Office of Underground Storage Tanks, within the Office of Solid Waste and Emergency Response (OSWER), issued Directive 9610.17: Use of Risk-

Based Decision-Making in UST Corrective Action Programs. The American Society for Testing and Materials (ASTM) has also developed guidance addressing risk-based decision-making in its recently issued standard ASTM E1739–95, Risk Based Corrective Action Applied at Petroleum Release Sites (referred to as RBCA). The ASTM standard is one example of how risk-based decision-making can be incorporated into state UST corrective action programs. EPA believes the ASTM standard may be a good starting point for the development of a risk-based process tailored to applicable state and local laws and regulatory practices. In addition, state UST RBCA processes may often be applicable to petroleum releases from sources other than leaking USTs.

EPA requests general comment on the use of the ASTM RBCA approach in the corrective action program; it is especially interested in comments which address: the appropriateness of using RBCA-like programs to address releases from sources other than leaking underground storage tanks (e.g., petroleum spills and contamination at refineries); whether the ASTM RBCA approach is acceptable for releases of chemicals other than petroleum products; and, whether there have been, or could be, conflicts between the result of a cleanup conducted using the ASTM RBCA approach and cleanups conducted using the RCRA corrective action or CERCLA approaches.

8. Definition of Facility for Corrective Action

As discussed in Section III.B.3.a of today's Notice, EPA's definition of facility for purposes of corrective action has been problematic in some situations. In certain circumstances, the concept of contiguity can bring large tracts of land not involved with hazardous waste management under corrective action authorities. In many cases, these large tracts of land are being (or could be) addressed using another cleanup authority (e.g., CERCLA or state cleanup programs); in other cases, they may not be a high priority for cleanup. For example, EPA indicated in the 1990 proposal that, if five acres of a one hundred-acre parcel of land were leased to a company that engaged in hazardous waste management, the facility for purposes of corrective action could be the entire 100-acre parcel. EPA also stated that if (in the same example) the lessee/operator also owned 20 acres of land adjacent to the 100-acre parcel (but not necessarily adjacent to the five acres used for hazardous waste management), the facility might include that 20 acres as well. (See, 55 *FR* 30808, July 27, 1990.) In practice, EPA has found that imposing this interpretation of contiguity on situations such industrial parks, port districts, and large areas of Federally owned land (e.g., national forests) can, in some cases, force the Agency to address sites which are not engaged in hazardous waste management and which may not be a high priority for cleanup using limited corrective action resources. Another concern has been that it may be seen as inequitable to require the operator of a small facility to be responsible for the cleanup of a much larger parcel that he or she does not own. Accordingly, EPA is requesting comment on whether corrective action requirements should apply more narrowly (e.g., only to the portion of the facility under the control of the operator engaged in hazardous waste management). EPA requests that commenters endorsing a narrow definition of facility address the concern that it would encourage facility owners/operators to narrowly define their facilities in an effort to avoid legitimate corrective action obligations and also address other potential consequences and concerns, if any, of a facility definition which is too narrow.

E. Balance Between Site-specific Flexibility and National Consistency

To account for the variety of circumstances at corrective action facilities, EPA has emphasized a flexible, facility-specific approach to cleanup; however, using a facility-specific approach can raise issues associated with national consistency and minimum national standards. The Agency requests general comment on the appropriate balance between national consistency and site-specific decision-making in the corrective action program. The Agency is specifically interested in comments which address:

1. Land Use

EPA has been criticized for too often assuming that the future uses of facilities undergoing cleanups will be residential. Residential use is considered unrestricted land use and carries the greatest potential for exposures and the most conservative exposure assessments. As discussed in Section III.C.5.j of today's Notice, the Agency believes that the 1990 proposal adequately provides for reasonable consideration of future land use during development of remedial goals at corrective action facilities; however, it recognizes that the uncertainties surrounding land use assumptions may cause many program implementors and facility owners/operators to choose a conservative approach to future land use issues. Today the Agency invites comment on the general issues associated with consideration of future land use in the corrective action context. EPA is specifically interested in comments which address:

(a) Effect. EPA is interested in comments on the effect of a non-residential land use determination on a facility owner/operator's corrective action obligations and the need (if any) for additional regulations to address incorporation of land use determination in the corrective action process. For example, how, if at all, should non-residential land use determinations affect the scope of facility investigations? Should land use determinations be explicitly required as part of remedy selection?

(b) Institutional controls. When final remedies rely on non-residential exposure assumptions, steps must be taken to ensure the non-residential exposure assumptions remain valid and to trigger additional cleanups should exposures change. EPA is interested in comments which address the role of the government, if any, in ensuring the continued application of exposure assumptions and in imposing additional cleanups as necessary. In addition to the role of government, commenters should list other factors, incentives or institutions they believe will play a role in this process. The Agency is particularly interested in comment on the adequacy of institutional controls (e.g., deed notices, easements, or local land use controls) to ensure that changes in land use trigger additional cleanups as appropriate, the advantages or disadvantages associated with such controls as opposed to direct governmental oversight.

(c) Additional cleanup necessitated by changing land use. EPA requests that commenters specifically address completion of any additional increment of cleanup necessitated by changing land use. The Agency is also interested in comments which address the continuing obligation, if any, of the facility owner/operator to ensure that (should land use change) additional cleanups will be effected, the obligation (if any) on the person who changes the land use at the facility, the legal mechanisms that might be used to impose these obligations, the role of the Agency and/or facility owner/operator in monitoring land use changes and the necessity, if any, for the facility owner/operator or others to provide financial assurance in case an additional cleanup should become necessary.

(d) Periodic review of remedies. The Superfund program periodically reviews

remedies to ensure their continued effectiveness. EPA requests commenters address the need for and potential benefits or problems associated with periodic review of RCRA corrective action remedies. Commenters who believe periodic review of remedies is desirable should address the frequency and content of such reviews.

2. Points of Compliance

The location at which media cleanup levels must be attained (point of compliance or POC) has significant implications for the scope, magnitude and cost of corrective actions. Comments regarding the POC for corrective actions were received in response to the 1990 proposal; this issue has remained controversial and EPA believes it is appropriate to provide another opportunity for public review and comment at this time. The Agency requests general comment on its implementation of the point of compliance concept in the corrective action program and other POC issues. EPA is especially interested in comments which address:

(a) Alternatives to the throughout-the-plume/unit boundary POC. EPA requests suggestions on alternative POCs, especially groundwater POCs. Commenters should address the factors, scenarios, and decision-making criteria that should be considered in justifying alternatives to a throughout-the-plume/unit boundary POC (e.g., a facility boundary POC). In supplying input on alternative POCs for groundwater, commenters should consider the Agency's expectations for groundwater cleanups, (1) returning groundwater to its maximum beneficial uses wherever practicable; (2) preventing or minimizing further migration, preventing exposure to the contaminated groundwater and evaluating further risk-reduction; and, (3) controlling or eliminating surface and subsurface sources of groundwater contamination. Commenters who believe that changes to EPA's expectations for groundwater are necessary to support appropriate POCs are also invited to comment on EPA's groundwater expectations in general.

(b) Points of compliance for stabilization. EPA requests comments on whether it should develop a stabilization point of compliance or to support the Stabilization Initiative. As discussed in Section II.E.1 of today's Notice, the Stabilization Initiative is EPA's primary corrective action implementation strategy. Stabilization actions for groundwater often involve source control and hydraulic containment. A stabilization point of compliance could be used to help define the location at which a performance measure of groundwater plume containment would be measured.

(c) Point of compliance for surface water. Typically, the point of compliance for releases to surface water is at the point where the release enters the surface water. EPA requests comments regarding factors that should be considered in selecting the appropriate standards that must be achieved at the point where the release enters surface water. For example, is it appropriate to consider the mixing that occurs within the receiving surface water when establishing points of compliance for surface water discharges? Mixing zones are often considered when evaluating the acceptability of waste water discharges regulated by the National Pollution Discharge Elimination System (NPDES).

EPA also requests comments on the differences between evaluating the actual and potential impact from point source ''pipeline'' NPDES discharge and a more widespread discharge of groundwater entering as base-flow into the surface water body. Of particular interest associated with groundwater discharge to surface water is the potential for, and impacts from accumulation of contaminants in sediments. Also, the Agency is interested in feedback regarding the degree to which monitoring would be capable of assessing impacts of both the short- and long-term discharge of groundwater to surface and the associated standard of protection being afforded. The Agency is interested in examples where a discharge to surface water of certain loadings of contaminated groundwater was determined to be harmful or not harmful to human or ecologic receptors.

3. Standardized Lists of Action Levels and Media Cleanup Levels

The attempt to balance flexibility with the need for national consistency can be particularly contentious in the area of media-specific action and cleanup levels. Some stakeholders argue that lists of clearly defined action and cleanup levels will reduce transaction costs, increase the pace of cleanups and encourage voluntary actions; many program implementors and facility owners/operators currently use lists of standardized action or cleanup levels when implementing corrective action requirements (e.g., some states have lists of standardized media-specific cleanup levels). Other stakeholders argue that standardized lists of action or cleanup levels are too often developed based on conservative residential exposure scenarios, can be too easily misapplied, and often result in overly stringent cleanup actions. As an alternative to lists of standardized action and cleanup levels, some Agencies have developed standardized approaches (i.e., formulas) that allow for consideration of site-specific conditions. EPA has recently taken this approach in developing the Superfund Soil Screening Guidance (see, Section II.F.6.b of today's Notice).

EPA invites general comments and suggestions pertaining to the development, distribution and use of media-specific action and cleanup levels. The Agency is specifically interested in comments which address the advantages, disadvantages and preferences regarding standardized approaches verses publishing lists of standardized levels (note, lists of standardized levels would be developed using standardized approaches, the difference is in consideration of site-specific factors, such as depth to groundwater). Since many states have already developed standardized approaches or lists of action and cleanup levels, EPA requests commenters also address the role of EPA in developing, distributing, and periodically updating national approaches or lists and the relationship of any standardized approaches or lists developed at the national level to existing state programs.

4. Area Wide Contamination Issues

In some cases corrective action facilities are located in areas of widely dispersed contamination. For example, some corrective action facilities may be located in tidal areas which were reclaimed by placement of fill materials now considered contaminated. In other cases, an RCRA corrective action facility may be impacted by releases from off-site source areas not subject to RCRA corrective action (e.g., sources at an adjacent facility not seeking an RCRA permit). In some of these circumstances, cleanup of the corrective action facility to risk based media cleanup levels, while desirable in the long term, might not make sense in the short term because contamination from off-site or otherwise unrelated sources would quickly re-contaminate the facility. EPA requests comments on application of corrective action requirements in areas of widely dispersed contamination and when the RCRA facility is otherwise impacted by releases from off-site sources. EPA requests that commenters specifically address the obligation, if any, a facility owner/operator should have to address the area-wide contamination to the extent it is present at his or her facility. If commenters

believe facility owners/operators should not be required to address area-wide contamination, the Agency requests comments on the continuing obligation under RCRA, if any, such facility owners/operators should have for an eventual cleanup to risk based levels.

5. Ecological Risk

As described in Section III.C.5.g of today's Notice, EPA's mandate is to protect both human health and the environment; therefore, assessing risks to ecologic receptors may be warranted in the context of implementing RCRA corrective action at many sites. The Agency recognizes, however, that assessing impact to ecologic receptors from environmental contamination is a rapidly evolving field of study. Therefore, the Agency is interested in receiving comments and data pertaining to: state-of-the-art approaches and tools for conducting ecologic-risk assessment, including initial screening as well as detailed assessments; availability of identification of useful guidance; availability of standardized eco-based action levels and cleanup levels, or standardized approaches for developing site-specific levels; site-specific examples of impacts to ecologic receptors from RCRA corrective action sites, and examples of successful remedial actions implemented to address these impacts; limitations associated with assessing ecologic risks, and taking remedial actions to protect ecologic receptors in general; specific needs for additional guidance and research; and suggestions regarding the scope of specific corrective action regulations dealing with assessment and protection of ecologic receptors.

6. Risk Assessment Methods

EPA has been criticized for relying on uniform, ''one size fits all'' risk assessment methods, particularly in the context of its remedial action programs. According to critics, often, the default assumptions or models incorporated into Agency risk assessment guidance documents do not adequately reflect site-specific conditions. The use of empirical data collected from a site, or methods developed expressly for application at specific sites or types of sites, could result in more valid and reliable characterizations of risks to human health and the environment. On the other hand, not every site would benefit from a comprehensive site-specific evaluation. EPA thus needs to strike a balance between the ease of uniform risk assessment methods and the improved targeting and effectiveness associated with accounting for site-specific conditions.

EPA is interested in the effect of provisions which would encourage the expanded consideration of site-specific conditions and other innovative risk assessment methods where such provisions would enhance program effectiveness or efficiency. For example, how could the Agency provide for the use of site-specific or innovative approaches to risk assessment while still enabling EPA or state agencies to maintain adequate oversight? Are there mechanisms available for risk assessment to be independently validated as reasonable characterizations of site risk, thereby reducing the demands for technical oversight and the time required to approve site-specific decisions. What incentives (if any) should EPA provide to encourage these efforts? What provisions or procedures, either in the 1990 proposal or in existing regulations, inhibit the effective use of site-specific risk assessments?

Significant improvements in risk assessment methodology have occurred since the 1990 proposal. EPA is interested in capturing these benefits in the corrective action program. The Agency thus seeks comments concerning how RCRA corrective action regulations might be constructed so as to maximize the extent to which these improvements are reflected in site evaluations, as well as the development and selection of remedial alternatives. Further, EPA is interested in comments addressing actions the Agency could take to act as a positive force for change in the evolutionary improvement of risk assessment methods.

F. Public Participation and Environmental Justice

EPA intends for the final corrective action regulations to be consistent with the Agency's efforts to improve permitting and public participation while providing sufficient flexibility to meet site-specific goals. The Agency believes that facility owners/operators, state environmental agencies, tribes, and private citizens are often in the best positions to determine what modes of communication and participation will work best in their communities. EPA believes the final rule should provide the flexibility necessary to find the best local solutions.

EPA requests general comment on the role of public participation in the corrective action program and on opportunities to improve public participation, especially the participation of any communities which have not been effectively involved in the corrective action process to date. The Agency is particularly interested in comments which address:

(a) Public participation tools. Currently, most public participation opportunities center around use of public notices (usually in a local newspaper) and public meetings. EPA requests that commenters address the use of additional public participation tools (such as public participation plans, community advisory panels, fact sheets, workshops, on-line communications, and informal meetings) which might be more effective in reaching communities.

(b) Public participation responsibility. EPA believes there may be situations where the corrective action process would benefit if the facility initiated the permit modifications under 40 CFR 270.42, rather than the Agency initiating permit modifications under 40 CFR 270.41. For instance, if a facility owner/operator must undertake an interim action, it may be more appropriate for the facility to request a permit modification. EPA anticipates that allowing this flexibility would improve interaction between the public and the facility and allow owners/operators to streamline the process by combining modifications, where appropriate. We request comment on this approach and the use of owner/operator initiated permit modifications to provide public participation opportunities.

(c) Tailoring public participation to the level of interest. EPA encourages facility owners/operators and regulatory agencies to choose a level of public participation that is commensurate with the level of public interest. The Agency is aware of innovative approaches to public participation where the level of public participation opportunities increase dramatically if a certain number of citizens from the affected community request increase public participation. The Agency realizes that every corrective action process is different and may involve overlapping and varied activities. EPA requests comments on public participation tools which could be used to tailor public participation opportunities to the level of interest in the affected community and to the significance of any given corrective action activity. The Agency requests that commenters who support tailoring public participation requirements to the level of interest at any given facility also address the degree to which the Agency or the facility owner/operator should take steps to inform the public of the onset of corrective actions to initiate public interest.

G. When Permits Can Be Terminated

The 1990 proposal contained a provision requiring owners and operators to obtain RCRA permits for the entire ''period necessary to comply with the requirements of Subpart S'' (proposed 40 CFR 270.1(c)). As discussed in the preamble to the 1990 proposal (see, 55 *FR* at 30846) this was intended to apply even where the hazardous waste management activities that originally triggered the need to obtain a permit were no longer continuing. The aim of this provision was to ensure that corrective action was carried to its conclusion. Furthermore, EPA believed that if corrective action obligations ceased when the need for the permit otherwise ended, an artificial incentive would be created to terminate viable facilities (e.g., facility owners/operators would choose to curtail management of hazardous waste—and the need for an RCRA permit—in to avoid completing corrective actions).

When the CAMU rule was promulgated, EPA reiterated its view that facilities undergoing corrective action must continue to renew their permits, even if the original regulated hazardous waste activity has ceased, until the corrective action has been completed. See 58 *FR* at 8676–77. EPA clarified that this obligation arises under existing statutes and regulations, even pending final promulgation of the additional language proposed in 1990. EPA indicated at that time that it would determine whether further regulatory clarification of this issue was necessary.

At this time, EPA is inviting comment on whether, as a policy matter, extended permitting is the best approach to ensuring that corrective action is carried out over the long term, or whether other alternatives should be considered. For example, one approach might be to terminate the permit when active hazard waste management ceased, but to continue the cleanup obligation through some other vehicle, possibly an enforcement order. Any alternatives proposed should address such matters as the reliability of the approach over the very long term, the level of administrative oversight required, the legal basis in RCRA for imposing the requirement if a permit is not issued and whether the RCRA statute would allow terminating a permit before the corrective action was complete. Commenters proposing alternatives are particularly encouraged to address options for the situation where engineering or institutional controls must be managed indefinitely into the future and whether permits can or should be terminated when the final remedy involves some form of engineering or institutional controls. Commenters who support permit termination when final remedies involve engineering or institutional controls are encouraged to address what other mechanisms, if any, should be used to ensure continued reliability of the engineering or institutional control and the role of EPA, if any, in imposing, maintaining and enforcing such mechanisms.

H. Effect of Property Transfer on Corrective Action Requirements

The transfer of part of a facility subject to corrective action creates questions regarding which corrective action obligations continue at the transferred parcel and which party has the corrective action responsibility. The 1990 proposal discussed this issue, and EPA is still interested in general comments in this area. The 1990 proposal identified two options: requiring the permittee to complete corrective action even on parcels sold to others, and requiring the purchaser of the parcel to complete the corrective action. EPA continues to be interested in comments on these two options.

A related issue is the point in time at which the extent of the facility is defined. For example, if a parcel were transferred after a permit application had been submitted, but before a permit or corrective action order was issued, the implications might be different from if the transfer occurred after the permit was issued. The 1990 proposal also suggested that it might make a difference whether the transfer occurred before implementation of the remedy. Since RCRA corrective action requirements apply to the current owner and operator of an RCRA facility and do not routinely extend to past facility owners/operators, EPA believes there may be some incentive for facility owners/operators to sell portions of their facilities before corrective action requirements can be imposed. EPA is aware of situations where a facility owner/operator has sold entire facilities, excluding only the closed RCRA regulated units, in what seems to be an effort to avoid application of RCRA corrective action requirements. While EPA has numerous authorities that could be used to address cleanup requirements even after portions of the facility had been sold, EPA believes application of these other authorities, rather than RCRA corrective action authorities, could increase transaction costs and delay cleanups.

I. Financial Assurance for Corrective Action

Currently, Financial Assurance for Corrective Action or FACA is required under 40 CFR 264.101. More detailed requirements for financial assurance for corrective action were proposed on October 24, 1986 (51 *FR* 37854) and in the 1990 proposal. EPA requests general comment on the need for detailed corrective action financial assurance regulations and the utility of the 1986 and 1990 proposals as guidance in this area. Commenters should address whether regulations or guidance would better promote the goals of the corrective action program and financial assurance for corrective action, and whether the flexibility inherent in the FACA proposals has been useful or detrimental. In addition, EPA is interested in comments which address:

(a) Timing of financial assurance. EPA requests commenters address both the stages in the corrective action process where FACA requirements have proven most useful (e.g., should financial assurance be required before a remedy is selected, perhaps to ensure completion of facility investigations) and the stages, if any, where FACA requirements have been of limited utility. In its previous notices, EPA has said that financial assurance should be required at the time of remedy selection. Is this still an appropriate policy? EPA is especially interested in comments that address whether financial assurance has been an impediment to corrective actions due to the investment entailed. In addition, the Agency requests comments on how the amount of financial assurance required should be determined. For example, should financial assurance be required for operation and maintenance costs in perpetuity or should it be required for a standardized length of time (e.g., five, ten or twenty years)? Should the financial assurance timing be adjusted to address interim measures and support the stabilization initiative? Because cost estimations at certain stages in the process can be inaccurate, should financial assurance requirements cover shorter time frames, such as two years? Should EPA be concerned with financial assurance for short term investigation and construction costs, or should we focus on assuring long term operations and maintenance expenses?

(b) Design of a FACA rule. Commenters who believe that EPA should promulgate detailed regulations on financial assurance for corrective action should address the design of such rules. Alternatively, are the current general rules sufficient or more

appropriate? Are there algorithms or decision guidelines which have proven successful in ensuring adequate financial assurance; should EPA adopt these guidelines as guidance or in regulation for corrective action financial assurance? How should financial capability enter into decisions on stabilization or corrective measures? How well is the current financial assurance for corrective action program working? EPA is interested in alternative approaches to ensuring the completion of corrective actions. For example, are there particular state rules which have proven effective in dealing with both financially sound and financially weak firms? Are there other clean up programs which address financial assurance more effectively than the current corrective action program? Should evidence of corporate commitments to cleanups such as continuing construction and progress affect financial assurance requirements? If so, how?

(d) Cost estimates. EPA requests that commenters address the accuracy and timing of FACA cost estimates. EPA is interested in comments which address the causes for differences among FACA estimates at various stages in the corrective action process, differences between estimates and actual figures, particular stages of the corrective action process which are more prone to cost errors than others, the time period over which cost estimates are most accurate, and the relationship between costs reported to permitting authorities and costs reported in financial reports. Some permittees have suggested that cost estimates cover only a period of two to three years with annual updates. Would this be adequate and appropriate?

(e) Discounting. EPA requests that commenters address the use of discounting in the FACA process. For example, would discounting produce better estimates of corrective action costs or change corrective action decisions? If commenters believe discounting is appropriate, the Agency requests that comments address the effect of discounting on FACA instruments, appropriate discount factors and time frames and, if discounting is used, the bases for requiring or not requiring FACA for the whole process.

(f) Use of the 1986 Proposal As Guidance. EPA requests that commenters provide information on when the 1986 proposal has been useful as guidance. Have the mechanisms in the proposal provided for clean ups or clean up activities which would not have occurred without them? Have the mechanisms or requirements diverted resources from actual clean up activities? Are the proposal mechanisms unnecessary, insufficient, or outdated?

J. State Authorization

EPA requests comments on general issues associated with state authorization for corrective action and the relative roles of state and Federal agencies in authorized states. EPA is particularly interested in comments which address:

(a) Rate and pace of authorization. EPA intends for states to be the primary implementors of the RCRA program. Although 49 states and territories are authorized to implement the RCRA program, many of these states are also authorized for significant amendments to the RCRA program, including 29 states which are authorized for corrective action. EPA requests comments on incentives (and disincentives) to corrective action authorization and suggestions for improving the efficiency of authorization processes.

(b) Role of EPA in authorized states. As more states become authorized, EPA's role is changing. For example, in many states EPA is doing much less direct program implementation. EPA is interested in defining its role in authorized states and in developing oversight models which use state and Federal resources most efficiently (e.g., focus on results, rather than process).

(c) Effect of promulgation of corrective action rules on authorized state programs. Final corrective action regulations will be promulgated pursuant to HSWA. Ordinarily, more stringent HSWA rules are immediately effective in authorized states (RCRA Section 3006(g)(1). However, EPA is concerned about potential disruptions to ongoing cleanup being conducted pursuant to authorized state corrective action programs and does not want authorized state corrective action programs to revert back to EPA. Therefore, in 1990, EPA proposed that any revisions to final Subpart S corrective action regulations would not become effective in states authorized for Subpart S until those states had adopted the new rules. Currently 29 states are authorized for the existing corrective action regulations, EPA believes the same logic that led it to propose that revisions to the corrective action regulations proposed in 1990 would not become effective in authorized states until states adopted them could arguably be applied to the current situation; therefore, EPA requests comments on whether final corrective action regulations should not be effective in states authorized for the existing corrective action program until those states adopt the final rules. EPA also requests comments on approaches to authorization which will minimize disruption of existing state corrective action programs upon promulgation of new Federal corrective action requirements.

Dated: April 12, 1996.

Carol M. Browner,

Administrator.

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Table 1: Interim Corrective Action Quick Reference Table

Result	Description	Workshop Module(s)	Ref. Notes
General Performance Standard for Interim Measures	Control, Minimize, or eliminate releases(s) that pose actual or potential threats to human health and the environment; and, to the extent practicable, should be consistent with final remedies	Environmental Indicators	1
Environmental Indicators	Current Human Exposures Under Control, and Migration of Contaminated Groundwater Under Control	CSM, Environmental Indicators	2
Stabilization	As situations warrant, control or abate threats to human health and/or the environment from releases at RCRA facilities, and/or to prevent or minimize the further spread of contamination	CSM, Environmental Indicators	3
Supporting Topics	**Description**	**Workshop Module(s)**	**Ref. Notes**
Action or Screening Levels	Represent contaminant- and media-specific concentrations above which further action (e.g. additional characterization, risk assessment, and or remedial action) is generally warranted	CSM, Risk and Uncertainty, EI	4
Public Participation prior to and in support of interim measures	Should occur at the initiation of Corrective Action, and for the selection of "significant" interim measures	CSM, Risk and Uncertainty, Communication	5
Institutional Controls	See Corrective Action Results Table 2	CSM, Environmental Indicators	See Table 2

Reference Notes for Table 1: Interim Corrective Action

1. **Interim Measures**

One of EPA's primary goals for the corrective action program is to expedite risk reduction through implementation of interim measures to control or minimize ongoing threats to human health or the environment. In many state and Federal remedial programs, interim measures are used to address risks to human health or the environment in advance of final remedy selection. EPA believes that the concept of interim measures is especially appropriate at facilities subject to RCRA corrective action, since they are generally operating industrial facilities, where a final facility cleanup might not be completed for many years.

Recommended Interim Measure Performance Standard

(1) control, minimize, or eliminate releases(s) or potential release(s) that pose actual or potential threats to human health and the environment and, (2) to the extent practicable, be consistent with remedies that meet the remedy performance standard.

EPA believes that the recommended performance standard for interim measures to "control, minimize or eliminate" covers the broad range of actions that might be needed at a site-specific level in the short term to address risk to human health and the environment during interim measures. The Agency continues to believe, as discussed in the 1990 proposal, that interim measures should, to the extent practicable, be consistent with final remedies. In choosing interim measures, program implementors should be aware of the primary elements of what would be acceptable as a final remedy for the site, including preference for treatment of principal threats, and consider this when they implement interim measures. Since the corrective action program was initiated, a variety of types of interim measures have been implemented. In most cases, these measures, such as source removal, supply of alternate water supplies, plume containment or access controls, are consistent with any final remedy and are an effective use of remedial resources.

In a minority of cases, interim measures are not entirely consistent with the site-specific approaches chosen to meet the goals of the final remedy. A common example is a temporary cap to address direct exposure that later has to be removed as part of a final remedy. However, in such cases, in view of a final remedy that would not be implemented quickly, interim actions would be undertaken in the near term to reduce risk or to prevent further migration of contamination.

In some circumstances, an interim measure or measures may become the final remedy. For example, an interim measure that involves removal of only highly contaminated soils ("hot spots"), might, after more comprehensive site investigation, be sufficient for a final remedy. Of course, for an interim measure to be approved as a final remedy it would have to meet the remedy performance standard, including the opportunity for public input.

2. **Environmental Indicators**

General Definition of Environmental Indicators

Environmental Indicators (EIs) are measures being used by the RCRA Corrective Action program to go beyond programmatic activity measures (e.g., reports received and approved) to track improvement in the quality of the environment. The two EIs developed to-date are

designed to indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated groundwater.

"Current Human Exposures Under Control" EI:
A positive "Current Human Exposures Under Control" EI determination ("YE" status code) indicates that there are no "unacceptable" human exposures to "contamination" (i.e., contaminants in concentrations in excess of appropriate risk-based levels) that can be reasonably expected under current land- and groundwater-use conditions (for all "contamination" subject to RCRA Corrective Action at or from the identified facility (i.e., site-wide)).

"Migration of Contaminated Groundwater Under Control" EI:
A positive "Migration of Contaminated Groundwater Under Control" EI determination ("YE" status code) indicates that the migration of "contaminated" groundwater has stabilized, and that monitoring will be conducted to confirm that contaminated groundwater remains within the original "area of contaminated groundwater" (for all groundwater "contamination" subject to RCRA Corrective Action at or from the identified facility (i.e., site-wide)).

3. **Stabilization**

The Stabilization Initiative started in 1991 as the primary implementation strategy for the RCRA Corrective Action Program. Through the Stabilization Initiative, EPA is seeking to achieve an increased overall level of environmental protection by implementing a greater number of actions across many facilities rather than implementing final, more comprehensive remedies at a few facilities. Stabilization activities can occur at a unit or specific area, in contrast to the site-wide EI determinations.

Controlling exposures or the migration of a release may “stabilize” a problem or even an entire facility, but does not necessarily mean that the facility is completely cleaned up. Overseeing regulatory agencies should make it clear to facility owner/operators that while stabilization, as well as achievement of EIs, are appropriate interim goals, it is not necessarily the final goal for RCRA Corrective Action.

More detailed explanation and guidance regarding RCRA stabilization is included in the October 21, 1991 Memo titled, “Managing the Corrective Action Program for Environmental Results: The RCRA Stabilization Effort,” which is found in the Corrective Action Workshop toolbook.

4. **Action or Screening Levels**

EPA recognizes that using action or screening levels continue to be a valuable tool to help focus resources on contamination at a facility that warrants some further action. Using action levels can be particularly helpful to focus interim remedial actions and site characterization, but can also be useful to focus final remedy evaluation and selection. When relying on action levels to focus resources, contamination found in a particular medium below an appropriate action level would not generally be subject to remediation or further study.

Action levels are health- or environmental-based concentrations typically derived using chemical-specific toxicity information and standardized exposure assumptions. Action levels are often established at the more protective end of the risk range (e.g., $1x10^{-6}$) using conservative exposure and land use assumptions. However, action levels based on less conservative exposure assumptions could be appropriate for certain sites, such as facilities where the land use has been

designated non-residential. Such use of non-residential-based action levels may be particularly helpful to focus interim actions which are often based more on current exposures and land uses.

EPA recognizes that there are no national lists of action levels; however, numerous lists produced by EPA regional offices and specific states are available and routinely used. As stated in the 1996 ANPR, EPA cautions program implementers to ensure that action levels reflect up-to-date toxicity information and the assumptions used to develop the action levels are reasonably consistent with the physical conditions and current or reasonably anticipated exposure assumptions at a given facility. The latest national EPA guidance dealing with the action level concept can be found in the Superfund Soil Screening Guidance at http://www.epa.gov/superfund/resources/soil/index.htm .

5. **Public Participation for Interim Measures**

EPA's strong preference continues to be for full, fair and equitable opportunities for public participation throughout the process of cleaning up corrective action facilities. EPA expects that some form of public involvement will be appropriate when developing and implementing most interim measures. Due to the diversity, scale, and time-critical nature of some actions that have been taken as interim measures, EPA does not specify the types of public participation activities that would be appropriate during all interim measures, nor does EPA believe public participation should be required for all interim measure decisions. However, the Agency believes that the public should be involved during the selection of "significant interim measures," The Agency believes that a tentative "significant" interim measure should be provided to the public for review and comment and that the opportunity should be provided for a public meeting. Interim measures that the Agency would consider to be significant are discussed below.

In addition to the recommended public involvement for significant interim measures, the Agency continues to encourage frequent, meaningful public involvement for corrective action activities in general. Because of the diversity of potential interim measures, the types of public participation activities that would be appropriate during interim measures will vary, and in some cases, public participation may not be necessary. For example, EPA anticipates that a straightforward source removal, where small volumes of hazardous wastes are removed from a corrective action facility and sent for disposal at a facility permitted to accept hazardous waste, would not generally require public involvement for the decision, but public notice of the action may be appropriate. However, at some sites, due to risk factors or other community concerns, the owner/operator or oversight agency may provide the opportunity for public input into the decision to undertake a small volume, straightforward removal.

As discussed above, some significant interim measures may, in time, be demonstrated to be sufficient to serve as the final remedy for the site. Of course, a decision that an interim measure should be approved as a final remedy should go through the same type of public notice and provide the same opportunities for public review and comment that EPA would expect during remedy selection.

Significant interim measures.

In EPA's experience, many activities undertaken as interim measures may be significant actions or may for other reasons warrant public involvement in the decision to undertake the action. EPA recognizes that defining which interim measures are significant is best determined on a site-

specific basis. However, EPA's current thinking is that significant interim measures are those such as soil removals or groundwater extraction that affect a large part of a facility, measures that will be implemented a year or more prior to implementation of a final remedy, or measures that will involve transport of large volumes of remediation waste through the local community.

EPA's Public Participation Manual

EPA's most comprehensive public involvement guidance for RCRA Corrective Action under permits and 3008(h) orders are identified in Chapter 4 of RCRA Public Participation Manual, EPA 530-R-96-007, September 1996. In addition, Chapter 5 provides good information on how to involve the public. Chapter 4 of the manual calls for: early participation, consistency with Superfund, and shared responsibility for public participation activities. A copy of Chapter 4 of this manual is provided in the Communication section of the Corrective Action Tool Book.

Early participation

The need for public information and involvement varies from site to site. By canvassing the public early in the Corrective Action process, the regulatory agency and facility can determine the level of public interest and need for information. This, in turn, increases the likelihood of a public participation effort tailored to meet the specific community needs. Public participation is often most effective if initiated early in the Corrective Action process. An important benefit of early participation is an increased likelihood of gaining the public's trust. Parties that trust one another can more easily communicate and cooperate to achieve a Corrective Action.

Consistency with Superfund

EPA encourages permitting agencies and facilities to make public participation activities during Corrective Action consistent with those activities required under Superfund. For example, public participation activities for a significant interim action should generally equal or exceed those required for a Superfund removal action.

Shared responsibility for public participation activities

The Corrective Action process may involve several steps initiated by a regulatory agency or a facility. Thus, public participation is an activity shared by the regulatory agency and the facility.

Table 2: Final Corrective Action Quick Reference Table

Result	Description	Workshop Module(s)	Ref. Notes
Recommended Final Remedy Performance Standards (general)	Developed from May 1, 1996 Advance Notice of Proposed Rulemaking -- includes concepts of overall protection, media cleanup objectives and remediation of sources	Remedy Selection	1
Final Remedy Performance Standard #1	Protect human health and the environment	CSM, Remedy Selection	2
Final Remedy Performance Standard #2	Attain media cleanup objectives are broad objectives made up of **media cleanup levels, points of compliance and remediation time frames**	CSM, Remedy Selection	3
Final Remedy Performance Standard #3	Remediate the sources of releases to eliminate or further reduce threats to human health and the environment	CSM, Remedy Selection	4
Supporting Topics	**Description**	**Workshop Module(s)**	**Ref. Notes**
Public Participation	Opportunity for public review and comment should take place: prior to remedy proposal; when tentative remedy decision has been made; when final remedy decision is made; and when tentative decision is made that Corrective Action is complete	Communication, remedy selection, remedy completion	5
Media Cleanup "Levels"	Site specific cleanup concentrations protective of human health and the environment	CSM, Remedy Selection	6
Points of Compliance	Locations where media cleanup levels should be measured and achieved	CSM, Remedy Selection	7
Remediation Time Frame	Site-specific remedy implementation schedule	CSM, Remedy Selection	8

Remedy Evaluation/Balancing Factors	Long-term reliability and effectiveness; reduction of toxicity, mobility or volume; short-term effectiveness; implementability; capital as well as operation and maintenance costs; community acceptance; and state acceptance	Remedy Selection	9
Remedial Expectations	Tool to help regulators and owner/operators focus resources on remedial alternatives that are likely to achieve performance standards and fair well in with respect to the evaluation/balancing criteria. Expectations address: treatment of principal threats, engineering controls for low-level threats, institutional controls, innovative technologies, groundwater restoration, contaminated soils	Remedy Selection	10
Preference for Treatment	Long-standing policy for remedies that involve treatment (primarily focused on "principal threats")	CSM, Remedy Selection	10, 11
Land Use	Long-standing policy to recognize current as well as reasonably anticipated land use.	CSM, Remedy Selection	12
Groundwater Use	Media cleanup objectives and remedial expectation point toward remediating groundwater to levels that are consistent with designated use	CSM, Remedy Selection	13
Technical Impracticability	A determination by the overseeing regulatory program that, for certain media or constituents at certain facilities or portions of facilities, it may be technically impracticable from an engineering perspective to achieve media cleanup objectives.	CSM, Remedy Selection	14

Institutional Controls	Non-engineering methods (usually, but not always, legal controls) intended to affect human activities in such a way as to prevent exposure to hazardous substances.	CSM, Environmental Indicators, Remedy Selection	15

Reference Notes for Table 2: Final Corrective Action Results

1. **Recommended Final Remedy Performance Standards**
   These "results" for final remedies were developed from guidance contained on pages 19448-19450 in the May 1, 1996 ANPR. The three recommended performance standards (dealing with overall protection, media cleanup objectives, and remediation of sources) in this context were previously referred to as "threshold criteria" in the July 1990 Subpart S proposal. Proposed Subpart S included a performance standard that required remedies to "comply with standards for management of wastes." EPA no longer believes this remedy criterion needs to be expressed, since compliance with applicable waste management standards is automatically required under existing RCRA Subtitle C and D regulations.

2. **Recommended Performance Standard #1 - Protect Human Health and the Environment.**
   The protection of human health and the environment is a general mandate from the RCRA Sections 3004(u) and (v) and other Sections (e.g., Section 3008(h)) require Corrective Action as necessary to protect human health and the environment. Repetition of this overarching performance standard is necessary to reinforce the principle that the entire cleanup must meet this standard. For example, providing an alternative drinking water supply may be necessary to achieve this performance standard while other actions are being implemented to achieve the remaining two performance standards discussed below.

3. **Recommended Performance Standard #2 - Attain Media Cleanup Objectives**
   As discussed in the 1996 ANPR, EPA believes that the concept of media cleanup objectives includes three components: media cleanup levels, points of compliance, and remediation time frames. If Corrective Action is proceeding in advance of Agency oversight, facility owner/operators should be careful to document their decisions about media cleanup levels, points of compliance, and remediation time frames to support review of the remedy. If Corrective Action is overseen by a regulatory agency, EPA believes that these three components should generally be recommended by the facility owner/operator in the remedy recommendation and established by the overseeing agency in the final remedy decision.

   Media cleanup objectives should be appropriate to the assumptions regarding current and reasonably anticipated land use(s), and current and potential beneficial uses of water resources.

4. **Recommended Performance Standard #3 - Remediation of Sources**

Remediation of the sources of releases of contamination is typically a critical part of Corrective Action activities. In this context, "sources" include both the location of the original release as well as locations where significant mass of contaminants may have migrated. EPA's continuing emphasis on remediation of sources of releases reflects the Agency's strong preference for remedies that are protective in the long term and is consistent with the Agency's strong and longstanding preference for treatment to permanently reduce the toxicity, mobility or volumes of materials that pose a substantial inherent threat to human health or the environment due to their toxicity or mobility. As discussed in the 1990 proposal and the 1996 ANPR, the emphasis on remediation of release sources does not preclude remedies that include containment or other physical or institutional controls, provided the potential for future releases from any remaining source areas is adequately controlled and long-term protectiveness is provided.

5. **Public Participation for Remedy Selection and Completion**

EPA continues to believe that public involvement is a critical part of the remedy selection process. For that reason, EPA believes that the public should generally have an opportunity to provide comment at a minimum: prior to a remedy proposal to allow community acceptance to be weighed as remedy balancing factor where appropriate (see note number 9 below); at the time a tentative remedial decision has been made; when a final remedial decision is made; and when a decision is made that no further Corrective Action is necessary (i.e., Corrective Action is complete). These opportunities for public input should be in addition to opportunities provided at the initiation of Corrective Action and at the time in which a significant interim measures are proposed and selected. EPA anticipates that the public review and comment procedures currently used for draft RCRA permits in 40 CFR Part 124.10 -12 (or authorized state equivalent) will be most appropriate for review and comment on tentative remedy decisions. Following public review and comment of a tentative remedial decision, the overseeing Agency should make the final decision and provide that decision along with a concise statement of the reasons for the decision and a response to significant comments, to the facility owner/operator, all persons who submitted comments on the tentative remedy selection, all persons on the facility mailing list (if a mailing list is required for the facility) and, where appropriate, other interested or appropriate persons.

EPA recognizes that at some facilities or portions of facilities, owner/operators may choose to go forward with remedy selection and implementation absent real-time agency oversight. For example, an owner/operator of a low priority corrective action facility might plan to sell or redevelop a portion of that facility and might want to complete cleanup prior to such sale or redevelopment. EPA strongly cautions facility owner/operators who make this choice to document their remedy selection and implementation decisions carefully. In situations where facility owners/operators go forward with remedy selection and implementation absent real-time agency oversight, future Agency assessments of the need for additional corrective action at the site will likely be influenced by the level of documentation of the remedy created by the owner/operator. Because Agency guidance sets out what the Agency generally believes should be conducted to select and implement a protective remedy, a well-documented decision

appropriately considering the factors the Agency has recommended is less likely to warrant further corrective action, than a decision which was not documented in this manner.

Similarly, the Agency emphasizes again that it is important for facility owners/operators who proceed without real-time Agency oversight to involve the public and other interested citizens in remedy selection and implementation decisions. Specifically, the owner/operator should provide opportunity for notice and comment on remedy recommendation, make any public comments it receives available to the public, and respond to any comments including how the owner/operator factored public comments into any corrective action decision. Based on its experience in implementing the corrective action program, and the effect of public input on site-specific remedy design and implementation, EPA may find the owner/operator's remedy unsatisfactory and require additional corrective action where the public has not been given a full and fair opportunity to participate. Because of the value of public participation to the remedial action, the Agency generally should give heightened scrutiny to requests for determinations that corrective action is complete when the subject remedies have been selected and implemented without adequate public involvement.

EPA continues to emphasize that the Agency's regulations do not prohibit a facility owner/operator from going forward with corrective action, including remedy selection and implementation, in advance of oversight or direction from the Agency; however, the owner operator is cautioned to make sure they are aware that such actions not preclude the Agency from requiring additional measures in the future.

EPA's most comprehensive public involvement guidance for RCRA Corrective Action under permits and 3008(h) orders are identified in Chapter 4 of RCRA Public Participation Manual, EPA 530-R-96-007, September 1996. In addition, Chapter 5 provides good information on how to involve the public. Chapter 4 of the manual calls for: early participation, consistency with Superfund, and shared responsibility for public participation activities. A copy of Chapter 4 of this manual is provided in the Communication section of the Corrective Action Tool Book.

6. Media Cleanup Levels

There is often confusion between the terms "media cleanup objectives" and "media cleanup levels" used in Agency guidance. Media cleanup levels are site-specific concentrations of individual hazardous constituents in a given medium that should be achieved as part of a Corrective Action remedy. Media cleanup objectives are the combination of media cleanup levels, points of compliance, and remediation time frames. Note, in the 1990 proposal, media cleanup levels were referred to as media cleanup standards.

As discussed in the 1990 proposal and the 1996 ANPR, EPA believes that media cleanup levels should be established consistent with available, protective, risk-based cleanup levels (e.g., MCLs or appropriate State cleanup levels) or, when such levels do not exist, to protective cleanup levels developed for the site in question (e.g., using a site-specific risk

assessment). Both approaches should be based on a site-specific, risk-based decision.

When available media cleanup levels are used, the assumptions used to develop the standardized cleanup levels should be consistent with the site-specific conditions at the facility in question. For example, use of MCLs promulgated under the Safe Drinking Water Act, or other more stringent State drinking water standards, would generally be appropriate as media cleanup levels for groundwater that has been appropriately identified as a current or potential source of drinking water. As described in the preamble to the 1990 proposal (30804), alternative levels protective of the environment and safe for other uses could be established for groundwater that is not an actual or reasonably expected source of drinking water. This is also consistent with the Superfund NCP, which states that, generally, drinking water standards should not be chosen as preliminary remedial goals for groundwater that is not a current or potential future source of drinking water (1990 NCP preamble 55 FR 8733).

For human health, EPA's risk reduction goal remains to reduce the threat from carcinogenic contaminants such that, for any medium, the excess risk of cancer to an individual exposed over a lifetime generally falls within a range from $1x10^{-4}$ to $1x10^{-6}$ and, for non-carcinogens, the degree to which exposure would no longer cause deleterious effects. For non-carcinogenic constituents, this is generally interpreted as not exceeding a Hazard Index of one. In addition to protecting human health, media cleanup levels should protect against unacceptable cross-media transfer and unacceptable risks to ecological receptors. Issues associated with unacceptable risks to ecological receptors may also require that individual constituents achieve cleanup levels that are more conservative than $1x10^{-6}$ for human health. EPA's latest guidance on ecological risk assessment is provided in the June 1997 Interim Final Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA 540-R-97-006). References: National Contingency Plan, 55 Federal Register 8733, March, 1990.

7. **Points of Compliance**

Points of compliance are the site-specific locations at which the concentrations of individual hazardous constituents should be measured and achieved. Points of compliance should be established at the same time as media cleanup levels and remediation time frames. Points of compliance should be established for all affected media subject to a final remedy. If corrective action is proceeding in advance of Agency oversight, facility owners/operators should be careful to document their decisions about points of compliance to support future review of their emediation. If corrective action is being overseen by a regulatory agency, EPA generally expects that points of compliance will be recommended by the facility owner/operator in the remedy recommendation and established by the overseeing agency in the final remedy decision.

For groundwater, the media cleanup levels should generally be achieved throughout the contaminated groundwater or when waste is left in place, up to the outside boundary of the area(s) encompassing hazardous wastes or hazardous constituents that are being managed in place as part of a remedial action. This is typically referred to as the "throughout-the-

plume/unit boundary point of compliance for groundwater.

For air, cleanup levels should generally be achieved at the location of the most exposed individual, or at other specified points of exposure closer to the source of the release, as necessary to protect human health and the environment.

For surface water, cleanup levels should generally be achieved at the point where releases enter surface waters, or within a specified mixing zone in sediments or surface water.

For soils, cleanup levels should generally be achieved at any point where direct contact exposure to the soils may occur and at any other points necessary to protect against unacceptable cross-media transfer.

For surface water sediments, cleanup levels should generally be achieved throughout the sediments or at other specific locations in sediments or surface water as necessary to protect human health and the environment.

8. **Remediation Time Frames**

Remediation time frames are the time periods and schedules over which remedies will be implemented as well as the estimates of when cleanup levels will be achieved at points of compliance.

As discussed in the 1990 proposal and the 1996 ANPR, EPA continues to believe that program implementers and facility owners/operators should generally consider the following factors when estimating remediation time frames: the extent and nature of contamination and the potential risks to human health and the environment from exposure to contamination prior to completion of the remedy; the practical capabilities of remedial technologies in achieving the media cleanup levels and other remedial objectives; the availability of treatment and/or disposal capacity for wastes managed during implementation of the remedy; and the desirability of utilizing technologies that are not currently available but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety, or ability to achieve media cleanup levels and other remedial objectives. In addition to these factors, the EPA believes that when developing a remediation time frame estimate, program implementers and facility owners/operators should generally also consider: community preferences; financial resources of facility owners/operators; and current and reasonable anticipated future land and water use. Implementers may find it useful to at times distinguish between time frames associated with implementing a remedy (e.g., installing a certain remedial technology) and the time frame associated with achieving a media cleanup level at a point of compliance. This distinction should allow implementers to set schedule for constructing a remedy, for which there is generally less uncertainty, as compared to only setting schedules for achieving a media cleanup level, for which there is often greater uncertainty as discussed below. An example could be that at a particular site it will take 6 months to install a groundwater pumping and treatment system, but the best estimates might be that it will take approximately 10 years of

operation to achieve the media cleanup level in the ground water at the points of compliance.

EPA is aware that there may be uncertainty in estimating remediation time frames at some sites. Examples include situations where remedies are implemented in stages or where there is uncertainty with how long a particular technology (e.g. pump and treat) will take to reach objectives. In these cases, program implementers and facility owners/operators should clearly explain the reasons for the imprecision of their remediation time frame estimates in the remedy documentation or, in situations where EPA requires a facility owner/operator to implement a remedy, in the remedy recommendation.

9. **Recommended Remedy Evaluation/Balancing Criteria**

Depending on site-specific circumstances, any number of remedial alternatives might satisfy the three recommended remedy performance standards. For example, as discussed in the 1996 ANPR, remedies can attain media cleanup standards using various combinations of removal, treatment, engineering and institutional controls. While many remedies might meet the remedy performance standards, each will present a different combination of other attributes such as long-term protectiveness and implementability. As discussed in the 1996 ANPR, a formal evaluation of remedial alternatives is not always necessary, nor is it necessary to always have a formal evaluation of more than one alternative if a single remedial option is determined by the overseeing regulatory program to be acceptable. The recommended remedy evaluation/balancing criteria described below can be used, where appropriate, to help select the "best" remedy by balancing the pros and cons of various alternatives, or they can be used to judge how well a single remedial option would likely perform when a formal evaluation of multiple alternatives is not warranted. If an owner/operator proposes only one alternative for consideration, the overseeing regulatory program may (1) accept the proposal, (2) request modification, or (3) request that the owner/operator develop additional alternatives to allow for a comparison between potential options. In determining whether an evaluation of multiple alternatives is warranted, the overseeing regulatory program should consider such factors such as site complexity, community feedback, uncertainties associated with remedial performance (e.g., a natural attenuation remedy), etc.

EPA's current thinking is that seven evaluation/balancing criteria are generally appropriate: (1) Long-term reliability and effectiveness, along with the degree of certainty that remedies will remain protective of human health and the environment, considering, as appropriate: the magnitude of risks that will remain at a site from untreated hazardous wastes and hazardous constituents and treatment residuals; and, the reliability of any containment systems and institutional controls; (2) Reduction of toxicity, mobility or volume through treatment of hazardous wastes and hazardous constituents, including how treatment is used to address principal threats posed by the facility, and the degree to which remedies employ treatment that reduces the toxicity, mobility or volume of hazardous waste and hazardous constituents, considering, as appropriate: the treatment processes to be used and the amount of hazardous waste and hazardous constituents that will be treated; the degree to which treatment is irreversible; and the types of treatment residuals that will be produced; (3) Short-term

effectiveness and short-term risks remedies pose, along with the amount of time it will take for remedy design, construction and implementation; (4) Ease or difficulty of remedy implementation, considering, as appropriate: the technical feasibility of constructing, operating and monitoring the remedy; the administrative feasibility of coordinating with and obtaining necessary approvals and permits from other agencies; and the availability of services and materials, including capacity and location of needed treatment, storage and disposal services; (5) Capital and operation and maintenance costs, and the net present value of the capital and operation and maintenance costs; (6) The degree to which remedies are acceptable to the surrounding community; and, (7) The degree to which remedies are acceptable to the state in which the subject facility is located.

The recommended primary balancing criteria of long-term reliability and effectiveness, reduction of toxicity, mobility or volume through treatment, implementability, and cost were discussed in detail in the 1990 proposal. EPA's thinking on these criteria has not changed significantly since that time. Although the Agency is not reviewing the primary remedy balancing criteria in detail here, it notes that, in applying the criteria of long-term effectiveness and reduction of toxicity, mobility or volume through treatment, program implementors and facility owners/operators should generally give great weight to the Agency's strong and longstanding preference for remedies that involve treatment to permanently reduce the toxicity, mobility or volumes of materials that pose a substantial inherent threat to human health or the environment due to their toxicity or mobility (i.e., are "principal threats" discussed as part of the Agency's remedial expectations for final Corrective Action remedies).

The remedy balancing criteria of community and state acceptance were not explicitly discussed as remedy balancing criteria in the 1990 proposal and are therefore discussed below. EPA's latest thinking is that these two recommended criteria are important to ensure that program implementors and facility owners/operators appropriately involve communities in cleanup activities and, in cases where states are not selecting corrective action remedies, appropriately consider state views. Adding community and state acceptance as recommended evaluation/balancing factors have the added advantage of making the recommended corrective action remedy balancing factors explicitly conform with the remedy balancing criteria used in the Federal CERCLA program. EPA believes this will generally reduce the likelihood that individuals might question the ability of a remedy approved by one program to satisfy the requirements of the other program.

10. **Remedial Expectations**

Remedy expectations are not binding requirements; rather, they reflect collective experience and are designed to guide development of remedial alternatives. In effect, remedial expectations allow program implementers and facility owner/operators to profit from prior EPA experience and focus resources on the most plausible remedial alternatives. Many of these expectations were first described in the CERCLA National Contingency Plan (NCP) (40CFR430(a)(1)), and were also described in the May 1, 1996 ANPR.

(1) EPA expects to use treatment to address the principal threats posed by a site whenever practicable and cost-effective. Contamination that represents principal threats for which treatment is most likely to be appropriate includes contamination that is highly toxic, highly mobile, or cannot be reliably contained, and that would present a significant risk to human health and the environment should exposure occur. The term "cost-effective" does not necessarily imply least costly.

(2) EPA expects to use engineering controls, such as containment, for wastes and contaminated media that can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable. Future land use should be considered when evaluating the appropriateness of engineered controls.

(3) EPA expects to use a combination of methods (e.g., treatment, and engineering and institutional controls), as appropriate, to achieve protection of human health and the environment.

(4) EPA expects to use institutional controls such as water and land use restrictions primarily to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous wastes and constituents. EPA does not expect that institutional controls often will be the sole remedial action.

(5) EPA expects to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, less adverse impact, or lower costs for acceptable levels of performance when compared to more conventional technologies.

(6) EPA expects to return usable groundwaters to their maximum beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of groundwater is not practicable, EPA expects to prevent or minimize further migration of the plume that represents a threat to human health or the environment, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. EPA also expects to control or eliminate surface and subsurface sources of groundwater contamination

(7) EPA expects to remediate contaminated soils as necessary to prevent or limit direct exposure of human and environmental receptors and prevent the transfer of unacceptable concentrations of contaminants (e.g., via leaching, runoff, or airborne emissions) from soils, including subsurface soils, to other media.

11. **Preference for Treatment**

Despite EPA's longstanding preference for remedies that involve treatment to permanently reduce the toxicity, mobility or volumes of materials that pose a substantial inherent threat to human health or the environment due to their toxicity or mobility, program implementors and

facility owners/operators often struggle to find an appropriate balance between approaches that emphasize reductions in toxicity (e.g., through treatment to reduce toxicity, mobility or volume) and approaches that emphasize preventing exposure (e.g., through engineering and institutional controls). While preventing exposure may appear to be the most direct near-term means of reducing risk, permanent reduction of the toxicity, mobility and/or volume of contaminated material can be the most cost-effective means of reducing risk over time. For example, at a facility where the remedy relies, in part, on engineering controls to prevent exposure there could be: associated operation and maintenance costs; the need to maintain the RCRA facility permit for the life of the remedy; increased Agency involvement to monitor the continued effectiveness of the remedy; and, need for institutional controls. In cases where treatment to reduce toxicity, mobility or volume is chosen, EPA does not necessarily expect the remedy to involve treatment alone. For example, under some site-specific conditions, highly toxic contaminated material could be treated so that the concentrations of hazardous constituents, while still above media cleanup levels, would support a reliable containment remedy.

The exact balance between reduction in toxicity, mobility or volume and exposure control will best be established on a case-by-case basis in consideration of site-specific conditions; however, as discussed in the 1996 ANPR, the Agency's consistent and longstanding policy is to place special emphasis on remedies that provide adequate protection of human health and the environment over the long term. For this reason, the Agency continues to prefer remedies that involve treatment to permanently and significantly reduce the toxicity, mobility, or volume of highly toxic or highly mobile waste. Program implementors and facility owners/operators are cautioned against too great a reliance on exposure control remedies when alternatives that include treatment to permanently reduce toxicity, mobility or volume are available, affordable and practical.

While EPA maintains a preference for treatment, the clear emphasis is to focus treatment on contamination identified as "Principal Threats" (see expectations in note 10 above). Guidance on determining whether contamination represents a "principal threat" which should treatment is generally appropriate can be found in documents developed by the Superfund program but are also relevant to the RCRA Corrective Action program. Those guidance documents are titled, "A Guide to Principal Threat and Low Level Threat Wastes," Superfund Publication 9380.3-06FS, November 1991, which is included the Workshop Toolbook; and, "Rules of Thumb for Superfund Remedy Selection," OSWER Directive No. 9355.0-69, August 1997 which is available to download at http://www.epa.gov/superfund/resources/rules/index.htm. The "Rules of Thumb" guidance includes important information pertaining to principal threats which updates the 1991 guidance previously mentioned.

12. **Land Use**

EPA believes that current and reasonably anticipated future land use should generally be explicitly considered during the site-specific development of media cleanup objectives. EPA believes that media cleanup objectives should be appropriate to the assumptions regarding

current and reasonably anticipated land use(s) and current and potential beneficial uses of water resources. Consideration of current and reasonably anticipated future land use has always been part of the Corrective Action program. In the 1990 proposal, EPA indicated, "...contaminated soil at an industrial site might be cleaned up to be sufficiently protective for industrial use but not residential use, as long as there is reasonable certainty that the site would remain industrial." (55 FR 30803) The role of current and reasonably anticipated future land use was discussed in detail in the 1996 ANPR. EPA's views have not changed significantly since that time.

Additionally, EPA strongly encourages program implementers, as appropriate, to select remedies that encourage some type of beneficial use of properties, rather than just leaving contaminated properties fences and unused.

Program implementors and facility owner/operators are cautioned against automatically restricting assumptions of future land use to extrapolations of the current use or relying only on designated zoning or industrial use codes to establish land use assumptions. In addition to the considerations of any given facility owner/operator, community concerns and plans also should be considered when making decision on reasonably anticipated future land use. Where it is possible, EPA encourages owner/operators and program implementors to begin a dialogue with the community on land or water use prior to considering final remedies. As an additional benefit of early land use discussions, investigations can be better tailored to assess actual risks or to collect information to help in remedy selection or implementation. Additional guidance on incorporating reasonable future land use assumptions in remedial decision-making is available in "Land Use in the CERCLA Remedy Selection Process," OSWER Directive No. 9355.7-04, May 25, 1995, which can be found in the Corrective Action Workshop Toolbook. The Superfund program is in the process of updating this guidance to included discussion on land re-use.

Land use decisions are typically also only as good as the “institutional controls” (see institutional controls note # 15 below) put in place to ensure that the use doesn’t change, or if it does, that the remedy could be reopened to make sure conditions are protective of new alternative uses. The earlier institutional controls are determined, the better equipped the owner/operators, communities, and developers will be to address future land use issues.

13. **Groundwater Use**

As stated above (note # 10 above), EPA generally expects to return usable groundwaters to their maximum beneficial uses wherever practicable. This expectation, along with the “Attain Media Cleanup Objectives ” recommended performance standard (note # 3 above), are designed to point program implementers toward considering groundwater use as a factor in evaluating and selecting final remedies.

EPA is concerned that the lack of current use of the groundwater as drinking water at a particular site could be used inappropriately as justification for a non-drinking water use determination. Factors that generally should be considered in making groundwater use

decisions include: (1) whether the use determination was based on a Comprehensive State Ground Water Protection Program (CSGWPP) that has been endorsed by EPA and has provisions for site-specific decision-making; or (2) in the absence of a State CSGWPP, whether the determination was based on EPA-endorsed State classifications or other State designations and/or Federal groundwater guidelines (e.g., Class I, II, and III groundwater). EPA believes the following factors (from "Final Comprehensive State Groundwater Protection Program Guidance, December 1992, Figure 2-1) should generally be used to set relative priorities of groundwater resources:

- Intrinsic sensitivity, hydrogeologic regimes and flow patterns (recharge discharge areas), geologic/hydraulic parameters and local hydrogeologic setting;
- Quantity and potential yield;
- Ambient and/or background groundwater quality as determined by monitoring;
- Potential for remediation where contamination already exists;
- Current use;
- Reasonably expected future use based on demographics, land use, remoteness, quality, and availability of alternative water supplies;
- Values attributed to groundwater resources (see Appendix B of CSGWPP Guidance);
- The interactions and potential contamination impacts between surface water and groundwater and the value of groundwater quality to the maintenance of ecosystem integrity; and,
- Inter-jurisdictional characteristics.

For more information regarding CSGWPPS, refer to OSWER Directive 9283.1-09, "The Role of CSGWPPs in EPA Remediation Programs," April 4, 1997 at http://www.epa.gov/superfund/resources/csgwpp/role.pdf .

14. **Technical Impracticability**

Technical impracticability was discussed in detail in the 1996 ANPR and the 1990 Subpart S proposal, and the Agency's views have not changed significantly since that time. The Agency continues to believe that, for certain media or constituents at certain facilities or portions of facilities, it may be technically impracticable, from an engineering perspective, to achieve media cleanup objectives (recall media cleanup objectives include concepts of media cleanup levels, points of compliance and remediation time frames). Detailed Agency guidance on this subject can also be found "Guidance for Evaluating the Technical Impracticability of Ground Water Restoration" (EPA 540-R-93-080). As stated in the 1996 ANPR, recognizing technical impracticability does not indicate that the Agency is scaling back the general goal of returning contaminated groundwater to beneficial uses. Technical impracticability decisions should generally be based on appropriate technical justification that should be provided by the owner/operator. Where technical impracticability is determined for a defined area, the Agency expects that an alternative remedial strategy would be implemented that is: (1) technically practicable; (2) consistent with the overall remedial objectives for the site; and (3) controls the source(s) of contamination and exposures to human and environmental receptors. Additionally,

program implementors should recognize that technical impracticability determinations should be made for a geographically defined area (ideally in three dimensions if appropriate); this reference to a "defined area" means that while it may be technically impracticable to achieve a certain cleanup level in one area, it may still be technically practicable, and therefore appropriate, to achieve the same cleanup level outside that area. Program implementors should also keep in mind that a determination of technical impracticability in the RCRA Corrective Action program is an acknowledgment of the current understanding of site conditions and available remedial technologies. Additional measures may be required, as appropriate, by EPA in the future if subsequent advances in remedial technologies make attainment of media cleanup objectives technically practicable.

Program implementers considering technical impracticability determinations should keep abreast of advances in remedial remedial technologies, especially with regard to advances (e.g., using heat, surfactants, etc.) made in enhanced extraction of non-aqueous phase liquid (NAPL) contamination. Experience has shown that relying solely on "pump and treat" to remediate NAPL contaminated groundwater is typically inefficient and often ineffective with regard to achieving a restoration objective. Therefore, technical impracticability determinations being considered for NAPL contaminated groundwater should generally include an evaluation of enhanced recovery techniques, rather than basing the technical impracticability determination solely on the apparent inability of pump and treat to achieve objectives.

Helpful resources include:

Remediation Technologies Screening Matrix and Reference Guide, Third Edition, Federal Remediation Technologies Roundtable, http://www.frtr.gov (Handout included in Tool Book)

Remediation Case Studies: Fact Sheet and Order Form, EPA542-F-98-023, Federal Remediation Technologies Roundtable, Searchable database of case studies at http://www.frtr.gov (fact sheet included in Tool Book)

EPA Remediation and Characterization Innovative Technologies (EPA REACHIT) Fact Sheet, USEPA, 1998, On-line database at http://ww.epareachit.com (fact sheet included in Tool Book)

15. **Institutional Controls (long-term physical or land use controls)**

Final remedies at RCRA Corrective Action facilities can incorporate a range of physical requirements, operation and maintenance requirements, and land use designations. For the most part, EPA believes that remedies which rely on operation and maintenance or physical controls should be completed (e.g. should be at the stage where continued operation and maintenance or maintenance of a physical control are no longer necessary) before a facility owner/operator seeks a determination that corrective action is complete. However, the Agency also recognizes that in some instances, after there is no more need for long-term monitoring or active operation and maintenance, it could be appropriate to find that corrective

action is complete when hazardous waste or hazardous constituents are left in place at a facility. EPA believes this will most often be the case when corrective action decisions are based on non-residential land use assumptions. In such situations, EPA strongly believes that the remaining restrictions on facility use should be adequately and accurately recorded to ensure that future property owners do not unknowingly violate the conditions in a corrective action remedy and, thereby, risk exposure.

In 1990, EPA proposed that the Regional Administrator could require facility owners/operators to provide notice (by means of a deed notice) whenever hazardous waste or hazardous constituents were left in place after remedy completion. The notice would have consisted of a notation in the deed to the facility property or a notification through some other instrument routinely searched when property ownership was transferred. Under the 1990 proposal, this notice requirement would have applied whether hazardous waste or hazardous constituents were left in place on discrete units (e.g. a landfill) or diffused throughout any given medium. The Agency continues to believe that providing information on the deed through informational devices like deed notifications (or notifications in other instruments) is generally appropriate when hazardous waste or hazardous constituents are left in place at a facility. However, EPA's views on the use of protective institutional controls for such remedies has evolved since 1990. The following discussion represents EPA's most current approach.

When a deed notification, or notification in another instrument, is required, EPA believes it should clearly indicate the types, concentrations, and locations of hazardous waste or hazardous constituents that remain at a facility in addition to the land use or other assumptions on which the remedy selection was based. The Agency further believes determinations that corrective action is complete are generally appropriate only when any long- term monitoring associated with a remedy is complete. This is, in EPA's view, analogous to the completion of post-closure care.

Since the 1990 Proposal, the Agency has learned that when corrective action is deemed complete, and the site ceases to be subject to the same level of regulatory oversight, use of an informational device that provides information on the deed, such as the use of the deed notice or deed notification alone may not provide a sufficiently protective remedy in all cases. The reason is that an informational device like the deed notice, for example, is not an "interest in real property", meaning that it simply provides information, and does not exert any sort of proprietary control over the property in question. Recording a notice, for example, has little or no effect on a property owner's legal rights regarding the future use of the property. Neither the present owner, nor any successors would be legally bound by any use restrictions referred to in the deed notice.

Where a final remedy involves leaving hazardous waste or hazardous constituents in place above levels suitable for unrestricted use (such as remedies that rely on non-residential future land use determinations), the Agency strongly encourages the appropriate responsible state or local governments to require that any controls limiting exposure be appropriately established,

implemented, monitored, and enforced in a manner that ensures long-term protection of human health and the environment. Such exposure controls may include non-engineering or "institutional controls", and may be most attractive to states and local governments that already have the statutory authority to implement such controls.

The term "institutional controls" refers to non-engineering measures (usually, but not always, legal controls) intended to affect human activities in such a way as to prevent exposure to hazardous substances. Where a cleanup is protective for industrial, but not residential, exposures, institutional controls may be needed to prevent residential use from taking place at the site. Establishing effective institutional controls will in some cases depend upon the authority of state or local government entities to impose such controls. Therefore, it is extremely important to identify as early as possible what state and local authorities may have jurisdiction over a particular property, and what state and local provisions may provide the basis for institutional controls. In developing final remedies with institutional controls, EPA or the authorized state should consult with state or local governmental authorities to determine whether they would be willing to take the lead on enforcing institutional controls, and what concerns they may have should they be asked to play this role. Such consultation should take place during the analysis and evaluation stage, and not postponed until after the remedy is selected.

Institutional controls can be created in a variety of ways. Property law devices, or "proprietary" controls are perhaps the most common type of control. Controls established through some governmental entity's regulatory authority, such as zoning restrictions or controls on well drilling, are a second category. Enforcement tools, such as unilateral or consent decrees issued under RCRA Section 30008(h) or CERCLA Section 106, can also be used to limit land use. In many cases, such controls may be most effective when different types (deed restrictions, informational devices, zoning restrictions, etc.) are layered on the same piece of property so that they are sufficient to prevent current and future exposure to humans and/or the environmental receptors above media cleanup levels.

The term "deed restrictions" should be understood as simply a catchall term for proprietary controls such as easements and covenants that are legally enforceable against subsequent owners. Absent some special authority under state law, only the conveyance of a property interest, such as an easement, creates an enforceable control. A distinctive feature of proprietary controls is that, because they are based on generally applicable property law, they can be implemented without the intervention of any federal, state or local regulatory authority. Easements are generally less useful where a large number of parcels are involved, and the current owner of the land is not subject to regulation under RCRA (or CERCLA). Easements may not be a practical way of preventing exposure to contaminated groundwater where a plume has spread over a wide area. Traditional common law doctrines can limit the enforceability of easements against successors in title. Things to consider when planning to use a proprietary type of control are: the nature and extent of the control to be imposed; whether the control will be binding on subsequent property owners; and whether the right to enforce the control can be transferred to other parties.

Governmental controls use the regulatory authority of a governmental unit to impose restrictions on citizens or sites under its jurisdiction. Since RCRA and CERCLA do not specifically authorize EPA to regulate land use in a comprehensive manner, EPA should generally turn to state or local governments to establish controls of such type. Examples of governmental controls are zoning laws/ordinances, local permits (building, etc), tailored ordinances, groundwater use restrictions, advisories, state registry of hazardous waste sites, and property condemnation. The advantages of this type of control over proprietary controls are that they don't require the negotiation of parcel by parcel restrictions, and that the legal impediments to the long run enforcement of proprietary controls can be avoided; i.e. they remain effective as long as they are not repealed.

Enforcement tools available to EPA under RCRA and CERCLA may also be used to restrict the use of land. Enforcement authority might be used in two ways in establishing institutional controls. First, an enforcement instrument such as an administrative order or consent decree may prohibit the party named in the order or decree from using land in certain ways, or from carrying out prohibited activities at the specified property. Second, a consent decree may be used to require settling parties to put in place some other form of control, such as a proprietary control (for example, by conveying an easement to the government, or obtaining one from a third party). Enforcement authority may be based on orders under ss. 3008(h) and 7003 of RCRA.

It may be desirable to establish restrictions that run with the land and bind future landowners as well as the current owner/operator. This would be most likely where there is a desire to create restrictions that will outlive the RCRA permit or order. To accomplish this, it will generally be necessary to establish a proprietary or governmental control. For proprietary controls, there should generally be a transaction conveying a property interest (e.g. an easement) from the landowner to another party who is then the holder and enforcer of that interest. A permit or order may direct the owner/operator to convey such an interest to someone who will then be the enforcer. If a governmental approach appears promising, the permit or order would likely require the owner/operator to take steps to see that such controls are adopted by the local jurisdiction.

In addition to controls discussed above, it is generally advisable that the o/o also document, for the appropriate authorities, the land use assumptions on which the remedy selection was based, and to also inform them whenever any of the basic assumptions/conditions had changed over time so as to be inconsistent with the initial assumptions. Notification of changes in conditions is generally critical because, even if land and groundwater uses were restricted, there would typically be some remaining potential for migration of contamination and/or for exposure of potentially exposed populations and the environment to occur.

FACT SHEET #2

EXPECTATIONS FOR FINAL REMEDIES AT RCRA CORRECTIVE ACTION FACILITIES

Congress, the general public, EPA, and State agencies believe the rate and pace of RCRA cleanups should be increased. Speaking at the RCRA National Program meeting on January 12, 1999, Acting Assistant Administrator Tim Fields indicated that Corrective Action progress was the RCRA program's highest priority in 1999. One of the efforts designed to improve Corrective Action progress is a new workshop titled, "RCRA Corrective Action Workshop on Results-Based Project Management." This is the second in a series of fact sheets supporting the Workshop.

WHAT IS THE PURPOSE OF THIS FACT SHEET?

This fact sheet [1,2] conveys the Agency's general expectations for final remedies at RCRA Corrective Action facilities. EPA believes that an awareness of these expectations will help focus facility investigations as well as the evaluation and selection of remedial alternatives.

WHAT ARE THE AGENCY'S EXPECTATIONS FOR FINAL CORRECTIVE ACTION REMEDIES?

Final remedies for RCRA Corrective Action facilities should be protective of human health and the environment, and maintain protection over time. In meeting this remedial goal, EPA has learned that certain combinations of facility-specific circumstances are often addressed by similar approaches. Based on this experience, the Agency has developed certain general expectations [3] for remedies. Remedy expectations are not binding requirements; rather, they should be used to focus program implementors and facility owner/operators on remedial alternatives that have the greatest likelihood of fulfilling the statutory and regulatory intent of RCRA Corrective Action. Currently, EPA has the following remedial expectations for implementing final remedies at RCRA Corrective Action facilities:

- EPA expects to use treatment to address the principal threats posed by a site whenever practicable and cost-effective. Contamination that represents principal threats for which treatment is most likely to be appropriate includes contamination that is highly toxic, highly mobile, or cannot be reliably contained, and that would present a significant risk to human health and the environment should exposure occur.

- EPA expects to return usable groundwaters to their maximum beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of groundwater is not practicable, EPA expects to prevent or minimize further migration of the plume, prevent exposure to the contaminated groundwater and evaluate further risk reduction. EPA also expects to control or eliminate surface and subsurface sources of groundwater contamination.

- EPA expects to use engineering controls, such as containment, for wastes and contaminated media which can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable.

- EPA expects to use a combination of methods (e.g., treatment, engineering and institutional controls), as appropriate, to achieve protection of human health and the environment.

- EPA expects to use institutional controls such as water and land use restrictions primarily to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous wastes and constituents. EPA does not expect that institutional controls will often be the sole remedial action.

- EPA expects to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, less adverse impact, or lower costs for acceptable levels of performance when compared to more conventional technologies.

- EPA expects to remediate contaminated soils as necessary to prevent or limit direct exposure of human and environmental receptors and prevent the transfer of unacceptable concentrations of contaminants (e.g., via leaching, runoff or air borne emissions) from soils, including subsurface soils, to other media..

WHERE DO I GET MORE INFORMATION?

For more information about RCRA Corrective Action and the Results Based Site Management Workshop, visit the Corrective Action Internet Home Page at http://www.epa.gov/correctiveaction.

Notes:

1. This document provides guidance to EPA and States on how best to implement RCRA and EPA' s regulations to facilitate RCRA Corrective Action. It also provides guidance to the public and the regulated community on how EPA intends to exercise its discretion in implementing its regulations. The document does not, however, substitute for EPA' s regulations, nor is it regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future as appropriate.

2. These expectations were taken from the May 1, 1996 Advance Notice of Proposed Rulemaking (ANPR) for RCRA Corrective Action Facilities (61 FR 19432). Many of these expectations were first articulated in the discussion of remedy selection at CERCLA sites in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 430(a)(1)).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 25 1991

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Managing the Corrective Action Program for Environmental Results: The RCRA Facility Stabilization Effort

FROM: Sylvia K. Lowrance, Director
Office of Solid Waste

Bruce M. Diamond, Director
Office of Waste Programs Enforcement

TO: Regions I-X RCRA Waste Management Division Directors

The purpose of this memo is two-fold. First, we are transmitting to you some important guidance documents that have been developed to ease the implementation of the RCRA facility stabilization effort. Second, and perhaps more importantly, we wanted to take this opportunity to ask for your help and personal involvement in making the stabilization effort a reality. Fully embracing this effort means adjusting our Program's philosophy by placing increased emphasis on taking actions at many facilities to prevent situations from getting worse. We need your help in transmitting this message down through the ranks and in identifying and overcoming obstacles to success.

When the RCRA Implementation Study (RIS) was issued in July, 1990, it suggested that the RCRA Corrective Action Program needed to adjust its longtime program emphasis. In essence, the RIS recommended that we adopt as our program strategy more frequent use of interim actions to achieve near term environmental results at facilities with the most serious problems. While final cleanup is still the longterm goal for the corrective action program, this strategy emphasizes the importance of controlling releases and stabilizing sites to prevent the further spread of contamination as the first phase of corrective action. Stabilization of RCRA facilities means that we take whatever action is necessary at as many facilities as possible to address actual exposures (imminent risks) and to prevent the further spread of contamination. Although we recognize that stabilization actions will not always be appropriate or possible, we should demonstrate a "bias" for stabilization actions in the way we manage corrective action at RCRA facilities. We need your full support and dedication to this effort for it to be successful.

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Over the course of the past year, Headquarters and the Regions have worked hard to take this recommendation and pave the road to implementation. The FY92 RCRA Implementation Plan (RIP) identifies stabilization activities as an area of national program emphasis and outlines the STARS measures associated with evaluating facilities for stabilization actions, and with implementing those measures. Further, this memo includes as attachments several guidance documents and a proposed checklist for completing stabilization actions. We hope that you will find this guidance, which was developed with a great deal of regional involvement, helpful as you begin implementing this important initiative.

Thank you for your efforts and your continuing support.

Attachments

RCRA STABILIZATION STRATEGY

Goals

One of the major recommendations of the RCRA Implementation Study (RIS) calls for the RCRA corrective action program to adopt as a program management goal the "stabilization" of RCRA facilities as soon as possible. Over the next several years, the Agency and the States will begin implementing a major initiative to achieve this goal. This strategy paper is intended to:

- Explain the concept of facility stabilization; and
- Discuss the basic data needs to make decisions concerning facility stabilization and future guidance development in this area.

The overall goal of stabilization is to, as situations warrant, control or abate threats to human health and/or the environment from releases at RCRA facilities, and/or to prevent or minimize the further spread of contamination while long-term remedies are pursued.

Implementing the stabilization strategy will yield substantial benefits for the corrective action program. Focusing resources in the near term on stabilizing environmental problems, rather than pursuing final, comprehensive remedies at all facilities, should enable the Agency and States to control the most serious environmental problems at a larger number of facilities, more quickly. Furthermore, by imposing such expeditious controls, the extent and incidence of continued environmental degradation from existing releases should be significantly reduced. However, if a stabilization measure is found to be inconsistent with the final remedy or the waste or site conditions, it should be modified or not be imposed.

Process

To a large extent, this stabilization effort builds on work that has been ongoing in EPA Regions and States. Although stabilization is a new RCRA strategy, it will not create a new regulatory or administrative process. Stabilization measures will be implemented through the existing process described in the proposed RCRA corrective action rule, and in the RCRA Interim Measures Guidance Document. Interim measures are the corrective action activities used to achieve the goal of stabilization. Regions have already required a large number of facility owners/operators to undertake interim measures to address obvious environmental problems, particularly where actual or imminent exposure of human or environmental populations has been identified.

Interim measures, as discussed in the proposed corrective action rule and in the RCRA Interim Measures Guidance, may be conducted at a facility whenever the Agency determines that a release, or threat of a release, poses a threat to human health or the environment. These releases may be actual, imminent, or potential, and pose a threat to such receptors as human populations, animals, ecosystems, and/or drinking water.

Along with interim measures, other RCRA remedial approaches (e.g., conditional remedies and voluntary actions by owner/operators) will also be used to achieve stabilization. These remedial approaches are intended to phase-in over time and, therefore, may include stabilization activities to control the migration of wastes on-site and to expedite cleanup of releases that have migrated beyond the facility boundary. Voluntary corrective actions may be conducted at RCRA facilities that wish to initiate stabilization activities rather than wait for EPA to begin actively pursuing corrective action at the facility. Voluntary activities, however, do not release owners/operators from RCRA liability or exempt them from future Agency action, if necessary.

While this stabilization effort builds upon ongoing activities, the significant change is that the national program is adopting the philosophy that overall there are increased environmental benefits associated with taking stabilization actions at more facilities in the near to mid-term, prior to pursuing final, comprehensive remedies at most facilities. However, RCRA Facility Investigations (RFIs) will continue, albeit at a slower pace, at many facilities since they are necessary for the ultimate cleanup of a facility.

By implementing stabilization measures at a facility, the Agency may be able to limit active oversight of the facility while addressing other high priority facilities; in other circumstances, stabilization could simply be a milestone within a continuing remediation process. There may also be cases where a stabilization measure could be technically effective enough to serve as a final remedy for a particular release (e.g., when stabilization achieves final clean-up levels). Consideration of the stabilization measure as a final remedy would be based upon evaluation of performance monitoring data collected after the measure was implemented. In addition, public participation should be a part of any stabilization action that is viewed as the potential final remedy for the facility.

Procedurally, it is expected that stabilization will typically involve an evaluation of RCRA Facility Assessment (RFA) information to identify the need for stabilization techniques. Subsequent information gathering during the RFI should be focused to support technical decisions regarding the stabilization approach chosen, and implementing the technical "fix." Although public participation should be a part of a stabilization action that serves as the final remedy, interim measures that are part of a permit or order do not necessarily have to be public noticed at the time the measure is implemented.

The initiation of the stabilization "process" will be primarily a function of the overall priority of the facility, as determined by the national corrective action prioritization protocol. The Agency will assign the highest priority to those facilities that are determined to pose actual or imminent exposure threats to human populations or environmental receptors. Regions and States can also impose stabilization measures at middle and low priority facilities after appropriate actions have been taken to stabilize releases at high priority facilities.

Technical Considerations

Stabilization is a new program philosophy and should not be confused with measures that were historically considered stabilization technologies. Many of the stabilization technologies had the goals of immobilizing wastes and included solidification, vitrification, and other immobilization techniques. Although these technologies may be effective as stabilization measures in certain situations, this effort is broader and includes other source control measures along with measures that will mitigate the further spread of contamination. Measures to stabilize releases or other environmental problems could include the installation of a large scale pump and treat system combined with treatment and/or containment-based source control actions. In addition, exposure controls, such as fences, other access controls, or provision of alternative water supplies, may also be required to mitigate actual or imminent exposure to health threats.

Stabilization may be appropriate for a facility under any of the following conditions:

- There are releases at the facility which pose actual or imminent exposure threats to humans or ecosystems at levels of concern;

- There are releases that, if not addressed expeditiously, will result in further significant contamination of environmental media in the near to mid-term (e.g., 5-10 years); or

- The site characteristics suggest that the site may be amenable to measures designed to control or abate imminent threats or prevent or minimize the further spread of contamination.

Information needed to answer these questions may be available after the RFA has been completed, especially data on imminent threats. However, in many situations data on the fate and transport of hazardous constituents will not be available until the RFI is underway or completed. Given that the selection of an appropriate stabilization measure is dependent upon the collection of sufficient site/unit characterization data, the Agency suggests that data needed to make decisions on stabilization be gathered up-front in the RFI process. Figure 1 briefly outlines some key decision points for selecting stabilization measures.

Stabilization measures should be applied to address releases to all environmental media. Technical limitations of remedial efforts (such as restoring contaminated ground water to drinking water quality), and lack of detailed information on contaminants and releases (such as with air releases), further underline the need to focus remedial efforts on preventing the further spread of existing contamination problems, as well as preventing new contamination from occurring.

The timing, process, and technical approach to stabilizing facilities will vary widely, and will be highly dependant on a variety of site-specific factors. These factors could include:

- Environmental significance (i.e., priority) of the facility;

- Immediacy of exposure threats;

- Types of contaminants and volumes of releases;

- Technical complexity of remediation;

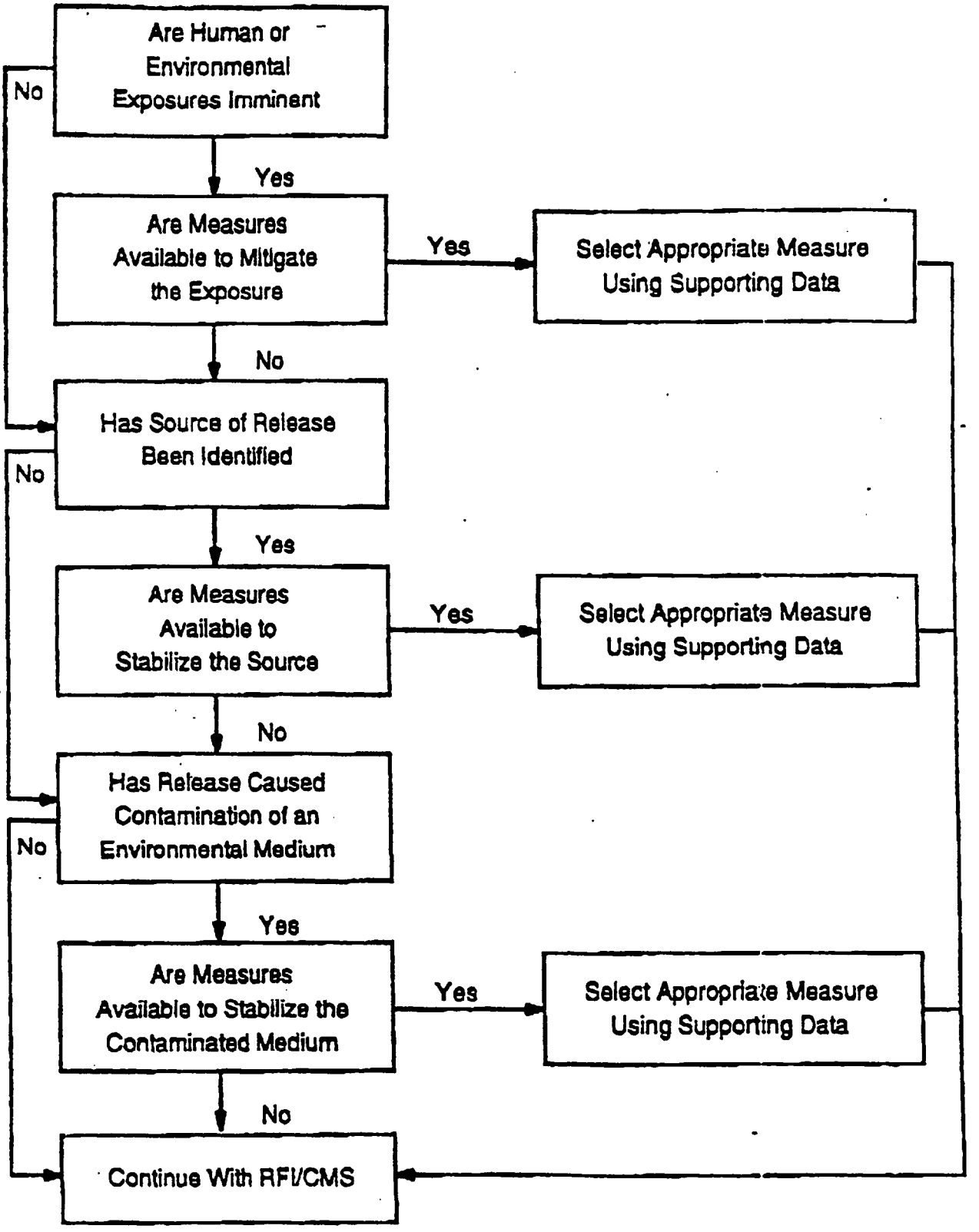
- Site hydrogeology, or other media-specific characteristics; and

decisions for stabilization will also vary greatly. Obvious removal-type situations might often be done more or less immediately, without extensive studies; while ground-water contamination in a complex hydrogeologic setting could require extensive investigations before an effective stabilization remedy could be chosen.

The Office of Solid Waste and Emergency Response (OSWER) is developing guidance that specifies the types of environmental problems which should be the focus of stabilization actions. The guidance will specify technical approaches to accelerate data-gathering to support decisions on appropriate stabilization measures, and describe phasing the RFI process to gather the necessary data to make decisions regarding stabilization. Draft guidance should be available in the fall, 1991.

The OSWER is also working closely with the Office of Research and Development, Center for Environmental Research Information (ORD-CERI) to produce guidance on stabilization technologies and case studies of successful implementation of stabilization technologies. Several actual examples of stabilization technologies that have be implemented at RCRA facilities will be used as case studies for discussing the appropriateness of certain technologies. In addition, the technical guidance document will cover data needs, performance criteria, and environmental conditions. This document should also be available in the fall, 1991.

Figure 1
Key Decision Points for Selecting Interim Measures



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 25 1995

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

OSWER Directive No. 9355.7-04

MEMORANDUM

SUBJECT: Land Use in the CERCLA Remedy Selection Process

FROM: Elliott P. Laws
Assistant Administrator

TO: Director, Waste Management Division
Regions I, IV, V, VII
Director, Emergency and Remedial Response Division
Region II
Director, Hazardous Waste Management Division
Regions III, VI, VIII, IX
Director, Hazardous Waste Division,
Region X
Director, Environmental Services Division
Regions I, VI, VII

Purpose:

This directive presents additional information for considering land use in making remedy selection decisions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at National Priorities List (NPL) sites. The U.S. Environmental Protection Agency (EPA) believes that early community involvement, with a particular focus on the community's desired future uses of property associated with the CERCLA site, should result in a more democratic decisionmaking process; greater community support for remedies selected as a result of this process; and more expedited, cost-effective cleanups.

The major points of this directive are:

- Discussions with local land use planning authorities, appropriate officials, and the public, as appropriate, should be conducted as early as possible in the scoping phase of the Remedial Investigation/Feasibility Study (RI/FS). This will assist EPA in understanding the

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reasonably anticipated future uses of the land on which the Superfund site is located;

- If the site is located in a community that is likely to have environmental justice concerns, extra efforts should be made to reach out to and consult with segments of the community that are not necessarily reached by conventional communication vehicles or through local officials and planning commissions;

- Remedial action objectives developed during the RI/FS should reflect the reasonably anticipated future land use or uses;

- Future land use assumptions allow the baseline risk assessment and the feasibility study to be focused on developing practicable and cost effective remedial alternatives. These alternatives should lead to site activities which are consistent with the reasonably anticipated future land use. However, there may be reasons to analyze implications associated with additional land uses;

- Land uses that will be available following completion of remedial action are determined as part of the remedy selection process. During this process, the goal of realizing reasonably anticipated future land uses is considered along with other factors. Any combination of unrestricted uses, restricted uses, or use for long-term waste management may result.

Discussions with local land use authorities and other locally affected parties to make assumptions about future land use are also appropriate in the RCRA context. EPA recognizes that RCRA facilities typically are industrial properties that are actively managed, rather than the abandoned sites that are often addressed under CERCLA. Therefore, consideration of non-residential uses is especially likely to be appropriate for RCRA facility cleanups. Decisions regarding future land use that are made as part of RCRA corrective actions raise particular issues for RCRA (e.g., timing, property transfers, and the viability of long-term permit or other controls) in ensuring protection of human health and the environment. EPA intends to address the issue of future land use as it relates specifically to RCRA facility cleanups in subsequent guidance and/or rulemakings.

This guidance is also relevant for Federal Facility sites. Land use assumptions at sites that are undergoing base closure may be different than at sites where a Federal agency will be maintaining control of the facility. Most land management agency sites will remain in Federal ownership after remedial actions. In these cases, Forest Land Management Plans and other resource

management guidelines may help develop reasonable assumptions about future uses of the land. At all such sites, however, this document can focus the land use consideration toward appropriate options.[1]

Background:

Reasonably anticipated future use of the land at NPL sites is an important consideration in determining the appropriate extent of remediation. Future use of the land will affect the types of exposures and the frequency of exposures that may occur to any residual contamination remaining on the site, which in turn affects the nature of the remedy chosen. On the other hand, the alternatives selected through the National Oil and Hazardous Substance Contingency Plan (NCP) [55 Fed. Reg. 8666, March 8, 1990] process for CERCLA remedy selection determine the extent to which hazardous constituents remain at the site, and therefore affect subsequent available land and ground water uses.

The NCP preamble specifically discusses land use assumptions regarding the baseline risk assessment. The baseline risk assessment provides the basis for taking a remedial action at a Superfund site and supports the development of remedial action objectives. Land use assumptions affect the exposure pathways that are evaluated in the baseline risk assessment. Current land use is critical in determining whether there is a current risk associated with a Superfund site, and future land use is important in estimating potential future threats. The results of the risk assessment aid in determining the degree of remediation necessary to ensure long-term protection at NPL sites.

EPA has been criticized for too often assuming that future use will be residential. In many cases, residential use is the least restricted land use and where human activities are associated with the greatest potential for exposures. This directive is intended to facilitate future remedial decisions at NPL sites by outlining a public process and sources of information which should be considered in developing reasonable assumptions regarding future land use.

This directive expands on discussions provided in the preamble to the National Oil and Hazardous Substance Contingency Plan (NCP); "Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual" (Part A) (EPA/540/1-89/002, Dec. 1989); "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (OSWER Directive 9355.3-01, Oct. 1988); and

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[1] Federal agency responsibility under CERCLA 120(h)(3), which relates to additional clean up which may be required to allow for unrestricted use of the property, is not addressed in this guidance.

"Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" (OSWER Directive 9355.0-30, April 22, 1991).

This land use directive may have the most relevance in situations where surface soil is the primary exposure pathway. Generally, where soil contamination is impacting ground water, protection of the ground water may drive soil cleanup levels. Consideration of future ground water use for CERCLA sites is not addressed in this document. There are separate expectations established for ground water in the NCP rule section 300.430 (a)(1)(iii)(F) that "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site."

Objective

This directive has two primary objectives. First, this directive promotes early discussions with local land use planning authorities, local officials, and the public regarding reasonably anticipated future uses of the property on which an NPL site is located. Second, this directive promotes the use of that information to formulate realistic assumptions regarding future land use and clarifies how these assumptions fit in and influence the baseline risk assessment, the development of alternatives, and the CERCLA remedy selection process.

Implementation

The approach in this guidance is meant to be considered at current and future sites in the RI/FS pipeline, to the extent possible. This directive is not intended to suggest that previous remedy selection decisions should be re-opened.

Developing Assumptions About Future Land Use

In order to ensure use of realistic assumptions regarding future land uses at a site, EPA should discuss reasonably anticipated future uses of the site with local land use planning authorities, local officials, and the public, as appropriate, as early as possible during the scoping phase of the RI/FS. EPA should gain an understanding of the reasonably anticipated future land uses at a particular Superfund site to perform the risk assessment and select the appropriate remedy.

A visual inspection of the site and its surrounding area is a good starting point in developing assumptions regarding future land use. Discussions with the local land use authorities and appropriate officials should follow. Discussions with the public can be accomplished through a public meeting and/or other means. By developing realistic assumptions based on information gathered from these sources early in the RI/FS process, EPA may develop

remedial alternatives that are consistent with the anticipated future use.

The development of assumptions regarding the reasonably anticipated future land use should not become an extensive, independent research project. Site managers should use existing information to the extent possible, much of which will be available from local land use planning authorities. Sources and types of information that may aid EPA in determining the reasonably anticipated future land use include, but are not limited to:

- Current land use
- Zoning laws
- Zoning maps
- Comprehensive community master plans
- Population growth patterns and projections (e.g., Bureau of Census projections)
- Accessibility of site to existing infrastructure (e.g., transportation and public utilities)
- Institutional controls currently in place
- Site location in relation to urban, residential, commercial, industrial, agricultural and recreational areas
- Federal/State land use designation (Federal/State control over designated lands range from established uses for the general public, such as national parks or State recreational areas, to governmental facilities providing extensive site access restrictions, such as Department of Defense facilities
- Historical or recent development patterns
- Cultural factors (e.g., historical sites, Native American religious sites)
- Natural resources information
- Potential vulnerability of ground water to contaminants that might migrate from soil
- Environmental justice issues
- Location of on-site or nearby wetlands
- Proximity of site to a floodplain
- Proximity of site to critical habitats of endangered or threatened species
- Geographic and geologic information
- Location of Wellhead Protection areas, recharge areas, and other areas identified in a State's Comprehensive Ground-water Protection Program

These types of information should be considered when developing the assumptions about future land use. Interaction with the public, which includes all stakeholders affected by the site, should serve to increase the certainty in the assumptions made regarding future land use at an NPL site and increase the

confidence expectations about anticipated future land use are, in fact, reasonable.

For example, future industrial land use is likely to be a reasonable assumption where a site is currently used for industrial purposes, is located in an area where the surroundings are zoned for industrial use, and the comprehensive plan predicts the site will continue to be used for industrial purposes.

Community Involvement

NPL sites are located in diverse areas of the country, with great variability in land use planning practices. For some NPL sites, the future land use of a site may have been carefully considered through local, public, participatory, planning processes, such as zoning hearings, master plan approvals or other vehicles. When this is the case, local residents around the Superfund site are likely to demonstrate substantial agreement with the local land use planning authority on the future use of the property. Where there is substantial agreement among local residents and land use planning agencies, owners and developers, EPA can rely with a great deal of certainty on the future land use already anticipated for the site. For other NPL sites, however, the absence or nature of a local planning process may yield considerably less certainty about what assumptions regarding future use are reasonable. In some instances the local residents near the Superfund site may feel disenfranchised from the local land use planning and development process. This may be an especially important issue where there are concerns regarding environmental justice in the neighborhood around the NPL site. Consistent with the principle of fairness, EPA should make an extra effort to reach out to the local community to establish appropriate future land use assumptions at such sites.

Land Use Assumptions in the Baseline Risk Assessment

Future land use assumptions allow the baseline risk assessment and the feasibility study to focus on the development of practicable and cost-effective remedial alternatives, leading to site activities which are consistent with the reasonably anticipated future land use.

The baseline risk assessment generally needs only to consider the reasonably anticipated future land use; however, it may be valuable to evaluate risks associated with other land uses. The NCP preamble (55 Fed. Reg. 8710) states that in the baseline risk assessment, more than one future land use assumption may be considered when decision makers wish to understand the implications of unexpected exposures. Especially where there is some uncertainty regarding the anticipated future land use, it may be useful to compare the potential risks associated with several land use scenarios to estimate the impact

on human health and the environment should the land use unexpectedly change. The magnitude of such potential impacts may be an important consideration in determining whether and how institutional controls should be used to restrict future uses. If the baseline risk assessment evaluates a future use under which exposure is limited, it will not serve the traditional role, evaluating a "no action" scenario. A remedy, i.e. institutional controls to limit future exposure, will be required to protect human health and the environment. In addition to analyzing human health exposure scenarios associated with certain land uses, ecological exposures may also need to be considered.

Developing Remedial Action Objectives

Remedial action objectives provide the foundation upon which remedial cleanup alternatives are developed. In general, remedial action objectives should be developed in order to develop alternatives that would achieve cleanup levels associated with the reasonably anticipated future land use over as much of the site as possible. EPA recognizes, however, that achieving either the reasonably anticipated land use, or the land use preferred by the community, may not be practicable across the entire site, or in some cases, at all. For example, as RI/FS data become available, they may indicate that the remedial alternatives under consideration for achieving a level of cleanup consistent with the reasonably anticipated future land use are not cost-effective nor practicable. If this is the case, the remedial action objective may be revised which may result in different, more reasonable land use(s).

EPA's remedy selection expectations described in section 300.430(a)(1)(iii) of the NCP should also be considered when developing remedial action objectives. Where practicable, EPA expects to treat principal threats, to use engineering controls such as containment for low-level threats, to use institutional controls to supplement engineering controls, to consider the use of innovative technology, and to return usable ground waters to beneficial uses to protect human health and the environment. (Some types of applicable or relevant and appropriate requirements (ARARs) define protective cleanup levels which may, in turn, influence post-remediation land use potential.)

In cases where the future land use is relatively certain, the remedial action objective generally should reflect this land use. Generally, it need not include alternative land use scenarios unless, as discussed above, it is impracticable to provide a protective remedy that allows for that use. A landfill site is an example where it is highly likely that the future land use will remain unchanged (i.e., long-term waste management area), given the NCP's expectation that treatment of high volumes of waste generally will be impracticable and the fact that EPA's presumptive remedy for landfills is containment. In such a case,

a remedial action objective could be established with a very high degree of certainty to reflect the reasonably anticipated future land use.

In cases where the reasonably anticipated future land use is highly uncertain, a range of the reasonably likely future land uses should be considered in developing remedial action objectives. These likely future land uses can be reflected by developing a range of remedial alternatives that will achieve different land use potentials. The remedy selection process will determine which alternative is most appropriate for the site and, consequently, the land use(s) available following remediation.

As discussed in "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" (OSWER Directive 9355.0-30, April 22, 1991), EPA has established a risk range for carcinogens within which EPA strives to manage site risks. EPA recognizes that a specific cleanup level within the acceptable risk range may be associated with more than one land use (e.g., an industrial cleanup to 10^{-6} may also allow for residential use at a 10^{-4} risk level.) It is not EPA's intent that the risk range be partitioned into risk standards based solely on categories of land use (e.g., with residential cleanups at the 10^{-6} level and industrial cleanups at the 10^{-4} risk level.) Rather, the risk range provides the necessary flexibility to address the technical and cost limitations, and the performance and risk uncertainties inherent in all waste remediation efforts.

Land Use Considerations in Remedy Selection

As a result of the comparative analysis of alternatives with respect to EPA's nine evaluation criteria, EPA selects a site-specific remedy. The remedy determines the cleanup levels, the volume of contaminated material to be treated, and the volume of contaminated material to be contained. Consequently, the remedy selection decision determines the size of the area that can be returned to productive use and the particular types of uses that will be possible following remediation.

The volume and concentration of contaminants left on-site, and thus the degree of residual risk at a site, will affect future land use. For example, a remedial alternative may include leaving in place contaminants in soil at concentrations protective for industrial exposures, but not protective for residential exposures. In this case, institutional controls should be used to ensure that industrial use of the land is maintained and to prevent risks from residential exposures. Conversely, a remedial alternative may result in no waste left in place and allow for unrestricted use (e.g., residential use).

Results of Remedy Selection Process

Several potential land use situations could result from EPA's remedy selection decision. They are:

- The remedy achieves cleanup levels that allow the entire site to be available for the reasonably anticipated future land use in the baseline risk assessment (or, where future land use is uncertain, all uses that could reasonably be anticipated).

- The remedy achieves cleanup levels that allow most, but not all, of the site to be available for the reasonably anticipated future land use. For example, in order to be cost effective and practicable, the remedy may require creation of a long-term waste management area for containment of treatment residuals or low-level waste on a small portion of the site. The cleanup levels in this portion of the site might allow for a more restricted land use.

- The remedy achieves cleanup levels that require a more restricted land use than the reasonably anticipated future land use for the entire site. This situation occurs when no remedial alternative that is cost-effective or practicable will achieve the cleanup levels consistent with the reasonably anticipated future land use. The site may still be used for productive purposes, but the use would be more restricted than the reasonably anticipated future land use. Furthermore, the more restricted use could be a long-term waste management area over all or a portion of the site.

Institutional Controls

If any remedial alternative developed during the FS will require a restricted land use in order to be protective, it is essential that the alternative include components that will ensure that it remain protective. In particular, institutional controls will generally have to be included in the alternative to prevent an unanticipated change in land use that could result in unacceptable exposures to residual contamination, or, at a minimum, alert future users to the residual risks and monitor for any changes in use. In such cases, institutional controls will play a key role in ensuring long-term protectiveness and should be evaluated and implemented with the same degree of care as is given to other elements of the remedy. In developing remedial alternatives that include institutional controls, EPA should determine: the type of institutional control to be used, the existence of the authority to implement the institutional control, and the appropriate entity's resolve and ability to

implement the institutional control. An alternative may anticipate two or more options for establishing institutional controls, but should fully evaluate all such options. A variety of institutional controls may be used such as deed restrictions and deed notices, and adoption of land use controls by a local government. These controls either prohibit certain kinds of site uses or, at a minimum, notify potential owners or land users of the presence of hazardous substances remaining on site at levels that are not protective for all uses. Where exposure must be limited to assure protectiveness, a deed notice alone generally will not provide a sufficiently protective remedy. While the ROD need not always specify the precise type of control to be imposed, sufficient analysis should be shown in the FS and ROD to support a conclusion that effective implementation of institutional controls can reasonably be expected.

Suppose, for example, that a selected remedy will be protective for industrial land use and low levels of hazardous substances will remain on site. An industry may still be able to operate its business with the selected remedy in place. Institutional controls, however, generally will need to be established to ensure the land is not used for other, less restricted purposes, such as residential use, or to alert potential buyers of any remaining contamination.

Future Changes in Land Use

Where waste is left on-site at levels that would require limited use and restricted exposure, EPA will conduct reviews at least every five years to monitor the site for any changes. Such reviews should analyze the implementation and effectiveness of institutional controls with the same degree of care as other parts of the remedy. Should land use change, it will be necessary to evaluate the implications of that change for the selected remedy, and whether the remedy remains protective. EPA's role in any subsequent additional cleanup will be determined on a site-specific basis. If landowners or others decide at a future date to change the land use in such a way that makes further cleanup necessary to ensure protectiveness, CERCLA does not prevent them from conducting such a cleanup as long as protectiveness of the remedy is not compromised. (EPA may invoke CERCLA section 122(e)(6), if necessary, to prevent actions that are inconsistent with the original remedy.) In general, EPA would not expect to become involved actively in the conduct or oversight of such cleanups. EPA, however, retains its authority to take further response action where necessary to ensure protectiveness.

Further Information

If you have any questions concerning this directive, please call Sherri Clark at 703-603-9043.

NOTICE: The policies set out in this memorandum are intended solely as guidance. They are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this memorandum, or to act at variance with the guidance, based on an analysis of specific site circumstances. Remedy selection decisions are made and justified on a case-specific basis. The Agency also reserves the right to change this guidance at any time without public notice.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR - 4 1997

OSWER Directive 9283.1-09

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: The Role of CSGWPPs in EPA Remediation Programs

FROM: Timothy Fields, Jr.
Acting Assistant Administrator

TO: Regional Administrators
Regions I-X

PURPOSE

This Directive recommends that EPA remediation programs be familiar with Comprehensive State Ground Water Protection Programs (CSGWPPs) and utilize them as a means of giving more flexibility to a State for management of ground-water resources. EPA's ground-water remediation programs - **Superfund, RCRA Subtitle C and D, and Underground Storage Tanks -** have an important stake in the CSGWPP process. More specifically, this Directive establishes the policy that EPA remediation programs generally should:

- Defer to State determinations of current and future ground-water uses, when based on an EPA-endorsed CSGWPP that has provisions for site-specific decisions;
- Participate in EPA's review and endorsement of CSGWPPs; and
- Use other CSGWPP provisions, as appropriate, for more effective or efficient program implementation (e.g., increased program emphasis in geographic areas identified in a CSGWPP as having higher resource value or priority).

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For the Superfund program the policy, stated above, is intended to revise and supersede guidance provided in the Preamble to National Contingency Plan (NCP),[1] as discussed under *Implementation* (Section A) of this Directive.

Background information on CSGWPPs is provided below. More detailed discussion of when EPA should defer to State determinations of future ground-water use is provided under *Implementation,* Section A. Discussion of EPA involvement in the CSGWPP review and endorsement process is provided in Section B, and the role of other CSGWPP provisions in EPA remediation programs is discussed in Section C.

BACKGROUND

One of the primary purposes of a CSGWPP is to provide a framework for EPA to give greater flexibility to a State for management and protection of its ground-water resources. Such a program was first envisioned in EPA's Ground-Water Strategy for the 1990s,2 which states that:

> "To the extent authorized by EPA statute and consistent with Agency program implementation objectives, EPA will defer to State policies, priorities, and standards once a State has developed an 'adequate' program."

EPA's CSGWPP Guidance

Guidance describing what the Agency meant by an "adequate" ground-water program was issued in 1992. This document, entitled *Final Comprehensive State Ground Water Protection Program,*[3] identified six Strategic Activities that should be included in a Comprehensive State Ground Water Protection Program to be considered "adequate" by EPA. (Readers of this Directive are strongly advised to read the 1992 Final CSGWPP guidance to gain a more complete understanding of the CSGWPP approach.) The Strategic Activities identified in the 1992 Final CSGWPP Guidance are listed in Attachment 1.

The 1992 Final CSGWPP Guidance describes how developing a CSGWPP is a three-stage process. First, a State develops a Core CSGWPP and submits it to the EPA Regional office for review and endorsement. (The review and endorsement process is discussed under *Implementation,* Section B.) The Core Program **need include only one ground-water protection or remediation program** to demonstrate whether the State's CSGWPP approach is

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[1]The "National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule" (NCP) provides the regulatory framework for the Superfund program The NCP was published in 1990 in Volume 55, No. 46, March 8, 1990 of the Federal Register; and is included in the Code of Federal Regulations (CFR) as 40 CFR Part 300.

[2]"Protecting the Nations Ground Water: EPA's Strategy for the 1990s," Publication 2 1Z- 1020, Office of the Administrator, July 1991.

[3]EPA publication: EPA 1OO-R-93-OO1, Office of the Administrator, December 1992.

consistent with the guidance. Several States have already developed or are developing a Core CSGWPP, as indicated in Attachment 2. Second, after the Core Program is endorsed by EPA, joint State-EPA discussions should result in a "multi-year planning agreement" for incorporating additional State and EPA programs into the CSGWPP, leading to a "Fully Integrating CSGWPP." **The Core CSGWPP provides the basis for multi-year planning discussions.** Third, at the completion of the multi-year planning and implementation processes, a "Fully Integrating" CSGWPP occurs when the six previously mentioned Strategic Activities fundamentally influence and are supported by the day-to-day operations **of all federal, state and local ground-water related protection and remediation programs.** Adequacy criteria, which describe what EPA expects from a State for both a Core and Fully Integrating CSGWPP, are described in the 1992 Final CSGWPP guidance.

EPA Commitments Supporting CSGWPPs

In the 1992 Guidance, EPA recognized that fundamental changes within its own programs were just as much a prerequisite to achieving a Fully Integrating CSGWPP as the Strategic Activities that a State needs to undertake. EPA documented its willingness to change its own programs in a document entitled, *EPA's Commitments to Support Comprehensive State Ground- Water Protection Programs.*[4] This document identified specific actions, that EPA has already taken, will take, or will evaluate for future action to support CSGWPPs. The primary focus of the commitments is to provide the States enhanced flexibility for setting their own priorities and promoting greater State- and community-based decision making. The 1995 commitments reflect only the first set of EPA actions to support States developing CSGWPPs. EPA will continue to review proposals for future actions and program changes that could improve comprehensive ground-water protection.

CSGWPPs and Performance Partnership Agreements

A Performance Partnership Agreement (PPA) is a broad strategic document containing a joint statement of priorities and goals negotiated between a State and an EPA Region. It is also called an Environmental Performance Agreement. States that have negotiated or are in the process of negotiating PPAs may have accomplished some of the critical activities needed for a CSGWPP. For States that have an EPA-endorsed CSGWPP, the CSGWPP can become part of a PPA and would constitute the State's priority setting policy for ground-water protection and remediation. For further information concerning PPAs, refer to the EPA fact sheet entitled *State/EPA Performance Partnerships*[5].

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[4] EPA Publication EPA 100-R-95-002, Office of the Administrator, June 1995.

[5] Publication 1OO-F-96-O24, Office of Regional Operations and State/Local Operations, October 1996.

CSGWPPS and EPA Remediation Programs

The overall goal of EPA remediation programs is to protect human health and the environment. With respect to ground water, this goal includes taking actions to prevent ground-water resources from becoming contaminated in the first place, preventing unacceptable exposures of human and ecologic receptors to contaminated ground water, and remediating contaminated aquifers to beneficial uses where practicable. EPA recognizes the limited resources available for ground-water protection and remediation, the need to prioritize these activities, and the central role of the States in making ground-water protection and remediation decisions. EPA anticipates that the CSGWPP process will be the vehicle by which EPA and the States can come to a mutual understanding of regulatory requirements, policies and priorities that influence ground-water protection and remediation decision making.

In developing a Core CSGWPP, EPA generally expects a State to devise guidelines to classify and/or prioritize ground waters based upon their current use, expected future use, vulnerability to contamination, resource value, or similar factors. Such resource-based classifications or priorities can then be used by the State and EPA for a variety of purposes, including:

- **Program planning, so** that protection and remediation efforts can be emphasized in geographic areas with high priority ground waters (see *Implementation*, Section C); and

- **Program decision-making,** in which current and expected future uses (or other factors such as resource value) are an important factor in decisions regarding remediation of contaminated sites.

However, the Agency's experience with Core CSGWPPS developed to date is that they generally cannot be used for the site-specific decisions made by EPA remediation programs, because they either:

- Define broad scale (e.g., basin-wide) classifications or priorities that cannot be applied to ground waters at specific sites; or

- Do not define a basis for distinguishing among ground-water resources within the State (i.e, all ground waters have the same expected use or priority).

Implementation of EPA remediation programs requires that assessments and remediation decisions be made at specific sites or facilities. Thus, if a CSGWPP is expected to provide comprehensive guidance to EPA concerning remediation decisions, it should have provisions which allow ground-water classifications or priorities to be determined at a specific site anywhere in the State. For example, if a Core CSGWPP defines high value ground waters (and/or those of low value) and is expected to be utilized in remediation decisions, the definition should include criteria which allow the resource value of ground water to be determined at a

specific site anywhere in the State. Also, for this example, EPA and the State should have reached agreement on how the resource value of ground water is to be utilized in remediation assessments or decisions. Further discussion of CSGWPP provisions that support site-specific determination of ground-water classification or priority is provided under *Implementation,* Section A, of this Directive.

In general, a Core CSGWPP that provides no mechanism for distinguishing among ground waters of the State provides less useful information for site-specific remediation decisions than a CSGWPP that does draw distinctions among different ground-water resources. Further, such a CSGWPP does not meet the intent of EPA's 1992 CSGWPP guidance which expects a Core CSGWPP to provide some method for establishing priorities among ground-water resources based on ground-water characteristics and/or other factors.[6] For a CSGWPP that defines all ground waters as a source of drinking water or as high priority, EPA remediation programs should work with other EPA and State programs during the CSGWPP review process (see *Implementation,* Section B) to develop criteria which can be used to further distinguish among the State's ground waters at specific sites (see *Implementation,* Section A).

EPA recognizes that not all States plan to develop a ground-water classification system as part of their Core CSGWPP. As an alternative approach, a CSGWPP may define the relative value, priority or vulnerability of ground-water resources rather than current and expected future uses. For a CSGWPP that does not define current and future ground-water uses, EPA remediation programs should work with other EPA and State programs during the CSGWPP review process to clarify how the relative value, priority or vulnerability will be used to make assessment or remediation decisions at specific sites.

IMPLEMENTATION

A. EPA Deferral to State Determinations of Future Use

Current Practice

Determining current and future uses of contaminated ground waters at a particular site or facility is important for all EPA remediation programs. These programs consider ground-water uses when assessing the risks posed by the contamination, determining appropriate remedial objectives, and in setting appropriate cleanup levels when ground-water restoration is an objective. In the Underground Storage Tank program, site-specific cleanup requirements generally are established based on the current and future risks posed by the site, including risk-based cleanup levels for specific ground-water contaminants. In Superfund and the RCRA

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[6]This is called for by Core Adequacy Criterion 2 under Strategic Activity 2 (page 2-7) of the 1992 Final CSGWPP Guidance: "A State's ground water priority-setting process is based primarily on consideration of varying ground water characteristics such as those listed on Figure 2-1 on Page 2-18 [of the 1992 guidance]."

Subtitle C and D programs, drinking water standards[7] generally are used as cleanup levels for ground waters that are determined to be a current or potential future source of drinking water. Conversely, these programs generally do **not** use drinking water standards as cleanup levels for ground waters that are not a potential source of drinking water; and for this case, cleanup levels generally are determined from a site-specific evaluation of risk and receptors. For example, appropriate cleanup levels for contaminated ground water flowing into surface water could be based on ensuring protection of ecologic receptors, rather than direct ingestion of the ground water by humans. Also, ground-water uses could include support of surface water ecosystems. **Thus, determining current and future ground-water uses is necessary to determine the potential risks posed by the contamination, and as a result, the remediation objectives and/or cleanup levels needed to protect human health and the environment.**

Current practice in determining ground-water uses at a particular site or facility varies somewhat among EPA remediation programs. EPA programs generally consider State ground-water classifications or similar State designations for determining current and future ground-water uses. For the Superfund program, guidance on this issue is provided in the NCP Preamble, which recommends that the Agency's 1984 *Ground-Water Protection Strategy*[8] and *1986 Guidelines for Ground-Water Classification*[9] be used as guidelines for determining future use of ground waters at a particular site. (These documents defined Class I, II and III ground waters.) The Superfund program also considers State ground-water classifications in determining future use, but the NCP Preamble advises that where State and EPA classifications result in different ground-water use scenarios, the classification leading to the more "stringent" remediation goals should be used. Thus, ground waters at a given site are generally assumed to be a future source of drinking water if designated as such by the State or if considered to be a potential source of drinking water under the 1986 Classification Guidelines. For any use scenario, Superfund remedies must be protective of human health and the environment.

Policy Change for Superfund

For the Superfund program the policy of deferring to a State's ground-water use determination (discussed below) **supersedes the guidance** provided in the NCP Preamble (discussed above). This policy change is necessary to make the Superfund program consistent with *EPA's Strategy for the 1990s* and the 1992 Final CSGWPP guidance. Although the NCP Preamble is not part of the rule, it is used as program guidance. At the time it was written the NCP Preamble was consistent with the Agency's 1984 *Ground-Water Protection Strategy* and

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[7] Drinking water standards include maximum contaminant levels (MCLs) or non-zero Maximum Contaminant Level Goals (MCLGs) promulgated under the Safe Drinking Water Act, more stringent State drinking water standards, or risk-based levels for contaminants that do not have federal or State MCLs.

[8] "Ground-Water Protection Strategy," Office of Ground-Water Protection, August 1984.

[9] "Guidelines for Ground-Water Classification Under the [1984] EPA Ground-Water Protection Strategy, Final Draft," Office of Ground-Water Protection, November, 1986.

the 1986 Classification Guidelines, which have since been superseded by *EPA's Strategy for the 1990s* and the 1992 Final CSGWPP guidance. The NCP Preamble states:

> "If a state classification would lead to a less stringent solution than the EPA classification scheme, then the remediation goals will generally be based on EPA classification."'0

For States that have a CSGWPP that has been endorsed by EPA and has provisions for site-specific decisions, EPA will generally defer to State determinations of current and future ground-water uses, as discussed below. For States that do **not** have an EPA-endorsed CSGWPP, or for CSGWPPs that do **not** have provisions for making site-specific determinations of ground-water use (or resource value, priority or vulnerability), the Superfund program will continue to follow guidance provided in the NCP Preamble, as stated above. No policy change is needed for the RCRA Subtitle C and D and Underground Storage Tank programs because these programs already have the flexibility to defer, where appropriate, to State determinations of ground-water use under a wide range of circumstances.

Deferral to EPA-endorsed CSGWPPs

Under this Directive, Superfund and other EPA remediation programs should generally defer to a State's determination of current and future ground-water uses, when based on criteria or methodology that 1) are specified in an EPA-endorsed Core CSGWPP, and 2) can be applied at specific sites or facilities. **Under such a CSGWPP and except as noted below, EPA remediation programs generally should defer to a State's determination of ground-water use even when it differs from the use that would otherwise have been determined by EPA using the 1986 Classification Guidelines. As a result, EPA remediation programs should generally assess site risks (e.g., the Baseline Risk Assessment for Superfund sites) and establish remediation objectives and/or cleanup levels consistent with the CSGWPP-determined ground-water uses.**

Ground-water use determinations in previous remediation decisions, including Superfund Records of Decision and permits or orders issued under RCRA Subtitle C or D authority, are unaffected by this Directive or by EPA endorsement of a State's CSGWPP. EPA would follow applicable requirements of the relevant remediation program in determining whether to change any existing decision document, based on new information concerning the site or facility.

Exceptions to the above policy of EPA generally deferring to State ground-water use determinations may be appropriate under certain circumstances. These exceptions are expected to be rare for CSGWPPS that have been reviewed and endorsed by EPA remediation programs.

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[10] NCP Preamble at page 8733.

In general, it may be appropriate to depart from a State's determination of current and future ground-water use if the State's determination:

- Is not consistent with the EPA-endorsed CSGWPP;
- Is not consistent with an existing, applicable State or federal statute or promulgated regulation; [11]
- Is based on technically incorrect or erroneous information;
- Affects an interstate aquifer and is not consistent with the use determination for this aquifer in an adjacent State; or
- Would lead to selection of a remedy that EPA considers **not** sufficiently protective of human health and the environment.

States have been authorized to implement some EPA remediation programs, such as the RCRA Subtitle C and D and Underground Storage Tank programs. For States with an EPA-endorsed CSGWPP, EPA expects that State determinations of ground-water use at specific facilities to be assessed or remediated under these authorized or approved programs will generally be consistent with the CSGWPP.

Provisions Supporting Site-specific Decisions

If a CSGWPP is expected to provide comprehensive guidance to EPA concerning remediation decisions, the CSGWPP should have provisions which allow ground-water classifications or priorities to be determined at a specific site or facility anywhere in the State, as discussed above. In this Directive, CSGWPP provisions supporting site-specific decisions are defined as factors, criteria or a methodology included in the CSGWPP for determining ground-water classifications or priorities at a specific site. Including these provisions in a CSGWPP will ensure that these factors, criteria or methodology are consistently applied throughout the State. Examples of physical characteristics and other factors that can be used to define the use, or relative value or priority of ground-water resources at specific sites are provided in Figure 2-1 (page 2-1 8) of the 1992 CSGWPP Guidance. Also, EPA Region I has completed a regional guidance[12] which identifies factors for determining ground-water "use and value" at a specific site and explains how these determinations will generally be used by EPA remediation programs

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[11] For example the Safe Drinking Water Act and 40 CFR, Sections 144.3, and 146.3, define an "underground source of drinking water."

[12] "Final Groundwater Use and Value Determination Guidance, A Resource-Based Approach to Decision Making," U.S. EPA Region I, April 4, 1996. (For copies of this Region I guidance, contact Gloria Hume at (617) 573-5700.)

in that Region. The Region I guidance provides a good example of an approach to site-specific determination of ground-water resource priorities that can be included in a Core CSGWPP or developed as a separate EPA-State agreement subsequent to EPA endorsement of a Core CSGWPP.

As discussed above, some Core CSGWPPs do not provide a basis for distinguishing among ground-water resources within the State (i.e, all ground waters have the same expected future use or priority). Although some States have statutes or regulations designating all ground waters as potential drinking waters, the CSGWPP should include some method for setting ground-water resource priorities within the State. Examples of factors or criteria which can be used to distinguish among **potential drinking waters** on a site-specific basis are:

- Expected time frame of future use;
- Likelihood of use within a certain time period (e.g., 30 years);
- Relative priority or value; or
- Relative vulnerability of ground waters.

The types of site-specific provisions listed above are useful to EPA remediation programs because, in addition to assessing risks and establishing cleanup levels based on expected ground-water uses, these programs must evaluate alternative remedial measures and select those most appropriate for a given site or facility. Different remedial measures often require substantially different time periods to attain the remedial objectives. For example, remedial measures that require a relatively long period of time to attain drinking water standards may be appropriate for contaminated ground waters that are not expected to be used for this purpose in the near future. A longer remediation time frame may also be appropriate for ground waters of lower priority or resource value.

'To support remediation under the Underground Storage Tank program, the CSGWPP should also have a mechanism for providing site-specific flexibility in setting risk-based remediation requirements, including cleanup levels for specific ground-water contaminants, based on the current and future risks posed by the site.

Provisions that support site-specific remediation activities should be part of a **Core CSGWPP prior to EPA-endorsement** when it includes an EPA remediation program (i.e., the six Strategic Activities have been demonstrated using this program). When an EPA remediation program is **not** part of the Core CSGWPP, additional provisions for site-specific decision-making should be established in State-EPA negotiations during the subsequent "multi-year planning" stage. When provisions specific to one or more EPA remediation programs are added subsequent to EPA endorsement of the Core CSGWPP, these provisions can either be included

as a separate agreement (e.g. a Memorandum of Agreement) or as an update or attachment to the Core CSGWPP.

B. EPA Involvement in CSGWPP Review and Endorsement

Review Process

After developing their Core CSGWPPs, States submit them to EPA regional offices for cross-program review. **Regional staff from all EPA remediation programs, including RCRA Subtitle C and D, Superfund and Underground Storage Tanks, or cross-program representatives should be involved in the review of a Core CSGWPP.** In this review, EPA Regional staff should assess the implications for and useability of the principles developed in the Core CSGWPP by their respective programs. Regional staff should also make sure that program-specific issues will be resolved, either:

- In the Core CSGWPP, or
- During the "multi-year planning" stage, after the Core CSGWPP has been endorsed.

In the current review process, multiple program offices are part of the review team from both the respective Region and Headquarters, although Headquarters program offices review only the first Core CSGWPP submitted to each Region. Regional ground-water protection programs generally have the lead for the EPA review process.

Focus of Review

When reviewing a Core CSGWPP, EPA remediation program staff should pay particular attention to the following sections of a Core CSGWPP:

- **The** State's **method for establishing ground-water priorities,** based on "varying ground-water characteristics;"[13] and
- Discussion of how ground-water characteristics are to be used to **"support rational decision-making" for site-specific remediation activities**.[14]

These two Adequacy Criteria are closely linked. A Core CSGWPP **should define and demonstrate use** of a priority setting mechanism in at least one ground-water program. It should also discuss how this priority setting mechanism would be applied to other programs not profiled in the Core CSGWPP, including facility siting and remediation programs. EPA remediation

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[13] Adequacy Criterion 2 under Strategic Activity 2, defined in EPA's 1992 CSGWPP Guidance, page 2-7.

[14] Adequacy Criterion 6 under Strategic Activity 4, defined in EPA's 1992 CSGWPP Guidance, page 2-12.

program staff should determine whether the sections of the Core CSGWPP, noted above, adequately support types of site-specific assessments and decisions made by their specific remediation programs. If not, EPA remediation programs should request that provisions supporting site-specific decisions be added either to the Core CSGWPP prior to EPA endorsement or added in subsequent CSGWPP agreements, as appropriate. (See above discussion under "Provisions Supporting Site-specific Decisions.")

C. Role of Other CSGWPP Provisions in EPA Remediation Programs

In addition to current and expected future ground-water uses, a CSGWPP may provide additional information that can be used by EPA programs for program planning, so that protection and remediation efforts can be emphasized in areas where ground waters have a high resource value or priority. EPA remediation programs should utilize the resource value or priority defined in an EPA-endorsed C. SGWPP, as appropriate, for more effective or efficient implementation of program activities. For example, an EPA remediation program could set priorities for sites requiring initial assessments based in part on the resource value or priority defined in an EPA-endorsed CSGWPP. A more specific example would be where an EPA remediation program schedules initial site assessments in well head protection areas (i.e., high priority) prior to assessments in other areas.

For further information concerning the role of CSGWPPs in EPA remediation programs, contact Ken Lovelace of EPA's Office of Emergency and Remedial Response at (703) 603-8787, Guy Tomassoni of the Office of Solid Waste at (703) 308-8622, or John Heffelfinger of the Office of Underground Storage Tanks at (703) 603-7157. For more information about CSGWPPs in general, contact the ground-water program representative in your Region.

Attachments

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NOTICE: This document provides guidance to EPA staff. It also provides guidance to the public and to the regulated community on how EPA intends to exercise its discretion in implementing its regulations. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future, as appropriate.

Attachment

STRATEGIC ACTIVITIES OF A COMPREHENSIVE STATE GROUND WATER PROTECTION PROGRAM*

1. "Establishing a ground water protection goal to guide all relevant federal, State, and local programs operating within the State;

2. Establishing priorities, based on characterization of the resource, identification of sources of contamination, and programmatic needs, to guide all relevant federal, State, and local programs and activities in the State toward the most efficient and effective means of achieving the State's common ground water protection goal;

3. Defining authorities, roles, responsibilities, resources, and coordinating mechanisms across relevant federal, State, tribal, and local programs for addressing identified ground water protection priorities;

4. Implementing all necessary efforts to accomplish the State's ground water protection goal consistent with the State's priorities and schedules;

5. Coordinating information collection and management to measure progress, re-evaluate priorities, and support all ground water-related programs; and

6. Improving public education and participation in all aspects of ground water protection to achieve support of the State's protection goal, priorities, and programs."

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* From 1992 Final CSGWPP Guidance, pages 1-19 and 1-20.

Attachment 2*

STATUS OF COMPREHENSIVE STATE GROUND WATER PROTECTION PROGRAMS

EPA Region	States with Core CSGWPP Endorsed by EPA	States with Core CSGWPP Submitted to EPA
Region 1	Connecticut, Massachusetts, New Hampshire	
Region 2		New Jersey, New York
Region 3		
Region 4	Alabama	Georgia, Florida
Region 5	Wisconsin	Illinois
Region 6	Oklahoma	Arkansas, Louisiana
Region 7		
Region 8		Montana
Region 9		Nevada
Region 10		Washington
Total No. States	6 States	10 States

TOTAL OF 16 STATES HAVE SUBMITTED CSGWPPS TO EPA

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* Based on information provided by EPA's Office of Ground Water and Drinking Water, Ground Water Protection Division, as of March, 1997.

United States
Environmental Protection
Agency

Solid Waste and
Emergency Response

EPA 540-R-97-013
OSWER 9355.0-69
PB97-963301
August 1997

Superfund

RULES OF THUMB FOR SUPERFUND REMEDY SELECTION

EPA 540-R-97-013
OSWER 9355.0-69
PB97-963301
August 1997

RULES OF THUMB FOR SUPERFUND REMEDY SELECTION

Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency
Washington, DC 20460

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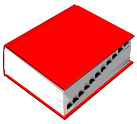
ABSTRACT

This guidance document describes key principles and expectations, interspersed with "best practices" based on program experience, that should be consulted during the Superfund remedy selection process. These remedy selection "Rules of Thumb" are organized into three major policy areas: 1) risk assessment and risk management, 2) developing remedial alternatives, and 3) ground-water response actions. The purpose of this guide is to briefly summarize key elements of various remedy selection guidance documents and policies in one publication. EPA believes that consistent application of national policy and guidance is an important means by which we ensure the reasonableness, predictability, and cost-effectiveness of our decisions. Gathering these remedy selection policy expectations into one document will support our ongoing efforts to promote these important objectives. For more detailed discussions of these policy areas, consult the National Contingency Plan (NCP) and the guidance documents listed at the end of each section. This guide has been developed as one of the Superfund administrative reforms announced by Administrator Carol Browner on October 2, 1995.



To Obtain Documents:

EPA employees can obtain additional copies of this guidance, or copies of documents referenced in this guidance, by calling the Superfund Document Center at 703-603-9232, or by sending an e-mail request to superfund.documentcenter@epamail.gov. Non-EPA employees can obtain these documents by contacting the National Technical Information Service at 703-487-4650. This document is also available on the Internet at http://www.epa.gov/superfund.

INTRODUCTION

The Superfund program's remedy selection process links the analysis of site cleanup alternatives, conducted in a remedial investigation/feasibility study (RI/FS), with the documentation of the selected remedy in a Record of Decision (ROD). Section 121 of the Superfund statute (the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)) established five principal requirements for the selection of remedies. Remedies must: 1) protect human health and the environment; 2) comply with applicable or relevant and appropriate requirements (ARARs) unless a waiver is justified; 3) be cost-effective; 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 5) satisfy a preference for treatment as a principal element, or provide an explanation in the ROD as to why this preference was not met.

In the Superfund regulations (the National Oil and Hazardous Substances Contingency Plan (NCP)), EPA established a national goal and a series of expectations to reflect the principal requirements of Section 121 and to help focus the RI/FS on appropriate waste management options (Exhibit 1). EPA also developed nine criteria for evaluating remedial alternatives to ensure that all important considerations are factored into remedy selection decisions (Exhibit 2). These criteria are derived from the statutory requirements of Section 121, as well as technical and policy considerations that have proven to be important for selecting among remedial alternatives. The nine criteria analysis comprises two steps: an individual evaluation of each alternative with respect to each criterion; and a comparison of options to determine the relative performance of the alternatives and identify major trade-offs among them (i.e., relative advantages and disadvantages).

Applicability to the RCRA Corrective Action Program

The Superfund and Resource Conservation and Recovery Act (RCRA) Corrective Action programs generally should yield similar remedies in similar circumstances. Therefore, the Agency believes that many of the principles conveyed in this document are applicable to the RCRA Corrective Action program, except where justified based on clear programmatic differences. For example, although RCRA Corrective Action incorporates risk-based decision making, formal "baseline risk assessments" are not always conducted as they are for Superfund sites. Superfund project managers using these principles can be confident that remedies selected generally will satisfy RCRA Corrective Action; likewise, RCRA Corrective Action project managers are encouraged to use these principles, as appropriate, to promote cost-effective remedial decision making and consistency with Superfund. For more information see: *Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities* (OSWER Directive 9200.0-25, September 24, 1996); and *Advance Notice of Proposed Rulemaking (ANPR) for RCRA Corrective Action* (61 FR 19432, May 1, 1996).

Exhibit 1

Superfund Program Goal and Expectations

Program Goal (40 CFR 300.430(a)(1)(i))

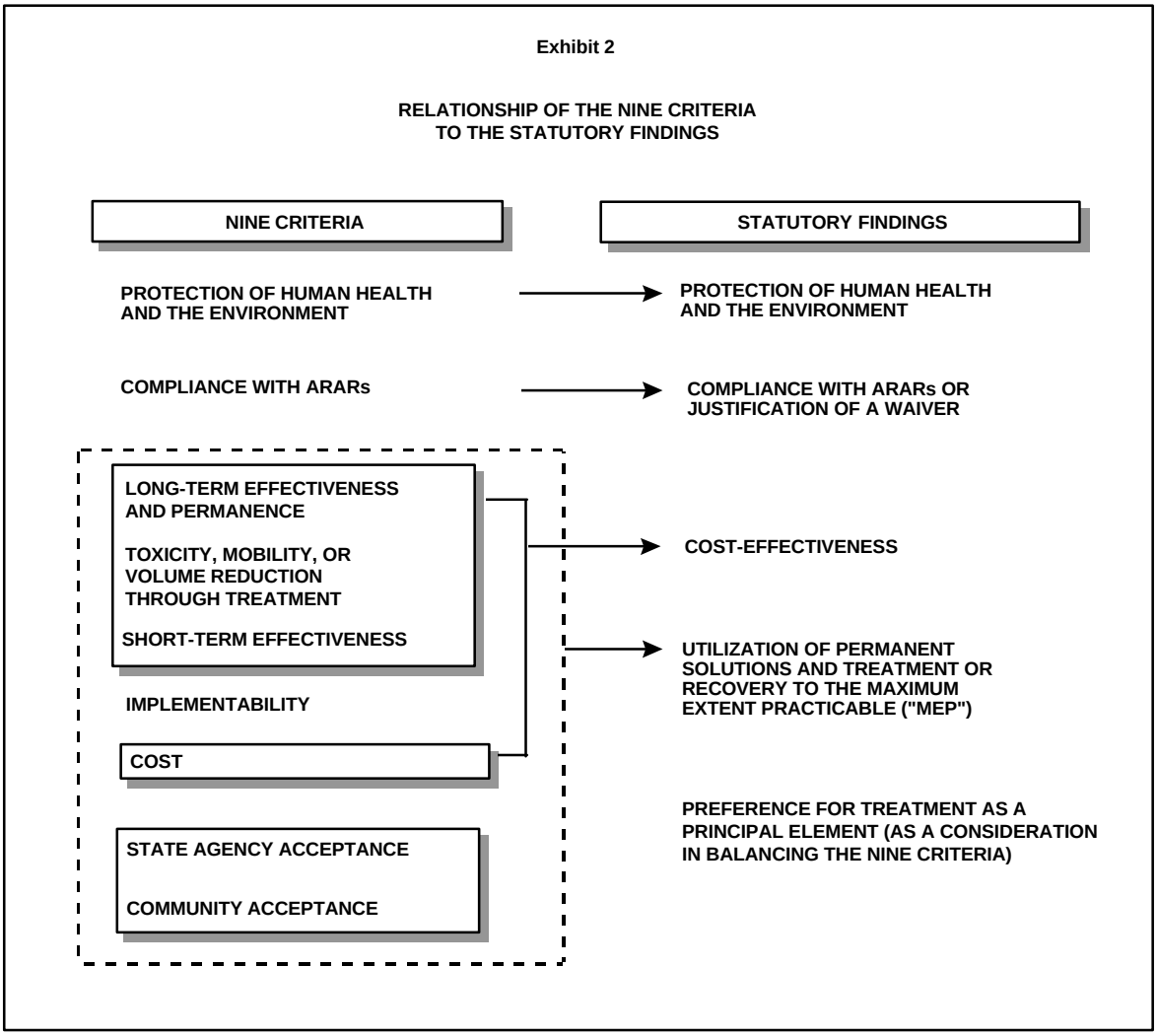
The national goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste.

Program Expectations (40 CFR 300.430(a)(1)(iii)(A-F))

EPA generally shall consider the following expectations in developing appropriate remedial alternatives:

- EPA expects to use treatment to address the principal threats posed by a site, wherever practicable.
- EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable.
- EPA expects to use a combination of methods, as appropriate, to achieve protection of human health and the environment.
- EPA expects to use institutional controls, such as water use and deed restrictions, to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants or contaminants.
- EPA expects to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies.
- EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site.

EPA established the RI/FS process for gathering the information necessary to select a remedy that is appropriate for the site and fulfills these statutory mandates. The RI includes sampling and analysis to characterize the nature and extent of site contamination, performance of a baseline risk assessment to assess the current and potential future risks to human health and the environment posed by that contamination, and the conduct of treatability studies (where appropriate) to evaluate the potential costs and effectiveness of treatment (or recovery) technologies to reduce the toxicity, mobility, or volume of specific site waste. The FS includes the development and screening of alternative remedial actions, and the detailed evaluation and comparison of the final candidate cleanup options. Typically, a range of options is developed during the FS concurrently with the RI site characterization, with the results of each influencing the other in an iterative fashion. (See *RI/FS Guidance* for a more complete discussion.)



EPA also established a two-step remedy selection process, in which a preferred remedial action is presented to the public for comment in a Proposed Plan, which summarizes preliminary conclusions as to why that option appears most favorable based on the information available and considered during the FS. Following receipt and evaluation of public comments on the Proposed Plan (which may include new information), EPA makes a final decision and documents the selected remedy in a ROD. (See *Remedy Selection Guidance* for a more complete discussion.)

EPA has issued numerous guidance documents that complement and clarify the remedy selection framework presented in the NCP. *Rules of Thumb for Superfund Remedy Selection* summarizes the remedy selection policy expectations contained in these guidance documents as well as in the Superfund statute and regulations. By summarizing this information in a single document, EPA expects to assist Remedial Project Managers and other program implementers in applying remedy selection principles in an appropriately consistent manner.

Please note that this guidance document is not a comprehensive guide to every Agency policy that might affect remedy selection, nor is it a replacement for the careful application of regulatory and statutory requirements to individual sites. Rather, the document is a synopsis of the principles and

expectations that are likely to have the most bearing on a wide range of site remedy selections. While this document should help expedite and focus the remedy selection process, it is not a substitute for a careful review and application of CERCLA, the NCP, and relevant guidance documents at individual sites.

Primary source documents for policy statements have been identified in parentheses in italics following each Rule of Thumb and full citations are included at the end of each major section. Specific page citations are provided, where appropriate, and represent the beginning of a relevant section in the document. These source documents should be obtained and consulted for more information.

For Additional Information on the Remedy Selection Process:

- ☞ NCP: *National Oil and Hazardous Substances Pollution Contingency Plan (The NCP): With the Preambles of 1988 and 1990 and the New Index of Key Terms* (OSWER Publication 9200.2-14, January 1992).

- ☞ RI/FS Guidance: *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 540-G-89-004, October 1988).

- ☞ ROD Guidance: *Interim Final Guidance on Preparing Superfund Decision Documents: The Proposed Plan, The Record of Decision, Explanation of Significant Differences, The Record of Decision Amendment: Interim Final* (EPA 540-G-89-007, July 1989). (Revision anticipated in 1998.)

- ☞ Remedy Selection Guidance: *A Guide to Selecting Superfund Remedial Actions* (OSWER Publication 9355.0-27FS, April 1990).

- ☞ SACM Guidance: *Guidance on Implementation of the Superfund Accelerated Cleanup Model (SACM) under CERCLA and the NCP* (OSWER Directive 9203.1-03, July 7, 1992). Five additional fact sheets also describe SACM and are available by citing the following reference: OSWER Directive 9203.1-05I (Volume 1, Numbers 1-5), December 1992.

- ☞ Non-Time Critical Removal Guidance: *Guidance on Conducting Non-Time Critical Removal Actions under CERCLA* (EPA 540-R-93-057, August 1993).

- ☞ Role of Cost Directive: *The Role of Cost in the Superfund Remedy Selection Process* (EPA 540-F-96-018, September 1996).

RISK ASSESSMENT AND RISK MANAGEMENT

Background

The mandate of the Superfund program is to protect human health and the environment from current and potential threats posed by uncontrolled hazardous waste sites. The NCP established the RI/FS process to characterize the nature and extent of site risks, develop and evaluate cleanup options, and gather other information necessary to select a remedy that is appropriate for a site. A baseline risk assessment is performed as part of the RI/FS to evaluate the potential threat to human health and the environment in the absence of any remedial action. EPA uses the results of the RI/FS and baseline risk assessment to make a series of site-specific risk management decisions in the Superfund remedy selection process.

Presented below is a summary of key principles and expectations for risk assessment and risk management that have been developed for the Superfund program. Consideration of these principles will help ensure that remedies are both cost-effective and appropriately consistent with national policy and guidance.

Risk Assessment Rules of Thumb

The following principles should be consulted when developing the baseline risk assessment. If the RI/FS only addresses a portion of the site or specific medium (e.g., ground water), these principles apply to the baseline risk assessment developed in support of that specific operable unit. Additional efforts may be required to relate the specific action to the overall risk posed by the site as a whole.

1) **Conceptual Site Model**: Evaluate available data and develop a well-defined conceptual site model (CSM) in the earliest stages of the baseline risk assessment. The CSM is a three-dimensional "picture" of site conditions that illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. The CSM documents current and potential future site conditions and is supported by maps, cross sections, and site diagrams that illustrate what is known about human and environmental exposure through contaminant release and migration to potential receptors. The CSM is initially developed during the scoping phase of the RI/FS and should be modified as additional information becomes available. (*RI/FS Guidance; DQO Guidance; Soil Screening Guidance; and RAGS I Part A*)

2) **Exposure Pathways**: Evaluate all relevant exposure pathways related to the site (e.g., direct ingestion, inhalation), for both current and reasonably anticipated future land uses as well as current and potential future ground-water and surface water uses. (*Land Use Directive; RAGS I Part A; and Soil Screening Level Guidance*)

3) **Data Needs**: Collect sufficient contaminant concentration data from each relevant medium

to adequately characterize the nature and extent of contamination and to develop sound estimates of risk associated with each exposure pathway. (*DQO Guidance*)

4) **Site-Specific Risk Calculation**: The following principles apply to site-specific risk calculations in the baseline risk assessment:

- Calculate the cumulative risks to an individual for chronic exposures, using reasonable maximum exposure (RME) assumptions by combining a statistically sound, arithmetic average, exposure-point concentration with reasonably conservative values for intake and duration. The most current updates on exposure assumptions, methods, and models for the residential exposure scenario can be obtained from the *Soil Screening Guidance*.

- Use the most current toxicity values provided by the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Tables (HEAST). Call the Superfund Technical Support Center in Cincinnati at (513) 569-7300 if toxicity values are not reported in IRIS or HEAST. (*RAGS I Part A*)

- Include estimates of risk for current and reasonably anticipated future land uses and potential future ground-water and surface water uses, without institutional controls. The baseline risk assessment is essentially an evaluation of the "no action" alternative (i.e., an assessment of the risk associated with a site in the absence of any remedial action or control). While institutional controls do not actively clean up the contamination at a site, they can control exposure and, therefore, are considered to be limited action alternatives that may be evaluated during the remedy selection process. (*1990 NCP Preamble at 55 FR 8710*)

- Include a discussion that identifies major sources of uncertainty or variability and their influence on the risk estimates. Probabilistic methods may aid in evaluating uncertainty at some sites. (*RAGS I Part A; and EPA's Risk Characterization Policy*)

5) **Other Measures of Risk**: Other measures of risk (e.g., central tendency) can be used to describe site risks more fully. However, RME risk generally should be the principal basis for evaluating potential risks at Superfund sites. (*1990 NCP Preamble at 55 FR 8711; RAGS I Part A, page 6-4; and EPA's Risk Characterization Policy*)

6) **Exposed Populations**: The risk analysis should clearly identify the population, or population sub-group (e.g., highly exposed or susceptible individuals), for which risks are being

evaluated. (*RAGS I Part A, page 6-6; and EPA's Risk Characterization Policy*)

7) **Ecological Risk Assessment**: Include an assessment of ecological risk in the baseline risk assessment in order to support EPA's mission to protect the environment. A screening ecological risk assessment generally should be conducted to identify those chemicals, media, and portions of the site requiring more detailed study and analysis. Use site-specific toxicity tests, field studies, and food-chain models whenever appropriate. (*ECO Risk Guidance; and RAGS II*)

Risk Management Rules of Thumb

The following principles should be consulted when making risk management decisions in the Superfund program. Unless otherwise noted, the Rules of Thumb presented in this section are derived from the *Role of Baseline Risk Assessment Directive.*

1) **Basis for Action**: A response action is generally warranted if one or more of the following conditions is met:

- The cumulative excess carcinogenic risk to an individual exceeds 10^{-4} (using reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use);

- The non-carcinogenic hazard index is greater than one (using reasonable maximum exposure assumptions for either the current or reasonably anticipated future land use);

- Site contaminants cause adverse environmental impacts; or

- Chemical-specific standards or other measures that define acceptable risk levels are exceeded and exposure to contaminants above these acceptable levels is predicted for the RME. Examples include: drinking water standards that are exceeded in ground water when that ground water is a current or potential source of drinking water; or water quality standards that are exceeded in surface or ground waters that support the designated uses of these waters (e.g., support aquatic life).

2) **Preliminary Remediation Goals for Carcinogens**: In the absence of ARARs for chemicals that pose carcinogenic risks, PRGs generally should be established at concentrations that achieve 10^{-6} excess cancer risk, modifying as appropriate based on exposure, uncertainty, and technical feasibility factors.

3) **Preliminary Remediation Goals for Non-Carcinogens**: In the absence of ARARs for chemicals that pose non-carcinogenic risks, PRGs generally should be established at concentrations that achieve a hazard quotient of one. Cumulative noncancer risks are determined by adding hazard quotients for chemicals with the same toxic endpoint or mechanism of action (e.g., the toxic endpoint for both ethylbenzene and styrene is liver toxicity and so these hazard quotients can be summed). In establishing PRGs for chemicals that affect the same target organ/system, PRGs for individual chemicals should be divided by the number of chemicals present in this group (*Soil Screening Guidance, page 32*).

RAOs, PRGs and Final Cleanup Levels

Remedial action objectives (RAOs) provide a general description of what the cleanup will accomplish (e.g., restoration of groundwater). Preliminary remediation goals (PRGs) are the more specific statements of the desired endpoint concentrations or risk levels, for each exposure route, that are believed to provide adequate protection of human health and the environment based on preliminary site information. Initial PRGs are developed early in the RI/FS process and are based on ARARs and other readily available information, such as concentrations associated with 10^{-6} cancer risk or a hazard quotient equal to one for noncarcinogens calculated from EPA toxicity information. Initial PRGs may also be modified based on exposure, uncertainty, and technical feasibility factors. As data are gathered during the baseline risk assessment and RI/FS, PRGs are refined into final contaminant-specific cleanup levels. Based on consideration of factors during the nine criteria analysis and using the PRG as a point of departure, the final cleanup level may reflect a different risk level within the acceptable risk range (10^{-4} to 10^{-6} for carcinogens) than the originally identified PRG. The final cleanup levels, not PRGs, are documented in the Record of Decision.

4) **Chemical-Specific ARARs**: When a single ARAR for a specific chemical (or in some cases a group of chemicals) defines an acceptable level of exposure, compliance with the ARAR generally will be considered protective even if it is outside the risk range (unless there are extenuating circumstances, such as exposure to multiple contaminants or pathways).

5) **Background Concentrations**: EPA does not generally clean up below natural background levels. However, where anthropogenic (i.e., man-made) background levels exceed acceptable risk-based levels, and EPA has determined that a response action is appropriate, EPA's goal is to develop a comprehensive response to address area-wide contamination. This will help avoid response actions that create "clean islands" amid widespread contamination (*Soil Screening Guidance, page 8*).

6) **Selecting Remedial Action**: In the absence of ARARs, remedies should reduce the risks

from carcinogenic contaminants such that the excess cumulative individual lifetime cancer risk for site-related exposures falls between 10^{-4} and 10^{-6}. The Agency has expressed a preference for cleanups achieving the more protective end of the risk range (i.e., 10^{-6}). (NOTE: The upper boundary of the risk range is not a discrete line at 1×10^{-4}, although EPA generally uses 1×10^{-4} in making risk management decisions. A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions.) For non-carcinogens, remedies generally should reduce contaminant concentrations such that exposed populations or sensitive sub-populations will not experience adverse effects during all or part of a lifetime, incorporating an adequate margin of safety (i.e., a hazard index at or below one).

7) **Timing**: A "phased approach" to site investigation and cleanup generally will accelerate risk reduction and provide additional technical site information on which to base long-term risk management decisions. Phased cleanup approaches should be employed wherever practicable (*40 CFR 300.430(a)(1)(ii)*(*A*)). For more information about the use of early actions to expedite site cleanup, see *SACM Guidance* and the *Ground-Water Presumptive Strategy*.

For Additional Information on Risk Assessment and Risk Management:

- ☞ RI/FS Guidance: *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 540-G-89-004, October 1988).

- ☞ RAGS I Part A: *Risk Assessment Guidance For Superfund, Volume 1, Part A: Human Health Evaluation Manual, Interim Final* (EPA 540-1-89-002, March 1989).

- ☞ RAGS II: *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual, Interim Final* (EPA 540-1-89-001, March 1989).

- ☞ RAGS I Part B: *Risk Assessment Guidance for Superfund, Volume I, Part B: Human Health Evaluation Manual, Development of Risk-Based Preliminary Remediation Goals, Interim Final* (EPA 540-1-89-002, December 1991). [Note: *Soil Screening Guidance* provides improvements in inhalation and ground water exposure pathway discussions.]

- ☞ RAGS I Part C: *Risk Assessment Guidance for Superfund, Volume I, Part C: Human Health Evaluation Manual, Risk Evaluation of Remedial Alternatives, Interim* (EPA 540-R-92-004, December 1991).

- ☞ Role of Baseline Risk Assessment Directive: *Role of the Baseline Risk Assessment in Superfund Remedy Selection* (OSWER Directive 9355.0-30, April 22, 1991).

- ☞ SACM Guidance: *Guidance on Implementation of the Superfund Accelerated Cleanup Model (SACM) under CERCLA and the NCP* (OSWER Directive 9203.1-03, July 7, 1992).

- ☞ DQO Guidance: *Data Quality Objectives Process for Superfund: Interim Final Guidance* (EPA 540-R-93-071, 1993).

- ☞ EPA's Risk Characterization Policy: *Policy for Risk Characterization at the U.S. Environmental Protection Agency* (Memorandum from Administrator Carol Browner, March 21, 1995).

- ☞ Land Use Directive: *Land Use in the CERCLA Remedy Selection Process* (OSWER Directive 9355.7-04, May 25, 1995).

- ☞ Soil Screening Guidance: *Soil Screening Guidance: Users Guide* (EPA 540-R-96-018, April 1996).

- ☞ Ground-Water Presumptive Strategy: *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites* (EPA 540-R-96-023, October 1996).

- ☞ ECO Risk Guidance: *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 540-R-97-006, June 1997).

DEVELOPING REMEDIAL ALTERNATIVES

Background

The national goal of the remedy selection process is to "select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste" (*40 CFR 300.430(a)(1)(i)*). While protection of human health and the environment can be achieved through a variety of methods, this goal reflects CERCLA's emphasis on achieving protection through the aggressive, but realistic, use of treatment. Remedies that rely on engineering and institutional controls as a major component, in addition to being less permanent than treatment remedies, may place constraints on the productive re-use of land.

To accomplish this goal, the NCP describes six expectations for the development of remedial alternatives. These expectations, derived from the mandates of CERCLA Section 121 and based on previous Superfund experience, were developed as guidelines to communicate the types of remedies that EPA generally will find appropriate for specific types of waste. Although remedy selection decisions are site-specific determinations based on analyses of remedial alternatives using the nine evaluation criteria, these expectations help to focus the RI/FS on appropriate waste management options. This section discusses the first four of the six NCP expectations presented in Exhibit 1. Unless otherwise noted, this section has been derived from the *Principal Threats Guidance.*

Reasonably Anticipated Future Land Use and Principal Threat Waste Identification

The reasonably anticipated future land use at a site is significant in defining principal threat waste areas. Pursuant to the NCP and the 1995 land use guidance, current land use and reasonably anticipated future land use should be considered in identifying realistic exposure scenarios for estimating site risks. When the baseline risks associated with the reasonably anticipated future land use trigger action, the definition of principal threat wastes may be determined by the reasonably anticipated future land use scenario as well. For example, soil contamination that could be considered a principal threat under a residential exposure scenario might be considered a low-level threat under a non-residential exposure scenario. Although no "threshold level" of risk has been established to identify principal threat waste, a general rule of thumb is to consider as a principal threat those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios. (For more information, see *Principal Threats Guidance* and *Land Use Directive*.)

Identifying Principal and Low-level Threat Wastes

The concept of principal threat waste and low-level threat waste, as developed by EPA in the NCP and expanded in subsequent guidance, should be applied on a site-specific basis when characterizing "source material." Source material is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure.

Contaminated ground-water plumes are generally not considered to be source material, although nonaqueous phase liquids (NAPLs) in the ground water generally would be viewed as source material.

Identifying principal and low-level threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, low-level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied.

Rules of Thumb for Developing Appropriate Remedial Alternatives for Source Materials

1) **Combination of Methods of Protection**: An appropriate combination of treatment technologies, engineering controls, and institutional controls should be considered when developing remediation approaches that will be protective of human health and the environment. Federal or state ARARs (e.g., land disposal restrictions under RCRA) may limit containment and treatment options.

2) **Treatment of Principal Threats**: "EPA expects to use treatment to address the principal threats posed by a site, wherever practicable" *(40 CFR 300.430(a)(1)(iii)(A))*.

3) **Containment of Principal Threats**: In some situations, it may be appropriate to contain rather than treat principal threat wastes due to difficulties in treating the wastes. The following situations generally should result in a determination that treatment is not practicable under the nine remedy selection criteria (Exhibit 2). For example, when:

- Treatment technologies are not technically feasible or are not available within a reasonable time frame;

- The extraordinary volume of materials or complexity of the site may make implementation of the treatment technologies impracticable (e.g., large landfills);

- Implementation of a treatment-based remedy would result in greater overall risk to human health and the environment due to risks posed to workers, the surrounding community, or impacted ecosystems during implementation (to the degree that these risks cannot be otherwise addressed through implementation measures); and

- Implementation of the treatment technology would have severe effects

across environmental media.

4) **Containment of Low Level Threats**: "EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable" *(40 CFR 300.430(a)(1)(iii)(B))*.

5) **Treatment of Low-Level Threats**: In some situations, it may be appropriate to treat rather than contain low-level threat wastes. For example:

- Once a decision has been made to treat some wastes onsite, economies of scale may make it cost-effective to treat more than just principal threat wastes, to alleviate or minimize the need to maintain engineering or institutional controls over time.

- In some circumstances, treatment of more than principal threat wastes may be appropriate in order to make the whole site consistent with the reasonably anticipated future land use (e.g., where there are plans for residential development). See the *Land Use Directive* to obtain additional information for considering land use in remedy selection decisions.

6) **NAPLs as Principal Threat Wastes**: Although nonaqueous phase liquids (NAPLs) are generally viewed as principal threat wastes, program experience has shown that removal and/or in-situ treatment of NAPLs may not be practicable. Hence, EPA generally expects that the quantity of free-phase NAPL (i.e., "free product") should be reduced to the extent practicable and that an appropriately designed containment strategy should be developed for NAPLs that cannot be removed from the subsurface. This policy applies to both dense nonaqueous phase liquids (DNAPLs) and light nonaqueous phase liquids (LNAPLs), although of the two, it is generally more difficult to remove or treat DNAPLs in the subsurface. (See *Ground-Water Rule of Thumb #10* for more complete discussion of DNAPLs.)

7) **Use of Institutional Controls**: Institutional controls (such as easements, well drilling prohibitions, building permit restrictions, land use zoning restrictions, or fishing bans) generally shall not substitute for more active measures (e.g., treatment and/or containment of source material) as the sole remedy unless active measures are not practicable, based on the balancing of trade-offs among alternatives that is conducted during the remedy selection process. Institutional controls typically will be used in conjunction with engineering controls when the remedy results in long-term waste management onsite. *(40 CFR 300.430(a)(1)(iii)(D))*

For Additional Information on Developing Remedial Alternatives:

- ☞ RI/FS Guidance: *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 540-G-89-004, October 1988).

- ☞ Principal Threats Guidance: *A Guide to Principal Threat and Low Level Threat Wastes* (OSWER Directive 9380.3-06FS, November 1991).

- ☞ Land Use Directive: *Land Use in the CERCLA Remedy Selection Process* (OSWER Directive 9355.7-04, May 25, 1995).

- ☞ Ground-Water Presumptive Strategy: *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites* (EPA 540-R-96-023, October 1996).

GROUND-WATER RESPONSE ACTIONS

Background

Contaminated ground water exists at over 85 percent of the sites on the National Priorities List (NPL). The goal of ground-water remediation at Superfund sites is to protect human health and the environment through a combination of short-term measures (e.g, provision of alternate water supplies) and long-term measures to restore ground-water quality appropriate for its beneficial uses. Remedial action for contaminated ground water generally is warranted when EPA determines, based on the results of the baseline risk assessment, that the contamination poses a current or potential threat to human health or the environment (CERCLA §104(a)(1)). Additionally, where the ground water is currently used (or is potentially usable) as a drinking water supply, exceedance of Maximum Contaminant Levels (MCLs) and non-zero Maximum Contaminant Level Goals (MCLGs) established under the Safe Drinking Water Act also may be used as the basis for taking a remedial action. The goals of the long-term ground-water cleanup program are summarized in the NCP as follows:

> "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction" (*40 CFR 300.430(a)(1)(iii)(F)*).

Key Ground-Water Response Questions

- What are the current and potential future beneficial uses of the contaminated ground water?
- What is the approximate timing of the future need for ground water?
- Is restoration of ground water to beneficial uses technically practicable within a reasonable timeframe?
- What is the range of remedial alternatives that restore ground water in different but "reasonable" time periods?
- If restoration is not technically practicable, what remedial activities are necessary to prevent exposure to contaminants and prevent further plume migration?

Rules of Thumb for Ground-Water Response Actions

The rules of thumb for ground-water response actions are organized into four sequential steps. EPA recognizes that site investigation and analysis is a dynamic process that evolves as more information is gathered during the RI and a cleanup strategy is developed and refined in accordance with the best available site data. Hence, this framework is not strictly sequential, and should be tailored to address site-specific situations.

Step 1: Identifying Remedial Action Objectives and Preliminary Remediation Goals Based on Current and Potential Future Ground-Water Uses

Once it has been determined that there is a basis for taking a ground-water response action, the first step should be to identify RAOs and PRGs for the ground water. These RAOs and PRGs should reflect current and potential future uses of the ground water and exposure scenarios that are consistent with these uses. Several factors should be considered when identifying ground-water RAOs and PRGs:

1) **Current Ground-Water Uses**: RAOs and PRGs must reflect current human use (e.g., drinking water supply) as well as current environmental receptors (e.g., surface waters that are recharged by ground water and that are used by sensitive environmental receptors). (*Ground-Water Presumptive Strategy, page 15*)

2) **Potential Future Ground-Water Uses**: Where available, potential future ground-water uses should be determined from a Comprehensive State Ground-Water Protection Program (CSGWPP) that has been endorsed by EPA and has provisions for site-specific use determinations. In the absence of such a CSGWPP, determination of potential future uses should consider State ground water classifications or other designations and Federal ground-water guidelines (e.g., Class I, II, and III ground waters). The Federal classification system can be found in "*Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy*," hereafter referred to as the Federal Guidelines. Where State and Federal classifications result in different ground-water use scenarios, the "use classification" leading to the more "stringent" RAOs should be used. Thus, ground waters at a given site are generally assumed to be a potential future source of drinking water if designated as such by the State or if considered to be a potential source of drinking water under the Federal Guidelines. (*CSGWPP Directive*; *Federal Guidelines*; and *1990 NCP Preamble at 55 FR 8733*)

3) **PRGs for Drinkable Waters**: Generally, drinking water standards (Federal MCLs, non-zero MCLGs, or more stringent State drinking water standards) are relevant and appropriate as PRGs, and ultimately as final cleanup levels, for ground waters that are determined to be a current or potential future source of drinking water. (*40 CFR 300.430(e)(2)(i)(B and C);* and *Ground-Water Presumptive Strategy, page 15)*

4) **Limitation of Using Drinking Water Standards**: Generally, drinking water standards should not be chosen as PRGs for ground waters that are not current or potential future sources of drinking water (1990 NCP Preamble at *55 FR 8733*). The Federal Guidelines define "non-potable," or Class III, ground-water aquifers as those that: contain more than 10,000 mg/liter total dissolved solids; yield less than 150 gallons per day; or are so contaminated by naturally occurring conditions (e.g., salinity) or broad-scale human activity not related to a specific contaminant source that cleanup is not practicable. State classification systems may also identify ground waters that are not considered to be a potential future source of drinking water (see Ground Water Rule of Thumb #2 above). Where non-potable ground water has been contaminated, non-restoration RAOs may be appropriate (e.g., source control, plume containment). Establishment of PRGs for non-potable ground-water should consider any surface or ground-water bodies to which such non-potable ground waters discharge, and any current or potential future uses of the non-potable ground water such as for livestock watering, agricultural irrigation, industrial uses, or other purpose that might result in human or environmental exposures. (*Ground-Water Presumptive Strategy, page 15*)

5) **Consideration of More Stringent Ground-Water Standards**: Many states have anti-degradation standards or other requirements that are more stringent than the Federal drinking water standards for a given constituent. Where such a state requirement is determined to be an ARAR, it should be used as the PRG. (*Ground-Water Presumptive Strategy, page 16*)

6) **Relationship between Ground-Water RAOs and Soil PRGs**: At many sites, soil PRGs are set at levels that are needed to achieve long-term RAOs for ground water. As a result, these soil PRGs may need to be more stringent than would otherwise be necessary given the reasonably anticipated future land use. However, stringent soil PRGs intended to protect ground water generally will be inappropriate for site areas where the primary source of ground-water contamination is located below the soil (e.g., DNAPLs below the water table) <u>and</u> restoration of ground water is determined to be technically impracticable (see *Ground-Water Rule of Thumb #9* below). Therefore, both reasonably anticipated future land uses and potential future ground-water uses must be considered when developing the overall site remediation strategy. (*Ground-Water Presumptive Strategy, page 12*)

7) **Relationship Between Ground Water and Other Water Resources**: Contaminated ground waters may discharge and pose a risk to environmental resources such as streams, lakes, wetlands, or other uncontaminated aquifers. Therefore, ground-water PRGs should be set at levels that are protective of these other resources as well. For example, cleanup of contaminated ground waters that discharge to surface water should consider whether water quality criteria established under the Clean Water Act, or more stringent state surface water requirements, are ARARs. (*1990 NCP Preamble at 55 FR 8754*)

Step 2: Establishing Remedial Action Objectives and Final Cleanup Levels Based on Site-Specific Conditions

Once ground-water RAOs have been identified (in accordance with current and potential future uses), PRGs associated with those objectives should be identified and factored into the remedy selection process. PRGs developed during the RI/FS, and in accordance with the principles presented in the previous section, are the starting point for determining final cleanup levels which are documented in the ROD. The following rules of thumb relate to flexibilities in existing EPA policy which allow for selection of achievable RAOs and their associated cleanup levels and points of compliance.

8) **Restoration Potential**: If ground-water restoration is determined to be the RAO, MCLs, non-zero MCLGs, or other risk-based cleanup levels will have to be achieved in order for the ground-water resource to be restored. Site-specific information should be analyzed to determine the likelihood that ground water can be restored to these levels using available technologies (i.e., to determine the aquifer's "restoration potential"). (*TI Guidance, page 13;* and *Ground-Water Presumptive Strategy, page 5*)

9) **Technical Impracticability**: An ARAR waiver should be invoked for those portions of the contaminated soil or ground water where it has been demonstrated that attainment of one or more ARARs are technically impracticable from an engineering perspective. The "TI" waiver must be justified by site-specific information developed for the Administrative Record in accordance with EPA guidance. In the event that a TI waiver is invoked, an "alternative remedial strategy" must be developed that will ensure protection of human health and the environment. This strategy should be incorporated into the decision document along with the waiver justification and should define achievable RAOs and final cleanup levels for the site. At a minimum, the alternative strategy should prevent human exposure to the contaminated ground water, prevent further contaminant migration, and define any other appropriate risk reduction measures. Note that the waiver should be invoked only for that portion of the contaminated ground water for which restoration to ARARs is technically impracticable. As a result, RAOs and final cleanup levels may be different for different portions of the contaminant plume. (*TI Guidance;* and *Ground-Water Presumptive Strategy, page 17)*

10) **DNAPL Sites**: The likelihood of the presence of dense nonaqueous phase liquids (DNAPLs) should be evaluated wherever DNAPL-type compounds (e.g., chlorinated solvents such as TCE) are found in significant concentrations in the ground water or are known to have been managed or disposed of at the site. The presence of DNAPLs can significantly impact the restoration potential of the site. Where DNAPLs (or other persistent contamination sources) are present in the subsurface and cannot practicably be removed, containment of such sources may be the most appropriate remediation goal. In such cases, a TI waiver should be invoked for the DNAPL zone. Where significant quantities of potentially mobile DNAPL are identified, extraction should be considered in conjunction with containment. Extraction of potentially mobile DNAPLs will increase the long-term reliability of the containment remedy as well as remove source material from the aquifer. Containment of the DNAPL zone will increase the

likelihood that the remaining portion of the aqueous phase plume can be restored to a beneficial use. (*Ground-Water Presumptive Strategy, page 13; and TI Guidance, page 6*)

11) **Point of Compliance**: Final cleanup levels for contaminated ground water generally should be attained throughout the entire contaminant plume, except when remedies involve areas where waste materials will be managed in place. In the latter case, cleanup levels should be achieved "at and beyond the edge of the waste management area when waste is left in place" (*1990 NCP Preamble at 55 FR 8713*). In some cases, such as where several distinct sources are in close geographic proximity, it may be appropriate to move the point of compliance to "encompass the sources of release." In such cases, the point of compliance may be defined to address the problem as a whole, rather than source by source. (*1990 NCP Preamble at 55 FR 8753;* and *Ground-Water Presumptive Strategy, page 17*)

12) **Alternate Concentration Limits (ACLs)**: Under limited circumstances specified in CERCLA §121(d)(2)(B)(ii), ACLs may be established in lieu of cleanup levels that would otherwise be ARARs (e.g., MCLs). The conditions under which ACLs may be considered are where: 1) contaminated ground water discharges to surface water; 2) such ground-water discharge does not lead to "statistically significant" increases of contaminants in the surface water; and 3) enforceable measures can be implemented to prevent human consumption of the contaminated ground water. In general, ACLs may be used where the preceding conditions are satisfied, and where restoration of the ground water is found to be impracticable, based on a balancing of the remedy selection criteria. (*1990 NCP Preamble at 55 FR 8732 and 8754;* and *Ground-Water Presumptive Strategy, page 18*)

Step 3: Evaluating Remedial Technologies and Cleanup Time Frames

Following the establishment of achievable remedial action objectives, cleanup levels, and areas of compliance, a remediation technology (or combination of technologies) should be selected from those identified in the Feasibility Study. The principal factors to consider at this stage are how quickly the remedial action objectives need to be achieved, and what remediation strategies and technologies should be used to achieve them. These factors will have a significant impact on the type of remedy chosen for the site, as well as the cost of that remedy.

13) **Using Early Actions**: Early actions, such as a removal or interim remedial action taken before the final remedy is selected, should be used where appropriate to reduce site risks early in the site remediation process. In addition to reducing site risks and controlling further contaminant migration, these activities will also provide additional site characterization information that greatly improves the ability to make sound long-term remedy decisions. (*Ground-Water Presumptive Strategy, page 16;* and *SACM Guidance*)

14) **Restoration Time Frames**: Where the contaminated ground water is not currently used <u>or</u> an alternate water source is readily available, <u>and</u> there is no near-term future need for the

resource, it will likely be appropriate to consider a longer time frame for achieving restoration cleanup levels. Where longer remediation time frames are appropriate, less aggressive remediation methods and/or more passive remediation approaches (such as source control combined with monitored natural attenuation) should be considered. Restoration time frames should be estimated for all viable remedial alternatives being considered for the site *(40 CFR 300.430(e)(4))*. Comparison of aggressive and passive remedial alternatives can provide a helpful basis for identifying the range of time periods that will be needed to attain remediation objectives, and will provide the basis for determining the remediation timeframe and technologies appropriate for the site. (*1990 NCP Preamble at 55 FR 8732;* and *Ground-Water Presumptive Strategy, page 16*)

15) **Innovative Technologies**: New and emerging technologies should be evaluated in the FS if such technologies offer "the potential for comparable or superior performance or implementability; fewer or lesser adverse impacts than other available approaches; or lower costs for similar levels of performance than demonstrated treatment technologies" *(40 CFR 300.430(e)(5))*.

16) **Monitored Natural Attenuation**: At some sites, data gathered during the RI/FS may indicate that physical or biological processes (unassisted by human intervention) may effectively reduce contaminant concentrations such that remedial objectives in the contaminant plume (or certain portions of the plume) may be achieved in a reasonable time frame without active remediation. This approach is most likely to be appropriate in low concentration portions of the plume, where source control actions have removed the bulk of the contaminant mass, or where biodegradation will efficiently destroy the contaminants in situ. In some cases, remediation alternatives that combine active remediation (in source areas or areas of high concentration) with monitored natural attenuation (in lower concentration portions of the plume) may be most appropriate. Sufficient information is necessary to demonstrate that natural processes are capable of achieving remedial objectives for the site. Performance monitoring is a critical component of this remediation approach because monitoring is needed to ensure that the remedy is protective and that natural processes are reducing contamination levels as expected. Sites with contaminants that do not readily attenuate, or sites that require relatively rapid cleanup due to the demand for the ground-water resource, generally will not be appropriate candidates for natural attenuation. (*1990 NCP Preamble at 55 FR 8734; Ground-Water Presumptive Strategy, page 18;* and *Natural Attenuation Guidance*)

17) **Presumptive Treatment Technologies**: Generally, selection of technologies for ex-situ (above ground) treatment of extracted ground water should employ one or more of the presumptive technologies identified in the *Ground-Water Presumptive Strategy*. The engineering capabilities of these presumptive treatment technologies are well understood, enabling the selection process to be streamlined for the ex-situ treatment component of a ground-water remedy.

Step 4: Monitoring and Evaluating Remedy Performance

Selection of the site remedy marks the end of a data gathering, study, and decision-making process and marks the beginning of the cleanup phase, which includes designing, constructing, operating and maintaining the remedy. Since most ground-water remedies are expected to be operated, maintained, and/or monitored for long periods of time, further opportunities for improving the performance and cost-effectiveness of the cleanup should be explored and utilized if appropriate. An ongoing Administrative reform initiative highlights EPA's recent efforts to encourage appropriate changes to existing remedy decisions to enhance overall remedy effectiveness and cost-effectiveness, without compromising protectiveness or other objectives of the Superfund program. (See *Remedy Updates Guidance* for more information.*)* The following principles describe how periodic evaluation of a remedy can lead to improvements in performance and shortened cleanup time frames.

18) **Implementing Remedies in Multiple Phases**: Implementation of ground-water remedies in more than one phase may increase the performance and cost-effectiveness of the long-term remedy. Performance data from an early phase can be used to refine the design of later phases so that the ultimate remedy is optimized for actual site conditions (e.g., optimized number, location, and pumping rate of extraction wells). (*Ground-Water Presumptive Strategy, page 5 and page 12*)

19) **Periodic Review**: Performance of the ongoing remedy should be evaluated on a regular basis (e.g., every 1 to 5 years) to compare anticipated with actual results, to identify any potential deficiencies in the remedy's protectiveness, and to seek opportunities to improve its performance over the long term. This is especially important when the selected remedy relies on monitored natural attenuation. (*Ground-Water Presumptive Strategy, page 8;* and *Natural Attenuation Guidance*)

20) **Improving Remedy Performance**: Ground-water remedies often involve multiple extraction and/or injection points, subsurface structures or containment barriers, and other features whose actual performance in the field may vary from that assumed during design, given uncertainties about subsurface geology prior to construction. Careful assessment of performance monitoring data may be used to refine the remedy, such as modifying extraction rates or changing the pattern of extraction wells. Such improvements are capable of shortening cleanup time frames, and thus reducing costs. *(Ground-Water Presumptive Strategy, page 11*)

21) **Revisiting and Modifying Cleanup Goals**: At some sites it may be necessary to revisit the

ROD's remedial action objectives or final cleanup levels, if performance data indicate that attainment of these objectives or levels is not technically practicable. If it is determined that a TI waiver is appropriate, the waiver generally should be invoked in a ROD amendment, although in some cases an Explanation of Significant Differences (ESD) may be sufficient. An ESD may be used where the revised remedy is generally consistent with the "alternative remedial strategy" discussed in the original ROD and the original ROD: 1) contained detailed discussions of the potential need for a future TI waiver, and 2) identified an alternative remedial strategy to be used in the event a TI waiver was determined to be appropriate for the site. If an ESD is determined to be sufficient, public notice and opportunity for comment should also be provided. (*Ground-Water Presumptive Strategy, page 11; TI Guidance, page 19 and 24;* and *Remedy Updates Guidance*)

For Additional Information on Ground Water Response Actions:

- Federal Guidelines: *Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy, Final Draft* (EPA Office of Water, November 1986).

- Ground-Water Guidance: *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites* (EPA 540-G-88-003, December 1988).

- Role of Baseline Risk Assessment Directive: Role *of the Baseline Risk Assessment in Superfund Remedy Selection* (OSWER Directive 9355.0-30, April 22, 1991).

- DNAPL I: *Estimating Potential for Occurrence of DNAPL at Superfund Sites* (OSWER Publication 9355.4-07FS, January 1992).

- SACM Guidance: *Guidance on Implementation of the Superfund Accelerated Cleanup Model (SACM) under CERCLA and the NCP* (OSWER Directive 9203.1-03, July 7, 1992). Five additional fact sheets also describe SACM and are available by citing the following reference: OSWER Directive 9203.1-05I (Volume 1, Numbers 1-5), December 1992.

- TI Guidance: *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (EPA 540-R-93-080, September 1993).

- DNAPL II: *DNAPL Site Characterization* (OSWER Publication 9355.4-16FS, September 1994).

- Remedy Updates Guidance: *Superfund Reforms: Updating Remedy Decisions* (OSWER Directive 9200.0-22, September 27, 1996).

- Ground Water Presumptive Strategy: *Presumptive Response Strategy and Ex-situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites* (EPA 540-R-96-023, October 1996).

- CSGWPP Directive: *The Role of CSGWPPs in EPA Remediation Programs* (OSWER Directive 9283.1-09, April 4, 1997).

- Natural Attenuation Guidance: *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (OSWER Directive 9200.4-17, DRAFT).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

JAN 10 1992

MEMORANDUM

SUBJECT: Transmittal of "A Guide to Principal Threat and Low Level Threat Wastes"

FROM: Henry L. Longest II, Director
Office of Emergency and Remedial Response

Bruce M. Diamond, Director
Office of Waste Programs Enforcement

TO: Directors, Waste Management Division
Regions I, IV, V, VII, VIII
Director, Emergency and Remedial Response Division
Region II
Directors, Hazardous Waste Management Division
Regions III, VI, IX
Director, Hazardous Waste Division,
Region X

Purpose

The purpose of this memorandum is to transmit to you copies of the short sheet "A Guide to Principal Threat and Low Level Threat Wastes" which provides additional guidance for applying the National Contingency Plan's expectations concerning principal and low level threat wastes.

Background

The 1990 National Contingency Plan (NCP) (55 Fed. Reg. 8665-8865 (Mar. 8, 1990)) includes certain expectations on the kinds of remedies EPA anticipates selecting for certain types of waste (Section 300.430(a)(1)(iii)(A,B)). Specifically, the NCP indicates that "EPA expects to use treatment to address the principal threat posed by a site, whenever practicable" and "...to use engineering controls, such as containment, for waste that poses a relatively low long term threat or where treatment is impracticable." (55 Fed. Reg. 8846). The NCP provides some very general guidance for defining principal threats and low-level threats but does not provide a specific definition of these concepts.

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In the fall of 1990 a national workgroup was organized to assess the potential for enhancing consistency in risk management decision making in the Superfund program. The application of the concept of principal and low-level threats in the program was one topic the group addressed, and this short sheet is one of the outcomes of that workgroup.

Objective

This fact sheet should help to achieve a higher degree of standardization and documentation with regard to decisions made under the Superfund selection of remedy process. The definitions of principal and low level threats as they relate to the management expectations outlined in the National Contingency Plan are important concepts for guiding program performance.

Implementation

The fact sheet provides general guidelines rather that specifying a risk value to differentiate principal from low level threats. It also more fully describes the role of the principal threat concept in focusing the feasibility study on appropriate alternatives.

Contact

Questions regarding this fact sheet should be addressed to your respective Regional Coordinator in the Hazardous Site Control Division or David Cooper (FTS 678-8361) in the Remedial Operations and Guidance Branch.

Attachment

cc: Superfund Regional Branch Chiefs (Region I - X)
Superfund Regional Section Chiefs (Region I - X)

United States Environmental Protection Agency | Office of Solid Waste and Emergency Response | Superfund Publication: 9380.3-06FS November 1991

EPA

A Guide to Principal Threat and Low Level Threat Wastes

Office of Emergency and Remedial Response
Hazardous Site Control Division OS-220W

Quick Reference Fact Sheet

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) promulgated on March 8, 1990 states that EPA expects to use "treatment to address the principal threats posed by a site, wherever practicable" and "engineering controls, such as containment, for waste that poses a relatively low long-term threat." (40 CFR Section 300.430(a)(1)(iii).) These expectations, derived from the mandates of CERCLA §121 and based on previous Superfund experience, were developed as guidelines to communicate the types of remedies that the EPA generally anticipates to find appropriate for specific types of wastes. Although remedy selection decisions are ultimately site-specific determinations based on an analysis of remedial alternatives using the nine evaluation criteria, these expectations help to streamline and focus the remedial investigation/feasibility study (RI/FS) on appropriate waste management options. This guide explains considerations that should be taken into account in categorizing waste for which treatment or containment generally will be suitable and provides definitions, examples, and ROD documentation requirements related to waste that constitute a principal or low level threat. EPA makes this categorization of waste as principal or low level threat waste after deciding whether to take remedial action at a site. The "Interim Final Guidance on Preparing Superfund Decision Documents," (EPA/624/1-87/90, October 1990) and "A Guide to Developing Superfund Records of Decision" (Directive 9335.3-02FS-1, May 1990) provide additional information on ROD documentation.

NCP Expectations

EPA established general expectations in the NCP (40 CFR 300.430(a)(1)(iii)) to inform the public of the types of remedies that EPA has found to be appropriate for certain types of waste in the past and anticipates selecting in the future. These expectations (see Highlight 1) provide a means of sharing collected experience to guide the development of cleanup options. They reflect EPA's belief that certain source materials are addressed best through treatment because of technical limitations to the long-term reliability of containment technologies, or the serious consequences of exposure should a release occur. Conversely, these expectations also reflect the fact that other source materials can be safely contained and that treatment for all waste will not be appropriate or necessary to ensure protection of human health and the environment, nor cost effective.

Identifying Principal and Low Level Threat Wastes

The concept of principal threat waste and low level threat waste as developed by EPA in the NCP is to be applied on a site-specific basis when characterizing source material. "Source material" is defined as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or acts as a source for direct exposure. Contaminated ground water generally is not considered to be a source material although non-aqueous phase liquids (NAPLs)

HIGHLIGHT 1: NCP Expectations Involving Principal and Low Level Threat Wastes

EPA expects to:

1. Use treatment to address the principal threats posed by a site, wherever practicable.
2. Use engineering controls, such as containment, for wastes that pose a relatively low long-term threat or where treatment is impracticable.
3. Use a combination of methods, as appropriate, to achieve protection of human health and the environment. In appropriate site situations, treatment of principal threats posed by a site, with priority placed on treating waste that is liquid, highly toxic or highly mobile, will be combined with engineering controls (such as containment) and institutional controls, as appropriate, for treatment residuals and untreated waste.
4. Use institutional controls such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances.

may be viewed as source materials. The NCP establishes a different expectation for remediating contaminated ground water (i.e., to return usable ground waters to their beneficial uses in a time frame that is reasonable given the particular circumstances of the site). Examples of source and non-source materials are provided in Highlight 2.

HIGHLIGHT 2: Examples of Source and Non-Source Materials

Source Materials

- Drummed wastes
- Contaminated soil and debris
- "Pools" of dense non-aqueous phase liquids (NAPLs) submerged beneath ground water or in fractured bedrock
- NAPLs floating on ground water
- Contaminated sediments and sludges

Non-Source Materials

- Ground water
- Surface water
- Residuals resulting from treatment of site materials

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. They include liquids and other highly mobile materials (e.g., solvents) or materials having high concentrations of toxic compounds. No "threshold level" of toxicity/risk has been established to equate to "principal threat." However, where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, generally treatment alternatives should be evaluated.

Low level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of release. They include source materials that exhibit low toxicity, low mobility in the environment, or are near health-based levels.

Determinations as to whether a source material is a principal or low level threat waste should be based on the inherent toxicity as well as a consideration of the physical state of the material (e.g., liquid), the potential mobility of the wastes in the particular environmental setting, and the lability and degradation products of the material. However, this concept of principal and low level threat waste should not necessarily be equated with the risks posed by site contaminants via various exposure pathways. Although the characterization of some material as principal or low level threats takes into account toxicity (and is thus related to degree of risk posed assuming exposure occurs), characterizing a waste as a principal threat does not mean that the waste poses the primary risk at the site. For example, buried drums leaking solvents into ground water would be considered a principal threat waste, yet the primary risk at the site (assuming little or no direct contact threat) could be ingestion of contaminated ground water, which as discussed above is not considered to be a source material, and thus would not be categorized as principal threat.

The identification of principal and low level threats is made on a site-specific basis. In some situations site wastes will not be readily classifiable as either a principal or low level threat waste, and thus no general expectations on how best to manage these source materials of moderate toxicity and mobility will necessarily apply. [NOTE: In these situations wastes do not have to be characterized as either one or the other. The principal threat/low level threat waste concept and the NCP expectations were established to help streamline and focus the remedy selection process, not as a mandatory waste classification requirement.]

Examples of principal and low level threat wastes are provided in Highlight 3.

HIGHLIGHT 3: Examples of Principal and Low Level Threat Wastes

Wastes that generally will be considered to constitute principal threats include, but are not limited to:

- Liquids - waste contained in drums, lagoons or tanks, free product (NAPLs) floating on or under ground water (generally excluding ground water) containing contaminants of concern.
- Mobile source material - surface soil or subsurface soil containing high concentrations of contaminants of concern that are (or potentially are) mobile due to wind entrainment, volatilization (e.g., VOCs), surface runoff, or sub-surface transport.
- Highly-toxic source material - buried drummed non-liquid wastes, buried tanks containing non-liquid wastes, or soils containing significant concentrations of highly toxic materials.

Waste that generally will be considered to constitute low level threat wastes include, but are not limited to:

- Non-mobile contaminated source material of low to moderate toxicity - Surface soil containing contaminants of concern that generally are relatively immobile in air or ground water (i.e., non-liquid, low volatility, low leachability contaminants such as high molecular weight compounds) in the specific environmental setting.
- Low toxicity source material - soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk range.

Risk Management Decisions for Principal and Low Level Threat Wastes

The categorization of source material as a principal threat or low level threat waste, and the expectations regarding the use of treatment and containment technologies follows the fundamental decision as to whether any remedial action is required at a site. These determinations, and the application of the expectations, serve as general guidelines and do not dictate the selection of a particular remedial alternative. For example, EPA's experience has demonstrated that highly mobile wastes (e.g., liquids) are difficult to reliably contain and thus generally need to be treated. As such, EPA expects alternatives developed to address highly mobile material to focus on treatment options rather that containment approaches.

However, as stated in the preamble to the NCP (55 FR at 8703, March 8, 1990), there may be situations where wastes identified as constituting a principal threat may be contained rather than treated due to difficulties in treating the wastes. Specific situations that may limit the use of treatment include:

- Treatment technologies are not technically feasible or are not available within a reasonable time frame;
- The extraordinary volume of materials or complexity of the site make implementation of treatment technologies impracticable;
- Implementation of a treatment-based remedy would result in greater overall risk to human health and the environment due to risks posed to workers or the surrounding community during implementation; or
- Severe effects across environmental media resulting from implementation would occur.

Conversely, there may be situations where treatment will be selected for both principal threat wastes and low level threat wastes. For example, once a decision has been made to treat some wastes (e.g., in an onsite incinerator) economies of scale may make it cost effective to treat all materials including low level threat wastes to alleviate or minimize the need for engineering/institutional controls.

While these expectations may guide the development of appropriate alternatives, the fact that a remedy is consistent with the expectations does not constitute sufficient grounds for the selection of that remedial alternative. The selection of an appropriate waste management strategy is determined solely through the remedy selection process outlined in the NCP (i.e., all remedy selection decisions are site-specific and must be based on a comparative analysis of the alternatives using the nine criteria in accordance with the NCP). Independent of the expectations, selected remedies must be protective, ARAR-compliant, cost-effective, and use permanent solutions or treatment to the maximum extent practicable. Once the final remedy is selected, consistency with the NCP expectations should be discussed as part of the documented rationale for the decision.

ROD Documentation

Declaration

The "Description of the Selected Remedy" section should note whether the remedy is addressing any source materials that constitute "principal" or "low level" threat wastes, or both.

The "Statutory Determinations" section should discuss how the selected remedy satisfies the statutory preference stated in CERCLA §121 to select remedial actions "in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances, pollutants, and contaminants is a principal element." In evaluating this statutory preference, the site manager needs to decide whether treatment selected in the ROD constitutes treatment as a major component of the remedy for that site. Remedies which involve treatment of principal threat wastes likely will satisfy the statutory preference for treatment as a principal element, although this will not necessarily be true in all cases (e.g., when principal threat wastes that are treated represent only a small fraction of the wastes managed through containment). Ground water treatment remedies also may satisfy the statutory preference, even though contaminated ground water is not considered a principal threat waste and even though principal threat source material may not be treated.

Decision Summary

The "Decision Summary" of the ROD should identify those source materials that have been identified as principal threat and/or low level threat wastes, and the basis for these designations. These designations should be provided in the "Summary of Site Characteristics" section as part of the discussion focusing on these source materials that pose or potentially pose a risk to human health and the environment. In addition, the "Description of Alternatives" and the "Selection of Remedy" sections should briefly note how principal and/or low level threat wastes that may have been identified are being managed.

The "Statutory Determinations" section of the ROD should include a discussion of how the statutory preference for treatment as a principal element is satisfied or explain why it is not satisfied, stating reasons in terms of the nine evaluation criteria.

NOTICE: The policies set out in this memorandum are intended solely as guidance. They are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this memorandum, or to act at variance with the guidance, based on an analysis of specific site circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

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- Memorandum entitled Meeting RCRA Corrective Action GPRA Goals, from Fields, EPA, to Regional Administrators, February 11, 1999.

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- Corrective Action Overview: http://www.epa.gov/epaoswer/hazwaste/ca/index.htm
- Corrective Action Program: http://www.epa.gov/reg3wcmd/corrective_action.htm
- EPA/OSW Corrective Action Waste Cleanup: http://www.epa.gov/epaoswer/osw/cleanup.htm
- RCRA Hotline Phone Number - (800) 424-9346

CONCEPTUAL SITE MODEL (CSM)

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What is a SCEM?

A graphic presentation of how contaminants may be released and transported in the environment, resulting in exposure to human and ecological receptors. SCEMs are used during environmental site investigations as a planning tool for public health and ecological risk assessments.

Why Use a SCEM?

- To develop risk assessment data quality objectives (DQOs)
- Prioritize response actions
- To provide project teams with a tool to support and document project decisions
- To help exchange information among site investigators, stakeholders and agencies

What is the SCEM Builder?

A computer graphics tool that generates SCEMs and associated documentation. Previously, SCEMs were drawn manually by drafting technicians which made it difficult to modify when new site conditions are encountered or debated among decision-makers.

SCEM Builder Benefits

- User-friendly
- Shortens the time required to develop SCEMs
- SCEMS can be modified quickly, in the field, office, or public meeting
- Allows site data, assumptions and uncertainties to be stated in SCEMs

The SCEM Builder and User Manual can be downloaded from the DOE/EH-413 Home Page

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Contact

- John Bascietto (DOE/EH-413) (202) 586-7917
- Carlos Martins (HAZMED) (301) 577-9339

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USER'S GUIDE
SUBSURFACE FUGACITY SPREADSHEET TOOL
FOR RESULTS BASED PROJECT MANAGEMENT

The purpose of this User's Guide is to provide instructions regarding downloading and using a fugacity spreadsheet to determine the distribution of an organic chemical among air, water (aqueous), soil solids, and non-aqueous phase liquid (NAPL) in a subsurface environment.

1. access web address:
   http://www.engineering.usu.edu/uwrl/www/faculty/fugacity/fugacity.html

2. On page one, select Level 1 Fugacity Model

3. Information is provided in the tab labeled "Fugacity Level 1" for the chemical benzene.
   The information displayed addresses:
   (a) chemical characteristics of benzene,
   (b) default site characteristics, and
   (c) three formats [pie chart, bar chart, and table] for presenting information on the distribution of benzene among subsurface phases including air, water, soil solids, and NAPL. In addition, the table provides values for the concentration of benzene (mg/L) in each phase, based on a total amount of 1 gm of benzene and a total volume of all phases of 100 m^3.

4. Chemical characteristics are obtained from the tab labeled "chemical data." Chemical characteristics for the chemical of interest are obtained as follows:
   (1) access the "chemical data" tab, then
   (2) locate the chemical (listed in alphabetical order)
   (3) copy the list of chemical characteristics
   (4) paste the list of chemical characteristics under "Level 1 Fugacity."

5. Site characteristics are listed under the "Level 1 Fugacity." tab for a typical "evaluative site" and typical values are provided as default values. Site specific data is entered manually.
   (1) The volume of each phase can be provided as input, but the total volume of the "evaluative site" must be 100 (m^3). Therefore the values for each phase represent the "percent" of that phase within the "evaluative site." Ranges of values include:

Soil Phase	Range(% volume)	Typical Values (% volume)	
		Unsaturated Soil	Aquifer
Water	5 - 50	25	40
Air	0 - 40	25	0
Soil Solid	40-60	50	60
NAPL	0 - 50	0	0

   (2) Values for % organic carbon in the soil phase and soil bulk density can be provided as input based on measured values for a particular site. Standard procedures are available for measuring these properties (Methods of Soil Analysis, Parts 1& 2, American Society of Agronomy, Inc., 1982 (Part 1), 1986 (Part 2)). Values for % organic carbon and soil bulk density in soil include:

Property	Range	Typical Values	
		Unsaturated Soil	Aquifer
% Organic carbon	0.2 - 5.0	0.5	0.2
Bulk Density (Kg/m^3)	1.2 - 1.7	1.3	1.6

   (3) The default value for the mass of the compound in the system (air, water, soil solid, and NAPL) is one gram, but site-specific values can be provided as input. Calculation of chemical concentrations in each phase at equilibrium is provided.

LEVEL 1 FUGACITY MODEL

CHEMICAL CHARACTERISTICS

(copy and paste from chemical data tab)

Enter the compound name:	1,1,1-Trichloroethane
Enter the molecular weight:	133.4
Enter water solubility (mg/L):	9.50E+02
Enter vapor Pressure (mmHg):	1.00E+02
Enter Henry's law constant (atm*m^3/mol):	2.76E-03
Enter Log Kow:	2.49
Enter Log Koc	2.18

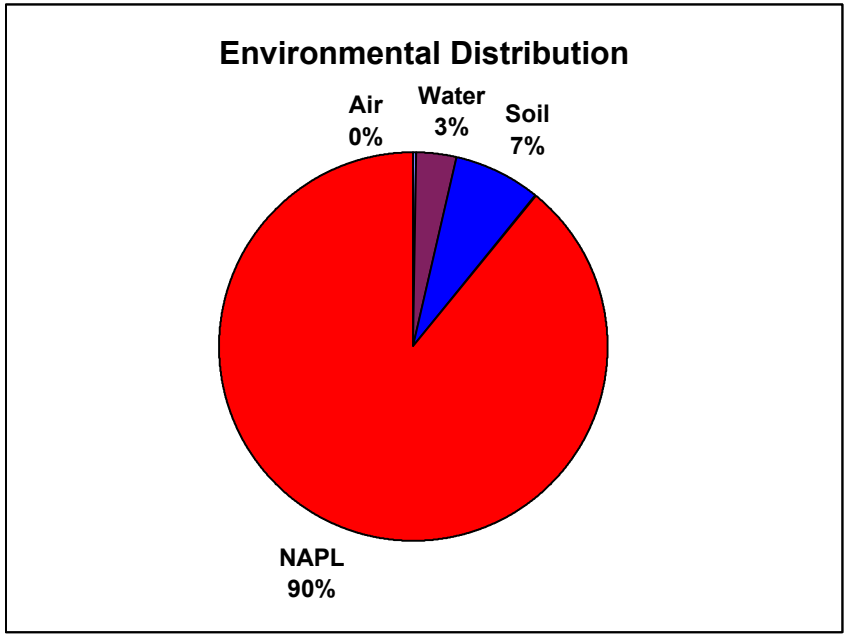
SITE CHARACTERISTICS

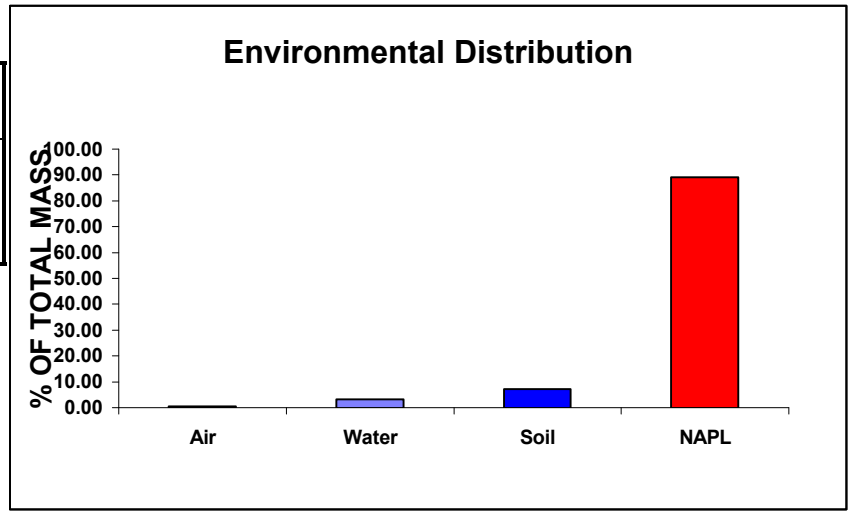
Enter the following:

Volume of air (m^3):	2.50E+01
Volume of Water(m^3):	2.30E+01
Volume of Soil(m^3):	5.00E+01
Volume of NAPL(m^3):	2
total volume (m^3) is :	**100**
Enter the % organic carbon in the soil phase:	0.5
Enter the Bulk Density of the Soil (Kg/m^3):	1325
Enter the total mass of the compound in the system (g):	1.00E+00

RESULTS

Compartment	Concentration (mg/L)	% distrubution
Air	0.000165395	**0.41**
Water	0.001440786	**3.31**
Soil	0.001444725	**7.22**
NAPL	0.445245394	**89.05**
	Sum=	100.0





LEVEL 1 FUGACITY MODEL

CHEMICAL CHARACTERISTICS

(copy and paste from chemical data tab)

Enter the compound name:	1,1-Dichloroethane
Enter the molecular weight:	99
Enter water solubility (mg/L):	5.50E+03
Enter vapor Pressure (mmHg):	1.82E+02
Enter Henry's law constant (atm*m^3/mol):	5.70E-03
Enter Log Kow:	1.79
Enter Log Koc	1.48

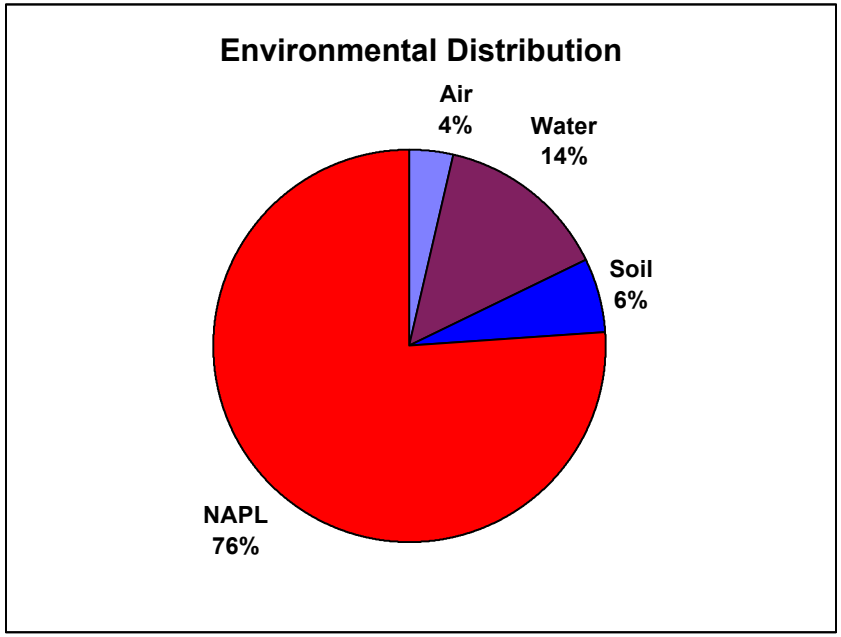
SITE CHARACTERISTICS

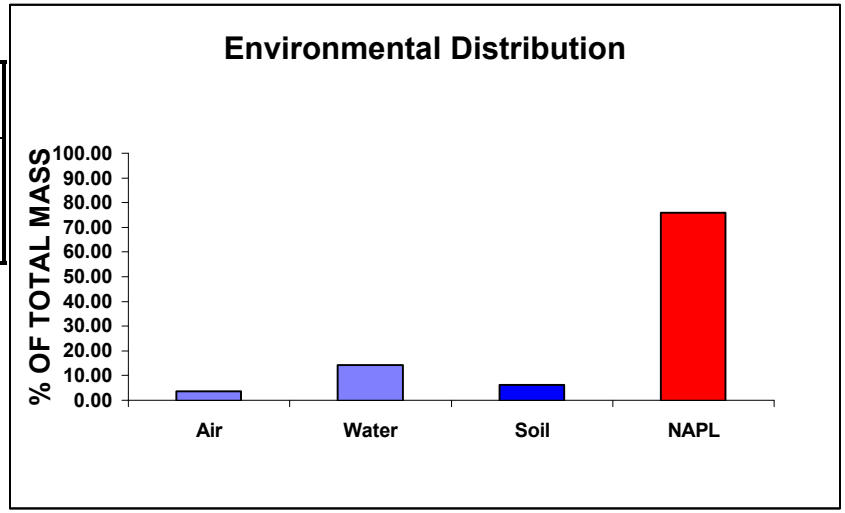
Enter the following:

Volume of air (m^3):	2.50E+01
Volume of Water(m^3):	2.30E+01
Volume of Soil(m^3):	5.00E+01
Volume of NAPL(m^3):	2
total volume (m^3) is :	**100**
Enter the % organic carbon in the soil phase:	0.5
Enter the Bulk Density of the Soil (Kg/m^3):	1325
Enter the total mass of the compound in the system (g):	1.00E+00

RESULTS

Compartment	Concentration (mg/L)	% distrubution
Air	0.001461182	**3.65**
Water	0.006163347	**14.18**
Soil	0.001233112	**6.17**
NAPL	0.380028926	**76.01**
	Sum=	100.0





LEVEL 1 FUGACITY MODEL

CHEMICAL CHARACTERISTICS

(copy and paste from chemical data tab)

Enter the compound name:	1,1-Dichloroethylene
Enter the molecular weight:	96.94
Enter water solubility (mg/L):	4.00E+02
Enter vapor Pressure (mmHg):	5.00E+02
Enter Henry's law constant (atm*m^3/mol):	1.54E-01
Enter Log Kow:	2.13
Enter Log Koc	1.81

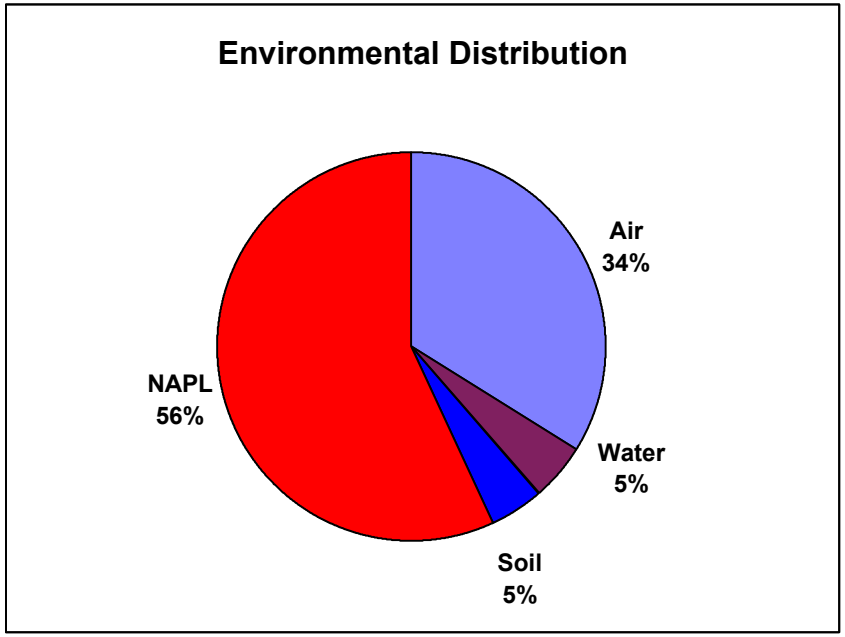
SITE CHARACTERISTICS

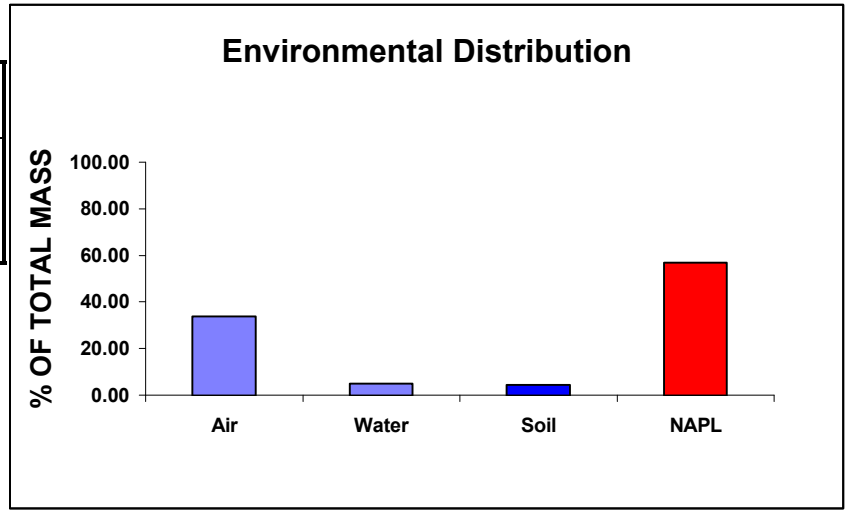
Enter the following:

Volume of air (m^3):	2.50E+01
Volume of Water(m^3):	2.30E+01
Volume of Soil(m^3):	5.00E+01
Volume of NAPL(m^3):	2
total volume (m^3) is :	**100**
Enter the % organic carbon in the soil phase:	0.5
Enter the Bulk Density of the Soil (Kg/m^3):	1325
Enter the total mass of the compound in the system (g):	1.00E+00

RESULTS

Compartment	Concentration (mg/L)	% distrubution
Air	0.01350427	**33.76**
Water	0.002108325	**4.85**
Soil	0.000901827	**4.51**
NAPL	0.284405204	**56.88**
	Sum=	100.0





LEVEL 1 FUGACITY MODEL

CHEMICAL CHARACTERISTICS

(copy and paste from chemical data tab)

Enter the compound name:	Chloroethane
Enter the molecular weight:	64.52
Enter water solubility (mg/L):	5.70E+03
Enter vapor Pressure (mmHg):	1.00E+03
Enter Henry's law constant (atm*m^3/mol):	1.10E+02
Enter Log Kow:	1.43
Enter Log Koc	1.17

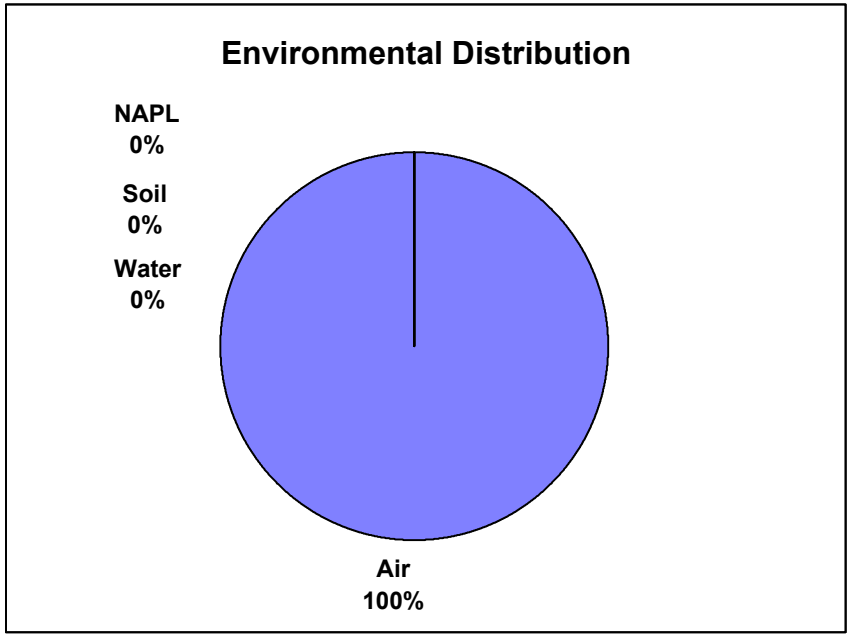
SITE CHARACTERISTICS

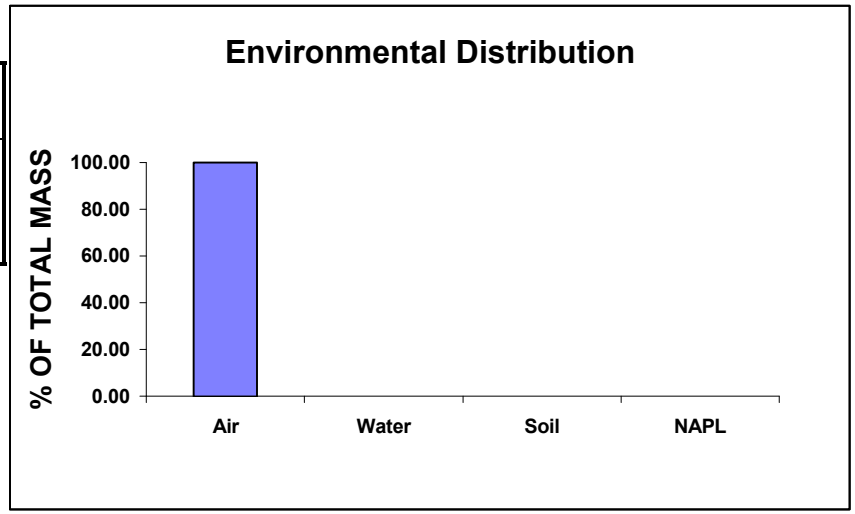
Enter the following:

Volume of air (m^3):	2.50E+01
Volume of Water(m^3):	2.30E+01
Volume of Soil(m^3):	5.00E+01
Volume of NAPL(m^3):	2
total volume (m^3) is :	**100**
Enter the % organic carbon in the soil phase:	0.5
Enter the Bulk Density of the Soil (Kg/m^3):	1325
Enter the total mass of the compound in the system (g):	1.00E+00

RESULTS

Compartment	Concentration (mg/L)	% distrubution
Air	0.039971438	**99.93**
Water	8.73664E-06	**0.02**
Soil	8.56111E-07	**0.00**
NAPL	0.00023515	**0.05**
	Sum=	100.0





EPA/540/2-90/01 1
October 1990

SUBSURFACE CONTAMINATION REFERENCE GUIDE

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

NOTICE

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Chapter 1

INTRODUCTION

Ground water contamination is a significant concern at approximately 70% of the Superfund sites. The difficulties associated with cleaning up contaminated ground water are becoming more and more evident as experience with this problem increases. A recent study of 19 ground water extraction systems (U.S. EPA, 1989, EPA/540/2-89/054) indicated several factors that can limit the effectiveness of the traditional pump-and-treat remediation systems and also identified possible enhancements than may improve the performance of these systems. Many of the factors limiting performance are a result of interactions between the contaminants and the subsurface environments and can be tied to particular contaminant properties (e.g., solubility, density) and/or the nature of the subsurface (e.g., low permeability, fractures).

As a result of the referenced study several recommendations were made including a recommendation to collect more detailed data on the vertical stratigraphy of the subsurface, the vertical variations in contaminant concentration, and the proportion of contaminant sorbed to the soil in the saturated zone. To the extent possible potential limitations should be recognized even before the investigation begins; i.e. during scoping, to better focus remedial investigation/feasibility study (RI/ FS) efforts.

This guide was developed to provide a source of information pertaining to important fate and transport properties for a variety of contaminants commonly found in ground water at Superfund sites. This information may help to focus site investigation efforts and identify early-on potential remediation strategies. Knowledge pertaining to the magnitude of these properties can be used to help to project whether contaminants will sorb significantly to soils, dissolve and move with ground water flow, migrate downward as a separate phase, or float on the water table. Potential remedial technologies have been identified for various combinations of contaminant types and hydrogeological environments.

Information pertaining to contaminant fate and transport properties have been presented in tabular form and provided as separately published charts for easy reference.

This document was prepared as a task of the Subsurface Remediation Information Center located at the U.S. EPA Robert S. Kerr Environmental Research Laboratory (RSKERL), Ada, Oklahoma. Questions pertaining to the information contained in this document should be addressed to John E. Matthews at RSKERL-Ada (405/332-8800).

Chapter 2

SUBSURFACE REMEDIAL TECHNOLOGIES

Subsurface remedial technologies which may be applicable at Superfund sites are described below. These descriptions are intended as guidance for use in conjunction with the tabular data presented in separately published charts that are provided with this document (Tables 1 and 2, EPA/540/2-90/011a; Table 3, EPA/ 540/2-90/011b).

2.1 PUMP AND TREAT

2.1.1 Continuous Pumping

Pump and treat remediation technology is applicable to the saturated zone and refers to the extraction of contaminated ground water from the subsurface and subsequent treatment of the extracted ground water at the surface. Extraction of contaminated ground water is accomplished through the use of extraction (pumping) wells which are completed at specified locations and depths to optimize contaminant recovery. Determination of the locations and depths of extraction wells requires prior delineation of the contaminant plume and knowledge of the aquifer properties. Injection wells may be installed to enhance contaminant recovery by flushing contaminants toward extraction wells.

Pump and treat technology is best suited for managing mobile chemicals (i.e., log K_{oc} or log K_{ow} values less than 3.0 and 3.5, respectively) residing in relatively permeable and homogeneous hydrogeologic settings. Factors which must be considered and may limit the ability of pump and treat remediation treatment to achieve cleanup concentrations in the ground water include: 1) the presence of chemicals with relatively high K_{oc} or log K_{ow} values (e.g. log $K_{oc} > 3.0$ or log $K_{ow} > 3.5$), 2) aquifers exhibiting low permeability properties (e.g., $< 10^{-6}$ cm/s), 3) highly heterogeneous hydrogeologic settings (e.g. highly stratified aquifers with multiple layers of coarse and fine textured material), and 4) the presence of spatially discontinuous or inaccessible dense non-aqueous phase liquid (DNAPL).

Pump and treat technology may, in many cases, be used to aid in the removal of light non-aqueous phase liquid (LNAPL) and/or DNAPL which may be present. Recovery of LNAPL residing as free product on the surface of the water table, for example, can be facilitated by using pumping wells to create cones of depression. DNAPL residing as large pools in topographical lows at the bottom of aquifers can be recovered by pumping from wells screened over the thickness of the pools. In cases where recovery is not feasible (e.g., DNAPL resides in fractures or is present as spatially discontinuous free product within an aquifer), alternative measures such as physical containment (e.g. cement-bentonite walls) should be considered.

Pumping technology may also be used as a means of containing or controlling contaminant plumes. This is accomplished through control of hydraulic gradients by selectively

locating pumping wells in the area of the plume. Control of hydraulic gradients should be considered in conjunction with physical containment options.

The surface treatment of extracted ground water will vary depending on the contaminants present. Typical actions include air stripping, activated carbon adsorption and biological treatment. In some cases, treated ground water may be amended with nutrients and oxygen and reinjected into the subsurface to aid in stimulating biodegradative processes.

Pump and treat remediation technology generally will play an important role in ground water cleanup. For information regarding applicability of pump and treat technology and its modifications, contact Randall R. Ross at the RSKERL-Ada (405/332-8800).

2.1.2 Pulsed Pumping

Pulsed pumping is a modification of standard pump and treat technology which involves regular or periodic cessation of pumping activities to optimize ground water cleanup. Pulsed pumping may be necessary or more cost-effective in cases where extraction wells can not sustain yields (e.g., in bedrock and unconsolidated deposits of low permeability), where desorption and/or dissolution of contaminants in the subsurface is relatively slow, or where hydraulic conductivity heterogeneity is high. Pulsed pumping may be appropriate for: 1) low yield consolidated and unconsolidated deposits; 2) relatively homogeneous hydrogeologic settings containing contaminants with log K_{oc} values between 2.0 and 4.0 (or log K_{ow}, values between 2.5 and 4.5); 3) heterogeneous formations consisting of alternating high and low permeability layers and containing contaminants with log K_{oc} and log K_{ow} values less than 3.0 and 3.5, respectively; and 4) hydrogeological settings containing low to moderately soluble residual non-aqueous phase liquid (NAPL).

A potential concern associated with implementation of pulsed pumping is the uncontrolled migration of the contaminant plume during non-pumping phases. Nearby water supply wells or irrigation systems may significantly impact the behavior of the contaminant plume during non-pumping phases and thereby create a potentially more serious contamination scenario.

2.1.3 Reinjection

Reinjection, which often is used in combination with pump and treat or pulsed pumping, generally refers to injection of treated ground water back into the subsurface. Reinjection may be accomplished through the use of injection wells or other means such as infiltration galleries. Reinjected ground water can be used to help remove contaminants residing in the unsaturated zone by forcing these contaminants towards extraction wells. Reinjection also may be used in the stimulation of biodegradative processes in the saturated zone, thereby enhancing cleanup of the saturated zone. In such cases, the injectate is amended with nutrients and an oxygen source. In special cases, the injectate may be amended with surfactants or other compounds (i.e. chemical extraction) to facilitate removal of adsorbed and residual organics in the unsaturated and/or saturated zones.

2.2 SOIL VACUUM EXTRACTION

Vacuum extraction technology involves the enhanced removal of chemicals in the subsurface through application of a vacuum. The applied vacuum enhances volatilization of compounds from soil and pore water. The technology is particularly applicable to relatively volatile organic compounds (Henry's Law Constant > 10^{-3} atm-m^3/mole) residing in the unsaturated zone. The technology also is applicable for removal of volatile light non-aqueous phase liquids (LNAPLs) floating on the water table or entrained in the capillary fringe. The process involves installation of vacuum extraction wells at strategic locations and depths. The spacing of extraction wells is dependent on soil properties such as permeability and porosity. The technology is applicable to most soil types although removal efficiency will generally decrease with decreasing soil permeability and increasing subsurface stratigraphy (heterogeneity).

Vapors released from the subsurface as a result of the vacuum extraction process may be captured and then processed through a liquid-vapor separator. The separated volatile organic vapor fraction may be treated with activated carbon or other means.

Vacuum extraction also can serve a dual purpose by enhancing removal of subsurface organic contaminants through stimulation of aerobic biodegradative processes. This is accomplished by ensuring a constant and ample supply of oxygen for use by indigenous subsurface microbial populations. Vacuum extraction also may be used in conjunction with in-situ steam extraction (see description below). Steam extraction may enhance the recovery of organic chemicals, including NAPL's, from the vadose zone.

Vacuum extraction is a proven remedial technology which is being increasingly applied at Superfund sites. For further information regarding the applicability of vacuum extraction contact Dominic DiGiulio at the RSKERL-Ada (405/332-8800).

2.2.1 In-Situ Steam Extraction

In-situ steam extraction facilitates the removal of moderately volatile (10^{-3} > v.p. > 10^{+0} mm Hg) residual organics, including NAPLs, from the vadose zone. Steam extraction technology utilizes injection of pressured steam to the contaminated horizon to thermally enhance the evaporative rate of the contaminant and its subsequent removal. Injection of steam also can be expected to enhance removal of residual NAPL's in the unsaturated zone by decreasing their viscosities. Steam extraction is an emerging technology that appears promising, particularly if used in conjunction with vacuum extraction.

2.3 SOIL FLUSHING

Soil flushing technology involves the use of extractant solvents to remove organic and/or inorganic contaminants from soils in the subsurface. Extractant solvents may include water, water-surfactant mixtures, acids, bases, chelating agents, oxidizing agents and reducing agents. The extractants used, however, should be limited to those which exhibit low toxicity and will not otherwise adversely impact the subsurface environment. Proper control measures must be

exercised to prevent migration of extractant-contaminant mixtures from the vadose zone into ground water.

In-situ soil flushing can be applicable to those compounds residing in the vadose zone which are not amenable to removal by vacuum extraction. These compounds may include semi-volatile organics, cyanide salts, and metals (e.g., selenium, arsenic, and hexavalent chromium). Applications are limited to soils with adequate permeability ($k > 10^{-5}$ cm/s) and a reasonable degree of homogeneity. For semi-volatile organics amenable to biodegradation, bioremediation in concert with in-situ vacuum extraction (or alternative air circulation technology) will likely be a better choice.

The effectiveness of soil flushing relative to other vadose zone remedial technologies is not clear. Due to the potential environmental impact of in-situ soil flushing, the technology should only be used in situations where other remediation technologies of lower potential environmental impact are not appropriate.

Soil flushing has been used at some Superfund sites although the level of its success is not clear. For information regarding the applicability of soil flushing, contact John Brugger at the EPA Risk Reduction Engineering Laboratory, Edison NJ (201/321 -6634).

2.3.1 Chemical Extraction

Chemical extraction as used in this document refers to a specialized form of soil flushing that applies only to the saturated zone. This technology involves the use of extractant solvents to enhance desorption or solubilization of contaminants in the saturated zone in conjunction with pump and treat operations. Extracted ground water is amended with solvents and/or other chemicals then reinjected at strategic locations into the aquifer. The extractants used are similar to those used in soil flushing in the vadose zone. Chemical extraction is most applicable in cases where contaminants are not easily mobilized or removed with water alone, i.e., strongly sorbed to aquifer solids or present as residual saturation. Caution should be exercised when using chemical extraction methods, however, because of the potential adverse impact introduced chemicals may have on the subsurface environment.

2.4 CONTAINMENT

Containment technologies are used to isolate contaminated areas in the subsurface from the surrounding uncontaminated environment. Containment usually involves installation of an impermeable barrier around, or a cap over, the affected area. The barrier may take the form of a slurry wall (e.g. soil-bentonite wall or cement-bentonite wall), a grout curtain, or sheet piling cut-offs. In the saturated zone, these barriers must be tied into an impermeable layer at the base of the aquifer. Containment, although not considered a remediation technology, warrants consideration in concert with remedial technologies or as an interim measure while remediation technologies can be considered. Spatially discontinuous DNAPL residing within an aquifer, for example, may be an appropriate scenario for considering containment. The selection of the barrier material must take into account the compatibility of the material with the contaminant(s)

in question. Containment also may include installation of a cap over the contaminated area to impede infiltration of water into that area.

Another method of controlling contaminant migration is hydraulic containment. Hydraulic containment involves retardation of movement of a ground water contaminant plume by using pumping wells to control hydraulic gradients. Hydraulic containment may be used early in a site investigation to prevent plume expansion while a more detailed characterization is completed. For information regarding the applicability of containment technologies, contact Dr. Walter Grube at the EPA Risk Reduction Engineering Laboratory, Cincinnati, OH (513/569-7798).

2.5 BIOREMEDIATION

Bioremediation technologies involve enhancing biodegradation of contaminants in the saturated and unsaturated zones of the subsurface environment through the artificial stimulation of indigenous soil and ground water microbial populations. Natural biodegradative processes are enhanced by optimizing conditions necessary for subsurface microbes to grow and complete metabolic pathways. Bioremediation is applicable only for treating organic contaminants. Bioremediation should only be considered in conjunction with source control.

Bioremediation for subsurface contamination often can be carried out in situ. The successful execution of an in-situ bioremediation program will depend upon: 1) amenability of the organic compound(s) to biodegradation, 2) permeability and heterogenic properties of the subsurface regime, 3) ability of the delivered oxygen and nutrients to reach the contaminated area, and 4) other factors such as temperature and pH.

In situ bioremediation in the saturated zone can be applied as a specialized form of pump and treat. Extracted ground water from the contaminated zone is treated at the surface, amended with nutrients and oxygen, and then reinjected into the subsurface at strategic locations. Difficulties may arise in the dissemination of oxygen and nutrients in low permeability or highly heterogeneous regimes. Some states may not allow reinjection of treated ground water; therefore, amendments must be delivered to the injection point in clean water.

In situ bioremediation in the unsaturated (vadose) zone can be applied as a specialized form of soil vacuum extraction. The air circulation induced by soil vacuum extraction ensures an ample supply of oxygen to the indigenous microbial population. Other vadose zone in situ bioremediation systems use infiltration galleries or injection wells for delivery of oxygen and nutrients.

Bioremediation is a promising technology for vadose zone soils and contaminated ground waters . For further information regarding the applicability of bioremediation, contact John E. Matthews, Scott G. Huling or John T. Wilson at the RSKERL-Ada (405/332-8800).

2.6 IN-SITU VITRIFICATION

In-situ vitrification (ISV) transforms contaminated soil into an inert glass-like mass that is highly resistant to weathering and leaching. The technique employs electrodes and a high amperage current to heat surrounding soil from 1600 °C to 2000 °C. When operating temperatures are reached a molten mass of contaminated soil is created. As the mass expands it assimilates nonvolatile compounds into its structure and destroys volatile organic compounds by pyrolysis. The technology is generally more applicable at sites having soils contaminated with metals or organic chemicals exhibiting high K_{oc} or K_{ow}, values.

In-situ vitrification is a proven technology which has been implemented at selected sites. For further information regarding the applicability of in-situ vitrification, contact Teri Shearer at the EPA Risk Reduction Engineering Laboratory, Cincinnati, OH (513/569-7949).

2.7 TREATMENT COMBINATIONS

Often it will be necessary to implement a combination of treatment technologies to effectively remediate or control subsurface contamination. An example of such a combination is pump and treat with in-situ bioremediation or chemical extraction. One of these combinations may be appropriate at sites where contaminants are strongly adsorbed within the aquifer, and pump and treat alone is expected to have limited success. In-situ bioremediation or chemical extraction could facilitate removal of the strongly sorbed contaminants, thereby enhancing the overall remediation effort. In general, in-situ bioremediation or chemical extraction would be most effective after initial recovery efforts using pump and treat alone have been completed.

Another useful treatment combination involves pump and treat and containment. This combination may be of interest in cases where DNAPL is distributed in a spatially discontinuous manner within the aquifer. Because DNAPL recovery in such a case would be very difficult, the only recourse might be to control and/or contain the contamination. Pump and treat would initially be used to draw in or reduce the size of the aqueous phase contaminant plume generated by the DNAPL. Physical containment would then be used to isolate the DNAPL source area.

An additional treatment combination which may be of interest is aquifer dewatering using pump and treat followed by soil vacuum extraction. This combination of technologies may be of use in cases where an aquifer is contaminated with volatile organics and dewatering portions of the aquifer is feasible. Pumping would be used to dewater a portion of the aquifer so that vacuum extraction could be applied to enhance volatilization and biodegradation of the volatile organics contaminants in the dewatered zone.

Combinations involving more than two treatment technologies also should be considered in efforts to optimize cleanup of subsurface contamination.

Chapter 3

CONTAMINANT PROPERTIES AFFECTING SUBSURFACE TRANSPORT AND FATE

The following is a description of some important properties which may play an important role in the transport and fate of contaminants in the subsurface. These descriptions are intended to provide guidance for using the tabular information presented in the separately published charts accompanying this document.

Melting Point - The melting point of a compound provides an indication of the physical state of a pure compound at field temperatures. Compounds with melting points above 30°C, for example, would be expected to be immobile in pure form. Such compounds would be of primary concern when in the dissolved phase, either in water or other solvent. Compounds with melting points lower than 30°C may be present as mobile non-aqueous phase liquid.

Water Solubility - Water solubility governs the extent to which a contaminant will partition into the aqueous phase. More soluble contaminants would be expected to migrate further in the subsurface than less soluble compounds. The greater the water solubility of a compound, the greater will be the tendency for that compound to migrate with the aqueous advective flow component. Contaminants with higher water solubilities are more amenable to removal from the saturated zone by pump and treat technology. These same compounds, however, are more likely to migrate through the vadose zone to ground water.

Vapor Pressure - The vapor pressure of a compound provides an indication of the extent to which the compound will volatilize. The tendency of a compound to volatilize will rise proportionately with its vapor pressure. Compounds with higher vapor pressures are more amenable to treatment with vacuum extraction technologies. For comparative purposes, the vapor pressure of water at 20°C is 17.5 mm Hg.

Henry's Law Constant - Henry's Law Constant provides an indication of the extent to which a compound will volatilize from an aqueous solution. Henry's Law Constant is directly proportional to the vapor pressure of the compound and inversely proportional to the water solubility of the compound. The greater the Henry's Law Constant of a compound, the greater will be the tendency of the compound to volatilize from aqueous solution. Compounds with higher Henry's Law Constants are more amenable to treatment with vacuum extraction technologies.

Density - The density of a compound indicates whether the compound is heavier or lighter than water. (The density of water is approximately 1.0 g/cc). Liquid compounds with densities greater than 1.0 g/cc and of only limited water solubility (i.e. DNAPLs), may migrate

vertically under the influence of gravity. DNAPLs may eventually gravitate to the bottom or other region of an aquifer where an impermeable layer is encountered. Compounds with limited water solubility and with densities less than 1.0 g/cc will tend to float on the water table.

Dynamic Viscosity - Dynamic viscosity provides an indication of the ease with which a compound (in its pure form) will flow. The mobility of the compound in pure form is inversely proportional to its dynamic viscosity. The dynamic viscosity of water is approximately 1.0 centipoise (cp).

Kinematic Viscosity - The kinematic viscosity of a compound takes into account the density of the compound and provides an indication of the ease with which the compound (in its pure form) will percolate through the subsurface. The lower the kinematic viscosity of a compound, the greater will be its tendency to migrate in a downward direction. Kinematic viscosity is of particular importance with regard to the movement of DNAPLs in aquifers. The lower the kinematic viscosity of a DNAPL, the greater will be the ease with which the DNAPL will move downwards and penetrate the finer grained layers in the subsurface. The kinematic viscosity of water is approximately 1.0 centistokes (cs).

Octanol/Water Partition Coefficient (K_{ow}) - The octanol/water partition coefficient is a measure of the extent to which a contaminant partitions between octanol and water. It is the ratio of the concentration of the compound in octanol to the concentration of the compound in water. The K_{ow}, provides an indication of the extent to which a compound will adsorb to a soil or an aquifer solid, particularly organic material. The greater the K_{ow}, value of a compound, the greater will be its tendency to be adsorbed in the subsurface.

Organic Carbon Partition Coefficient (K_{oc}) - The organic carbon partition coefficient is the ratio of the amount of chemical adsorbed per unit weight of organic carbon in the soil to the concentration of the chemical in solution at equilibrium. The K_{oc} is similar to the K_{ow}.

Biodegradability Potential - The biodegradability potential of a compound is important in determining the feasibility of using bioremediation as a treatment technology. The greater the biodegradability of a compound, the greater will be the susceptibility of the compound to a bioremediation process. Only aerobic biodegradability is addressed in this document.

TABLE
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Table 1. Contaminants Commonly Found at Superfund Sites

Halogenated Volatile Organics

Liquid Solvents

Carbon Tetrachloride
Chlorobenzene
Chloroform
Cis-1,2-dichloroethylene (d)
1,1-Dichloroethane (a)
1,2-Dichloroethane
1,1-Dichloroethylene
1,2-Dichloropropane (a)
Ethylene Dibromide (g)
Methylene Chloride
1,1,2,2-Tetrachloroethane
Tetrachloroethylene
Trans-1,2-dichloroethylene (d)
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene

Gases

Chloroethane
Vinyl Chloride

Non-Halogenated Volatile Organics

Ketones/Furans

Methyl Ethyl Ketone
4-Methyl-2-Pentanone
Tetrahydrofuran

Aromatics

Benzene (g)
Ethyl Benzene (g)
Styrene
Toluene (g)
m-Xylene (g)
o-Xylene (g)
p-Xylene (g)

Inorganics

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Cyanide (CN)
Lead (Pb)
Mercury (Hg)
Selenium (Se)
Iron (Fe) ‡

Halogenated Semivolatile Organics

PCBs (b)

Aroclor 1242
Aroclor 1254
Aroclor 1260

Pesticides

Chlordane
DDD
DDE
DDT
Dieldrin

Chlorinated Benzenes

1,2-Dichlorobenzene
1,4-Dichlorobenzene

Chlorinated Phenols

Pentachlorophenol (w)
2,3,4,6-Tetrachlorophenol

Non-Halogenated Semivolatile Organics

PAHs (e)

Acenaphthene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Chrysene
Dibenz(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
2-Methyl naphthalene
Naphthalene
Phenanthrene
Pyrene

Non-Chlorinated Phenols

m-Cresol (e)
o-Cresol (e)
p-Cresol (e)
2,4-Dimethylphenol (e)
2,4-Dinitrophenol
Phenol

(a) may be component of antiknock fluids added to fuel oils
(b) constituent in some oils, greases, dielectric liquids, and thermostatic fluids
(d) may be present in dye or lacquer solutions
(e) constituent of crude oil fractions (including fuel and motor oils) and/or coal tar fractions (including creosote); creosote may be present as DNAPL
(g) constituent in fuel oils (e.g. gasoline)
(w) combined with fuel oil #2 or kerosene when used as wood preservative

Note: Some contaminants listed may be present in subsurface as biological or chemical degradation products of others

‡ Although not normally classified as a contaminant, iron may strongly impact the subsurface behavior of other contaminants and may govern which treatment processes can or cannot be used.

Table 2. Property Ratings of Chemical Classes Commonly Found at Superfund Sites (from Table 1) and Applicable Technologies for In-Situ Treatment

Chemical Class	Melting Point	Water Solubility	Vapor Pressure	Henry's Law Constant	Density	Dynamic Viscosity	Kinematic Viscosity	Log K_{ow}	Log K_{oc}	Aerobic Biodegradability	Potential Subsurface Mobility
Halogenated Volatile Organics											
*Liquid Solvents**	low	moderate/high	high	moderate/high	high	†	†	low/moderate	low/moderate	†	moderate/high
Gases	low	high	high	high	low	NA	NA	low	low	ND	high
Nonhalogenated Volatile Organics											
Ketones/furans	low	high	high	moderate	low	low	moderate	low	low	ND	high
Aromatics	low	moderate/high	high	high	low	moderate	moderate/high	moderate	moderate	high	moderate
Halogenated Semivolatile Organics*											
PCBs	low	low	low	moderate	high	ND	ND	high	high	low	low
Pesticides	high	moderate	low	low/moderate	low/high	NA	NA	high	high	low	low
Chlorinated Benzenes	low/moderate	moderate	moderate	high	high	high	high	moderate	moderate	high	moderate
Chlorinated Phenols	moderate/high	moderate	low[P]	low[P]	high	NA	NA	high	high[P]	high[P]	low
Non-Halogenated Semivolatile Organics											
PAHs	moderate/high	low/moderate	moderate/low	†	high	NA	NA	high	high	moderate	low
Non-Chlorinated Phenols	moderate	high	moderate/low	low/moderate	high	high/NA	high/NA	low	low	high	high
Inorganics											
Se, As, CN Cr (VI)	*For detailed information on subsurface transport and fate behavior for these chemicals, see Table 3.*										high**
Hg, Pb, Cd, Cr (III)											low**

Table 2. Property Ratings of Chemical Classes Commonly Found at Superfund Sites (from Table 1) and Applicable Technologies for In-Situ Treatment (continued)

Chemical Class	Unconsolidated Deposits [0] (Vadose Zone)		Unconsolidated Deposits [0] (Saturated Zone)		Consolidated Deposits (Saturated Zone)	
	Homogeneous [1]	Heterogeneous [2]	Homogeneous [1]	Heterogeneous [2]	Fractured Bedrock	Karst Bedrock
Halogenated Volatile Organics						
*Liquid Solvents**	SVE (1) SF(5)	SVE (5) SF (5)	P&T + ISB (1) P&T (1)	P&T + ISB (5) P&T (5)	P&T (10)	P&T (5)
Gases	SVE (1)	SVE(5)	P&T (1)	P&T (5)	P&T (10)	P&T (5)
Nonhalogenated Volatile Organics						
Ketones/furans	SVE [B] (5) SF (5)	SVE [B] (5) SF (5)	P&T (1)	P&T (5)	P&T (10)	P&T (5)
Aromatics	SVE (1) SF (5)	SVE (5) SF (5)	P&T + ISB (1) P&T (5)	P&T + ISB (5) P&T (5)	P&T (10)	P&T (5)
Halogenated Semivolatile Organics*						
PCBs	SF [3] (5) ISV (5)	ISV (5) SF [3] (5)	P&T + CE [4] (5) P&T (10)	P&T + CE [4] (10) P&T (10)	P&T (10)	P&T (10)
Pesticides	SF [3] (5) ISV (5)	ISV (5) SF [3] (5)	P&T + CE [4] (5) P&T (10)	P&T + CE [4] (10) P&T (10)	P&T (10)	P&T (10)
Chlorinated Benzenes	SVE [B] (5) SF (5)	SVE [B] (5) SF (5)	P&T + ISB (1) P&T (5)	P&T + ISB (5) P&T (5)	P&T (10)	P&T (5)
Chlorinated Phenols	SF (5) SVE [B] (5)	SF (5) SVE [B] (10)	P&T + ISB (1) P&T (5)	P&T + ISB (5) P&T (10)	P&T (10)	P&T (10)
Non-Halogenated Semivolatile Organics						
PAHs	SVE [B] (5) SF [3] (5)	SVE [B] (10) SF [3] (10)	P&T + CE [4] (5) P&T + ISB (5)	P&T + CE [4] (10) P&T + ISB (10)	P&T (10)	P&T (10)
Non-Chlorinated Phenols	SF (5) SVE [B] (5)	SF (10) SVE [B] (10)	P&T + ISB (1) P&T (1)	P&T + ISB (5) P&T (5)	P&T (10)	P&T (5)
Inorganics						
Se, As, CN, Cr (VI)	SF (5) ISV (5)	ISV (5) SF (5)	P&T (1)	P&T (5)	P&T (10)	P&T (5)
Hg, Pb, Cd, Cr (III)	ISV (5) SF [3] (10)	ISV (5) SF [3] (10)	P&T (5) P&T + CE [4] (5)	P&T (10) P&T + CE [4] (10)	P&T (10)	P&T (10)

Table 2. Property Ratings of Chemical Classes Commonly Found at Superfund Sites (from Table 1) and Applicable Technologies for In-Situ Treatment (continued)

Qualitative Rating Key ‡

Rating	Melting Point (°C)	Water Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m³/mol)	Density (g/cc)	Dynamic Viscosity (centipoise)	Kinematic Viscosity (centistokes)	Log K_{ow}	Log K_{oc}	Aerobic Biodegradability	Potential Subsurface Mobility ¥
Low	≤13.00	≤1.00 E+00	≤1.00 E-03	≤1.00 E-05	<1*	<0.6	<0.4	<2.5	≤2.2	very slow or negligible	log K_{oc} > 3.2
Moderate	>13.00 ≤100.00	>1.00 E+00 <1.00 E+03	>1.00 E-03 ≤1.00 E+00	>1.00 E-05 ≤1.00 E-03	=1	≥0.6 ≤1.0	≥0.4 ≤0.8	≥2.5 ≤3.5	>2.2 ≤3.2	moderate	2.2 < log K_{oc} ≤ 3.2
High	>100.00	≥1.00 E+03	>1.00 E+00	≥1.00 E-03	>1*	>1.0	>0.8	>3.5	>3.2	rapid	log K_{oc} ≤ 2.2

‡ This key applies only to the list of chemicals given in Table 1 and rated in Table 2
¥ Applies to organic compounds only

Moderate/high	Indicates that most compounds within the chemical class have a high rating for the given property but that a few have a moderate rating; see Table 3 for compound specific values
Moderate/high	Indicates that some compounds within the chemical class have a high rating and some have a moderate rating for the given property; see Table 3 for compound specific values
NA	Not applicable because compounds in chemical class are not liquids at room temperature
ND	No data found or available
p	Applies to pentachlorophenol only
*	Compounds within chemical class may be present in subsurface as light non-aqueous phase liquid (LNAPL), often floating on the water table
*	Compounds within chemical class may be present in subsurface as dense non-aqueous phase liquid (DNAPL); recovery of DNAPL from the saturated zone will be difficult if the DNAPL is spatially discontinuous within the aquifer
**	Se, As, Hg, Pb, and CN may be present in volatile forms which enhance their mobility; see Table 3 for additional information
†	See Table 3

Table 2. Property Ratings of Chemical Classes Commonly Found at Superfund Sites (from Table 1) and Applicable Technologies for In-Situ Treatment (continued)

Treatment Technologies		Uncertainty Rating Key
P&T -	Pump & Treat	(1) Low (5) Moderate (10) High
ISB -	Bioremediation[§]	
CE -	Chemical Extraction	
ISV -	In-Situ Vitrification	Refers to uncertainty in restoring soil/ground water to health-based or MCL levels, assuming no NAPLs are present.
SF -	Soil Flushing	
SVE -	Soil Vacuum Extraction	

§ Biodegradative processes occur naturally in the subsurface. In situ bioremediation involves the enhancement of these processes through the addition of amendments such as oxygen and/or nutrients

◊ Unconsolidated deposits refer to gravel, sand, silt or clay or any combination thereof. Deposits consisting primarily of clay are difficult to remediate and excavation or containment may be the only applicable remedial options

ⁿ Indicates that the application of soil vacuum extraction will partly or primarily be for purposes of stimulating biodegradative processes

1 Refers to a subsurface regime in which the variability in hydraulic conductivity is less than one order of magnitude

2 Refers to a subsurface regime in which the hydraulic conductivity within the treatment zone varies by more than one order of magnitude. A heterogeneous subsurface regime may be layered (stratified) or trending. In general, a trending subsurface regime will be more amenable to treatment than a layered subsurface regime

3 Water alone will not suffice as a soil flushing extractant

4 Refers to the use of surfactants or other chemicals to enhance the mobility of contaminants. This technology should be considered with caution because of its limited success to date and because of the potential environmental impact of introduced chemicals

Table 3. Properties of Contaminants Commonly Found at Superfund Sites

Chemical	Melting Point (°C)	Water † Solubility (mg/l)	Vapor † Pressure (mm Hg)	Henry's Law † Constant (atm-m³/mol)	Density † (g/cc)	Dynamic † Viscosity (cp)	Kinematic † Viscosity (cs)	Log K_{ow}	Log K_{oc}	Aerobic Biodegrad-ability	MCL[17] (µg/l)
Halogenated Volatile Organics											
Liquid Solvents											
Carbon Tetrachloride	- 23 [7]	8 E+02 [1]	9.13 E+01 [1]	2 E-02 [1]	1.5947 [1]	0.965 [1]	0.605 [c]	2.83 [1]	2.64 [1]	D [2]	5 (f)
Chlorobenzene	- 45 [7]	4.9 E+02 [1]	8.8 E+00 [1]	3.46 E-03 *[1]	1.106 [1]	0.756 [1]	0.683 [c]	2.84 [1]	2.2 [1]	D5,A10 [2]	100 (p)
Chloroform	- 64 [7]	8.22 E+03 [1]	1.6 E+02 [1]	3.75 E-03 *[1]	1.485 [1]	0.563 [1]	0.379 [c]	1.97 [1]	1.64 [1]	A [2]	nd
Cis-1,2-dichloroethylene (d)	- 81 [7]	3.5 E+03 [1]	2 E+02*[7]	7.5 E-03 *[1]	1.284 [1]	0.467 [1]	0.364 [c]	1.86 [1]	1.5 [1]	B [2]	70 (p)
1,1-Dichloroethane (a)	- 97.4 [7]	5.5 E+03 [1]	1.82 E+02 [1]	5.7 E-03 *[1]	1.175 [1]	0.377 [1]	0.321 [c]	1.79 [1]	1.48 [1]	A [2]	nd
1,2-Dichloroethane	- 35.4 [7]	8.69 E+03 [1]	6.37 E+01 [1]	1.1 E-03 *[1]	1.253 [1]	0.84 [1]	0.67 [c]	1.48 [1]	1.15 [1]	B [2]	5 (f)
1,1-Dichloroethylene	-122.5 [7]	4 E+02 [1]	5 E+02 [1]	1.54 E-01 *[1]	1.214 [1]	0.33 [1]	0.27 [c]	2.13 [1]	1.81 [1]	A [2]	7 (f)
1,2-Dichloropropane (a)	- 90 [7]	2.7 E+03 [1]	3.95 E+01 [1]	3.6 E-03 *[1]	1.158 [1]	0.84 [1]	0.72 [c]	2.02 [1]	1.71 [1]	A [2]	5 (p)
Ethylene Dibromide (g)	9.97[7]	3.4 E+03 [1]	1.1 E+01 [1]	3.18 E-04 [1]	2.172 [1]	1.676 [2(C)1]	0.79 [3]	1.76 [1]	1.45 [1]	nd	0.05 (p)
Methylene Chloride	- 97 [7]	1.32 E+04 [1]	3.5 E+02 [1]	2.57 E-03 *[1]	1.325 [1]	0.43 [1]	0.324 [c]	1.25 [1]	0.94 [1]	D [2]	5 (f)
1,1,2,2-Tetrachloroethane	- 43 [7]	2.9 E+03 [1]	4.9 E+00 [1]	5 E-04 *[1]	1.600 [1]	1.77 [1]	1.10 [c]	2.39 [1]	2.34 [1]	N [2]	nd
Tetrachloroethylene	- 22.7 [7]	1.5 E+02 [1]	1.4 E+01 [1]	2.27 E-02 *[1]	1.625 [1]	0.89 [1]	0.54 [c]	3.14 [1]	2.82 [1]	A [2]	5 (p)
Trans-1,2-dichloroethylene (d)	- 50 [7]	6.3 E+03 [1]	2.65 E+02 [3]	6.6 E-03 *[1]	1.257 [1]	0.404 [1]	0.321 [c]	2.09 [1]	1.77 [1]	B [2]	70 (p)
1,1,1-Trichloroethane	- 32 [7]	9.5 E+02 [1]	1 E+02 [1]	2.76 E-03 *[1]	1.325 [1]	0.858 [1]	0.647 [c]	2.49 [1]	2.18 [1]	C [2]	200 (f)
1,1,2-Trichloroethane	- 36 [7]	4.5 E+03 [7]	1.88 E+01 [3]	1.17 E-03 [1][11]	1.4436 [5]	0.119 [3]	0.824 [c]	2.17 [4]	1.75 [13]	C [2]	nd
Trichloroethylene	- 87 [7]	1 E+03 [1]	5.87 E+01 [1]	8.92 E-03 *[1]	1.462 [1]	0.570 [1]	0.390 [c]	2.42 [1]	2.10 [1]	A [2]	5 (f)
Gases											
Chloroethane (b.p. 12.5 C)	-138.3 [7]	5.7 E+03 [1]	1 E+03 [1]	1.1 E-02 [1]	0.9414 [0C][1]	na	na	1.43 [1]	1.17 [1]	nd	nd
Vinyl Chloride (b.p. -13.9 C)	-157 [7]	1.1 E+03 [1]	2.3 E+03 [1]	6.95 E-01 [1]	0.9121 [15C][3]	na	na	0.60 [4]	0.91 [1]	nd	2 (f)
Non-Halogenated Volatile Organics											
Ketones/furans											
Methyl Ethyl Ketone	- 86.4 [7]	2.68 E+05 [11]	7.12 E+01 [3]	2.74 E-05 [1][13]	0.805 [5]	0.40 [3]	0.497 [c]	0.29 [17]	0.65 [11]	nd	nd
4-Methyl-2-Pentanone	- 83 [7]	1.9 E+04 [3]	1.6 E+01 [3]	1.55 E-04 [1][13]	0.8017 [7]	0.5848 [3]	0.729 [c]	1.25	1.38 [15]	nd	nd
Tetrahydrofuran	-108.5 [7]	3 E+05* [6]	4.56 E+01 [1][4]	1.1 E-04 [1][14]	0.8892 [6]	0.55 [13]	0.618 [c]	0.46 [14]	nd	nd	nd

Table 3. Properties of Contaminants Commonly Found at Superfund Sites (continued)

Chemical	Melting Point (°C)	Water † Solubility (mg/l)	Vapor † Pressure (mm Hg)	Henry's Law † Constant (atm-m³/mol)	Density † (g/cc)	Dynamic † Viscosity (cp)	Kinematic † Viscosity (cs)	Log K_{ow}	Log K_{oc}	Aerobic Biodegrad-ability	MCL[17] (µg/l)
Aromatics											
Benzene (g)	5.5 [7]	1.78 E+03 [1]	7.6 E+01 [1]	5.43 E-03 *[13]	0.8765 [1]	0.6468 [1]	0.7379 (c)	2.13 [1]	1.81 [1]	D [2]	5 (f)
Ethyl Benzene (g)	- 94.97 [7]	1.52 E+02 [1]	7 E+00 [1]	7.9 E-03 *[1]	0.867 [7]	0.678 [3]	0.782 (c)	3.15 [1]	2.83 [1]	D5,A10[12]	700 (p)
Styrene	- 30.6 [7]	3 E+02 [7]	5 E+00 [7]	2.28 E-03 [7]	0.9060 [13]	0.751 [13]	0.829 (c)	3.16 [14]	nd	nd	nd
Toluene (g)	- 95.1 [7]	5.15 E+02 [1]	2.2 E+01 [1]	6.61 E-03 *[13]	0.8669 [1]	0.58 [1]	0.669 (c)	2.73 [1]	2.41 [1]	D [2]	2000 (p)
m-Xylene (g)	- 50 [7]	2 E+02 [3]	9 E+00 [1]	6.91 E-03 *[1]	0.8642 *[1]	0.608 [1]	0.717 [3]	3.20 [1]	2.84 [1]	nd	10000 (p)
o-Xylene (g)	- 25 [7]	1.7 E+02 [3]	7 E+00 [1]	4.94 E-03 *[1]	0.880 *[1]	0.802 [1]	0.932 [3]	3.12 [1]	2.84 [1]	nd	10000 (p)
p-Xylene (g)	13 [7]	1.98 E+02*[3]	9 E+00 [1]	7.01 E-03 *[1]	0.8610 *[1]	0.635 [1]	0.753 [3]	3.15 [1]	2.84 [1]	nd	10000 (p)
Halogenated Semivolatile Organics											
PCBs (b)											
Aroclor 1242	-19 [1]	4.5 E-01*[11]	4.06 E-04*[9]	3.4 E-04 [1]	1.385 [1]	nd	nd	5.58 [9]	5 [1]	N [2]	nd
Aroclor 1254	10 [1]	1.2 E-02 [1]	7.71 E-05*[9]	2.8 E-04 [1]	1.538 [1][9]	nd	nd	6.03 [9]	nd	N [2]	nd
Aroclor 1260	nd	2.7 E-03 [1]	4.05 E-05*[9]	3.4 E-04 [1]	1.44 30C[1]	nd	nd	7.15 [9]	nd	N [2]	nd
Pesticides											
Chlordane	106 [1]	5.6 E-02*[1]	1 E-05 [1]	2.2 E-04 * [1]	1.6 *[1]	1.104 [3]	0.69 (c)	5.48 [1]	4.58 [1]	N [2]	2 (p)
DDD	112 [7]	1.60 E-01 24C[7]	1 E-06 30C[17]	7.96 E-06 [1][11]	1.385 [1][7]	na	na	5.56 [1]	5.38 [1]	M [2]	nd
DDE	88.4 [1]	4.0 E-02 [7]	6.40 E-06 [1]	1.9 E-04 *[1]	nd	na	na	5.69 [1]	5.41 [1]	M [2]	nd
DDT	108 [7]	3.1 E-03 [1]	1.5 E-07 [1]	2.8 E-05 *[1]	0.985 [1]	na	na	6.36 [1]	5.48 [1]	M [2]	nd
Dieldrin	176.5 [7]	1.86 E-01 [1][4]	1.78 E-07 [3]	9.7 E-06 *[8]	1.75 [3]	na	na	5.34 [4]	3.23 [14]	N [2]	nd
Chlorinated Benzenes											
1,2-Dichlorobenzene	- 17 [7]	1 E+02 [1]	9.6 E-01 [1]	1.88 E-03 *[1]	1.306 [1]	1.302 [1]	0.997 (c)	3.38 [1]	3.06 [1]	T [2]	600 (p)
1,4-Dichlorobenzene	53 [7]	8 E+01 [1]	6 E-01 [1]	1.58 E-03 *[1]	1.2475 [1]	1.258 [1]	1.008 (c)	3.39 [1]	3.07 [1]	T [2]	750 (f)
Chlorinated Phenols											
Pentachlorophenol (w)	190 [7]	1.4 E+01 [1]	1.1 E-04 [1]	2.8 E-06 [1]	1.978 [1]	na	na	5.12 [1]	4.80 [1]	A [2]	nd
2,3,4,6-Tetrachlorophenol	69.5 [7]	1.00 E+03 [1][11]	nd	nd	1.839 *[15]	na	na	4.1 [11]	2.0 [11]	nd	nd

Table 3. Properties of Contaminants Commonly Found at Superfund Sites (continued)

Chemical	Melting Point (°C)	Water † Solubility (mg/l)	Vapor † Pressure (mm Hg)	Henry's Law † Constant (atm-m³/mol)	Density † (g/cc)	Dynamic † Viscosity (cp)	Kinematic † Viscosity (cs)	Log K_{ow}	Log K_{oc}	Aerobic Biodegrad-ability	MCL[17] (µg/l)
Non-Halogenated Semivolatile Organics											
PAHs (e)											
Acenaphthene	92.5 [7]	3.88 E+00 *[8]	2.31 E-02 *[8]	1.20 E-03 *[c]	1.225 [12]	na	na	3.92 [12]	3.7 [11]	D [2]	nd
Anthracene	216.3 [7]	7.5 E-02 *[8]	1.08 E-05 *[8]	3.38 E-05 *[c]	1.25 [12]	na	na	4.45 [12]	4.1 [11]	A [2]	nd
Benzo(a)anthracene	167 [4]	1.4 E-02 *[12]	1.16 E-09 *[11]	4.5 E-06 [12]	1.174 [12]	na	na	5.61 [12]	6.14 [11]	N [2]	nd
Benzo(a)pyrene	179 [7]	3.8 E-03 *[12]	5.49 E-09 *[8]	1.8 E-05 *[12]	nd	na	na	6.06 [11]	6.74 [11]	nd	0.2 (t)
Benzo(b)fluoranthene	167 [4]	1.4 E-02 *[11]	5.00 E-07 *[12]	1.19 E-05 *[11]	nd	na	na	6.57 [12]	5.74 [11]	nd	nd
Benzo(ghi)perylene	278 [12]	2.6 E-04 * [7]	1 E-10 [14]	5.34 E-08 *[11]	nd	na	na	6.51 [11]	6.2 [11]	nd	nd
Benzo(k)fluoranthene	217 [12]	4.30 E-03 *[11]	9.59 E-11 [14]	3.94 E-05 *[11]	nd	na	na	6.06 [11]	5.74 [11]	nd	nd
Chrysene	254 [7]	6 E-03 * [7]	6.3 E-09 *[14]	1.05 E-06 *[14]	1.274 [7]	na	na	5.61 [11]	5.3 [11]	A5,N10[2]	nd
Dibenz(a,h)anthracene	266.5 [7]	2.5 E-03 *[12]	1 E-10 *[12]	7.33 E-08 *[11]	1.252 [12]	na	na	6.80 [11]	6.52 [11]	nd	nd
Fluoranthene	107 [7]	2.65 E-01 * [7]	E-02[10] E-06[12]	6.5 E-06 *[14]	1.252 [12]	na	na	4.90 [12]	4.58 [11]	A5,N10[2]	nd
Fluorene	116.7 [12]	1.90 E+00 *[8]	6.67 E-04 *[8]	7.65 E-05 *[c]	1.203 [12]	na	na	4.18 [12]	3.9 [11]	A [2]	nd
Indeno(1,2,3-cd)pyrene	163 [12]	5.30 E-04 *[11]	1 E-10 *[11]	6.95 E-08 *[14]	nd	na	na	6.5 [14]	6.2 [11]	nd	nd
2-Methyl naphthalene	34.58 [7]	2.54 E+01 *[6]	6.80 E-02 *[8]	5.06 E-02 *[c]	1.0058 [12]	na	na	3.86 [12]	3.93 [14]	nd	nd
Naphthalene	80.2 [4]	3.1 E+01 *[12]	2.336E-01 *[12]	1.27 E-03 *[c]	1.162 [12]	na	na	3.30 [12]	3.11 [14]	D [2]	nd
Phenanthrene	100 [7]	1.18 E+00 *[8]	2.01 E-04 *[8]	3.98 E-05 *[c]	0.9800 [12]	na	na	4.46 [12]	4.1 [11]	D [2]	nd
Pyrene	150 [7]	1.48 E-01 *[8]	6.67 E-06 *[8]	1.20 E-05 *[c]	1.271 [12]	na	na	4.88 [12]	4.58 [11]	D5,N10[2]	nd
Non-Chlorinated Phenols											
Phenol	41 [7]	8.4 E+04 [1]	5.293E-01 [1]	7.80 E-07 [c]	1.0576 41C [1]	3.02 50C[1]	3.87 46C	1.46 [1]	1.15 [14]	D [2]	nd
2,4-Dimethylphenol (e)	26 [7]	6.2 E+03 *[3]	9.8 E-02 *[3]	2.5 E-06 *[c]	1.036 [7]	na	na	2.50 [4]	2.35 [14]	D [2]	nd
2,4-Dinitrophenol	112 [7]	6 E+03 *[3]	1.49 E-05 *[11]	6.45 E-10 [11]	1.68 [3]	na	na	1.54 [3]	1.22 [11]	D [2]	nd
m-Cresol (e)	12 [7]	2.35 E+04 [7]	1.53 E-01 *[12]	3.8 E-05 *[12]	1.038 [7]	21 [12]	20 (c)	1.96 [12]	1.43 [15]	nd	nd
o-Cresol (e)	31 [7]	3.1 E+04 40C[7]	2.45 E-01 *[12]	4.7 E-05 *[12]	1.0273 [12]	na	na	1.95 [12]	1.23 [15]	nd	nd
p-Cresol (e)	34.8 [7]	2.40 E+04 40C[7]	1.08 E-01 *[12]	3.5 E-04 *[12]	1.0347 [7]	na	na	1.94 [7]	1.28 [15]	nd	nd

Table 3. Properties of Contaminants Commonly Found at Superfund Sites (continued)

CHEMICAL		MCL
Inorganics		
arsenic (As)	May occur in more than one oxidation state in subsurface. Arsenate form (AsO_4^{3-}) will dominate under oxidizing conditions. More toxic and mobile arsenite form (AsO_3^-) may dominate under increasingly reducing and acidic conditions. **Volatile alkylated-As compounds may form** under reducing conditions. **Volatile arsine (AsH_3) may form** under highly reducing conditions. Adsorption of arsenate and arsenite forms will generally increase with decreasing pH.	nd
cadmium (Cd)	Occurs only in divalent form in aqueous solutions (e.g. Cd^{2+}, $CdCl^+$, $CdSO_4^o$). Cd^{2+} tends to be dominant species. Adsorption behavior correlates with cation exchange capacity (CEC) of soil and aquifer material. Adsorption/ precipitation increases with increasing pH with most Cd precipitating out at pH>6.	5 (p)
chromium (Cr)	May occur in more than one oxidation state in subsurface. Trivalent form (Cr III) is dominant under pH and redox conditions generally present in subsurface. Cr III may be converted to highly mobile and toxic hexavalent form (Cr VI) under oxidizing conditions. Cr III is readily adsorbed in the subsurface while Cr VI is not.	100 (p)
cyanide (CN)	Cyanide ion (CN^-) predominates in aqueous solution only at pH>9. Hydrogen cyanide (HCN) predominates at pH<9. **HCN is volatile** (v.p. 741 mm Hg at 25C) and toxic. CN^- behaves similar to halide ions and tends to complex with iron. Undissolved cyanide salts may be present in vadose zone.	200 (t)
iron (Fe)	May occur in more than one oxidation state in the subsurface. Ferrous form (Fe^{2+}) is most soluble and mobile, and dominates under reducing conditions. Under oxidizing conditions, ferrous form is converted to ferric form (Fe^{3+}). Ferric form is less soluble, less mobile, and will tend to precipitate. Compounds and metals complexed to iron may be removed from solution through the precipitation process. Conversely, compounds and metals adsorbed to iron in the subsurface may be increasingly mobilized under increasingly reduced conditions. Precipitated iron may hinder treatment processes such as in-situ bioremediation and air stripping.	300 (f)
lead (Pb)	Dominant species in aqueous solution are Pb^{2+} under acidic conditions and Pb^{2+}- carbonate complexes under alkaline conditions. Adsorption behavior correlates with cation exchange capacity (CEC) of soil and aquifer material. Adsorption/precipitation increases with increasing pH with most Pb precipitating out at pH>6. **Volatile alkylated-Pb compounds may be present** or may form under reducing conditions.	5 (p)
mercury (Hg)	May occur in more than one oxidation state. May occur in subsurface in mercuric form (Hg^{2+}), mercurous form (Hg_2^{2+}), elemental form (Hg^o), and in alkylated form (e.g. methyl and ethyl mercury). Hg_2^{2+} and Hg^{2+} are more stable under oxidizing conditions and are strongly adsorbed by soils. Hg^o and alkylated forms are more stable under reducing conditions. Conversion to alkylated forms may occur under reducing conditions. **Hg^o and alkylated-Hg forms are volatile**, toxic, and may not be as strongly adsorbed by soils.	2 (p)
selenium (Se)	May occur in more than one oxidation state in subsurface. Selenate form (SeO_4^{2-}) will dominate under oxidizing conditions. Selenite form (SeO_3^{2}) will dominate under increasingly reducing conditions. Selenide form (Se^{2-}) may dominate under highly reducing conditions. Selenate and selenite are more soluble and mobile forms. Adsorption of selenate and selenite will generally increase with decreasing pH. **Volatile alkylated-Se compounds may form** under reducing conditions.	50 (p)

Table 3. Properties of Contaminants Commonly Found at Superfund Sites (continued)

A - significant degradation with gradual adaption
B - slow to moderate activity, concomitant with significant rate of volatilization
C - very slow biodegradative activity, with long adaption period needed
D - significant degradation with rapid adaption
M - not significantly degraded under the conditions of the test method
N - not significantly degraded under the conditions of test method and/or precluded by extensive rate of volatilization
T - significant degradation with gradual adaption followed by deadaptive process in subsequent subcultures (toxicity)

(a) - may be component of antiknock fluids added to fuel oils; remedial treatment may require consideration of constituent in oil phase
(b) - constituent in some oils, greases, dielectric liquids, and thermostatic fluids; remedial treatment may require consideration of constituent in oil phase
(c) - calculated
(d) - may be present in dye or lacquer solutions; remedial treatment may require consideration of constituent in oil phase
(e) - constituent of crude oil fractions (including fuel oils and motor oils) and/or coal tar fractions (including creosote); creosote may be present as DNAPL; remedial treatment may require consideration of constituent in oil phase
(f) - final MCL
(g) - constituent in fuel oils (e.g. gasoline); remedial treatment may require consideration of constituent in oil phase
(p) - proposed MCL
(t) - tentative MCL
(w) - combined with fuel oil #2 or kerosene when used as wood preservative; remedial treatment may require consideration of constituent in oil phase

na - not applicable
nd - no data found

[ ] Reference

† - Values are given at 20°C unless otherwise specified

* - Value is at 25°C

‡ - Value is at unknown temperature but is assumed to be at 20-30°C

Soil Screening Guidance

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

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Soil Screening Guidance: Fact Sheet

Office of Emergency and Remedial Response

Quick Reference Fact Sheet

This fact sheet summarizes key aspects of the U.S. Environmental Protection Agency's (EPA) Soil Screening Guidance. The Soil Screening Guidance is a tool developed by EPA to help standardize and accelerate the evaluation and cleanup of contaminated soils at sites on the National Priorities List (NPL) where future residential land use is anticipated. The User's Guide provides a simple step-by-step methodology for environmental science/engineering professionals to calculate risk-based, site-specific soil screening levels (SSLs) for contaminants in soil that may be used to identify areas needing further investigation at NPL sites. The Technical Background Document presents the analysis and modeling upon which this approach is based, as well as generic SSLs calculated using conservative default values, and guidance for conducting more detailed analysis of complex site conditions, where needed.

SSLs are not national cleanup standards. SSLs alone do not trigger the need for response actions or define "unacceptable" levels of contaminants in soil. In this guidance, "screening" refers to the process of identifying and defining areas, contaminants, and conditions, at a particular site that do not require further Federal attention. Generally, at sites where contaminant concentrations fall below SSLs, no further action or study is warranted under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as "Superfund." (Some States have developed screening numbers that are more stringent than the generic SSLs presented here; therefore, further study may be warranted under State programs.) Where contaminant concentrations equal or exceed SSLs, further study or investigation, but not necessarily cleanup, is warranted.

The decision to use the Soil Screening Guidance at a site will be driven by the potential benefits of eliminating areas, exposure pathways, or contaminants from further investigation. By identifying areas where concentrations of contaminated soil are below levels of concern under CERCLA, the guidance provides a means to focus resources on exposure areas, contaminants and exposure pathways of concern.

SSLs are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. Three options for developing screening levels are included in the guidance, depending on how the numbers will be used to screen at a site, and the amount of site-specific information that will be collected or is available. Details of these approaches are presented in the User's Guide (EPA, 1996a) and the Technical Background Document (TBD) (EPA, 1996b). The three options for using SSLs are:

- Applying generic SSLs
- Developing simple, site-specific SSLs
- Developing site-specific SSLs based on more detailed modeling

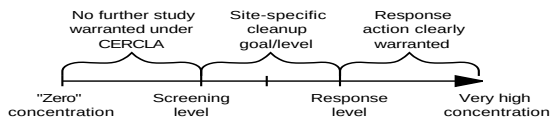
The progression from generic to simple site-specific and more detailed site-specific SSLs

usually involves an increase in investigation costs and, generally a decrease in the stringency of the screening levels because conservative assumptions can be replaced with less conservative site-specific information. Generally, the decision of which method to use involves balancing the increased investigation costs with the potential savings associated with higher (but protective) SSLs. The User's Guide focuses on the application of a simple site-specific approach by providing a step-by-step methodology to calculate site-specific SSLs. The TBD provides more information about the other approaches.

Generic SSLs for the most common contaminants found at NPL sites are included in the TBD. Generic SSLs are calculated from the same equations presented in the User's Guide, but are based on a number of default assumptions chosen to be protective of human health for most site conditions. Generic SSLs can be used in place of site-specific screening levels; however, in general, they are expected to be more stringent than site-specific levels. The site manager should weigh the cost of collecting the data necessary to develop site-specific SSLs with the potential for deriving a higher SSL that provides an appropriate level of protection.

The TBD also includes more detailed modeling approaches for developing screening levels that take into account more complex site conditions than the simple site-specific methodology emphasized in the User's Guide. More detailed approaches may be appropriate when site conditions (e.g., a thick vadose zone) are different from those assumed in the simple site-specific methodology presented here. The technical details supporting the methodology used in the User's Guide are provided in the TBD. SSLs developed in accordance with the User's Guide are based on future residential land use assumptions and related exposure scenarios. Using this guidance for sites where residential land use assumptions do not apply could result in overly conservative screening levels; however, EPA recognizes that some parties responsible for sites with non-residential land use might still find benefit in using the SSLs as a tool to conduct a conservative initial screening.

SSLs developed in accordance with this guidance could also be used for Resource Conservation and Recovery Act (RCRA) corrective action sites as "action levels," since the RCRA corrective action program currently views the role of action levels as generally fulfilling the same purpose as soil screening levels.[1] In addition, States may use this guidance in their voluntary cleanup programs, to the extent they deem appropriate. When applying SSLs to RCRA corrective action sites or for sites under State voluntary cleanup programs, users of this guidance should recognize, as stated above, that SSLs are based on residential land use assumptions. Where these assumptions do not apply, other approaches for determining the need for further study might be more appropriate.



Highlight 1. Conceptual Risk Management Spectrum for Contaminated Soil

1.2 Role of Soil Screening Levels

In identifying and managing risks at contaminated sites, EPA considers a spectrum of contaminant concentrations. The level of concern associated with those concentrations depends on the likelihood of exposure to soil contamination at levels of potential concern to human health or to ecological receptors.

Highlight 1 illustrates the spectrum of soil contamination encountered at Superfund sites and the conceptual range of risk management responses. At one end are levels of contamination that clearly warrant a response action; at the other end are levels that are below regulatory concern. Screening levels identify the lower bound of the spectrum—levels below

1 Further information on the role of action levels in the RCRA corrective action program is available in an Advance Notice of Proposed Rulemaking (signed April 12, 1996).

which there is generally no concern under CERCLA, provided conditions associated with the SSLs are met. Appropriate cleanup goals for a particular site may fall anywhere within this range depending on site-specific conditions.

EPA anticipates the use of SSLs as a tool to facilitate prompt identification of contaminants and exposure areas of concern during both remedial actions and some removal actions under CERCLA. However, the application of this or any screening methodology is not mandatory at sites being addressed under CERCLA or RCRA. The framework leaves discretion to the site manager and technical experts (e.g., risk assessors, hydrogeologists) to determine whether a screening approach is appropriate for the site and, if screening is to be used, the proper method of implementation. The decision to use a screening approach should be made early in the process of investigation at the site.

EPA developed the Soil Screening Guidance to be consistent with and to enhance the current Superfund investigation process and anticipates its primary use during the early stages of a remedial investigation (RI) at NPL sites. It does not replace the Remedial Investigation/ Feasibility Study (RI/FS), including the risk assessment portion of the RI, but the use of screening levels can focus sampling and risk assessment on aspects of the site that are likely to be a concern under CERCLA. By screening out areas of sites, potential chemicals of concern, or exposure pathways from further investigation, site managers and technical experts can limit the scope of the field investigation or risk assessment.

SSLs can save resources by helping to determine which areas do not require additional Federal attention early in the process. Furthermore, data gathered during the soil screening process can be used in later Superfund phases, such as the baseline risk assessment, feasibility study, treatability study, and remedial design. This guidance may also be appropriate for use by the removal program when demarcation of soils above residential risk-based numbers coincides with the purpose and scope of the removal action.

The simple, site-specific soil screening levels are likely to be most useful where it is difficult to determine whether areas of soil are contaminated to an extent that warrants further investigation or response (e.g., whether areas of soil at an NPL site require further investigation under CERCLA through an RI/FS). As noted above, the screening levels have been developed assuming residential land use. Although some of the models and methods presented in this guidance could be modified to address exposures under other land uses, EPA has not yet standardized assumptions for exposure scenarios related to those other uses.

This guidance provides the information needed to calculate SSLs for 110 chemicals. Sufficient information may not be available to develop soil screening levels for additional chemicals. These chemicals should not be screened out, but should be addressed in the baseline risk assessment for the site. The *Risk Assessment Guidance for Superfund* (RAGS), *Volume 1: Human Health Evaluation Manual* (HHEM)*, Part A, Interim Final* (U.S. EPA, 1989a) provides guidance on conducting baseline risk assessments for NPL sites. In addition, the baseline risk assessment should address the chemicals, exposure pathways, and areas at the site that are not screened out.

Although SSLs are "risk-based," they do not eliminate the need to conduct a site-specific risk assessment for those areas identified as needing further investigation. SSLs are concentrations of contaminants in soil that are designed to be protective of exposures in a residential setting. A site-specific risk assessment is an evaluation of the risk posed by exposure to site contaminants in various media. To calculate SSLs, the exposure equations and pathway models are run in reverse to backcalculate an "acceptable level" of a contaminant in soil. For the ingestion, dermal, and inhalation pathways, toxicity criteria are used to define an acceptable level of contamination in soil, based on a one-in-a-million (10^{-6}) individual excess cancer risk for carcinogens and a hazard quotient (HQ) of 1 for non-carcinogens. SSLs are backcalculated for migration to ground water pathways using ground water concentration limits [nonzero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or

health-based limits (HBLs) (10^{-6} cancer risk or a HQ of 1) where MCLs are not available].

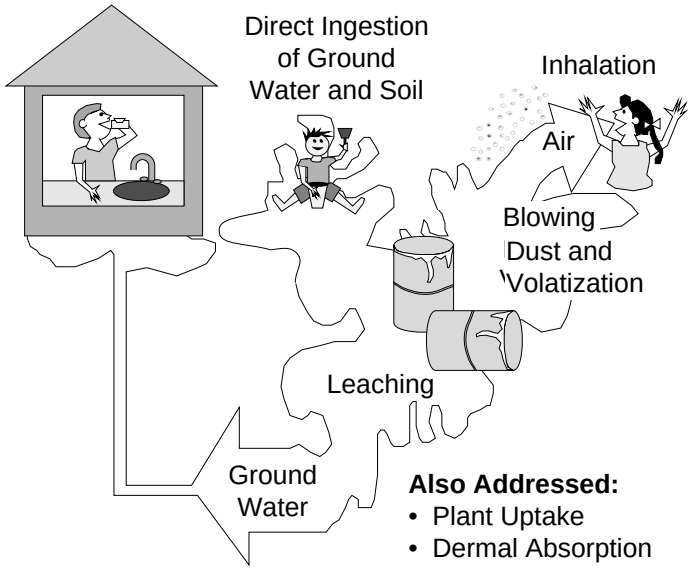
SSLs can be used as Preliminary Remediation Goals (PRGs) provided appropriate conditions are met (i.e., conditions found at a specific site are similar to conditions assumed in developing the SSLs). The concept of calculating risk-based contaminant levels in soils for use as PRGs (or "draft" cleanup levels) was introduced in the RAGS HHEM*, Part B, Development of Risk-Based Preliminary Remediation Goals.* (U.S. EPA, 1991b).

PRGs may then be used as the basis for developing final cleanup levels based on the nine-criteria analysis described in the National Contingency Plan [Section 300.430 (3)(2)(I)(A)]. The directive entitled *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (U.S. EPA, 1991c) discusses the modification of PRGs to generate cleanup levels. The SSLs should only be used as cleanup levels when a site-specific nine-criteria evaluation of the SSLs as PRGs for soils indicates that a selected remedy achieving the SSLs is protective, complies with Applicable or Relevant and Appropriate Requirements (ARARs), and appropriately balances tradeoffs between cleanup options with respect to the other criteria, including cost.

1.3 Scope of Soil Screening Guidance

In a residential setting, potential pathways of exposure to contaminants in soil are as follows (see Highlight 2):

- Direct ingestion
- Inhalation of volatiles and fugitive dusts
- Ingestion of contaminated ground water caused by migration of chemicals through soil to an underlying potable aquifer
- Dermal absorption
- Ingestion of homegrown produce that has been contaminated via plant uptake
- Migration of volatiles into basements.



Highlight 2. Exposure Pathways Addressed by SSLs.

The Soil Screening Guidance addresses each of these pathways to the greatest extent practical. The first three pathways -- direct ingestion, inhalation of volatiles and fugitive dusts, and ingestion of potable ground water -- are the most common routes of human exposure to contaminants in the residential setting. These pathways have generally accepted methods, models, and assumptions that lend themselves to a standardized approach. The additional pathways of exposure to soil contaminants, dermal absorption, plant uptake, and migration of volatiles into basements, may also contribute to the risk to human health from exposure to specific contaminants in a residential setting. The guidance addresses these pathways to a limited extent based on available empirical data. (See Step 5 and the TBD for further discussion).

The Soil Screening Guidance addresses the human exposure pathways listed previously and will be appropriate for most residential settings. The presence of additional pathways or unusual site conditions does not preclude the use of SSLs in areas of the site that are currently residential or likely to be residential in the future. However, the risks associated with additional pathways or conditions (e.g., fish consumption, raising of livestock, heavy truck traffic on unpaved roads)

should be considered in the RI/FS to determine whether SSLs are adequately protective.

An ecological assessment should also be performed as part of the RI/FS to evaluate potential risks to ecological receptors.

The Soil Screening Guidance should not be used for areas with radioactive contaminants.

Highlight 3 provides key attributes of the Soil Screening Guidance: User's Guide.

Highlight 3: Key Attributes of the User's Guide

- Standardized equations are presented to address human exposure pathways in a residential setting consistent with Superfund's concept of "Reasonable Maximum Exposure" (RME).
- Source size (area and depth) can be considered on a site-specific basis using mass-limit models.
- Parameters are identified for which site-specific information is needed to develop SSLs.
- Default values are provided to calculate generic SSLs when site-specific information is not available.
- SSLs are based on a 10^{-6} excess risk for carcinogens or a hazard quotient of 1 for noncarcinogens. SSLs for migration to ground water are based on (in order of preference): nonzero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or the aforementioned risk-based targets.

2.0 SOIL SCREENING PROCESS

Applying site-specific screening levels involves developing a conceptual site model (CSM), collecting a few easily obtained site-specific soil parameters (such as the dry bulk density and percent moisture), and sampling to measure contaminant concentrations in surface and subsurface soils. Often, much of the information needed to develop the CSM can be derived from previous site investigations [e.g., the Preliminary Assessment/Site Inspection (PA/SI)] and, if properly planned, SSL sampling can be accomplished in one mobilization. This fact sheet provides a brief overview of the steps in the process. A full discussion of the steps and their implementation is available in the User's Guide.

The soil screening process (outlined in Highlight 4) is a step-by-step approach that involves:

- Developing a conceptual site model (CSM)
- Comparing the CSM to the SSL scenario
- Defining data collection needs
- Sampling and analyzing soils at site
- Deriving site-specific SSLs, as appropriate
- Comparing site soil contaminant concentrations to SSLs
- Determining which areas of the site require further study.

The overall outline is fundamentally the same, whether you are using the simple site-specific approach, the generic levels, or a more detailed approach. However, the details of any specific application will be different. In particular, developing the simple site specific SSLs is obviously more involved than using the generic screening levels available in the TBD.

Highlight 4

Soil Screening Process

Step One: Develop Conceptual Site Model

- Collect existing site data (historical records, aerial photographs, maps, PA/SI data, available background information, State soil surveys, etc.)
- Organize and analyze existing site data
  - Identify known sources of contamination
  - Identify affected media
  - Identify potential migration routes, exposure pathways, and receptors
- Construct a preliminary diagram of the CSM
- Perform site reconnaissance
  - Confirm and/or modify CSM
  - Identify remaining data gaps

Step Two: Compare Soil Component of CSM to Soil Screening Scenario

- Confirm that future residential land use is a reasonable assumption for the site
- Identify pathways present at the site that are addressed by the guidance
- Identify additional pathways present at the site not addressed by the guidance
- Compare pathway-specific generic SSLs with available concentration data
- Estimate whether background levels exceed generic SSLs

Step Three: Define Data Collection Needs for Soils to Determine Which Site Areas Exceed SSLs

- Develop hypothesis about distribution of soil contamination (i.e., which areas of the site have soil contamination that exceed appropriate SSLs?)
- Develop sampling and analysis plan for determining soil contaminant concentrations
  - Sampling strategy for surface soils (includes defining study boundaries, developing a decision rule, specifying limits on decision errors, and optimizing the design)
  - Sampling strategy for subsurface soils (includes defining study boundaries, developing a decision rule, specifying limits on decision errors, and optimizing the design)
  - Sampling to measure soil characteristics (bulk density, moisture content, organic carbon content, porosity, pH)
- Determine appropriate field methods and establish QA/QC protocols

Step Four: Sample and Analyze Soils at Site

- Identify contaminants
- Delineate area and depth of sources
- Determine soil characteristics
- Revise CSM, as appropriate

Step Five: Derive Site-specific SSLs, if needed

- Identify SSL equations for relevant pathways
- Identify chemical of concern for dermal exposure and plant uptake
- Obtain site-specific input parameters from CSM summary
- Replace variables in SSL equations with site-specific data gathered in Step 4
- Calculate SSLs
  - Account for exposure to multiple contaminants

Step Six: Compare Site Soil Contaminant Concentrations to Calculated SSLs

- For surface soils, screen out exposure areas where all composite samples do not exceed SSLs by a factor of 2
- For subsurface soils, screen out source areas where the highest average soil core concentration does not exceed the SSLs
- Evaluate whether background levels exceed SSLs

Step Seven: Decide How to Address Areas Identified for Further Study

- Consider likelihood that additional areas can be screened out with more data
- Integrate soil data with other media in the baseline risk assessment to estimate cumulative risk at the site
- Determine the need for action
- Use SSLs as PRGs

However, developing site specific levels may be worthwhile given the less stringent but equally protective levels that will generally result.

An important part of this guidance is a recommended sampling approach that balances the need for more data to reduce uncertainty with the need to limit data collection costs. Where data are limited such that use of the "maximum test" (Max test) presented in the User's Guide is not appropriate, the guidance also provides direction on the use of other conservative estimates of contaminant concentrations for comparison with the SSLs.

2.1 Step 1: Developing a Conceptual Site Model

The conceptual site model (CSM) is a three-dimensional "picture" of site conditions that illustrates contaminant distributions, release mechanisms, exposure pathways and migration routes, and potential receptors. The CSM documents current site conditions and is supported by maps, cross sections, and site diagrams that illustrate human and environmental exposure through contaminant release and migration to potential receptors. Developing an accurate CSM is critical to proper implementation of the Soil Screening Guidance.

As a key component of the RI/FS and EPA's Data Quality Objectives (DQO) process, the CSM should be updated and revised as investigations produce new information about a site. *Data Quality Objectives for Superfund: Interim Final Guidance* (U.S. EPA, 1993a) and *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. EPA, 1989c) provide a general discussion about the development and use of the CSM during RIs.

2.2 Step 2: Comparing the CSM to SSL Scenario

In this step, the conceptual site model for a particular site is compared to the conceptual site model assumed for the development of the Soil Screening Guidance. This comparison should determine whether the SSL scenario is sufficiently similar to the CSM so that use of the guidance is appropriate. The Soil Screening Guidance was developed assuming residential land use. The primary exposure pathways associated with residential land use (given in section 1.3) are (1) direct ingestion, (2) inhalation of volatile and fugitive dusts, and (3) ingestion of contaminated ground water caused by migration of chemicals through soil to an underlying potable aquifer. The residential exposure assumptions associated with these pathways are given in Highlight 5.

Highlight 5
Residential Exposure Assumptions

Exposure frequency ..... 350 days/year
Exposure duration ..... 30 years

For Noncarcinogens
Body weight ..... 15 kg
Ingestion rate ..... 200 mg/day

For Carcinogens
Body weight .. age adjusted from 15 -70 kg
Ingestion rate ..... age adjusted from
..... 200 - 100 mg/day
Drinking water ingestion rate ..... 2 L/day
Inhalation rate ..... 20 m^3/day

The CSM may include other sources and exposure pathways that are not covered by this guidance. Compare the CSM with the assumptions and limitations inherent in the SSLs to determine whether additional or more detailed assessments are needed for any exposure pathways or chemicals. The Soil Screening Guidance can be used to screen those sources and exposures pathways that are covered by the guidance. Early identification of areas or conditions where SSLs are not applicable is important so that other characterization and response efforts can be considered when planning the sampling strategy.

Where the following conditions exist, a more detailed site-specific investigation will be needed:

- site adjacent to surface water,
- potential terrestrial or aquatic ecological concerns
- other human exposure pathways likely (e.g. local fish consumption, homegrown dairy, livestock or other agricultural use, or
- unusual site conditions (e.g., presence of non-aqueous phase liquids, unusually high fugitive dust levels from site activities.)

A consideration of background concentrations should be made to determine whether SSLs are likely to be useful, since the SSLs have much less utility where background concentrations exceed the SSLs. Background concentrations exceeding generic SSLs do not necessarily indicate that a health threat exists, but may suggest that additional analysis is appropriate. For example, it may be important to determine whether the high background concentrations are anthropogenic or naturally occuring. Generally, EPA does not clean up below natural background; however, where anthropogenic background levels exceed SSLs, EPA may determine that some type of comprehensive response is necessary and feasible.

2.3 Step 3: Defining Data Collection Needs for Soils

Once the CSM has been developed and the site manager has determined that the Soil Screening Guidance is appropriate to use at a site, a Sampling and Analysis Plan (SAP) should be developed. Highlight 4 outlines the general strategy for developing sampling plans likely to be needed to apply the Soil Screening Guidance. A different sampling approach is used for the surface and subsurface because different exposure pathways are being addressed. Sampling should also provide site characteristics data necessary to develop site-specific SSLs. The User's Guide provides information on the development of SAPs for these three types of information.

To develop sampling strategies that will properly assess site contamination, EPA recommends that site managers consult with the technical experts in their Region, including risk assessors, toxicologists, chemists and hydrogeologists, who can assist the site manager to use the DQO process to satisfy Superfund program objectives. The DQO process is a systematic planning process developed by EPA to ensure that sufficient data are collected to support EPA decision making. A full discussion of the DQO process is provided in *Data Quality Objectives for Superfund: Interim Final Guidance* (U.S. EPA, 1993a) and the *Guidance for the Data Quality Objectives Process* (U.S. EPA, 1994a). Many of the key elements have been incorporated as part of the guidance.

One of the critical decisions to make before developing the SAP is to define the specific area to which the Soil Screening Guidance will be applied. Existing data (e.g., preliminary assessment, other site investigation data, historical documents discussing site activities) can be used to determine what level and type of investigation may be appropriate. Areas known to be important sources of ground water contamination should be sampled for subsurface contamination, but it often will not be necessary to develop screening levels based on surface contamination for these areas. Sampling in known source areas will focus on developing remedial alternatives with some sampling to confirm expected problems, as necessary. Other areas may have good historical information to indicate that no waste handling activities occurred there and it is expected that these areas are unlikely to be contaminated. A few samples may be taken to confirm this hypothesis. Much of the sampling effort for soil screening is likely to focus on areas of uncertain contamination levels and history. The User's Guide provides more information about the use of historical information, the statistical basis for the sampling strategy, and the soil characteristics that are needed to develop site-specific screening levels.

2.4 Step 4: Sampling and Analyzing Site Soils

Once the sampling strategies have been developed and implemented, the samples should be analyzed according to the analytical laboratory and field methods specified in the SAP. An important outcome of these analyses is the estimation of the concentrations of potential contaminants of concern which will be compared to the SSLs. At this point, the generic SSLs may be useful for comparison purposes. Where estimated concentrations are above the generic SSLs, site-specific SSLs can be calculated to provide another, less stringent but still conservative comparison.

Because these analyses reveal new information about the site, update the CSM accordingly.

2.5 Step 5: Calculating Site-specific SSLs

With the soil properties data collected in Step 4 of the screening process, site-specific soil screening levels can now be calculated using the equations presented in the User's Guide. The Soil Screening Guidance provides the equations necessary to develop a simple site-specific soil screening levels. For a description of how these equations were developed, as well as background on their assumptions and limitations, consult the TBD. When generic SSLs are being used as for comparison to site concentration, this step may be omitted.

All SSL equations were developed to be consistent with reasonable maximum exposure (RME) for the residential setting. The Superfund program estimates the RME for chronic exposures on a site-specific basis by combining an average exposure-point concentration with reasonably conservative values for intake and duration (U.S. EPA, 1989a; RAGS HHEM, *Supplemental Guidance: Standard Default Exposure Factors*, U.S. EPA, 1991a). Thus, all site-specific parameters (soil, aquifer, and meteorologic parameters) used to calculate SSLs should reflect average or typical site conditions in order to calculate average exposure concentrations at the site.

Exposure pathways addressed in the process for screening surface soils include direct ingestion, dermal contact, and inhalation of fugitive dusts. While the guidance provides all the relevant toxicity from EPA sources necessary to calculate site-specific SSLs, Integrated Risk Information System (IRIS) (U.S. EPA, 1995a) or Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1995b) should be checked for current values. Only the most current values should be used to calculate SSLs.

The Soil Screening Guidance addresses two exposure pathways for subsurface soils: inhalation of volatiles and ingestion of ground water contaminated by the migration of contaminants through soil to an underlying potable aquifer. Because the equations developed to calculate SSLs for these pathways assume an infinite source, they can violate mass-balance considerations, especially for small sources. To address this concern, the guidance also includes equations for calculating mass-limit SSLs for each of these pathways when the size (i.e., area and depth) of the contaminated soil source is known or can be estimated with confidence.

The Soil Screening Guidance uses a simple linear equilibrium soil/water partition equation or a leach test to estimate contaminant release in soil leachate. It also uses a simple water-balance equation to calculate a dilution factor to account for reduction of soil leachate concentration from mixing in an aquifer.

The methodology for developing SSLs for the migration to ground water pathway was designed for use during the early stages of a site evaluation when information about subsurface conditions may be limited. Hence, the methodology is based on rather conservative, simplified assumptions about the release and transport of contaminants in the subsurface (Highlight 6). These assumptions are inherent in the SSL equations and should be reviewed for consistency with the conceptual site model (see

Step 2) to determine the applicability of SSLs to the migration to ground water pathway.

Highlight 6: Simplifying Assumptions for the SSL Migration to Ground Water Pathway

- Infinite source (i.e., steady-state concentrations are maintained over the exposure period)
- Uniformly distributed contamination from the surface to the top of the aquifer
- No contaminant attenuation (i.e., adsorption, biodegradation, chemical degradation) in soil
- Instantaneous and linear equilibrium soil/water partitioning
- Unconfined, unconsolidated aquifer with homogeneous and isotropic hydrologic properties
- Receptor well at the downgradient edge of the source and screened within the plume
- No contaminant attenuation in the aquifer
- No NAPLs present (if NAPLs are present, the SSLs do not apply).

Address Exposure to Multiple Chemicals. The SSLs generally correspond to a 10^{-6} excess risk level for carcinogens and a hazard quotient of 1 for noncarcinogens. This "target" hazard quotient is used to calculate a soil concentration below which it is unlikely that sensitive populations will experience adverse health effects. The potential for additive effects has not been "built in" to the SSLs through apportionment. For carcinogens, EPA believes that setting a 10^{-6} excess risk level for individual chemicals and pathways generally will lead to cumulative site risks within the 10^{-4} to 10^{-6} risk range for the combinations of chemicals typically found at NPL sites.

For noncarcinogens, there is no widely accepted risk range, and EPA recognizes that cumulative risks from noncarcinogenic contaminants at a site could exceed the target hazard quotient. However, EPA also recognizes that noncancer risks should be added only for those chemicals with the same toxic endpoint or mechanism of action.

If more than one chemical detected at a site affects the same target organ (i.e., has the same critical effect as defined by the RfD methodology), an overall hazard index (HI) for the source (or exposure area) can be calculated. If this HI exceeds 1, further investigation is needed. The guidance provides a list of target organs for all chemicals with SSLs based on noncarcinogenic effect.

2.6 Step 6: Comparing Site Soil Contaminant Concentrations to Calculated SSLs

Now that the site-specific SSLs have been calculated for the potential contaminants of concern, compare them with the site contaminant concentrations. At this point, it is reasonable to review the CSM with the actual site data to confirm its accuracy and the overall applicability of the Soil Screening Guidance.

Thus, for surface soils, the contaminant concentrations in each composite sample from an exposure area are compared to 2 times the SSL. (When SSL DQOs were developed, 2 times the SSL was determined to a reasonable upper limit for comparison that would still be protective of human health. Use of this decision rule is appropriate only when the quantity and quality of data are comparable to the levels discussed in the User's Guide. For a complete discussion for the SSL DQOs, see the TBD.) If any composite has concentrations that equal or exceed 2 times the SSL, the area cannot be screened out, and further study is needed.

However, if all composite samples are below 2 times the SSLs, no further study is needed.

For data sets of lesser quality, the 95% upper confidence level on the arithmetic mean of contaminant soil concentration can be compared directly to the SSLs. The TBD discusses strengths and weaknesses of different calculations of the mean and when they are appropriate for making screening decisions.

Since subsurface soils are not characterized to the same extent as surface soils, there is less confidence that the concentrations measured are representative of the entire source. Thus, a more conservative approach to screening is warranted. Because it may not be protective to allow for comparison to values above the SSL, mean contaminant concentrations from each soil boring taken in a source area are compared with the calculated SSLs. Source areas with any mean soil boring contaminant concentration greater than the SSLs generally warrant further consideration. On the other hand, where the mean soil boring contaminant concentrations within a source are all less than the SSLs, that source area is generally screened out.

2.7 Step 7: Addressing Areas Identified for Further Study

Areas that have been identified for further study become a subject of the RI/FS (U.S. EPA, 1989c). The results of the baseline risk assessment conducted as part of the RI/FS will establish the basis for taking remedial action. The threshold for taking action differs from the criteria used for screening. As outlined in *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (U.S. EPA, 1991c), remedial action at NPL sites is generally warranted where cumulative risks for current or future land use exceed $1x10^{-4}$ for carcinogens or an HI of 1 for noncarcinogens. The data collected for soil screening are useful in the RI and baseline risk assessment. However, additional data will probably need to be collected during future site investigations. This additional data will better define the risks and threats at the site and could conceivably indicate that no action is required.

Once the decision has been made that remedial action may be appropriate, the SSLs can then serve as PRGs. This process is referenced in Section 1.2 of this document.

FOR FURTHER INFORMATION

The technical details (e.g, equations and assumptions necessary to implement the soil screening guidance are available in the *Soil Screening Guidance: User's Guide* (U.S. EPA, 1996a). More detailed discussions of the technical background and assumptions supporting the development of the Soil Screening Guidance are presented in the *Soil Screening Guidance: Technical Background Document* (U.S. EPA, 1996b). The final portion of the guidance package is the *Soil Screening Guidance: Response to Comments*, (U.S. EPA, 1996c) which describes changes made to the guidance following peer review and public comment. For additional copies of this fact sheet, the User's Guide, the Technical Background Document, Response to Comments, or other EPA documents, call the National Technical Information Service (NTIS) at (703) 487-4650 or 1-800-553-NTIS (6847).

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DISCLAIMER

Notice: The Soil Screening Guidance is based on policies set out in the Preamble to the Final Rule of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which was published on March 8, 1990 (55 *Federal Register* 8666).

This guidance document sets forth recommended approaches based on EPA's best thinking to date with respect to soil screening. This document does not establish binding rules. Alternative approaches for screening may be found to be more appropriate at specific sites (e.g., where site circumstances do not match the underlying assumptions, conditions and models of the guidance). The decision whether to use an alternative approach and a description of any such approach should be placed in the Administrative Record for the site. Accordingly, if comments are received at individual sites questioning the use of the approaches recommended in this guidance, the comments should be considered and an explanation provided for the selected approach. The Soil Screening Guidance: Technical Background Document (TBD) may be helpful in responding to such comments.

The policies set out in both the Soil Screening Guidance: User's Guide and the supporting TBD are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States government. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change the guidance at any time without public notice.

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLP	Contract Laboratory Program
CSM	Conceptual Site Model
CV	Coefficient of Variation
DAF	Dilution Attenuation Factor
DNAPL	Dense Nonaqueous Phase Liquid
DQA	Data Quality Assessment
DQO	Data Quality Objective
EA	Exposure Area
EPA	Environmental Protection Agency
HBL	Health Based Limit
HEAST	Health Effects Assessment Summary Table
HELP	Hydrological Evaluation of Landfill Performance
HHEM	Human Health Evaluation Manual
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
ISC2	Industrial Source Complex Model
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NAPL	Nonaqueous Phase Liquid
NOAEL	No-Observed-Adverse-Effect Level
NPL	National Priorities List
NTIS	National Technical Information Service
OERR	Office of Emergency and Remedial Response
PA/SI	Preliminary Assessment/Site Inspection
PCB	Polychlorinated Biphenyl
PEF	Particulate Emission Factor
PRG	Preliminary Remediation Goal
Q/C	Site-Specific Dispersion Model
QA/QC	Quality Assurance/Quality Control
QL	Quantitation Limit
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SAB	Science Advisory Board
SAP	Sampling and Analysis Plan
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Soil Screening Level
TBD	Technical Background Document
TCLP	Toxicity Characteristic Leaching Procedure
USDA	U.S. Department of Agriculture
VF	Volatilization Factor
VOC	Volatile Organic Compound

1.0 INTRODUCTION

1.1 Purpose

The Soil Screening Guidance is a tool that the U.S. Environmental Protection Agency (EPA) developed to help standardize and accelerate the evaluation and cleanup of contaminated soils at sites on the National Priorities List (NPL) with future residential land use.[1] This guidance provides a methodology for environmental science/engineering professionals to calculate risk-based, site-specific, soil screening levels (SSLs) for contaminants in soil that may be used to identify areas needing further investigation at NPL sites.

SSLs are not national cleanup standards. SSLs alone do not trigger the need for response actions or define "unacceptable" levels of contaminants in soil. In this guidance, "screening" refers to the process of identifying and defining areas, contaminants, and conditions, at a particular site that do not require further Federal attention. Generally, at sites where contaminant concentrations fall below SSLs, no further action or study is warranted under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). (Some States have developed screening numbers that are more stringent than the generic SSLs presented here; therefore, further study may be warranted under State programs.) Generally, where contaminant concentrations equal or exceed SSLs, further study or investigation, but not necessarily cleanup, is warranted.

SSLs are risk-based concentrations derived from equations combining exposure information assumptions with EPA toxicity data. This User's Guide focuses on the application of a simple site-specific approach by providing a step-by-step methodology to calculate site-specific SSLs and is part of a larger framework that includes both generic and more detailed approaches to calculating screening levels. The Technical Background Document (TBD) (EPA, 1996), provides more information about these other approaches. Generic SSLs for the most common contaminants found at NPL sites are included in the TBD. Generic SSLs are calculated from the same equations presented in this guidance, but are based on a number of default assumptions chosen to be protective of human health for most site conditions. Generic SSLs can be used in place of site-specific screening levels; however, in general, they are expected to be more conservative than site-specific levels. The site manager should weigh the cost of collecting the data necessary to develop site-specific SSLs with the potential for deriving a higher SSL that provides an appropriate level of protection.

The framework presented in the TBD also includes more detailed modeling approaches for developing screening levels that take into account more complex site conditions than the simple site-specific methodology emphasized in this guidance. More detailed approaches may be appropriate when site conditions (e.g., a thick vadose zone) are different from those assumed in the simple site-specific methodology presented here. The technical details supporting the methodology used in this guidance are provided in the TBD.

SSLs developed in accordance with this guidance are based on future residential land use assumptions and related exposure scenarios. Using this guidance for sites where residential land use assumptions do not apply could result in overly conservative screening levels; however, EPA recognizes that some parties responsible for sites with non-residential land use might still find benefit in using the SSLs as a tool to conduct a conservative initial screening.

SSLs developed in accordance with this guidance could also be used for Resource Conservation and Recovery Act (RCRA) corrective action sites as "action levels," since the RCRA corrective action program currently views the role of action levels as generally fulfilling the same purpose as soil screening levels.[2] In addition, States may use this guidance in their voluntary cleanup programs, to the extent they deem appropriate. When applying SSLs to RCRA corrective action sites or for sites under State voluntary cleanup programs, users of this guidance should recognize, as stated above, that SSLs are based on residential land use assumptions. Where these assumptions do not apply, other approaches

1. Note that the Superfund program defines "soil" as having a particle size under 2mm, while the RCRA program allows for particles under 9mm in size.

2 Further information on the role of action levels in the RCRA corrective action program is available in an Advance Notice of Proposed Rulemaking (signed April 1996).

for determining the need for further study might be more appropriate.

1.2 Role of Soil Screening Levels

In identifying and managing risks at sites, EPA considers a spectrum of contaminant concentrations. The level of concern associated with those concentrations depends on the likelihood of exposure to soil contamination at levels of potential concern to human health or to ecological receptors.

Exhibit 1 illustrates the spectrum of soil contamination encountered at Superfund sites and the conceptual range of risk management responses. At one end are levels of contamination that clearly warrant a response action; at the other end are levels that are below regulatory concern. Screening levels identify the lower bound of the spectrum—levels below which EPA believes there is no concern under CERCLA, provided conditions associated with the SSLs are met. Appropriate cleanup goals for a particular site may fall anywhere within this range depending on site-specific conditions.

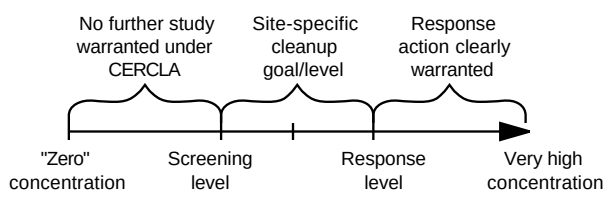


Exhibit 1. Conceptual Risk Management Spectrum for Contaminated Soil

EPA anticipates the use of SSLs as a tool to facilitate prompt identification of contaminants and exposure areas of concern during both remedial actions and some removal actions under CERCLA. However, the application of this or any screening methodology is not mandatory at sites being addressed under CERCLA or RCRA. The framework leaves discretion to the site manager and technical experts (e.g., risk assessors, hydrogeologists) to determine whether a screening approach is appropriate for the site and, if screening is to be used, the proper method of implementation. If comments are received at individual sites questioning the use of the approaches recommended in this guidance, the comments should be considered and an explanation provided as part of the site's Record of Decision (ROD). The decision to use a screening approach should be made early in the process of investigation at the site.

EPA developed the Soil Screening Guidance to be consistent with and to enhance the current Superfund investigation process and anticipates its primary use during the early stages of a remedial investigation (RI) at NPL sites. It does not replace the Remedial Investigation/Feasibility Study (RI/FS) or risk assessment, but use of screening levels can focus the RI and risk assessment on aspects of the site that are more likely to be a concern under CERCLA. By screening out areas of sites, potential chemicals of concern, or exposure pathways from further investigation, site managers and technical experts can limit the scope of the remedial investigation or risk assessment. SSLs can save resources by helping to determine which areas do not require additional Federal attention early in the process. Furthermore, data gathered during the soil screening process can be used in later Superfund phases, such as the baseline risk assessment, feasibility study, treatability study, and remedial design. This guidance may also be appropriate for use by the removal program when demarcation of soils above residential risk-based numbers coincides with the purpose and scope of the removal action.

The process presented in this guidance to develop and apply simple, site-specific soil screening levels is likely to be most useful where it is difficult to determine whether areas of soil are contaminated to an extent that warrants further investigation or response (e.g., whether areas of soil at an NPL site require further investigation under CERCLA through an RI/FS). As noted above, the screening levels have been developed assuming residential land use. Although some of the models and methods presented in this guidance could be modified to address exposures under other land uses, EPA has not yet standardized assumptions for those other uses.

Applying site-specific screening levels involves developing a conceptual site model (CSM), collecting a few easily obtained site-specific soil parameters (such as the dry bulk density and percent

moisture), and sampling to measure contaminant levels in surface and subsurface soils. Often, much of the information needed to develop the CSM can be derived from previous site investigations [e.g., the Preliminary Assessment/Site Inspection (PA/SI)] and, if properly planned, SSL sampling can be accomplished in one mobilization.

An important part of this guidance is a recommended sampling approach that balances the need for more data to reduce uncertainty with the need to limit data collection costs. Where data are limited such that use of the "maximum test" (Max test) presented here is not appropriate, the guidance provides direction on the use of other conservative estimates of contaminant concentrations for comparison with the SSLs.

This guidance provides the information needed to calculate SSLs for 110 chemicals. Sufficient information may not be available to develop soil screening levels for additional chemicals. These chemicals should not be screened out, but should be addressed in the baseline risk assessment for the site. The *Risk Assessment Guidance for Superfund* (RAGS), *Volume 1: Human Health Evaluation Manual* (HHEM)*, Part A, Interim Final.* (U.S. EPA, 1989a) provides guidance on conducting baseline risk assessments for NPL sites. In addition, the baseline risk assessment should address the chemicals, exposure pathways, and areas at the site that are not screened out.

Although SSLs are "risk-based," they do not eliminate the need to conduct a site-specific risk assessment. SSLs are concentrations of contaminants in soil that are designed to be protective of exposures in a residential setting. A site-specific risk assessment is an evaluation of the risk posed by exposure to site contaminants in various media. To calculate SSLs, the exposure equations and pathway models are run in reverse to backcalculate an "acceptable level" of a contaminant in soil. For the ingestion, dermal, and inhalation pathways, toxicity criteria are used to define an acceptable level of contamination in soil, based on a one-in-a-million (10^{-6}) individual excess cancer risk for carcinogens and a hazard quotient (HQ) of 1 for non-carcinogens. SSLs are backcalculated for migration to ground water pathways using ground water concentration limits [nonzero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or health-based limits (HBLs) (10^{-6} cancer risk or a HQ of 1) where MCLs are not available].

SSLs can be used as Preliminary Remediation Goals (PRGs) provided appropriate conditions are met (i.e., conditions found at a specific site are similar to conditions assumed in developing the SSLs). The concept of calculating risk-based contaminant levels in soils for use as PRGs (or "draft" cleanup levels) was introduced in the RAGS HHEM*, Part B, Development of Risk-Based Preliminary Remediation Goals.* (U.S. EPA, 1991c). **The models, equations, and assumptions presented in the Soil Screening Guidance to address <u>inhalation</u> exposures supersede those described in RAGS HHEM, Part B, for residential soils. In addition, this guidance presents methodologies to address the leaching of contaminants through soil to an underlying potable aquifer. This pathway should be addressed in the development of PRGs.**

PRGs may then be used as the basis for developing final cleanup levels based on the nine-criteria analysis described in the National Contingency Plan [Section 300.430 (3)(2)(I)(A)]. The directive entitled *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (U.S. EPA, 1991d) discusses the modification of PRGs to generate cleanup levels. The SSLs should only be used as cleanup levels when a site-specific nine-criteria evaluation of the SSLs as PRGs for soils indicates that a selected remedy achieving the SSLs is protective, complies with Applicable or Relevant and Appropriate Requirements (ARARs), and appropriately balances the other criteria, including cost.

1.3 Scope of Soil Screening Guidance

In a residential setting, potential pathways of exposure to contaminants in soil are as follows (see Exhibit 2):

- Direct ingestion
- Inhalation of volatiles and fugitive dusts

- Ingestion of contaminated ground water caused by migration of chemicals through soil to an underlying potable aquifer
- Dermal absorption
- Ingestion of homegrown produce that has been contaminated via plant uptake
- Migration of volatiles into basements.

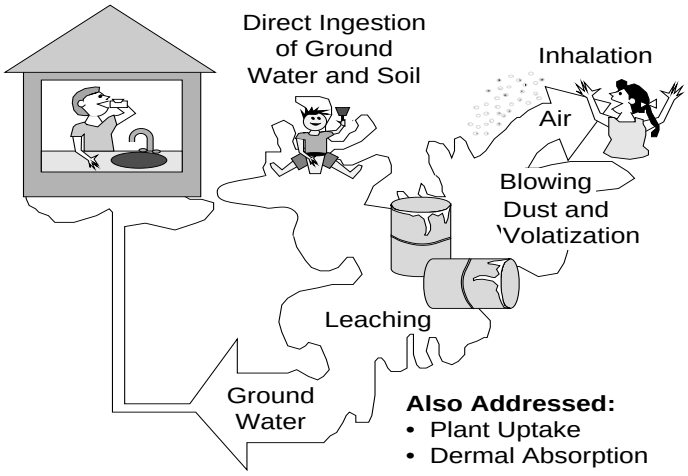


Exhibit 2. Exposure Pathways Addressed by SSLs.

The Soil Screening Guidance addresses each of these pathways to the greatest extent practical. The first three pathways -- direct ingestion, inhalation of volatiles and fugitive dusts, and ingestion of potable ground water -- are the most common routes of human exposure to contaminants in the residential setting. These pathways have generally accepted methods, models, and assumptions that lend themselves to a standardized approach. The additional pathways of exposure to soil contaminants, dermal absorption, plant uptake, and migration of volatiles into basements, may also contribute to the risk to human health from exposure to specific contaminants in a residential setting. This guidance addresses these pathways to a limited extent based on available empirical data. (See Step 5 and the TBD for further discussion).

The Soil Screening Guidance addresses the human exposure pathways listed previously and will be appropriate for most residential settings. The presence of additional pathways or unusual site conditions does not preclude the use of SSLs in areas of the site that are currently residential or likely to be residential in the future. However, the risks associated with additional pathways or conditions (e.g., fish consumption, raising of livestock, a heavy truck traffic on unpaved roads) should be considered in the RI/FS to determine whether SSLs are adequately protective.

An ecological assessment should also be performed as part of the RI/FS to evaluate potential risks to ecological receptors.

The Soil Screening Guidance should not be used for areas with radioactive contaminants.

Exhibit 3 provides key attributes of the Soil Screening Guidance: User's Guide.

Exhibit 3: Key Attributes of the User's Guide

- Standardized equations are presented to address human exposure pathways in a residential setting consistent with Superfund's concept of "Reasonable Maximum Exposure" (RME).
- Source size (area and depth) can be considered on a site-specific basis using mass-limit models.
- Parameters are identified for which site-specific information is needed to develop SSLs.
- Default values are provided to calculate generic SSLs when site-specific information is not available.
- SSLs are based on a 10^{-6} risk for carcinogens or a hazard quotient of 1 for noncarcinogens. SSLs for migration to ground water are based on (in order of preference): nonzero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or the aforementioned risk-based targets.

2.0 SOIL SCREENING PROCESS

The soil screening process (Exhibit 4) is a step-by-step approach that involves:

- Developing a conceptual site model (CSM)
- Comparing the CSM to the SSL scenario
- Defining data collection needs
- Sampling and analyzing soils at site
- Calculating site-specific SSLs
- Comparing site soil contaminant concentrations to calculated SSLs
- Determining which areas of the site require further study.

It is important to follow this process to implement the Soil Screening Guidance properly. The remainder of this guidance discusses each activity in detail.

2.1 Step 1: Developing a Conceptual Site Model

The CSM is a three-dimensional "picture" of site conditions that illustrates contaminant distributions, release mechanisms, exposure pathways and migration routes, and potential receptors. The CSM documents current site conditions and is supported by maps, cross sections, and site diagrams that illustrate human and environmental exposure through contaminant release and migration to potential receptors. Developing an accurate CSM is critical to proper implementation of the Soil Screening Guidance.

As a key component of the RI/FS and EPA's Data Quality Objectives (DQO) process, the CSM should be updated and revised as investigations produce new information about a site. *Data Quality Objectives for Superfund: Interim Final Guidance* (U.S. EPA, 1993a) and *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. EPA, 1989c) provide a general discussion about the development and use of the CSM during RIs. Developing the CSM involves several steps, discussed in the following subsections.

2.1.1 Collect Existing Site Data. The initial design of the CSM is based on existing site data compiled during previous studies. These data may include site sampling data, historical records, aerial photographs, maps, and State soil surveys, as well as information on local and regional conditions relevant to contaminant migration and potential receptors. Data sources include Superfund site assessment documents (i.e., the PA/SI), documentation of removal actions, and records of other site characterizations or actions. Published information on local and regional climate, soils, hydrogeology, and ecology may be useful. In addition, information on the population and land use at and surrounding the site will be important to identify potential exposure pathways and receptors. The RI/FS guidance (U.S. EPA, 1989c) discusses collection of existing data during RI scoping, including an extensive list of potential data sources.

2.1.2 Organize and Analyze Existing Site Data. One of the most important aspects of the CSM development process is to identify and characterize all potential exposure pathways and receptors at the site by considering site conditions, relevant exposure scenarios, and the properties of contaminants present in site soils.

Attachment A, the Conceptual Site Model Summary, provides four forms for organizing site data for soil screening purposes. The CSM summary organizes site data according to general site information, soil contaminant source characteristics, exposure pathways and receptors.

Note: If a CSM has already been developed for the site in question, use the summary forms in Attachment A to ensure that it is adequate.

2.1.3 Construct a Preliminary Diagram of the CSM. Once the existing site data have been organized and a basic understanding of the site has been attained, draw a preliminary "sketch" of the site conditions, highlighting source areas, potential exposure pathways, and receptors.

Exhibit 4

Soil Screening Process

Step One: Develop Conceptual Site Model

- Collect existing site data (historical records, aerial photographs, maps, PA/SI data, available background information, State soil surveys, etc.)
- Organize and analyze existing site data
  - Identify known sources of contamination
  - Identify affected media
  - Identify potential migration routes, exposure pathways, and receptors
- Construct a preliminary diagram of the CSM
- Perform site reconnaissance
  - Confirm and/or modify CSM
  - Identify remaining data gaps

Step Two: Compare Soil Component of CSM to Soil Screening Scenario

- Confirm that future residential land use is a reasonable assumption for the site
- Identify pathways present at the site that are addressed by the guidance
- Identify additional pathways present at the site not addressed by the guidance
- Compare pathway-specific generic SSLs with available concentration data
- Estimate whether background levels exceed generic SSLs

Step Three: Define Data Collection Needs for Soils to Determine Which Site Areas Exceed SSLs

- Develop hypothesis about distribution of soil contamination (i.e., which areas of the site have soil contamination that exceed appropriate SSLs?)
- Develop sampling and analysis plan for determining soil contaminant concentrations
  - Sampling strategy for surface soils (includes defining study boundaries, developing a decision rule, specifying limits on decision errors, and optimizing the design)
  - Sampling strategy for subsurface soils (includes defining study boundaries, developing a decision rule, specifying limits on decision errors, and optimizing the design)
  - Sampling to measure soil characteristics (bulk density, moisture content, organic carbon content, porosity, pH)
- Determine appropriate field methods and establish QA/QC protocols

Step Four: Sample and Analyze Soils at Site

- Identify contaminants
- Delineate area and depth of sources
- Determine soil characteristics
- Revise CSM, as appropriate

Step Five: Derive Site-specific SSLs, if needed

- Identify SSL equations for relevant pathways
- Identify chemical of concern for dermal exposure and plant uptake
- Obtain site-specific input parameters from CSM summary
- Replace variables in SSL equations with site-specific data gathered in Step 4
- Calculate SSLs
  - Account for exposure to multiple contaminants

Step Six: Compare Site Soil Contaminant Concentrations to Calculated SSLs

- For surface soils, screen out exposure areas where all composite samples do not exceed SSLs by a factor of 2
- For subsurface soils, screen out source areas where the highest average soil core concentration does not exceed the SSLs
- Evaluate whether background levels exceed SSLs

Step Seven: Decide How to Address Areas Identified for Further Study

- Consider likelihood that additional areas can be screened out with more data
- Integrate soil data with other media in the baseline risk assessment to estimate cumulative risk at the site
- Determine the need for action
- Use SSLs as PRGs

Ultimately, when site investigations are complete, this sketch will be refined into a three-dimensional diagram that summarizes the data. Also, a brief summary of the contamination problem should accompany the CSM. Attachment A provides an example of a complete CSM summary.

2.1.4 Perform Site Reconnaissance. At this point, a site visit would be useful because conditions at the site may have changed since the PA/SI was performed (e.g., removal actions may have been taken). During site reconnaissance, update site sketches/topographic maps with the locations of buildings, source areas, wells, and sensitive environments. Anecdotal information from nearby residents or site workers may reveal undocumented disposal practices and thus previously unknown areas of contamination that may affect the current CSM interpretation.

Based on the new information gained from site reconnaissance, update the CSM as appropriate. Identify any remaining data gaps in the CSM so that these data needs can be incorporated into the Sampling and Analysis Plan (SAP).

2.2 Step 2: Comparing CSM to SSL Scenario

The Soil Screening Guidance is likely to be appropriate for sites where residential land use is reasonably anticipated. However, the CSM may include other sources and exposure pathways that are not covered by this guidance. Compare the CSM with the assumptions and limitations inherent in the SSLs to determine whether additional or more detailed assessments are needed for any exposure pathways or chemicals. Early identification of areas or conditions where SSLs are not applicable is important so that other characterization and response efforts can be considered when planning the sampling strategy.

2.2.1 Identify Pathways Present at the Site Addressed by Guidance. The following are potential pathways of exposure to soil contaminants in a residential setting and are addressed by this guidance document:

- Direct ingestion
- Inhalation of volatiles and fugitive dusts
- Ingestion of contaminated ground water caused by migration of chemicals through soil to an underlying potable aquifer
- Dermal absorption
- Ingestion of homegrown produce that has been contaminated via plant uptake
- Migration of volatiles into basements.

This guidance quantitatively addresses the ingestion, inhalation, and migration to ground water pathways and also addresses, more qualitatively, the potential for dermal absorption and plant uptake based on limited empirical data. Whether some or all of the pathways are relevant at the site depends upon the contaminants and conditions at the site.

For **surface** soils under the residential land use assumption, routinely consider the direct ingestion route in the soil screening decision. Inhalation of fugitive dusts and dermal absorption can be of concern for certain chemicals and site conditions.

For **subsurface** soils, risks from inhalation of volatile contaminants and migration of soil contaminants to an underlying aquifer are potential concerns for this scenario. The inhalation pathway may be eliminated from further analysis if the presence of volatile contaminants are not suspected in the subsurface soils. Likewise, consideration of the ground water pathway may be eliminated if ground water beneath or adjacent to the site is not a potential source of drinking water. Coordinate this decision on a site-specific basis with State or local authorities responsible for ground water use and classification. The rationale for excluding this exposure pathway should be consistent with EPA ground water policy (U.S. EPA, 1988a, 1990a, 1992a, 1992c, and 1993b).

The potential for plant uptake of contaminants should be addressed for both surface and subsurface soils.

In addition to the more common pathways of exposure in a residential setting, concerns have been raised regarding the potential for migration of

volatile organic compounds (VOCs) from subsurface soils into basements. The Johnson and Ettinger model (1991) was developed to address this pathway, and an analysis of the potential use of this model for soil screening is provided in the TBD (U.S. EPA, 1996). The analysis suggests that the use of the model is limited due to its sensitivity to a number of parameters such as distance from the source to the building, building ventilation rate and the number and size of cracks in the basement wall. Such data are difficult to obtain for a current use scenario, and extremely uncertain for any future use scenario. Thus, instead of relying exclusively on the model, data from a comprehensive soil-gas survey are recommended to address the potential for migration of VOCs in the subsurface. Soil-gas data and site-specific information on soil permeability can be used to replace default parameters in the Johnson and Ettinger model to obtain a more reliable estimate for the impact of this pathway on site risk.

2.2.2 Identify Additional Pathways Present at the Site Not Addressed by Guidance. The presence of additional pathways does not preclude the use of SSLs in site areas that are currently residential or likely to be residential in the future. However, the risks associated with these additional pathways should also be considered in the RI/FS to determine whether SSLs are adequately protective. Where the following conditions exist, a more detailed site-specific study should be performed:

- The site is **adjacent to bodies of surface water** where the potential for contamination of surface water by overland flow or release of contaminated ground water into surface water through seeps should be considered.
- There are potential terrestrial or aquatic **ecological concerns**.
- There are **other likely human exposure pathways** that were not considered in development of the SSLs (e.g., local fish consumption, raising of beef, dairy, or other livestock).
- There are **unusual site conditions** such as the presence of nonaqueous phase liquids (NAPLs), large areas of contamination, unusually high fugitive dust levels due to soil being tilled for agricultural use, or heavy traffic on unpaved roads.
- There are **certain subsurface site conditions** such as karst, fractured rock aquifers, or contamination extending below the water table, that result in the screening models not being sufficiently conservative.

2.2.3 Compare Available Data to Background. EPA may be concerned with two types of background at sites: naturally occurring and anthropogenic. Natural background is usually limited to metals; whereas, anthropogenic (i.e., man-made) background can include both organic and inorganic contaminants. A comparison of available data (e.g., State soil surveys) on local background concentrations with generic SSLs may indicate whether background concentrations at the site are elevated. Although background concentrations exceeding generic SSLs do not necessarily indicate that a health threat exists, further investigation may be necessary.

Generally, EPA does not cleanup below natural background levels; however, where anthropogenic background levels exceed SSLs and EPA has determined that a response action is necessary and feasible, EPA's goal will be to develop a comprehensive response to address area soils. This will often require coordination with different authorities that have jurisdiction over other sources of contamination in the area (such as a regional air board or RCRA program). This will help avoid response actions that create "clean islands" amid widespread contamination.

To determine the need for a response action, the site investigation should include gathering site-specific background data for any potential chemicals of concern and their speciation, because contaminant solubility in water and bioavailability (absorption into an organism) are important considerations for the risk assessment. Speciation of compounds such as metals and congener-specific analysis of similar organic chemicals [e.g., dioxins, polychlorinated biphenyls (PCBs)] can sometimes provide improved estimates of exposure and subsequent toxicity of chemically related compounds. While water solubility is not often a

good predictor of uptake of a toxicant into the blood of an exposed receptor for physiological reasons, relative bioavailability and toxicity can sometimes be estimated through analytical speciation of related compounds. For example, various forms of metals are more or less toxic and can behave as quite disparate compounds in terms of exposure and risk. Inorganic forms of metals are not likely to cross biological membranes as easily or may not bioaccumulate as readily as organometallics. Different valences of metals can produce dramatically different toxicities (e.g., chromium). Different matrices can render metals more or less bioaccessible (e.g., lead in auto emissions from leaded gas vs. lead in mine wastes). Similarly, the position and number of halogens on complex organic molecules can affect uptake and toxicity (e.g., dioxins). When applying these concepts to a screening analysis, the risk assessor should establish a credible rationale based on relevant literature and site data that supports actual differences in uptake and/or toxicity, since one cannot predict bioavailability from simple solubility studies. More likely, such an in-depth evaluation of chemical speciation and bioavailability would be conducted as part of a more detailed site-specific risk assessment.

2.3 Step 3: Defining Data Collection Needs for Soils

Once the CSM has been developed and the site manager has determined that the Soil Screening Guidance is appropriate to use at a site, an SAP should be developed. Attachment A, the Conceptual Site Model Summary, lists the data needed to apply the Soil Screening Guidance. The summary will help identify data gaps in the CSM that require collection of site-specific data. The soil SAP is likely to contain different sampling strategies that address:

- Surface soil
- Subsurface soil
- Soil characteristics

To develop sampling strategies that will properly assess site contamination, EPA recommends that site managers consult with the technical experts in their Region, including risk assessors, toxicologists, chemists and hydrogeologists. These experts can assist the site manager to use the DQO process to satisfy Superfund program objectives. The DQO process is a systematic planning process developed by EPA to ensure that sufficient data are collected to support EPA decision making. A full discussion of the DQO process is provided in *Data Quality Objectives for Superfund: Interim Final Guidance* (U.S. EPA, 1993a) and the *Guidance for the Data Quality Objectives Process* (U.S. EPA, 1994a).

Most key elements of the DQO process have already been incorporated as part of this Soil Screening Guidance (see Exhibits 5 through 8 and Attachment B). The remaining elements involve identifying the site-specific information needed to calculate SSLs. For example, the dry bulk density and the fraction of organic carbon content will need to be collected for the subsurface soil investigation.

The following sections present an overview of the sampling strategies needed to use the Soil Screening Guidance. For a more detailed discussion, see the supporting TBD.

2.3.1 Stratify the Site Based on Existing Data. At this point in the soil screening process, existing data can be used to stratify the site into three types of areas requiring different levels of investigation:

- Areas unlikely to be contaminated
- Areas known to be highly contaminated
- Areas that may be contaminated and cannot be ruled out.

Areas that are unlikely to be contaminated generally will not require further investigation if historical site use information or other site data, which are reasonably complete and accurate, confirm this assumption. These may be areas of the site that were completely undisturbed by hazardous-waste-generating activities.

Exhibit 5: Data Quality Objectives Process

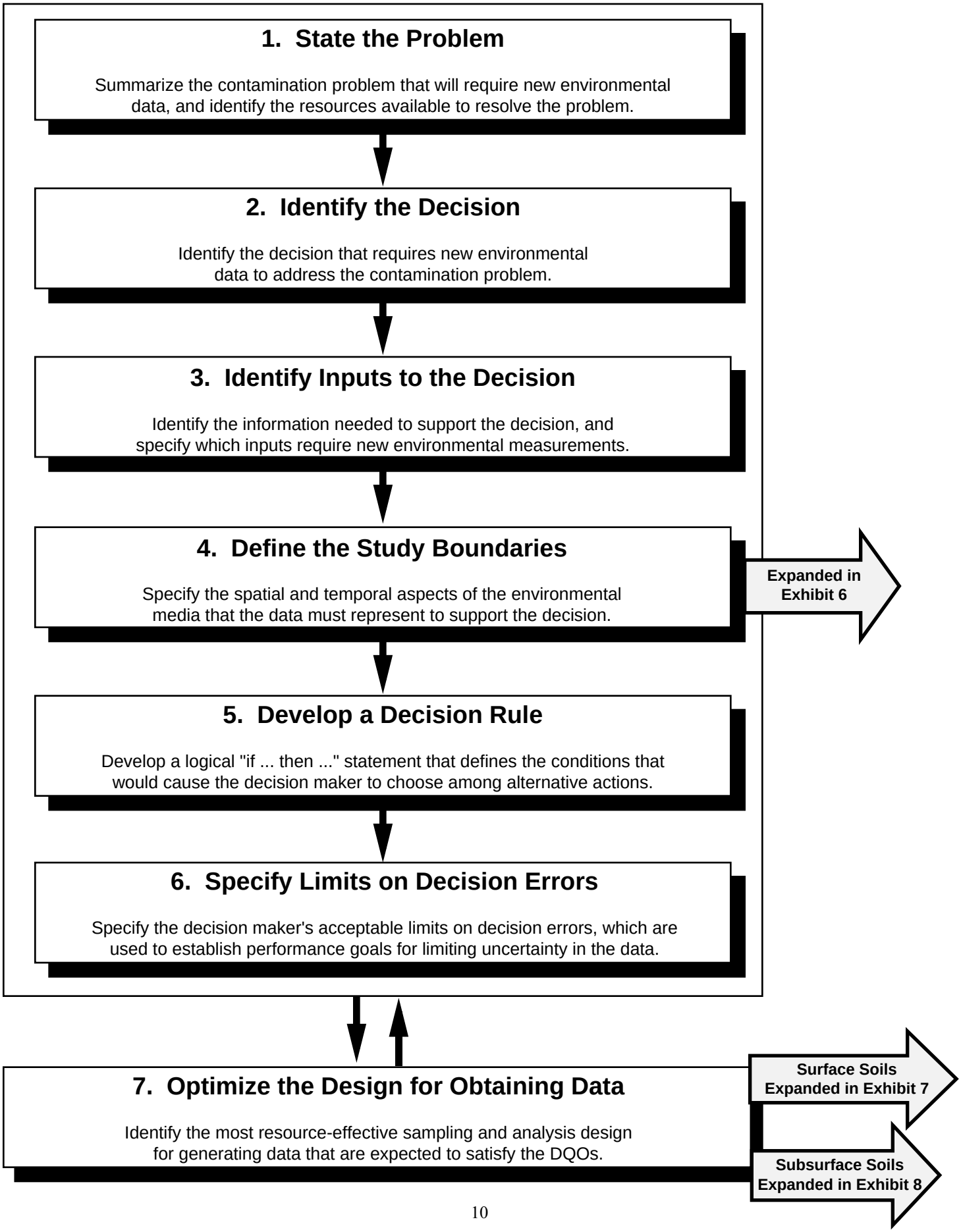
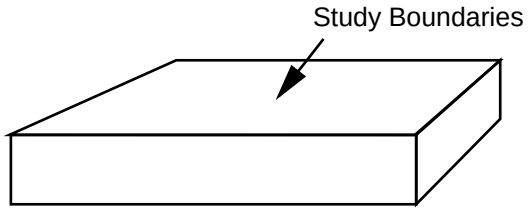
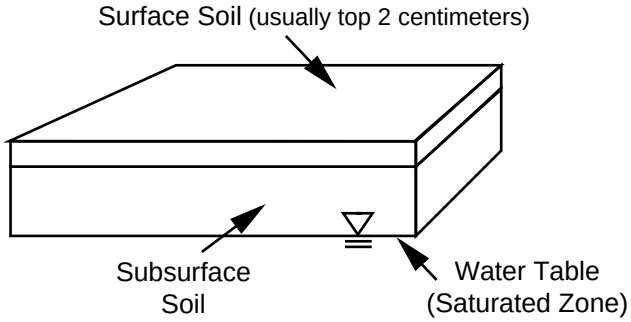


Exhibit 6: Defining the Study Boundaries

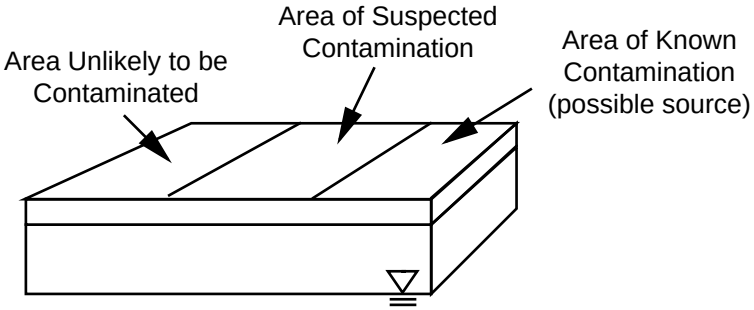
1. Define Geographic Area of the Investigation



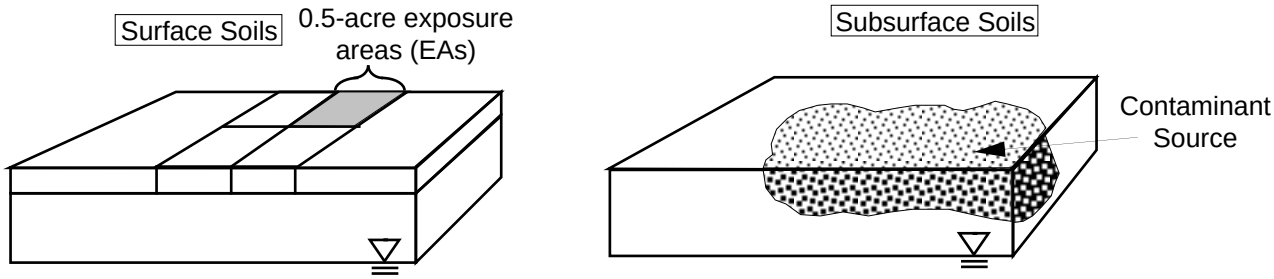
2. Define Population of Interest



3. Stratify the Site



4. Define Scale of Decision Making for Surface or Subsurface Soils



Back to Exhibit 5, Step 5, "Develop a Decision Rule"

A crude estimate of the degree of soil contamination can be made for other areas of the site by comparing site concentrations to the generic SSLs in Appendix A of the TBD. Generic SSLs have been calculated for 110 chemicals using default values in the SSL equations, resulting in conservative values that will be protective for the majority of site conditions.

The pathway-specific generic SSLs can be compared with available concentration data from previous site investigations or removal actions to help divide the site into areas with similar levels of soil contamination and develop appropriate sampling strategies.

The surface soil sampling strategy discussed in this document is most appropriate for those areas that may be contaminated and can not be designated as uncontaminated. Areas which are known to be contaminated (based on existing data) will be investigated and characterized in the RI/FS.

2.3.2 Develop Sampling and Analysis Plan for Surface Soil. The surface soil sampling strategy is designed to collect the data needed to evaluate exposures via direct ingestion, dermal absorption, and inhalation of fugitive dusts.

As explained in the *Supplemental Guidance to* RAGS: *Calculating the Concentration Term* (U.S. EPA, 1992d), an individual is assumed to move randomly across an **exposure area (EA)** over time, spending equivalent amounts of time in each location. Thus, the concentration contacted over time is best represented by the spatially averaged concentration over the EA. Ideally, the surface soil sampling strategy would determine the true population mean of contaminant concentrations in an EA. Because determination of the "true" mean would require extensive sampling at high costs, the maximum contaminant concentration from composite samples is used as a conservative estimate of the mean.

This Max test strategy compares the results of composite samples with the SSLs. Another, more complex strategy called the Chen test is presented in Part 4 of the TBD.

The User's Guide uses the Max test rather than the Chen test because the Max test is based on a statistical null hypothesis that is more appropriate for NPL sites (i.e., the EA requires further investigation). Although the Chen test is not well suited for screening decisions at NPL sites, it may be useful in a non-NPL, voluntary cleanup context.

The depth over which surface soils are sampled should reflect the type of exposures expected at the site. The *Urban Soil Lead Abatement Demonstration Project* (U.S. EPA 1993d) defined the top 2 centimeters as the depth of soil where direct contact predominantly occurs. The decision to sample soils below 2 centimeters depends on the likelihood of deeper soils being disturbed and brought to the surface (e.g., from gardening, landscaping or construction activities).

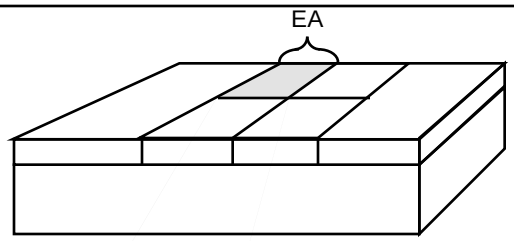
Note that the size, shape, and orientation of sampling volume (i.e., "support") for heterogenous media have a significant effect on reported measurement values. For instance, particle size has a varying affect on the transport and fate of contaminants in the environment and on the potential receptors. Comparison of data from methods that are based on different supports can be difficult. Defining the sampling support is important in the early stages of site characterization. This may be accomplished through the DQO process with existing knowledge of the site, contamination, and identification of the exposure pathways that need to be characterized. Refer to *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies* (U.S. EPA, 1992e) for more information about soil sampling support.

The SAP developed for surface soils should specify sampling and analytical procedures as well as the development of QA/QC procedures. To identify the appropriate analytical procedures, the screening levels must be known. If data are not available to calculate site-specific SSLs (Section 2.5.1), then the generic SSLs in Appendix A of the TBD should be used.

The following strategy can be used for **surface soils** to estimate the mean concentration of semivolatiles, inorganics, and pesticides in an exposure area. Volatiles are not included in the estimations because they are not expected to remain at the surface for an extended period of time.

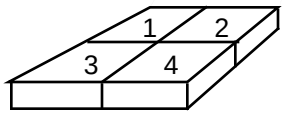
Exhibit 7: Designing a Sampling and Analysis Plan for Surface Soils

1. Subdivide Site Into EAs



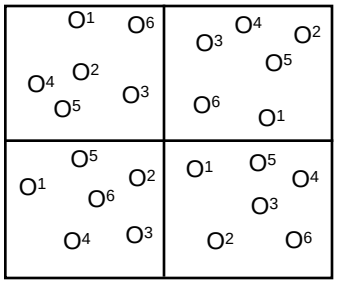
For surface soils, the individual unit for decision making is an "EA," or exposure area. It measures 0.5 acre in area or less.

2. Divide EA Into a Grid



This step defines the number of specimens (N) that will make up one composite sample.

3. Organize Surface Sampling Program for EA



Placement of sample locations on the grid was developed using a default sample size of 6 (which is based on acceptable error rates for a CV of 2.5) and a stratified random sampling pattern.

If the EA CV is suspected to be greater than 2.5, use the table below to select an adequate sample size or refer to the TBD for other sample design options.

Probability of Decision Error at 0.5 SSL and 2 SSL Using Max Test

	CV=2.5[a]		CV=3.0		CV=3.5		CV=4.0	
Sample Size [b]	$E_{0.5}$[c]	$E_{2.0}$[d]	$E_{0.5}$	$E_{2.0}$	$E_{0.5}$	$E_{2.0}$	$E_{0.5}$	$E_{2.0}$
	C = 4 specimens per composite[e]							
6	**0.21**	**0.08**	0.28	0.11	0.31	0.11	0.35	0.16
7	0.25	0.05	0.31	0.08	0.36	0.09	0.41	0.15
8	0.25	0.04	0.36	0.05	0.42	0.07	0.41	0.09
9	0.28	0.03	0.36	0.04	0.44	0.07	0.48	0.08

[a] The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA, including measurement error.
[b] Sample size (N) = number of composite samples
[c] $E_{0.5}$ = Probability of requiring further investigation when the EA mean is 0.5 SSL
[d] $E_{2.0}$ = Probability of not requiring further investigation when the EA mean is 2.0 SSL
[e] C = number of specimens per composite sample, when each composite consists of points from a stratified random or systemic grid sample from across the entire EA.

NOTE: All decision error rates are based on 1,000 simulations that assume that each composite is representative of the entire EA, half the EA has concentrations below the limit of detection, and half the EA has concentrations that follow a gamma distribution (a conservative distributional assumption).

- Divide areas to be sampled in the screening process into 0.5-acre exposure areas, the size of a suburban residential lot. If the site is currently residential, the exposure area should be the actual residential lot size. The exposure areas should not be laid out in such a way that they unnecessarily combine areas of high and low levels of contamination. The orientation and exact location of the EA, relative to the distribution of the contaminant in the soil, can lead to instances where sampling the EA may have contaminant concentration results above the mean, and in other instances, results below the mean. Try to avoid straddling contaminant "distribution units" within the 0.5-acre EA.

- Composite surface soil samples. Because the objective of surface soil screening is to estimate the mean contaminant concentration, the physical "averaging" that occurs during compositing is consistent with the intended use of the data. Compositing allows sampling of a larger number of locations while controlling analytical costs, since several individual samples are physically mixed (homogenized) and one or more subsamples are drawn from the mixture and submitted for analysis.

- Strive to achieve a false negative error rate of 5 percent (i.e., in only 5 percent of the cases, soil contamination is assumed to be below the screening level when it is really above the screening level). EPA also strives to achieve a 20 percent false positive error rate (i.e., in only 20 percent of the cases, soil contamination is assumed to be above the screening level when it is really below the screening level). These error rate goals influence the number of samples to be collected in each exposure area. For this guidance, EPA has defined the "gray region" as one-half to 2 times the SSL. Refer to Section 2.6 for further discussion.

- The default sample size chosen for this guidance (see Exhibit 7) provides adequate coverage for a coefficient of variation (CV) based upon 250 percent variability in contaminant values (CV=2.5). (If a CV larger than 2.5 is expected, use an appropriate sample size from the table in Exhibit 7 of the User's Guide, or tables in the TBD.)

- Take six composite samples, for each exposure area, with each composite sample made up of four individual samples. Exhibit 7 shows other sample sizes needed to achieve the decision error rates for other CVs. Collect the composites randomly across the EA and through the top 2 centimeters of soil, which are of greatest concern for incidental ingestion of soil, dermal contact, and inhalation of fugitive dust.

- Analyze the six samples per exposure area to determine the contaminants present and their concentrations.

For further information on compositing across or within EA sectors, developing a random sampling strategy, and determining sample sizes that control decision error rates, refer to the TBD.

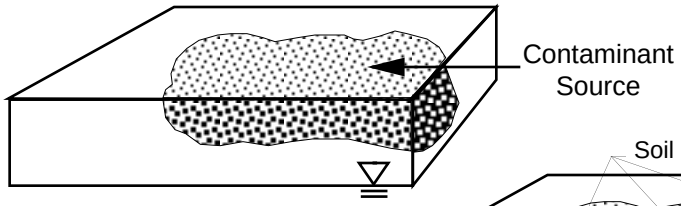
Note that the Max test requires a Data Quality Assessment (DQA) test following sampling and analysis (Section 2.4.2) to ensure that the DQOs (i.e., decision error rate goals) are achieved. If DQOs are not met, additional sampling may be required.

2.3.3 Develop Sampling and Analysis Plan for Subsurface Soils. The subsurface and surface soil sampling strategies differ because the exposure mechanisms differ. Exposure to surface contaminants occurs randomly as individuals move around a residential lot. The surface soil sampling strategy reflects this type of random exposure.

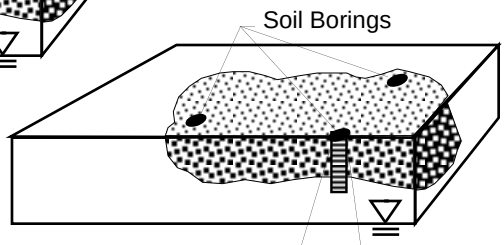
In general, exposure to subsurface contamination occurs when chemicals migrate up to the surface or down to an underlying aquifer. Thus, subsurface sampling focuses on collecting the data required for modeling the volatilization and migration to ground water pathways. Measurements of soil characteristics and estimates of the area and depth of contamination and the average contaminant concentration in each source area are needed to supply the data necessary to calculate the inhalation and migration to ground water SSLs.

Exhibit 8: Designing a Sampling and Analysis Plan for Subsurface Soils

1. Delineate Source Area

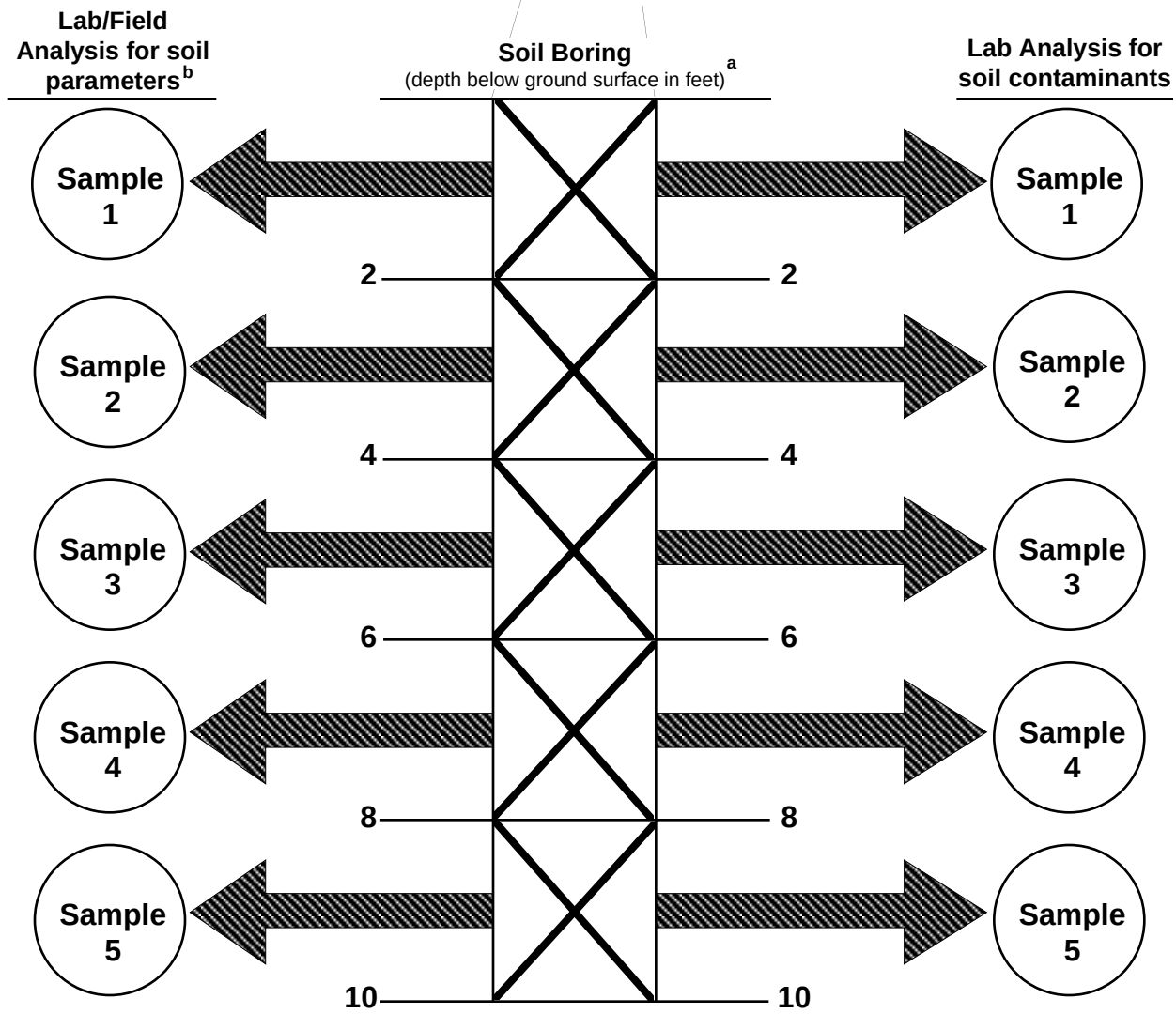


2. Choose Subsurface Soil Sampling Locations



For screening purposes, EPA recommends drilling 2 to 3 borings per source area in areas of highest suspected concentrations. Soil sampling should not extend past water table or saturated zone.

3. Design Subsurface Sampling and Analysis Plan



[a] Picture depicts a continuous boring with 2 foot segments. For information on other methods such as interval sampling and depth weighted analysis, please refer to 2.3.3 of the User's Guide or 4.2 of the TBD.

[b] Soil Texture, Dry Bulk Density, Soil Organic Carbon, pH. Retain samples for possible discrete contaminant sampling.

Source areas are the decision units for subsurface soils. A source area is defined by the horizontal extent, and vertical extent or depth of contamination. For this purpose, "contamination" is defined by either the Superfund's Contract Laboratory Program (CLP) practical quantitation limits (QLs) for each contaminant, or the SSL. **Sites with multiple sources should develop separate SSLs for each source.**

The SAP developed for subsurface soils should specify sampling and analytical procedures as well as the development of QA/QC procedures. To identify the appropriate procedures, the SSLs must be known. If data are not available to calculate site-specific SSLs (Section 2.5.2), then the generic SSLs in Appendix A of the TBD should be used.

The primary goal of the subsurface sampling strategy is to estimate the mean contaminant concentration and average soil characteristics within the source area. As with the surface soil sampling strategy, the subsurface soil sampling strategy follows the DQO process (see Exhibits 5, 6, and 8). The decision rule is based on comparing the mean contaminant concentration within each contaminant source with source-specific SSLs.

Current investigative techniques and statistical methods cannot accurately determine the mean concentration of subsurface soils within a contaminated source without a costly and intensive sampling program that is well beyond the level of effort generally appropriate for screening. Thus, conservative assumptions should be used to develop hypotheses on likely contaminant distributions.

This guidance bases the decision to investigate a source area further on the highest mean soil boring contaminant concentration within the source, reflecting the conservative assumption that the highest mean subsurface soil boring concentration among a set of borings taken from the source area represents the mean of the entire source area. Similarly, estimates of contaminant depths should be conservative. The investigation should include the maximum depth of contamination encountered within the source without going below the water table.

For each source, the guidance recommends taking 2 or 3 soil borings located in the areas suspected of having the highest contaminant concentrations within the source. These subsurface soil sampling locations are based primarily on knowledge of likely surface soil contamination patterns (see Exhibit 6) and subsurface conditions. However, buried sources may not be discernible at the surface. Information on past practices at the site included in the CSM can help identify subsurface source areas.

For sites contaminated with VOCs, the subsurface sampling strategy should include soil gas surveys as well as soil matrix sampling. VOCs are commonly found in vapor phase in the unsaturated zone, and soil matrix samples may yield results that are deceptively low. Soil gas data are needed to help locate sources, define source size, to place soil boring locations within a source, and can also be used in conjunction with modeling to address VOC transport in the vadose zone for both the volatilization and migration to ground water pathways.

Take soil cores from the soil boring using either split spoon sampling or other appropriate sampling methods. *Description and Sampling of Contaminated Soils: A Field Pocket Guide* (U.S. EPA, 1991f), and *Subsurface Characterization and Monitoring Techniques: A Desk Reference Guide, Vol. I & II* (U.S. EPA, 1993e), can be consulted for information on appropriate subsurface sampling methods.

Sampling should begin at the ground surface and continue until either no contamination is encountered or the water table is reached. **Subsurface sampling intervals can be adjusted at a site to accommodate site-specific information on subsurface contaminant distributions and geological conditions** (e.g., thick vadose zones in the West). The concept of "sampling support" introduced in Section 2.3.2 also applies to subsurface sampling. For example, sample splits and subsampling should be performed according to *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies* (U.S. EPA, 1992e).

If each subsurface soil core segment represents the same subsurface soil interval (e.g., 2 feet), then the average concentration from the surface to the depth of contamination is the simple arithmetic average of contaminant concentrations measured for core samples representative of each of the 2-foot segments from the surface to the depth of contamination. However, if the sample intervals are not all of the same length (e.g., some are 2 feet while others are 1 foot or 6 inches), then the calculation of the average concentration in the total core must account for the different lengths of the segments.

If c_i is the concentration measure in a core sample, representative of a core interval or segment of length l_i, and the n-th segment is considered to be the last segment sampled in the core (i.e., the n-th segment is at the depth of contamination), then the average concentration in the core from the surface to the depth of contamination should be calculated as the following depth-weighted average ($\bar{c}$).

$$\bar{c} = \frac{\sum_{i=1}^{n} l_i c_i}{\sum_{i=1}^{n} l_i}$$

Alternatively, the average boring concentration can be determined by adding the total contaminant masses together (from the sample results) for all sample segments to get the total contaminant mass for the boring. The total contaminant mass is then divided by the total dry weight of the core (as determined by the dry bulk density measurements) to estimate average soil boring concentration.

For the leach test option, collect discrete samples along a soil boring from within the zone of contamination and composite them to produce a sample representative of the average soil boring concentration. Take care to split each discrete sample before analysis so that information on contaminant distributions with depth will not be lost. A leach test may be conducted on each soil core.

Finally, the soil investigation for the migration to ground water pathway should not be conducted independently of ground water investigations. Contaminated ground water may indicate the presence of a nearby source area that would leach contaminants from soil into aquifer systems.

2.3.4 Develop Sampling and Analysis Plan to Determine Soil Characteristics. The soil parameters necessary for SSL calculations are soil texture, dry bulk density, soil organic carbon, and pH. Some can be measured in the field, while others require laboratory measurement. Although laboratory measurements of these parameters cannot be obtained under Superfund's CLP, independent soil testing laboratories across the country can perform these tests at a relatively low cost.

To appropriately apply the volatilization and migration-to-ground water models, average or typical soil properties should be used for a source in the SSL equations (see Step 5). Take samples for measuring soil parameters with samples for measuring contaminant concentrations. If possible, consider splitting single samples for contaminant and soil parameter measurements. Many soil testing laboratories can handle and test contaminated samples. However, if testing contaminated samples for soil parameters is a problem, samples may be obtained from clean areas of the site as long as they represent the same soil texture and are taken from approximately the same depth as the contaminant concentration samples.

Soil Texture. Soil texture class (e.g., loam, sand, silt loam) is necessary to estimate average soil moisture conditions and to apply the Hydrological Evaluation of Landfill Performance (HELP) model to estimate infiltration rates (see Attachment A). The appropriate texture classification is determined by a particle size analysis and the U.S. Department of Agriculture (USDA) soil textural triangle shown in Exhibit 9. This classification system is based on the USDA soil particle size classification.

The particle size analysis method in Gee and Bauder (1986) can provide this particle size distribution. Other methods are appropriate as long as they provide the same particle size breakpoints for sand/silt (0.05 mm) and silt/clay (0.002 mm). Field methods are an alternative for determining soil

textural class; Exhibit 9 presents an example from Brady (1990).

Dry Bulk Density. Dry soil bulk density (ρ_b) is used to calculate total soil porosity and can be determined for any soil horizon by weighing a thin-walled tube soil sample (e.g., Shelby tube) of known volume and subtracting the tube weight [American Society for Testing and Materials (ASTM) D 2937]. Determine moisture content (ASTM 2216) on a subsample of the tube sample to adjust field bulk density to dry bulk density. The other methods (e.g., ASTM D 1556, D 2167, D 2922) are generally applicable only to surface soil horizons and are not appropriate for subsurface characterization. ASTM soil testing methods are readily available in the *Annual Book of ASTM Standards, Volume 4.08, Soil and Rock; Building Stones*, available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA, 19428.

Organic Carbon and pH. Soil organic carbon is measured by burning off soil carbon in a controlled-temperature oven (Nelson and Sommers, 1982). This parameter is used to determine soil-water partition coefficients from the organic carbon soil-water partition coefficient, K_{oc}. Soil pH is used to select site-specific partition coefficients for metals (Table C-4, Attachment C) and ionizing organics (Table C-2, Attachment C). This simple measurement is made with a pH meter in a soil/water slurry (McLean, 1982) and may be measured in the field using a portable pH meter.

2.3.5 Determine Analytical Methods and Establish QA/QC Protocols. Assemble a list of feasible sampling and analytical methods during this step. Verify that a CLP method and a field method for analyzing the samples exist and that the analytical method QL or field method QL is appropriate for (i.e., is below) the site-specific or generic SSL. *Sampler's Guide to the Contract Laboratory Program* (U.S. EPA, 1990b) and *User's Guide to the Contract Laboratory Program* (U.S. EPA, 1991e) contain further information on CLP methods.

Field methods, such as soil gas surveys, immunoassay, or X-ray fluorescence, can be used if the field method quantitation limit is below the SSL. EPA recommends the use of field methods where applicable and appropriate. However, at least 10 percent of both the discrete samples and the composites should be split and sent to a CLP laboratory for confirmatory analysis. (*Quality Assurance for Superfund Environmental Data Collection Activities,* U.S. EPA, 1993c).

Because a great amount of variability and bias can exist in the collection, subsampling, and analysis of soil samples, some effort should be made to characterize this variability and bias. *A Rationale for the Assessment of Errors in the Sampling of Soils* (U.S. EPA, 1990c) outlines an approach that advocates the use of a suite of QA/QC samples to assess variability and bias. Field duplicates and splits are some of the best indicators of overall variability in the sampling and analytical processes.

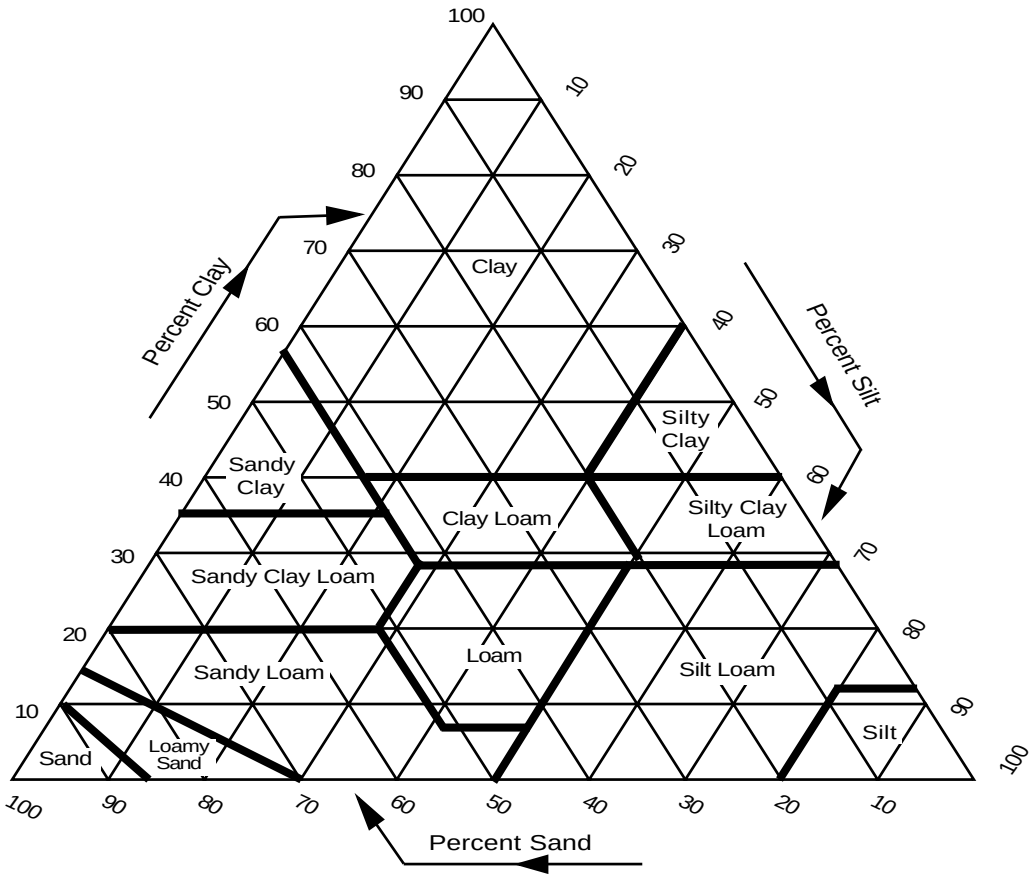
Field methods will be useful in defining the study boundaries (i.e., area and depth of contamination) during both site reconnaissance and sampling. The design and capabilities of field portable instrumentation are rapidly evolving. Documents describing the standard operating procedures for field instruments are available though the National Technical Information Service (NTIS).

Regardless of whether surface or subsurface soils are sampled, the Superfund quality assurance program guidance (U.S. EPA, 1993c) should be consulted. Standard limits on the precision and bias of sampling and analytical operations conducted during sampling do apply and should be followed to give consistent and defensible results.

2.4 Step 4: Sampling and Analyzing Site Soils & DQA

Once the sampling strategies have been developed and implemented, the samples should be analyzed according to the analytical laboratory and field methods specified in the SAP. Results of the analyses should identify the concentrations of potential contaminants of concern for which site-specific SSLs will be calculated.

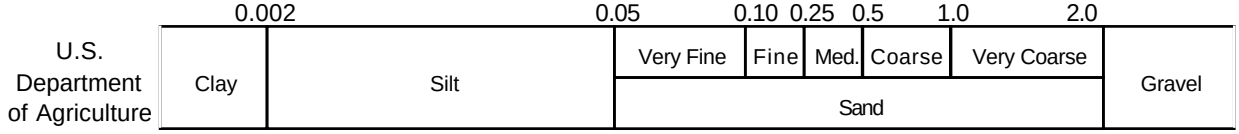
Exhibit 9: U.S. Department of Agriculture soil texture classification.



Criteria Used with the Field Method for Determining Soil Texture Classes (Source: Brady, 1990)

Criterion	Sand	Sandy loam	Loam	Silt loam	Clay loam	Clay
1. Individual grains visible to eye	Yes	Yes	Some	Few	No	No
2. Stability of dry clods	Do not form	Do not form	Easily broken	Moderately easily broken	Hard and stable	Very hard and stable
3. Stability of wet clods	Unstable	Slightly stable	Moderately stable	Stable	Very stable	Very stable
4. Stability of "ribbon" when wet soil rubbed between thumb and fingers	Does not form	Does not form	Does not form	Broken appearance	Thin, will break	Very long, flexible

Particle Size, mm



Source: USDA.

2.4.1 Delineate Area and Depth of Source. Both spatial area and depth data, as well as soil characteristic data, are needed to calculate site-specific SSLs for the inhalation of volatiles and migration to ground water pathways in the subsurface. Site information from the CSM or soil gas surveys can be used to estimate the areal extent of the sources.

2.4.2 Perform DQA Using Sample Results. After sampling has been completed, a DQA should be conducted if all composite samples are less than 2 times the SSL. This is necessary to determine if the original CV estimate (2.5), and hence the number of samples collected (6), was adequate for screening surface soils.

To conduct the DQA for a composite sample whose mean is below 2 SSL, first calculate the sample CV for the EA in question from the sample mean ($\bar{x}$), the number of specimens per composite sample (C), and sample standard deviation (s) as follows:

$$CV = \frac{\sqrt{C}\, s}{\bar{x}} \quad .$$

Use the sample size table in Exhibit 7 to check, for this CV, whether the sample size is adequate to meet the DQOs for the sampling effort. If sampling DQOs are not met, supplementary sampling may be needed to achieve DQOs.

However, for EAs with small sample means (e.g., all composites are less than the SSL), the sample CV calculated using the equation above may not be a reliable estimate of the population CV (i.e., as $\bar{x}$ approaches zero, the sample CV will approach infinity). To protect against unnecessary additional sampling in such cases, compare all composites against the formula SSL $/\sqrt{C}$. If the maximum composite sample concentration is below the value given by the equation, then the sample size may be assumed to be adequate and no further DQA is necessary. In other words, EPA believes that the default sample size will adequately support walk-away decisions when all composites are well below the SSL. The TBD describes the development of this formula and provides additional information on implementing the DQA process.

2.4.3 Revise the CSM. Because these analyses reveal new information about the site, update the CSM accordingly. This revision could include identification of site areas that exceed the generic SSLs.

2.5 Step 5: Calculating Site-specific SSLs

With the soil properties data collected in Step 4 of the screening process, site-specific soil screening levels can now be calculated using the equations presented in this section. For a description of how these equations were developed, as well as background on their assumptions and limitations, consult the TBD.

All SSL equations were developed to be consistent with RME in the residential setting. The Superfund program estimates the RME for chronic exposures on a site-specific basis by combining an average exposure-point concentration with reasonably conservative values for intake and duration (U.S. EPA, 1989a; RAGS HHEM, *Supplemental Guidance: Standard Default Exposure Factors*, U.S. EPA, 1991a). Thus, all site-specific parameters (soil, aquifer, and meteorologic parameters) used to calculate SSLs should reflect average or typical site conditions in order to calculate average exposure concentrations at the site.

Equations for calculating SSLs are presented for surface and subsurface soils in the following sections. **For each equation, site-specific input parameters are highlighted in bold and default values are provided for use when site-specific data are not available.** Although these defaults are not worst case, they are conservative. At most sites, higher, but still protective SSLs can be calculated using site-specific data. The TBD describes development of these default values and presents generic SSLs calculated using the default values.

Attachment D provides toxicity criteria for 110 chemicals commonly found at NPL sites. These criteria were obtained from Integrated Risk Information System (IRIS) (U.S. EPA, 1995b) or Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1995a), which are regularly

updated. **Prior to calculating SSLs at a site, check all relevant chemical-specific values in Attachment D against values from IRIS or HEAST. Only the most current values should be used to calculate SSLs.**

Where toxicity values have been updated, the generic SSLs should also be recalculated with current toxicity information.

2.5.1 SSL Equations--Surface Soils.

Exposure pathways addressed in the process for screening surface soils include direct ingestion, dermal contact, and inhalation of fugitive dusts.

Direct Ingestion. The Soil Screening Guidance addresses chronic exposure to noncarcinogens and carcinogens through direct ingestion of contaminated soil in a residential setting. The approach for calculating noncarcinogenic SSLs presented in this guidance leads to screening levels that are approximately 3 times more conservative than PRGs calculated based on the approach presented in RAGS HHEM, Part B (i.e., using a 30-year, time-weighted average soil ingestion rate for comparison to chronic toxicity criteria). Because a number of studies have shown that inadvertent ingestion of soil is common among children age 6 and younger (Calabrese et al., 1989; Davis et al., 1990: Van Wijnen et al., 1990), several commenters suggested that screening values should be based on this increased exposure during childhood. However, other commenters believe that comparing a six-year exposure to a chronic reference dose (RfD) is unnecessarily conservative. In their analysis of this issue, the Science Advisory Board (SAB) stated that, for most chemicals, the approach of combining the higher six-year exposure for children with chronic toxicity criteria is overly protective (U.S. EPA, 1993f). However, they noted that the approach may be appropriate for chemicals with chronic RfDs based on toxic endpoints that are specific to children (e.g., fluoride and nitrates) or where the dose-response curve is steep [i.e., the difference between the no-observed-adverse-effect level (NOAEL) and the adverse effect level is small]. Thus for the purposes of screening, Office of Emergency Remedial Response (OERR) opted to base the generic SSLs for noncarcinogenic contaminants on the more conservative "childhood only" exposure (Equation 1). The issue of whether to maintain this more conservative approach throughout the Baseline Risk Assessment and establishing remediation goals will depend on how the specific chemical's toxicology relates to the issues raised by the SAB.

Equation 1: Screening Level Equation for Ingestion of Noncarcinogenic Contaminants in Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{THQ \times BW \times AT \times 365\ d/yr}{1/RfD_o \times 10^{-6}\ kg/mg \times EF \times ED \times IR}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	15
AT/averaging time (yr)	6[a]
RfD_o/oral reference dose (mg/kg-d)	chemical-specific (Attachment D)
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	6
IR/soil ingestion rate (mg/d)	200

[a] For noncarcinogens, averaging time equals to exposure duration.

For carcinogens, both the magnitude and duration of exposure are important. Duration is critical because the toxicity criteria are based on "lifetime average daily dose." Therefore, the total dose received, whether it be over 5 years or 50 years, is averaged over a lifetime of 70 years. To be protective of exposures to carcinogens in the residential setting, Superfund focuses on exposures to individuals who may live in the same residence for a high-end period of time (e.g., 30 years) because exposure to soil is higher during childhood and decreases with age. Equation 2 uses a time-weighted average soil ingestion rate for children and adults. The derivation of this time-weighted average is presented in U.S. EPA, 1991c.

Default values are used for all input parameters in the direct ingestion equations. The amount of data required to derive site-specific values for these parameters (e.g., soil ingestion rates, chemical-specific bioavailability) makes their collection and use impracticable for screening. Therefore, site-specific data are not generally available for this

exposure route. The generic ingestion SSLs presented in Appendix A of the TBD are recommended for all NPL sites.

Equation 2: Screening Level Equation for Ingestion of Carcinogenic Contaminants in Residential Soil	
Screening Level (mg/kg) = $\frac{TR \times AT \times 365\ d/yr}{SF_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil/adj}}$	
Parameter/Definition (units)	**Default**
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (yr)	70
SF_o /oral slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (Attachment D)
EF/exposure frequency (d/yr)	350
$IF_{soil/adj}$ /age-adjusted soil ingestion factor (mg-yr/kg-d)	114

Dermal Contact. Contaminant absorption through dermal contact may contribute risk to human health in a residential setting. However, incorporation of dermal exposures into the soil screening process is limited by the amount of data available to quantify dermal absorption from soil for specific chemicals. Previous EPA studies suggest that absorption via the dermal route must be greater than 10 percent to equal or exceed the ingestion exposure (assuming 100 percent absorption of a chemical via ingestion; *Dermal Exposure Assessment: Principles and Applications*, U.S. EPA, 1992b).

Of the 110 compounds evaluated, available data show greater than 10 percent dermal absorption for **pentachlorophenol** (Wester et al., 1993). Therefore, pentachlorophenol is the only chemical for which the Soil Screening Guidance directly considers dermal exposure. The ingestion SSL for pentachlorophenol should be divided in half to account for the assumption that exposure via the dermal route is equivalent to the ingestion route. Preliminary studies show that certain semivolatile compounds (e.g., benzo(*a*)pyrene) may also be of concern for this exposure route. As adequate dermal absorption data are developed for such chemicals, the ingestion SSLs may need to be adjusted. The Agency will provide updates on this issue as appropriate.

Inhalation of Fugitive Dusts. Inhalation of fugitive dusts is a consideration for semivolatile organics and metals in surface soils. However, generic fugitive dust SSLs for semivolatile organics are several orders of magnitude higher than the corresponding generic ingestion SSLs. EPA believes that since the ingestion route should always be considered in screening decisions for surface soils, and ingestion SSLs appear to be adequately protective for inhalation exposures to fugitive dusts for organic compounds, the fugitive dust exposure route need not be routinely considered for organic chemicals in surface soils.

Likewise, the ingestion SSLs are significantly more conservative than most of the generic fugitive dust SSLs. As a result, fugitive dust SSLs need not be calculated for most metals. However, chromium is an exception. For chromium, the generic fugitive dust SSL is below the ingestion SSL. This is due to the carcinogenicity of hexavalent chromium, Cr^{+6}, through the inhalation exposure route. For most sites, fugitive dust SSLs calculated using the conservative defaults will be adequately protective. However, if site conditions that will result in higher fugitive dust emissions than the defaults (e.g., dry, dusty soils; high average annual windspeeds; vegetative cover less than 50 percent) are likely, consider calculating a site-specific fugitive dust SSL.

Equations 3 and 4 are used to calculate fugitive dust SSLs for carcinogens and noncarcinogens. These equations require calculation of a particulate emission factor (PEF, Equation 5) that relates the concentration of contaminant in soil to the concentration of dust particles in air. This PEF represents an annual average emission rate based on wind erosion that should be compared with chronic health criteria. It is **not** appropriate for evaluating the potential for more acute exposures.

Both the emissions portion and the dispersion portion of the PEF equation have been updated since the first publication of RAGS HHEM, Part B, in 1991. As in Part B, the emissions part of the PEF equation is based on the "unlimited reservoir" model developed to estimate particulate emissions due to wind erosion (Cowherd et al., 1985). Additional information on the update of the PEF equation is provided in the TBD. Cowherd et al. (1985) present methods for site-specific measurement of the

parameters necessary to calculate a PEF. A site-specific dispersion model (Q/C) is then selected as described in the section on calculating SSLs for the volatile inhalation pathway later in this document.

Equation 3: Screening Level Equation for Inhalation of Carcinogenic Fugitive Dusts from Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{URF \times 1{,}000\ \mu g/mg \times EF \times ED \times \frac{1}{PEF}}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (yr)	70
URF/inhalation unit risk factor $(\mu g/m^3)^{-1}$	chemical-specific (Attachment D)
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
PEF/particulate emission factor (m^3/kg)	**1.32×10^9 (Equation 5)**

Equation 4: Screening Level Equation for Inhalation of Noncarcinogenic Fugitive Dusts from Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{THQ \times AT \times 365\ d/yr}{EF \times ED \times \left[\frac{1}{RfC} \times \frac{1}{PEF}\right]}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
AT/averaging time (yr)	30
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
RfC/inhalation reference concentration (mg/m^3)	chemical-specific (Attachment D)
PEF/particulate emission factor (m^3/kg)	**1.32×10^9 (Equation 5)**

2.5.2 SSL Equations--Subsurface Soils.

The Soil Screening Guidance addresses two exposure pathways for subsurface soils: inhalation of volatiles and ingestion of ground water contaminated by the migration of contaminants through soil to an underlying potable aquifer. Because the equations developed to calculate SSLs for these pathways assume an infinite source, they can violate mass-balance considerations, especially for small sources.

Equation 5: Derivation of the Particulate Emission Factor

$$PEF\ (m^3/kg) = Q/C \times \frac{3{,}600\ s/h}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)}$$

Parameter/Definition (units)	Default
PEF/particulate emission factor (m^3/kg)	1.32×10^9
Q/C/inverse of mean conc. at center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	**90.80**
V/fraction of vegetative cover (unitless)	**0.5 (50%)**
U_m/mean annual windspeed (m/s)	**4.69**
U_t/equivalent threshold value of windspeed at 7 m (m/s)	**11.32**
F(x)/function dependent on U_m/U_t derived using Cowherd et al. (1985) (unitless)	**0.194**

To address this concern, the guidance also includes equations for calculating mass-limit SSLs for each of these pathways **when the size (i.e., area and depth) of the contaminated soil source is known or can be estimated with confidence.**

Attachment D provides the toxicity criteria and regulatory benchmarks for 110 chemicals commonly found at NPL sites. These criteria were obtained from IRIS (U.S. EPA, 1995b), HEAST (U.S. EPA, 1995a), and *Drinking Water Regulations and Health Advisories* (U.S. EPA, 1995c), which are regularly updated. **Prior to calculating SSLs at a site, all relevant chemical-specific values in Attachment D should be checked against the most recent version of their sources to ensure that they are up to date.**

Toxicity data are not available for all chemicals for the inhalation exposure route. At the request of commenters, EPA has looked into methods for extrapolating inhalation toxicity values from oral toxicity data. The TBD presents the results of this analysis along with information on current EPA

practices for conducting such route-to-route extrapolations.

Chemical properties necessary to calculate SSLs for the inhalation and migration to ground water pathways include solubility, air and water diffusivities, Henry's law constant, and soil/water partition coefficients. Attachment C provides values for 110 chemicals commonly found at NPL sites.

Site-specific parameters necessary to calculate SSLs for subsurface soils are listed on Exhibit 10, along with recommended sources and measurement methods. In addition to the soil parameters described in Step 3, other site-specific input parameters include soil moisture, infiltration rate, aquifer parameters, and meteorologic data. Guidance for collecting or estimating these other parameters at a site is provided on Exhibit 10 and in Attachment A.

Inhalation of Volatiles. Equations 6 and 7 are used to calculate SSLs for the inhalation of carcinogenic and noncarcinogenic volatile contaminants.To use these equations to calculate inhalation SSLs, a volatilization factor (VF) must be calculated.

The VF equation can be broken into two separate models: a model to estimate the emissions and a dispersion model (reduced to the term Q/C) that simulates the dispersion of contaminants in ambient air. In addition, a soil saturation limit (C_{sat}) must be calculated to ensure that the VF model is applicable to soil contaminant conditions at a site.

Volatilization Factor (VF). The soil-to-air VF (Equation 8) is used to define the relationship between the concentration of the contaminant in soil and the flux of the volatilized contaminant to air. **The Soil Screening Guidance replaces the Hwang and Falco (1986) model used as the basis for the RAGS HHEM, Part B, VF equation with the simplified equation developed by Jury et al. (1984)**.

The Jury model calculates the maximum flux of a contaminant from contaminated soil and considers soil moisture conditions in calculating a VF. The models are similar in their assumptions of an infinite contaminant source and vapor phase diffusion as the only transport mechanism (i.e., no transport takes place via nonvapor-phase diffusion and there is no mass flow due to capillary action). In some situations, information about the size of the source is available and SSLs can be calculated using the mass-limit approach.

Equation 6: Screening Level Equation for Inhalation of Carcinogenic Volatile Contaminants in Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{URF \times 1{,}000\ \mu g/mg \times EF \times ED \times \frac{1}{VF}}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (yr)	70
URF/inhalation unit risk factor $(\mu g/m^3)^{-1}$	chemical-specific (Attachment D)
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
VF/soil-to-air volatilization factor (m^3/kg)	**chemical-specific (Equation 8)**

Equation 7: Screening Level Equation for Inhalation of Noncarcinogenic Volatile Contaminants in Residential Soil

$$\text{Screening Level (mg/kg)} = \frac{THQ \times AT \times 365\ d/yr}{EF \times ED \times \left[\frac{1}{RfC} \times \frac{1}{VF}\right]}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
AT/averaging time (yr)	30
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
RfC/inhalation reference concentration (mg/m^3)	chemical-specific (Attachment D)
VF/soil-to-air volatilization factor (m^3/kg)	**chemical-specific (Equation 8)**

Other than initial soil concentration, air-filled soil porosity is the most significant soil parameter affecting the final steady-state flux of volatile contaminants from soil (U.S. EPA, 1980). In other words, the higher the air-filled soil porosity, the greater the emission flux of volatile constituents.

Exhibit 10. Site-specific Parameters for Calculating Subsurface SSLs

Parameter	SSL Pathway: Inhalation	SSL Pathway: Migration to ground water	Data source	Method
Source Characteristics				
Source area (A)	●		Sampling data	Measure total area of contaminated soil
Source length (L)		●	Sampling data	Measure length of source parallel to ground water flow
Source depth	●	●	Sampling data	Measure depth of contamination or use conservative assumption
Soil Characteristics				
Soil texture	❍	❍	Lab measurement	Particle size analysis (Gee & Bauder, 1986) and USDA classification; used to estimate θ_w & I
Dry soil bulk density (ρ_b)	●	●	Field measurement	All soils: ASTM D 2937; shallow soils: ASTM D 1556, ASTM D 2167, ASTM D 2922
Soil moisture content (w)	❍	❍	Lab measurement	ASTM D 2216; used to estimate dry soil bulk density
Soil organic carbon (f_{oc})	●	●	Lab measurement	Nelson and Sommers (1982)
Soil pH	❍	❍	Field measurement	McLean (1982); used to select pH-specific K_{oc} (ionizable organics) and K_d (metals)
Moisture retention exponent (b)	❍	❍	Look-up	Attachment A; used to calculate θ_w
Saturated hydraulic conductivity (K_s)	❍	❍	Look-up	Attachment A; used to calculate θ_w
Avg. soil moisture content (θ_w)	●	●	Calculated	Attachment A
Meteorological Data				
Air dispersion factor (Q/C)	●		Q/C table (Table 5)	Select value corresponding to source area, climatic zone, and city with conditions similar to site
Hydrogeologic Characteristics (DAF)				
Hydrogeologic setting		❍	Conceptual site model	Place site in hydrogeologic setting from Aller et al. (1987) for estimation of parameters below (see Attachment A)
Infiltration/recharge (I)		●	HELP model; Regional estimates	HELP (Schroeder et al., 1984) may be used for site-specific infiltration estimates; recharge estimates also may be taken from Aller et al. (1987) or may be estimated from knowledge of local meteorologic and hydrogeologic conditions
Hydraulic conductivity (K)		●	Field measurement; Regional estimates	Aquifer tests (i.e., pump tests, slug tests) preferred; estimates also may be taken from Aller et al. (1987) or Newell et al. (1990) or may be estimated from knowledge of local hydrogeologic conditions
Hydraulic gradient (i)		●	Field measurement; Regional estimates	Measured on map of site's water table (preferred); estimates also may be taken from Newell et al. (1990) or may be estimated from knowledge of local hydrogeologic conditions
Aquifer thickness (d)		●	Field measurement; Regional estimates	Site-specific measurement (i.e., from soil boring logs) preferred; estimates also may be taken from Newell et al. (1990) or may be estimated from knowledge of local hydrogeologic conditions

● Indicates parameters used in the SSL equations.
❍ Indicates parameters/assumptions needed to estimate SSL equation parameters.

Equation 8: Derivation of the Volatilization Factor

$$VF\ (m^3/kg) = \frac{Q/C \times (3.14 \times D_A \times T)^{1/2} \times 10^{-4}\ (m^2/cm^2)}{(2 \times \rho_b \times D_A)}$$

where

$$D_A = \frac{[(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter/Definition (units)	Default
VF/volatilization factor (m^3/kg)	--
D_A /apparent diffusivity (cm^2/s)	--
Q/C/inverse of the mean conc. at the center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	**68.81**
T/exposure interval (s)	9.5×10^8
ρ_b/dry soil bulk density (g/cm3)	**1.5**
θ_a /air-filled soil porosity (L_{air}/L_{soil})	n - θ_w
n/total soil porosity (L_{pore}/L_{soil})	1 - (ρ_b /ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	**0.15**
ρ_s /soil particle density (g/cm^3)	2.65
D_i /diffusivity in air (cm^2/s)	chemical-specific[a]
H′/dimensionless Henry's law constant	chemical-specific[a]
D_w /diffusivity in water (cm^2/s)	chemical-specific[a]
K_d /soil-water partition coefficient (cm^3/g) = K_{oc} f_{oc} (organics)	chemical-specific[a]
K_{oc} /soil organic carbon partition coefficient (cm^3/g)	chemical-specific[a]
f_{oc}/fraction organic carbon in soil (g/g)	**0.006 (0.6%)**

[a]See Attachment C.

Among the soil parameters used in Equation 8, annual average water-filled soil porosity (θ_w) has the most significant effect on air-filled soil porosity (θ_a) and hence volatile contaminant emissions. Sensitivity analyses have shown that soil bulk density (ρ_b) has too limited a range for surface soils (generally between 1.3 and 1.7 g/cm^3) to affect results with nearly the significance of soil moisture content (U.S. EPA, 1996).

Dispersion Model (Q/C). The box model in RAGS HHEM, Part B has been replaced with a Q/C term derived from the modeling exercise using the AREA-ST model incorporated into EPA's Industrial Source Complex Model (ISC2) platform. The AREA-ST model was run with a full year of meteorological data for 29 U.S. locations selected to be representative of a range of meteorologic conditions across the Nation (EQ, 1993). The results of these modeling runs are presented in Exhibit 11 for square area sources of 0.5 to 30 acres in size. When developing a site-specific VF for the inhalation pathway, place the site into a climatic zone (see Attachment B). Then select a Q/C value from Exhibit 11 that best represents a site's size and meteorological conditions.

Soil Saturation Limit (C_{sat}). The soil saturation limit (Equation 9) is the contaminant concentration at which soil pore air and pore water are saturated with the chemical and the adsorptive limits of the soil particles have been reached. Above this concentration, the contaminant may be present in free phase. C_{sat} concentrations represent an upper limit to the applicability of the SSL VF model because a basic principle of the model (Henry's law) does not apply when contaminants are present in free phase. VF-based inhalation SSLs are reliable only if they are at or below C_{sat}.

Equation 9 is used to calculate the soil saturation limit for each organic chemical in site soils. As an update to RAGS HHEM, Part B, this equation takes into account the amount of contaminant that is in the vapor phase in the pore spaces of the soil in addition to the amount dissolved in the soil's pore water and sorbed to soil particles. C_{sat} values should be calculated using the same site-specific soil characteristics used to calculate SSLs (e.g., bulk density, average water content, and organic carbon content). Because VF-based SSLs are not accurate for soil concentrations above C_{sat}, these SSLs should be compared to C_{sat} concentrations before they are used for soil screening.

Exhibit 11. Q/C Values by Source Area, City, and Climatic Zone

	Q/C (g/m^2-s per kg/m^3)					
	0.5 Acre	1 Acre	2 Acre	5 Acre	10 Acre	30 Acre
Zone I						
Seattle	82.72	72.62	64.38	55.66	50.09	42.86
Salem	73.44	64.42	57.09	49.33	44.37	37.94
Zone II						
Fresno	62.00	54.37	48.16	41.57	37.36	31.90
Los Angeles	68.81	60.24	53.30	45.93	41.24	35.15
San Francisco	89.51	78.51	69.55	60.03	53.95	46.03
Zone III						
Las Vegas	95.55	83.87	74.38	64.32	57.90	49.56
Phoenix	64.04	56.07	49.59	42.72	38.35	32.68
Albuquerque	84.18	73.82	65.40	56.47	50.77	43.37
Zone IV						
Boise	69.41	60.88	53.94	46.57	41.87	35.75
Winnemucca	69.23	60.67	53.72	46.35	41.65	35.55
Salt Lake City	78.09	68.47	60.66	52.37	47.08	40.20
Casper	100.13	87.87	77.91	67.34	60.59	51.80
Denver	75.59	66.27	58.68	50.64	45.52	38.87
Zone V						
Bismark	83.39	73.07	64.71	55.82	50.16	42.79
Minneapolis	90.80	79.68	70.64	61.03	54.90	46.92
Lincoln	81.64	71.47	63.22	54.47	48.89	41.65
Zone VI						
Little Rock	73.63	64.51	57.10	49.23	44.19	37.64
Houston	79.25	69.47	61.53	53.11	47.74	40.76
Atlanta	77.08	67.56	59.83	51.62	46.37	39.54
Charleston	74.89	65.65	58.13	50.17	45.08	38.48
Raleigh-Durham	77.26	67.75	60.01	51.78	46.51	39.64
Zone VII						
Chicago	97.78	85.81	76.08	65.75	59.16	50.60
Cleveland	83.22	73.06	64.78	55.99	50.38	43.08
Huntington	53.89	47.24	41.83	36.10	32.43	27.67
Harrisburg	81.90	71.87	63.72	55.07	49.56	42.40
Zone VIII						
Portland	74.23	65.01	57.52	49.57	44.49	37.88
Hartford	71.35	62.55	55.40	47.83	43.00	36.73
Philadelphia	90.24	79.14	70.14	60.59	54.50	46.59
Zone IX						
Miami	85.61	74.97	66.33	57.17	51.33	43.74

Equation 9: Derivation of the Soil Saturation Limit	
$C_{sat} = \frac{S}{\rho_b} (K_d \rho_b + \theta_w + H' \theta_a)$	
Parameter/Definition (units)	**Default**
C_{sat}/soil saturation concentration (mg/kg)	--
S/solubility in water (mg/L-water)	chemical-specific[a]
ρ_b/dry soil bulk density (kg/L)	**1.5**
K_d /soil-water partition coefficient (L/kg)	$K_{oc} \times f_{oc}$ (chemical-specific[a])
K_{oc} /soil organic carbon/water partition coefficient (L/kg)	chemical-specific[a]
f_{oc}/fraction organic carbon in soil (g/g)	**0.006 (0.6%)**
θ_w/water-filled soil porosity (L_{water}/L_{soil})	**0.15**
H′/dimensionless Henry's law constant	chemical-specific[a]
θ_a /air-filled soil porosity (L_{air}/L_{soil})	$n - \theta_w$
n/total soil porosity (L_{pore}/L_{soil})	$1 - (\rho_b / \rho_s)$
ρ_s /soil particle density (kg/L)	2.65

[a]See Attachment C.

C_{sat} values represent chemical-physical limits in soil and are not risk based. However, since they represent the concentration at which soil pore air is saturated with a contaminant, volatile emissions reach their maximum at C_{sat}. In other words, at C_{sat} the emission flux from soil to air for a chemical reaches a plateau. Volatile emissions will not increase above this level no matter how much more chemical is added to the soil. Chemicals with VF-based SSLs above C_{sat} are not likely to present a significant volatile inhalation risk at any soil concentration. To illustrate this point, the TDB presents an analysis of the inhalation risk levels at C_{sat} for a number of chemicals commonly found at Superfund sites whose generic SSLs (calculated using the default parameters shown in Equation 9) are above C_{sat}.

The analysis indicates that these C_{sat} values are all well below the screening risk targets of a 10^{-6} cancer risk or an HQ of 1.

Although the inhalation risks appear to be negligible, C_{sat} does indicate a potential for nonaqueous phase liquid (NAPL) to be present in soil and a possible risk to ground water. Thus, EPA believes that further investigation is warranted. Table C-3 (Attachment C) provides the physical state, liquid or solid, of various compounds at ambient soil temperature. When an inhalation SSL exceeds C_{sat} for compounds that are liquid at ambient soil temperature, the SSL is set at C_{sat}. Where soil concentrations exceed a C_{sat}-based SSL, site managers should refer to EPA's guidance, *Estimating the Potential for Occurrence of DNAPL at Superfund Sites* (U.S. EPA, 1992c) for further information on determining the likelihood of dense nonaqueous phase liquid (DNAPL) in the subsurface. Note that free-phase contaminants may be present at concentrations below C_{sat} if multiple organic contaminants are present. The DNAPL guidance (U.S. EPA, 1992c) also provides tools for evaluating the potential for such multiple component mixtures in soil.

For organic compounds that are solid at ambient soil temperature, concentrations above C_{sat} do not pose a significant inhalation risk or a potential for NAPL occurrence. Thus, soil screening decisions should be based on the appropriate SSL for other site pathways (e.g., migration to ground water, direct ingestion).

Migration to Ground Water SSLs. The Soil Screening Guidance uses a simple linear equilibrium soil/water partition equation or a leach test to estimate contaminant release in soil leachate. It also uses a simple water-balance equation to calculate a dilution factor to account for reduction of soil leachate concentration from mixing in an aquifer.

The methodology for developing SSLs for the migration to ground water pathway was designed for use during the early stages of a site evaluation when information about subsurface conditions may be limited. Hence, the methodology is based on rather conservative, simplified assumptions about the release and transport of contaminants in the

subsurface (Exhibit 12). These assumptions are inherent in the SSL equations and should be reviewed for consistency with the conceptual site model (see Step 2) to determine the applicability of SSLs to the migration to ground water pathway.

Exhibit 12: Simplifying Assumptions for the SSL Migration to Ground Water Pathway

- Infinite source (i.e., steady-state concentrations are maintained over the exposure period)
- Uniformly distributed contamination from the surface to the top of the aquifer
- No contaminant attenuation (i.e., adsorption, biodegradation, chemical degradation) in soil
- Instantaneous and linear equilibrium soil/water partitioning
- Unconfined, unconsolidated aquifer with homogeneous and isotropic hydrologic properties
- Receptor well at the downgradient edge of the source and screened within the plume
- No contaminant attenuation in the aquifer
- No NAPLs present (if NAPLs are present, the SSLs do not apply).

To calculate SSLs for the migration to ground water pathway, multiply the acceptable ground water concentration by the dilution factor to obtain a target soil leachate concentration. For example, if the dilution factor is 10 and the acceptable ground water concentration is 0.05 mg/L, the target soil/water leachate concentration would be 0.5 mg/L. Next, the partition equation is used to calculate the total soil concentration (i.e., SSL) corresponding to this soil leachate concentration. Alternatively, if a leach test is used, compare the target soil leachate concentration to extract concentrations from the leach tests.

Equation 10: Soil Screening Level Partitioning Equation for Migration to Ground Water

$$\text{Screening Level in Soil (mg/kg)} = C_w \left[K_d + \frac{(\theta_w + \theta_a H')}{\rho_b} \right]$$

Parameter/Definition (units)	Default
C_w/target soil leachate concentration (mg/L)	nonzero MCLG, MCL, or HBL[a] × dilution factor
K_d/soil-water partition coefficient (L/kg)	chemical-specific[b]
K_{oc} /soil organic carbon/water partition coefficient (L/kg)	$K_{oc} \times f_{oc}$ (organics) chemical-specific[b]
f_{oc} /fraction organic carbon in soil (g/g)	**0.002 (0.2%)**
θ_w/water-filled soil porosity (L_{water}/L_{soil})	**0.3**
θ_a/air-filled soil porosity (L_{air}/L_{soil})	$n - \theta_w$
ρ_b/dry soil bulk density (kg/L)	**1.5**
n/soil porosity (L_{pore}/L_{soil})	$1-(\rho_b/\rho_s)$
ρ_s/soil particle density (kg/L)	2.65
H′/dimensionless Henry's law constant	chemical-specific[b] (assume to be zero for inorganic contaminants except mercury)

[a]Chemical-specific (see Attachment D).

[b]See Attachment C.

Soil/Water Partition Equation. The soil/water partition equation (Equation 10) relates concentrations of contaminants adsorbed to soil organic carbon to soil leachate concentrations in the zone of contamination. It calculates SSLs corresponding to target soil leachate contaminant concentrations (C_w). An adjustment has been added to the equation to relate sorbed concentration in soil to the measured total soil concentration. This adjustment assumes that soil-water, solids, and gas are conserved during sampling. If soil gas is lost during sampling, θ_a should be assumed to be zero. Likewise, for inorganic contaminants except

mercury, there is no significant vapor pressure and H′ may be assumed to be zero.

The use of the soil/water partition equation to calculate SSLs assumes an infinite source of contaminants extending to the top of the aquifer. More detailed models may be used to calculate higher SSLs that are still protective in some situations. For example, contaminants at sites with shallow sources, thick unsaturated zones, degradable contaminants, or unsaturated zone characteristics (e.g., clay layers) may attenuate before they reach ground water. The TBD provides information on the use of unsaturated zone models for soil screening. The decision to use such models should be based on balancing the additional investigative and modeling costs required to apply the more complex models against the cost savings that will result from higher SSLs.

Leach Test. A leach test may be used instead of the soil/water partition equation. In some instances, a leach test may be more useful than the partitioning method, depending on the constituents of concern and the possible presence of RCRA wastes. If this option is chosen, soil parameters are not needed for this pathway. However, a dilution factor must still be calculated. This guidance suggests using the EPA Synthetic Precipitation Leaching Procedure (SPLP, EPA SW-846 Method 1312, U.S. EPA, 1994d). The SPLP was developed to model an acid rain leaching environment and is generally appropriate for a contaminated soil scenario. Like most leach tests, the SPLP may not be appropriate for all situations (e.g., soils contaminated with oily constituents may not yield suitable results). Therefore, apply the SPLP with discretion.

EPA is aware that many leach tests are available for application at hazardous waste sites, some of which may be appropriate in specific situations (e.g., the Toxicity Characteristic Leaching Procedure (TCLP) models leaching in a municipal landfill environment). It is beyond the scope of this document to discuss in detail leaching procedures and the appropriateness of their use.

Stabilization/Solidification of CERCLA and RCRA Wastes (U.S. EPA, 1989b) and the EPA SAB's review of leaching tests (U.S. EPA, 1991b) discuss the application of various leach tests to various waste disposal scenarios. Consult these documents for further information.

See Step 3 for guidance on collecting subsurface soil samples that can be used for leach tests. To ensure adequate precision of leach test results, leach tests should be conducted in triplicate.

Dilution Factor Model. As soil leachate moves through soil and ground water, contaminant concentrations are attenuated by adsorption and degradation. In the aquifer, dilution by clean ground water further reduces concentrations before contaminants reach receptor points (i.e., drinking water wells). This reduction in concentration can be expressed by a dilution attenuation factor (DAF), defined as the ratio of soil leachate concentration to receptor point concentration. The lowest possible DAF is 1, corresponding to the situation where there is no dilution or attenuation of a contaminant (i.e., when the concentration in the receptor well is equal to the soil leachate concentration). On the other hand, high DAF values correspond to a large reduction in contaminant concentration from the contaminated soil to the receptor well.

The Soil Screening Guidance addresses only one of these dilution-attenuation processes: contaminant dilution in ground water. A simple mixing zone equation derived from a water-balance relationship (Equation 11) is used to calculate a site-specific dilution factor. Mixing-zone depth is estimated from Equation 12, which relates it to aquifer thickness along with the other parameters from Equation 11. Mixing zone depth should not exceed aquifer thickness (i.e., use aquifer thickness as the upper limit for mixing zone depth).

Because of the uncertainty resulting from the wide variability in subsurface conditions that affect contaminant migration in ground water, defaults are not provided for the dilution model equations. Instead, a default DAF of 20 has been selected as protective for contaminated soil sources up to 0.5 acre in size. Analyses using the mass-limit models described below suggest that a DAF of 20 may be protective of larger sources as well; however, this hypothesis should be evaluated on a site-specific basis. A discussion of the basis for the default DAF and a description of the mass-limit analysis is found in the TBD. However, since migration to ground

water SSLs are most sensitive to the DAF, site-specific dilution factors should be calculated.

Equation 11: Derivation of Dilution Factor	
$$\text{dilution factor} = 1 + \frac{Kid}{IL}$$	
Parameter/Definition (units)	**Default**
dilution factor (unitless)	**20 (0.5-acre source)**
K/aquifer hydraulic conductivity (m/yr)	
i/hydraulic gradient (m/m)	
I/infiltration rate (m/yr)	
d/mixing zone depth (m)	
L/source length parallel to ground water flow (m)	

Equation 12: Estimation of Mixing Zone Depth
$$d = (0.0112\ L^2)^{0.5} + d_a\ \{1 - \exp[(-LI)/(Kid_a)]\}$$
Parameter/Definition (units)
d/mixing zone depth (m)
L/source length parallel to ground water flow (m)
I/infiltration rate (m/yr)
K/aquifer hydraulic conductivity (m/yr)
i/hydraulic gradient (m/m)
d_a/aquifer thickness (m)

Mass-Limit SSLs. Use of infinite source models to estimate volatilization and migration to ground water can violate mass balance considerations, especially for small sources. To address this concern, the Soil Screening Guidance includes models for calculating mass-limit SSLs for each of these pathways (Equations 13 and 14) that provide a lower limit to SSLs **when the area and depth (i.e., volume) of the source are known or can be estimated reliably.**

A mass-limit SSL represents the level of contaminant in the subsurface that is still protective when the entire volume of contamination either volatilizes or leaches over the 30-year exposure duration and the level of contaminant at the receptor does not exceed the health-based limit.

To use mass-limit SSLs, determine the area and depth of the source, calculate both standard and mass-limit SSLs, compare them for each chemical of concern and select the higher of the two values. Analyze the inhalation and migration to ground water pathways separately.

Equation 13: Mass-Limit Volatilization Factor	
$$VF = Q/C \times \frac{[\,T \times (3.15 \times 10^7\ s/yr)\,]}{(\rho_b \times d_s \times 10^6\ g/Mg)}$$	
Parameter/Definition (units)	**Default**
d_s /average source depth (m)	**site-specific**
T/exposure interval(yr)	30
Q/C/inverse of mean conc. at center of a square source (g/m^2-s per kg/m^3)	**68.81**
ρ_b /dry soil bulk density (kg/L or Mg/m^3)	**1.5**

Equation 14: Mass-Limit Soil Screening Level for Migration to Ground Water	
$$\text{Screening Level in Soil (mg/kg)} = \frac{(C_w \times I \times ED)}{\rho_b \times d_s}$$	
Parameter/Definition (units)	**Default**
C_w/target soil leachate concentration (mg/L)	(nonzero MCLG, MCL, or HBL)[a] × dilution factor
d_s/depth of source (m)	**site-specific**
I/infiltration rate (m/yr)	**0.18**
ED/exposure duration (yr)	70
ρ_b/dry soil bulk density (kg/L)	**1.5**

[a]Chemical-specific, see Attachment D.

Note that Equations 13 and 14 require a site-specific determination of the average depth of contamination in the source. Step 3 provides guidance for conducting subsurface sampling to determine source depth. Where the actual average depth of contamination is uncertain, a conservative estimate should be used (e.g., the maximum possible depth in the unsaturated zone). At many sites, the average water table depth may be used unless there is reason to believe that contamination extends below the water table. In this case SSLs do not apply and

further investigation of the source in question is needed.

Plant Uptake. Consumption of garden fruits and vegetables grown in contaminated residential soils can result in a risk to human health. This exposure pathway applies to both surface and subsurface soils.

The TBD includes an evaluation of the soil-plant-human pathway along with a discussion of the site-specific factors that influence plant uptake and plant contamination concentration. Generic screening levels are calculated for arsenic, cadmium, mercury, nickel, selenium, and zinc based on empirical data on the uptake (i.e., bioconcentration) of these inorganics into plants. In addition, levels of inorganics that have been reported to cause phytotoxicity (Will and Suter, 1994) are presented. Organic compounds are not addressed due to lack of empirical data.

The empirical data indicate that site-specific factors such as soil type, pH, plant type, and chemical form strongly influence the uptake of metals into plants. Where site conditions allow for the mobility and bioavailability of metals, the results of our generic analysis suggest that the soil-plant-human pathway may be of particular concern for sites with soils contaminated with cadmium and arsenic. However, the phytotoxicity of certain metals may limit the amount that can be bioconcentrated in plant tissues. The data on phytotoxicity suggest that, with the exception of arsenic, metal concentrations in soil that are considered toxic to plants are well below the levels that may impact human health through the soil-plant-human pathway. This implies that phytotoxic effects may prevent completion of this pathway for these metals. However, like plant uptake, phytotoxicity is also greatly influenced by the site-specific factors mentioned above. Thus, it is necessary to evaluate on a site-specific basis, the potential bioavailability of certain inorganics for the soil-plant-human pathway and the potential for phytotoxic effects in order to assess possible human health and ecological impacts through plant uptake.

2.5.3 Address Exposure to Multiple Chemicals. The SSLs generally correspond to a 10^{-6} risk level for carcinogens and a hazard quotient of 1 for noncarcinogens. This "target" hazard quotient is used to calculate a soil concentration below which it is unlikely that sensitive populations will experience adverse health effects. The potential for additive effects has not been "built in" to the SSLs through apportionment. For carcinogens, EPA believes that setting a 10^{-6} risk level for individual chemicals and pathways generally will lead to cumulative site risks within the 10^{-4} to 10^{-6} risk range for the combinations of chemicals typically found at NPL sites.

For noncarcinogens, there is no widely accepted risk range, and EPA recognizes that cumulative risks from noncarcinogenic contaminants at a site could exceed the target hazard quotient. However, EPA also recognizes that **noncancer risks should be added only for those chemicals with the same toxic endpoint or mechanism of action.**

Ideally, chemicals would be grouped according to their exact mechanism of action, and effect-specific toxicity criteria would be available for chemicals exhibiting multiple effects. Instead, data are often limited to gross toxicological effects in an organ (e.g., increased liver weight) or an entire organ system (e.g., neurotoxicity), and RfDs/reference concentrations (RfCs) are available for just one of the several possible endpoints of toxicity for a chemical.

Given the currently available criteria, noncarcinogenic contaminants should be grouped according to the critical effect listed as the basis for the RfD/RfC. If more than one chemical detected at a site affects the same target organ/system, SSLs for those chemicals should be divided by the number of chemicals present in the group. Exhibit 13 lists several chemicals with noncarcinogenic affects in the same target organ/system. However, the list is limited, and a toxicologist should be consulted prior to using SSLs on a site-specific basis.

If additive risks are being considered in developing site-specific SSLs for subsurface soils, recognize that, for certain chemicals, SSLs may be based on a "ceiling limit" concentration (C_{sat}) instead of toxicity. Because they are not risk-based, C_{sat}-based SSLs should not be modified to account for additivity.

2.6 Step 6: Comparing Site Soil Contaminant Concentrations to Calculated SSLs

Now that the site-specific SSLs have been calculated for the potential contaminants of concern, compare them with the site contaminant concentrations. At this point, it is reasonable to review the CSM with the actual site data to confirm its accuracy and the overall applicability of the Soil Screening Guidance.

In theory, an exposure area would be screened from further investigation when the true mean of the population of contaminant concentrations falls below the established screening level. However, EPA recognizes that data obtained from sampling and analysis are never perfectly representative and accurate, and that the cost of trying to achieve perfect results would be quite high. Consequently, EPA acknowledges that some uncertainty in data must be tolerated, and focuses on controlling the uncertainty which affects decisions based on those data. Thus, in the Soil Screening Guidance, EPA has developed an approach for surface soils to minimize the chance of incorrectly deciding to:

- Screen out areas when the correct decision would be to investigate further (Type I error); or
- Decide to investigate further when the correct decision would be to screen out the area (Type II error).

The approach sets limits on the probabilities of making such decision errors, and acknowledges that there is a range (i.e., gray region) of contaminant levels around the screening level where the variability in the data will make it difficult to determine whether the exposure area average concentration is actually above or below the screening level. The Type I and Type II decision error rates have been set at 5 percent and 20 percent, respectively, and the gray region has been set between one-half and two times the SSL. By specifying the upper edge of the gray region as twice the SSL, it is possible that exposure areas with mean contaminant concentration values slightly above the SSL may be screened from further study. Commenters have expressed concern that this is not adequately protective for SSLs based on noncarcinogenic effects. However, EPA believes that the approaches taken in this guidance to address chronic exposure to noncarcinogens are conservative enough for the majority of site contaminants (i.e., comparison of the 6 year "childhood only" exposure to the chronic RfD); and, use of maximum composite concentrations provide high coverage of the true population mean (i.e., there is high probability that the value equals or exceeds the true population mean).

Thus, for surface soils, the contaminant concentrations in each composite sample from an exposure area are compared to two times the SSL. Under the Soil Screening Guidance DQOs, areas are screened out from further study when contaminant concentrations in all of the composite samples are less than two times the SSLs. Use of this decision rule (comparing contaminant concentrations to twice the SSL) is appropriate only when the quantity and quality of data are comparable to the levels discussed in this guidance, and the toxicity of the chemical has been evaluated against the criteria presented in Section 2.5.1.

For existing data sets that may be more limited than those discussed in this guidance, the 95 percent upper-confidence limit on the arithmetic mean of contaminant concentrations in surface soils (i.e., the Land method as described in the *Supplemental Guidance to* RAGS*: Calculating the Concentration Term* (U.S. EPA, 1992d) should be used for comparison to the SSLs. The TBD discusses the strengths and weaknesses of using the Land method for making screening decisions.

Exhibit 13: SSL Chemicals with Noncarcinogenic Toxic Effects on Specific Target Organ/System

Target Organ/System	Effect
Kidney	
Acetone	Increased weight; nephrotoxicity
1,1-Dichloroethane	Kidney damage
Cadmium	Significant proteinuria
Chlorobenzene	Kidney effects
Di-*n*-octyl phthalate	Kidney effects
Endosulfan	Glomerulonephrosis
Ethylbenzene	Kidney toxicity
Fluoranthene	Nephropathy
Nitrobenzene	Renal and adrenal lesions
Pyrene	Kidney effects
Toluene	Changes in kidney weights
2,4,5-Trichlorophenol	Pathology
Vinyl acetate	Altered kidney weight
Liver	
Acenaphthene	Hepatotoxicity
Acetone	Increased weight
Butyl benzyl phthalate	Increased liver-to-body weight and liver-to-brain weight ratios
Chlorobenzene	Histopathology
Di-*n*-octyl phthalate	Increased weight; increased SGOT and SGPT activity
Endrin	Mild histological lesions in liver
Ethylbenzene	Liver toxicity
Flouranthene	Increased liver weight
Nitrobenzene	Lesions
Styrene	Liver effects
Toluene	Changes in liver weights
2,4,5-Trichlorophenol	Pathology
Central Nervous System	
Butanol	Hypoactivity and ataxia
Cyanide (amenable)	Weight loss, myelin degeneration
2,4 Dimethylphenol	Prostatration and ataxia
Endrin	Occasional convulsions
2-Methylphenol	Neurotoxicity
Mercury	Hand tremor, memory disturbances
Styrene	Neurotoxicity
Xylenes	Hyperactivity
Adrenal Gland	
Nitrobenzene	Adrenal lesions
1,2,4-Trichlorobenzene	Increased adrenal weights; vacuolization in cortex

Exhibit 13: (continued)

Target Organ/System	Effect
Circulatory System	
Antimony	Altered blood chemistry and myocardial effects
Barium	Increased blood pressure
trans-1,2-Dichloroethene	Increased alkaline phosphatase level
cis-1,2-Dichloroethylene	Decreased hematocrit and hemoglobin
2,4-Dimethylphenol	Altered blood chemistry
Fluoranthene	Hematologic changes
Fluorene	Decreased RBC and hemoglobin
Nitrobenzene	Hematologic changes
Styrene	Red blood cell effects
Zinc	Decrease in erythrocyte superoxide dismutase (ESOD)
Reproductive System	
Barium	Fetotoxicity
Carbon disulfide	Fetal toxicity and malformations
2-Chlorophenol	Reproductive effects
Methoxychlor	Excessive loss of litters
Phenol	Reduced fetal body weight in rats
Respiratory System	
1,2-Dichloropropane	Hyperplasia of the nasal mucosa
Hexachlorocyclopentadiene	Squamous metaplasia
Methyl bromide	Lesions on the olfactory epithelium of the nasal cavity
Vinyl acetate	Nasal epithelial lesions
Gastrointestinal System	
Hexachlorocyclopentadiene	Stomach lesions
Methyl bromide	Epithelial hyperplasia of the forestomach
Immune System	
2,4-Dichlorophenol	Altered immune function
p-Chloroaniline	Nonneoplastic lesions of splenic capsule

Source: U.S. EPA, 1995b, U.S. EPA, 1995a

In this guidance, fewer samples are collected for subsurface soils than for surface soils; therefore, different decision rules apply.

Since subsurface soils are not characterized as well, there is less confidence that the concentrations measured are representative of the entire source. Thus, a more conservative approach to screening is warranted. Because it may not be protective to allow for comparison to values above the SSL, mean contaminant concentrations from each soil boring taken in a source area are compared with the calculated SSLs. Source areas with any mean soil boring contaminant concentration greater than the SSLs generally warrant further consideration. On the other hand, where the mean soil boring contaminant concentrations within a source are all less than the SSLs, that source area is generally screened out.

2.7 Step 7: Addressing Areas Identified for Further Study

The chemicals, exposure pathways, and areas that have been identified for further study become a subject of the RI/FS. The results of the baseline risk assessment conducted as part of the RI/FS will establish the basis for taking remedial action. The threshold for taking action differs from the criteria used for screening. As outlined in *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (U.S. EPA, 1991d), remedial action at NPL sites is generally warranted where cumulative risks for current or future land use exceed 1×10^{-4} for carcinogens or a HQ of 1 for noncarcinogens. The data collected for soil screening are useful in the RI and baseline risk assessment. However, additional data will probably need to be collected during future site investigations.

Once the decision has been made to initiate remedial action, the SSLs can then serve as preliminary remediation goals. This process is referenced in Section 1.2 of this document.

FOR FURTHER INFORMATION

More detailed discussions of the technical background and assumptions supporting the development of the Soil Screening Guidance are presented in the *Soil Screening Guidance*: *Technical Background Document* (U.S. EPA, 1996). For additional copies of this guidance document, the Technical Background Document, or other EPA documents, call the National Technical Information Service (NTIS) at (703) 487-4650 or 1-800-553-NTIS (6847).

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Attachment A

Conceptual Site Model Summary

Attachment A

Conceptual Site Model Summary

Step 1 of the Soil Screening Guidance: User's Guide describes the development of a conceptual site model (CSM) to support the application of soil screening levels (SSLs) at a site. The CSM summary forms at the end of this attachment contain the information necessary to:

- Determine the applicability of SSLs to the site
- Calculate SSLs.

By identifying data gaps, these summary forms will help focus data collection and evaluation on the site-specific development and application of SSLs. The site investigator should use the summary forms during the SSL sampling effort to collect site-specific data and continually update the CSM with new information as appropriate.

The CSM summary forms indicate the information required for determining the applicability of the soil screening process to the site. Forms addressing source characteristics may be photocopied if more than one source is present at a site.

A site map showing contaminated soil sources and exposure areas (EAs) should be attached to the summary. If available, additional pages of other maps, summaries of analytical results, or more detailed descriptions of the site may be attached to the summary.

Form 1. General Site Information

The information included in this form is identical to the first page of the Site Inspection (SI) Data Summary form (page B-3 in *Guidance for Performing Site Inspections Under CERCLA*, U.S. EPA, 1992). However, the form should be updated to reflect any site activities conducted since the SI was completed.

Form 2. Site Characteristics

Form 2 indicates the information necessary to address the migration to ground water pathway and identify subsurface conditions that may limit the applicability of subsurface SSLs.

A hydrogeologic setting is defined as a unit with common hydrogeologic characteristics and therefore common vulnerability to contamination. Each setting provides a composite description of the hydrogeologic factors that control ground water movement and recharge. These factors can be used to make generalizations in the CSM about ground water conditions.

After placing the site into one of Heath's ground water regions (Heath, 1984), consider geologic and geomorphic features of the site and select a generic hydrogeologic setting from Aller et al. (1987) that is most similar to the site. If existing site information is not sufficient to definitively place the site in a setting, it should be possible to narrow the choice to two or three settings that will reduce the range of values necessary to develop SSLs. A copy of the setting diagram from Aller et al. (1987) should be attached to the CSM checklist to provide a general picture of subsurface site conditions.

Ground Water Flow Direction. The direction of ground water flow in the uppermost aquifer underlying each source is needed to determine source length parallel to that flow. If ground water flow direction is unknown or uncertain, assume it is parallel to the longest source dimension.

Aquifer Parameters. Aquifer parameters needed to estimate a site-specific dilution factor include hydraulic conductivity (K), hydraulic gradient (i), and aquifer thickness (d_a). Site-measured values for these parameters are the preferred alternative. Existing site documentation should be reviewed for in situ measurements of aquifer conductivity (i.e., from pump test data), water table maps that can be used to estimate hydraulic gradient, and boring logs that indicate the thickness of the uppermost aquifer. Detailed information on conducting and interpreting aquifer tests can be found in Nielsen (1991).

If site-measured values are not available, hydrogeologic knowledge of regional geologic conditions or measured values in the literature may be sources of reasonable estimates. Values from a similar site in the same region and hydrogeologic setting also may be used, but must be carefully reviewed to ensure that the subsurface conceptual models for the two sites show reasonable agreement. For all of these options, it is critical that the estimates and sources be reviewed by an experienced hydrogeologist knowledgeable of regional hydrogeologic conditions.

A third option is to obtain parameter estimates for the site's hydrogeologic setting from Aller et al. (1987) or from the American Petroleum Institute's (API's) hydrogeologic database (HGDB) (Newell et al., 1989, 1990). Aller et al. (1987) present ranges of values for K and i by hydrogeologic setting. The HGDB contains measured values for these parameters and aquifer depth for a number of sites in each hydrogeologic setting. If HGDB data are used, the median value presented for each setting should be used unless site-specific conditions indicate otherwise. Aquifer parameter values from these sources also can serve as a check of the validity of site-measured values or estimates obtained from other sources.

If outside sources such as Aller et al. (1987) are used to characterize site hydrogeologic conditions, the appropriate references and diagrams should be attached to the CSM checklist.

Infiltration Rate. Infiltration rate is used to calculate SSLs for subsurface soils (see Step 5). The simplest way to estimate infiltration rate (I) is to assume that infiltration is equal to recharge and obtain recharge estimates for the site's hydrogeologic setting from Aller et al. (1987). When using the Aller et al. (1987) estimates the user should recognize that these are estimates of average recharge conditions throughout the setting and site-specific values may differ to some extent. For example, areas within the setting with steeper than average slopes will tend to have lower infiltration rates and areas with flatter than average slopes will tend to have higher infiltration than average. An alternative is to use infiltration rates determined for a better-characterized site in the same hydrogeologic setting and with similar meteorological conditions as the site in question.

A third alternative is use the HELP model. Although HELP was originally written for hydrologic evaluation of landfills (Schroeder et al., 1984), inputs to the HELP program can be modified to estimate infiltration in undisturbed soils in natural settings. The most recent version of HELP and the most recent user's guide and documentation can be obtained by sending an address and two double-sided, high-density, DOS-formatted disks to:

attn. Eunice Burk
U.S. EPA
5995 Center Hill Ave.
Cincinnati, OH 45224
(513) 569-7871.

Meteorologic Parameters. Select a site-specific Q/C value from in the guidance for the volatilization factor (VF) equation or particulate emission factor (PEF) equation to place the site in a climatic zone (Figure A-1).

Several site-specific parameters are required to calculate a PEF if fugitive dusts are of concern at the site (see Step 5 for surface soils). The threshold windspeed at 7 meters above ground surface ($U_{t,7}$) is calculated from source area roughness height and the mode soil aggregate size as described in Cowherd et al. (1985). Mode soil aggregate size refers to the mode diameter of aggregated soil particles measured under field conditions.

Other site-specific variables necessary for calculating the PEF include fraction vegetative cover (V) and the mean annual windspeed (U_m). Fraction vegetative cover is estimated by visual observations of the surface of known or suspected source areas at the site. Mean annual windspeed can be obtained from the National Weather Service surface station nearest to the site.

Form 3. Exposure Pathways and Receptors

Form 3 includes information necessary to determine the applicability of the Soil Screening Guidance to a site (see Step 2 of the User's Guide). This form summarizes the site information necessary to identify and characterize potential exposure pathways and receptors at the site, such as site conditions, relevant exposure scenarios, and the properties of soil contaminants listed on Form 4. Table A-1 provides an example of exposure pathways that are not addressed by the guidance, but have relevance to CSM development.

Table A-1. Example Identification of Exposure Pathways Not Addressed by SSLs

Receptors/ Exposure Pathways	Contaminant Characteristics	Site Conditions
Human / Direct Pathways		
ingestion (acute exposure)	acute health effects (e.g., cyanide, phenol)	residential setting
inhalation - fugitive dusts (acute exposure)	acute health effects	high fugitive dusts (e.g., from soil tillage, heavy traffic on dirt roads; construction)
Human / Indirect Pathways		
consumption of meat or dairy products	bioaccumulation, biomagnification	nearby meat or dairy production
fish consumption	biomagnification	nearby surface waters with recreational or subsistence fishing
Ecological Pathways		
aquatic	aquatic toxicity	nearby surface waters or wetlands
terrestrial	toxicity to terrestrial organisms (e.g., DDT, Hg)	sensitive species on or near site

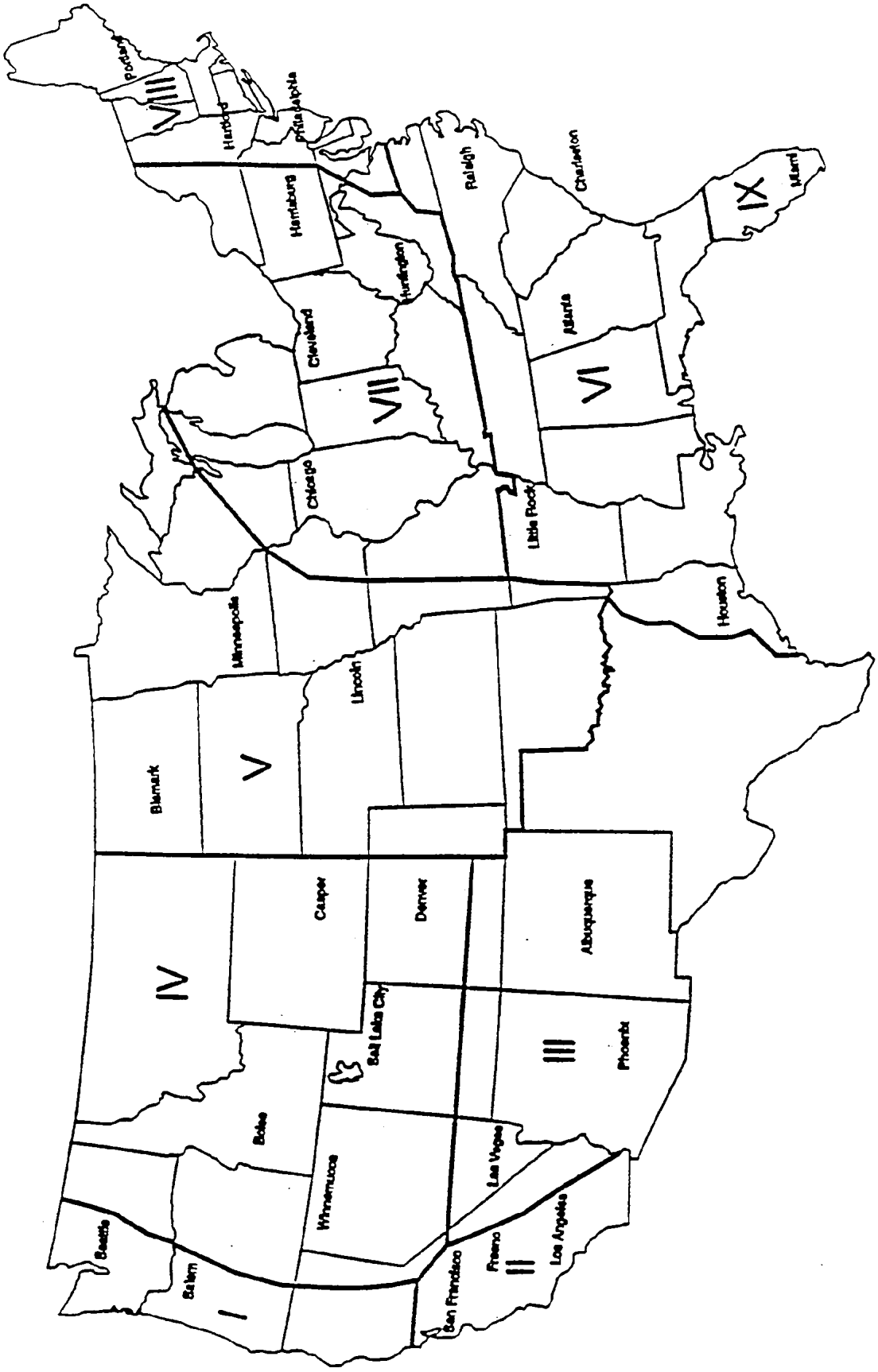

Figure A-1. U.S. climatic zones

Form 4. Soil Contaminant Source Characteristics

This form prompts the investigator to provide information on source characteristics, including soil contaminant levels and the physical and chemical parameters of site soils needed to calculate SSLs. One form should be completed for each contaminated soil source. Initially, the form should be filled out to the greatest extent possible with existing site information collected during CSM development (see Step 1 of the User's Guide). The forms should be updated after the SSL sampling effort is complete.

Measurement of contaminant levels and the soil parameters listed on this form is described in Step 3 of this guidance.

Average soil moisture content (θ_w) defines the fraction of total soil porosity that is filled by water and air. These parameters are necessary for determining the volatilization factor (VF) and the soil saturation limit (C_{sat}) and to apply the soil/water partition equation. It is important that the moisture content used to calculate these parameters represent the annual average soil moisture conditions. Moisture content measurements on discrete soil samples should not be used because they are affected by preceding rainfall events and thus may not represent average conditions. Volumetric average soil water content may be estimated by the following relationship developed by Clapp and Hornberger (1978) and presented in the *Superfund Exposure Assessment Manual* (U.S. EPA, 1988):

$$\theta_w = n\,(I/K_s)^{1/(2b+3)}$$

where

n = total soil porosity (L_{pore}/L_{soil})
I = infiltration rate (m/yr)
K_s = saturated hydraulic conductivity (m/yr)
b = soil-specific exponential parameter (unitless).

Total soil porosity (n) is estimated from dry soil bulk density (ρ_b) as follows:

$$n = 1 - (\rho_b/\rho_s)$$

where

ρ_s = soil particle density = 2.65 kg/L.

Values for K_s and the exponential term 1/(2b+3) are shown in Table A-2 by soil texture class (soil class determination is discussed under Step 3).

Site-specific values for infiltration rate (I) may be estimated using the HELP model or may be assumed to be equivalent to recharge (see Form 2).

Table A-2. Parameter Estimates for Calculating Average Soil Moisture Content (θ_w)

Soil texture	K_s (m/yr)	1/(2b+3)
Sand	1,830	0.090
Loamy sand	540	0.085
Sandy loam	230	0.080
Silt loam	120	0.074
Loam	60	0.073
Sandy clay loam	40	0.058
Silt clay loam	13	0.054
Clay loam	20	0.050
Sandy clay	10	0.042
Silt clay	8	0.042
Clay	5	0.039

Source: U.S. EPA, 1988.

Worksheets

The worksheets following Forms 1 through 4 provide a convenient means of assembling chemical-specific parameters necessary to calculate SSLs for the contaminants of concern (Worksheet 1), existing site data on contaminant concentrations collected during CSM development or the SSL sampling effort (Worksheet 2), and SSLs calculated for EAs (Worksheet 3) or contaminant sources (Worksheet 4) of concern at the site.

CSM Diagram

The CSM diagram is a product of CSM development that represents the linkages among contaminant sources, release mechanisms, exposure pathways and routes, and receptors to summarize the current understanding of the soil contamination problem (see Step 1 of the guidance). An example SSL CSM diagram, Figure A-2 (U.S. EPA, 1989), and a site sketch, Figure A-3 (U.S. EPA, 1987) are provided following the Worksheets.

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Soil Screening Guidance
Conceptual Site Model Summary Forms

Form 1: General Site Information **Site Name** _____

EPA Region_____ Date_____

Contractor Name and Address: _____

_____

_____

State Contact: _____

1. CERCLIS ID No. _____
   Address _____City _____
   County_____ State _____ Zip Code _____ Congressional District_____

2. Owner Name _____Operator Name _____
   Owner Address _____Operator Address_____
   City _____ State _____City _____ State _____

3. Type of ownership (check all that apply):
   ☐ Private ☐ Federal Agency _____ ☐ State ☐ County ☐ Municipal
   Other _____Ref. _____

4. Approximate size of property _____ acres Ref. _____

5. Latitude ___ o___|___ . ___" Longitude ___ o ___ |___ . ___" Ref. _____

6. Site status ☐ Active ☐ Inactive ☐ Unknown Ref. _____

7. Years of operation From_____ To _____ ☐ Unknown Ref. _____

8. Previous investigations

Type	Agency/State/Contractor	Date	
_____	_____	_____	Ref. _____
_____	_____	_____	Ref. _____
_____	_____	_____	Ref. _____
_____	_____	_____	Ref. _____
_____	_____	_____	Ref. _____
_____	_____	_____	Ref. _____

Ref. = reference(s) on information source

Figure A-1. U.S. climatic zones **Site Name** _____

Hydrogeologic Characteristics (migration to ground water pathway)

Is ground water of concern at the site? ☐ yes ☐ no (if no, move to Infiltration Rate below).

Heath region _____ **Hydrogeologic setting** _____

(attach setting diagram)

Check setting characteristics that apply: ☐ karst ☐ fractured rock ☐ solution limestone

Describe the stratigraphy and hydrogeologic characteristics of the site. (Attach available maps and cross-sections.)

_____

_____

_____

_____

Ref._____

Identify and describe nearby sites in similar settings that have already been characterized.

_____

_____

_____

_____

Ref._____

Aquifer Parameters	Unit	Typical	Min.	Max.	Reference or Source
hydraulic conductivity (K)	m/y				
hydraulic gradient (i)	m/m				
thickness (d_a)	m				

General direction of ground water flow across the site (e.g., NNE, SW): _____

(attach map.) Ref. _____

Infiltration rate (I) _____ m/yr Method _____

Meteorological Characteristics (inhalation pathway)

climatological zone: _____ (zone#, city) Q/C _____(g/m^2-s per kg/m^3)

fract. vegetative cover (V)_____ (unitless) Reference _____

mean annual windspeed (U_m)_____ m/s Reference _____

equivalent threshold value of windspeed at 7 m (U_t) _____m/s

fraction dependent on U_m/U_t _____(unitless)

Comments:_____

_____

_____

Soil Screening Guidance
Conceptual Site Model Summary Forms

Form 3: Exposure Pathways and Receptors **Site Name** _____

Land Use Conditions

Current site use:	Surrounding land use:	Future land use:
__ residential	__ residential	__ residential
__ industrial	__ industrial	__ industrial
__ commercial	__ commercial	__ commercial
__ agricultural	__ agricultural	__ agricultural
__ recreational	__ recreational	__ recreational
__ other	__ other	__ other

Size of exposure areas (in acres) _____

Contaminant Release Mechanisms (check all that apply):

Source #___ ☐ leaching ☐ volatilization ☐ fugitive dusts ☐ erosion/runoff ☐ uptake by plants

Source #___ ☐ leaching ☐ volatilization ☐ fugitive dusts ☐ erosion/runoff ☐ uptake by plants

Source #___ ☐ leaching ☐ volatilization ☐ fugitive dusts ☐ erosion/runoff ☐ uptake by plants

(describe rationale for not including any of the above release mechanisms)

_____

_____

_____

Media affected (or potentially affected) by soil contamination.

Source #___ ☐ air ☐ ground water ☐ surface water ☐ sediments ☐ wetlands

Source #___ ☐ air ☐ ground water ☐ surface water ☐ sediments ☐ wetlands

Source #___ ☐ air ☐ ground water ☐ surface water ☐ sediments ☐ wetlands

Check if present on-site or on surrounding land (attach map showing locations)

☐ wetlands ☐ surface water ☐ subsistence fishing ☐ recreational fishing ☐ dairy/beef production

Check SSL exposure pathways applicable at site; describe basis for not including any pathway

☐ ingestion ☐ inhalation ☐ migration to ground water ☐ dermal ☐ soil-plant-human

Check Potential for:

☐ **Acute Effects (describe)**

☐ **Other Human Exposure Pathways (describe)**

☐ **Ecological concerns (describe)**

Form 4: Soil Contaminant Source Characteristics **Site Name**_____

Source No.: _____

Name: _____ (e.g., drum storage area)

Type: _____ (e.g., spill, dump, wood treater)

Location:_____ (site map)

Waste type: _____ (e.g., solvents, waste oil)

Description (describe history of contamination, other information)

_____

_____

_____

_____

_____

Describe past/current remedial or removal actions

_____

_____

_____

_____

_____

Source depth:_____ m (☐ measures ☐ estimated) Ref. _____

Source area: _____ acres _____ m^2 (☐ measures ☐ estimated) Ref. _____

Source length parallel to ground water flow: _____ m (if uncertain, use longest source dimension)

Contaminant types (check all that apply): ☐ volatile organics ☐ other organics ☐ metals ☐ other inorganics

Soil Contaminants Present (list): _____

_____

_____

(attach Worksheet #1)

Describe previous soil analyses. (attach available results and map showing sample locations)

_____

_____

_____

_____

(attach Worksheet #2)

Are NAPLs suspected? ☐ **Yes** ☐ **No** Reason_____

_____

<u>Average Soil Characteristics</u>

average water content (θ_w)_____(L_{water}/L_{soil}) Ref. _____

fraction organic carbon (f_{oc}) _____g/g Ref. _____

dry bulk density (ρ_b) _____(kg/L) Ref. _____

pH _____ Ref. _____

Worksheet 1. Contaminant-specific properties **Site Name** _____

Regulatory and Human Health Benchmarks[1]

Contaminant	CAS #	MCLG, MCL, or HBL (mg/L)	Sources (no.)	RfD (mg/kg/-d)	SF_o $(mg/kg/-d)^{-1}$	URF $(\mu g/m^3)^{-1}$	RfC (mg/m^3)

Chemical Properties[2]

Contaminant	CAS #	Sources (no.)	K_{oc}[3] (L/kg)	K_d[4] (L/kg)	H[5]	D_{ia}[5] (cm^2/s)	D_{iw}[5] (cm^2/s)	S[5] (mg/L)

1. Attachment D
2. Attachment C
3. For organic compounds
4. For metals and inorganic compounds
5. Not applicable to metals except mercury

Worksheet 2. Contaminant concentrations by source **Site Name**_____

Source #:_____

Contaminant	CAS #	average	standard deviation	number of samples	minimum	maximum	variance

Source #:_____

Contaminant	CAS #	average	standard deviation	number of samples	minimum	maximum	variance

Worksheet 3. Surface SSLs by Exposure Area (EA) **Site Name**_____

EA #:_____ **SSL type:** ☐ **site-specific** ☐ **generic (default)**

Contaminant	CAS #	Soil Screening Level	
		ingestion	other (plant uptake; fugitive dust)

EA #:_____ **SSL type:** ☐ **site-specific** ☐ **generic (default)**

Contaminant	CAS #	Soil Screening Level	
		ingestion	other (plant uptake; fugitive dust)

Worksheet 4. Subsurface SSLs by source **Site Name** _____

Source #:_____ **SSL type:** ☐ **site-specific** ☐ **generic (default)**

Contaminant	CAS #	Soil Screening Level	
		inhalation of volatiles	migration to ground water

Source #:_____ **SSL type:** ☐ **site-specific** ☐ **generic (default)**

Contaminant	CAS #	Soil Screening Level	
		inhalation of volatiles	migration to ground water

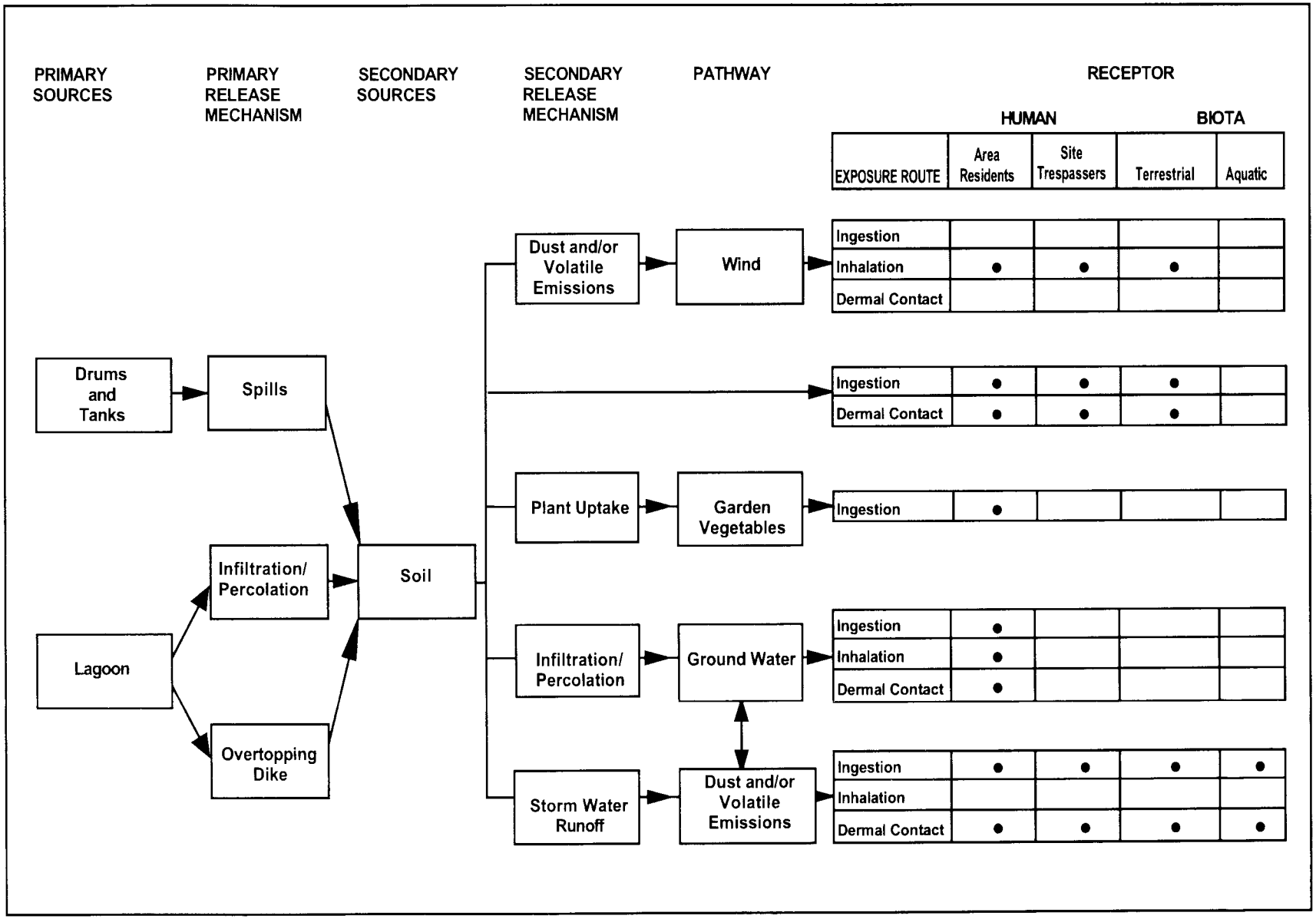

Figure A-2. Example conceptual site model diagram for contaminated soil (adapted from U.S. EPA, 1989).

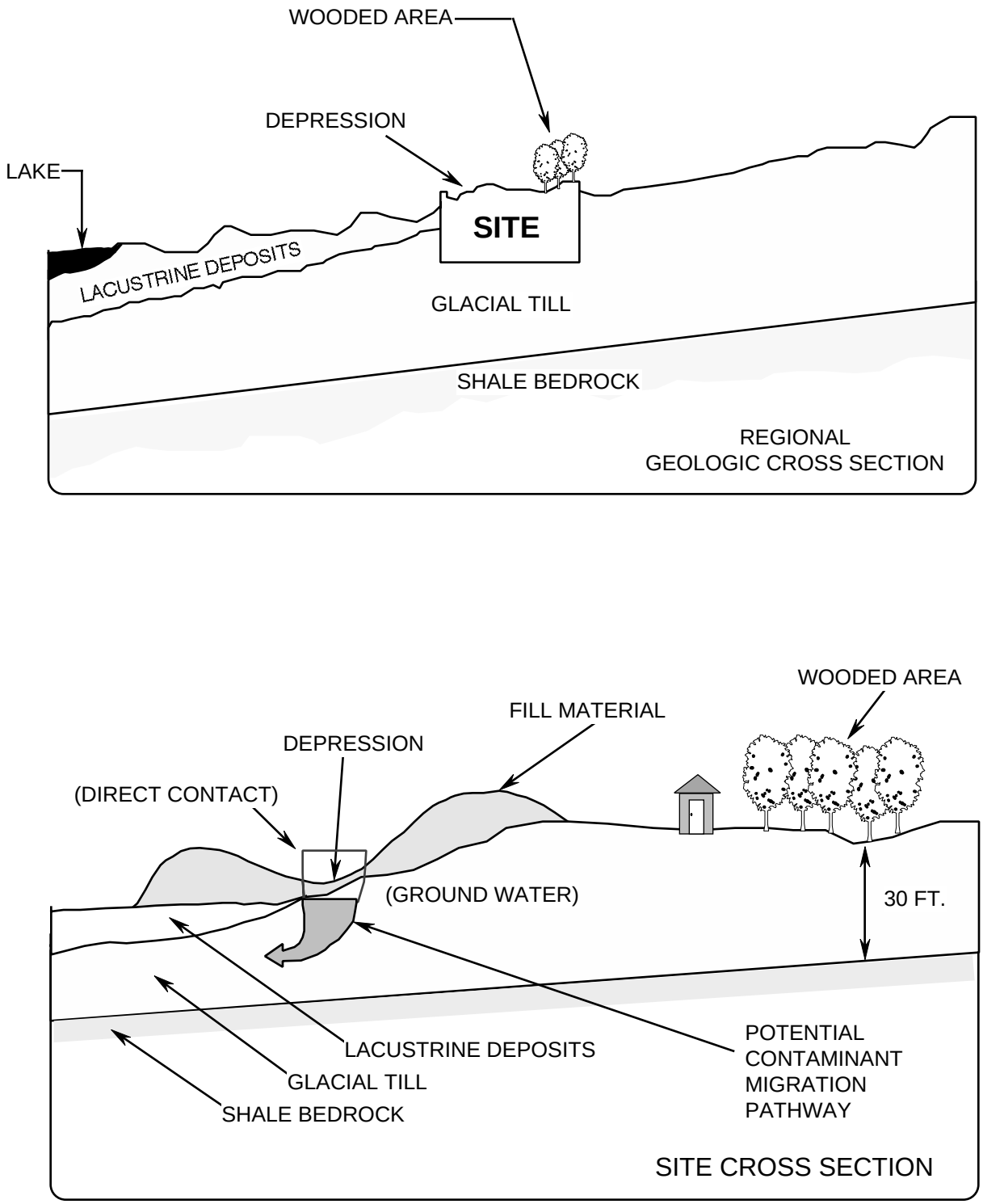

Figure A-3. Example Site Sketch (adapted from U.S. EPA, 1987)

Attachment B

Soil Screening DQOs for Surface Soils and Subsurface Soils

Soil Screening DQOs for Surface Soils Using the Max Test

DQO Process Steps	Soil Screening Inputs/Outputs
State the Problem	
Identify scoping team	Site manager and technical experts (e.g., toxicologists, risk assessors, statisticians)
Develop conceptual site model (CSM)	CSM development (described in Step 1)
Define exposure scenarios	Direct ingestion and inhalation of fugitive particulates in a residential setting; dermal contact and plant uptake for certain contaminants
Specify available resources	Sampling and analysis budget, scheduling constraints, and available personnel
Write brief summary of contamination problem	Summary of the surface soil contamination problem to be investigated at the site
Identify the Decision	
Identify decision	Do mean soil concentrations for particular contaminants (e.g., contaminants of potential concern) exceed appropriate screening levels?
Identify alternative actions	Eliminate area from further study under CERCLA or Plan and conduct further investigation
Identify Inputs to the Decision	
Identify inputs	Ingestion and particulate inhalation SSLs for specified contaminants Measurements of surface soil contaminant concentration
Define basis for screening	Soil Screening Guidance
Identify analytical methods	Feasible analytical methods (both field and laboratory) consistent with program-level requirements
Define the Study Boundaries	
Define geographic areas of field investigation	The entire NPL site, (which may include areas beyond facility boundaries), except for any areas with clear evidence that no contamination has occurred
Define population of interest	Surface soils (usually the top 2 centimeters, but may be deeper where activities could redistribute subsurface soils to the surface)
Divide site into strata	Strata may be defined so that contaminant concentrations are likely to be relatively homogeneous within each stratum based on the CSM and field measurements
Define scale of decision making	Exposure areas (EAs) no larger than 0.5 acre each (based on residential land use)
Define temporal boundaries of study	Temporal constraints on scheduling field visits
Identify practical constraints	Potential impediments to sample collection, such as access, health, and safety issues
Develop a Decision Rule	
Specify parameter of interest	“True mean” (μ) individual contaminant concentration in each EA. However, since the determination of the “true mean” would require the collection and analysis of many samples, another sample statistic, the maximum composite concentration, or “Max Test” is used.
Specify screening level	Screening levels calculated using available parameters and site data (or generic SSLs if site data are unavailable)
Specify "if..., then..." decision rule	Ideally, if the “true mean” EA concentration exceeds the screening level, then investigate the EA further. If the “true mean” is less than the screening level, then no further investigation of the EA is required under CERCLA.

Soil Screening DQOs for Surface Soils Using the Max Test (continued)

DQO Process Steps	Soil Screening Inputs/Outputs
Specify Limits on Decision Errors*	
Define baseline condition (null hypothesis)	The EA needs further investigation
Define the gray region**	From 0.5 SSL to 2 SSL
Define Type I and Type II decision errors	Type I error: Do not investigate further ("walk away from") an EA whose “true mean” exceeds the screening level of 2 SSL Type II error: Investigate further when an EA's “true mean” falls below the screening level of 0.5 SSL
Identify consequences	Type I error: potential public health consequences Type II error: unnecessary expenditure of resources to investigate further
Assign acceptable probabilities of Type I and Type II decision errors	Goals: Type I: 0.05 (5%) probability of not investigating further when “true mean” of the EA is 2 SSL Type II: 0.20 (20%) probability of investigating further when “true mean” of the EA is 0.5 SSL
Define QA/QC goals	CLP precision and bias requirements 10% CLP analyses for field methods
Optimize the Design	
Determine how to best estimate “true mean”	Samples composited across the EA as physical estimates of EA mean ($\bar{x}$). Use maximum composite concentration as a conservative estimate of the true EA mean.
Determine expected variability of EA surface soil contaminant concentrations	A conservatively large expected coefficient of variation (CV) from prior data for the site, field measurements, or data from other comparable sites and expert judgment. A minimum default CV of 2.5 should be used when information is insufficient to estimate the CV.
Design sampling strategy by evaluating costs and performance of alternatives	Lowest cost sampling design option (i.e., compositing scheme and number of composites) that will achieve acceptable decision error rates
Develop planning documents for the field investigation	Sampling and Analysis Plan (SAP) Quality Assurance Project Plan (QAPjP)

* Since the DQO process controls the degree to which uncertainty in data affects the outcome of decisions that are based on that data, specifying limits on decision errors will allow the decision maker to control the probability of making an incorrect decision when using the DQOs.

** The gray region represents the area where the consequences of decision errors are minor, (and uncertainty in sampling data makes decisions too close to call).

Soil Screening DQOs for Subsurface Soils

DQO Process Steps	Soil Screening Inputs/Outputs
State the Problem	
Identify scoping team	Site manager and technical experts (e.g., toxicologists, risk assessors, hydrogeologists, statisticians).
Develop conceptual site model (CSM)	CSM development (described in Step 1).
Define exposure scenarios	Inhalation of volatiles and migration of contaminants from soil to potable ground water (and plant uptake for certain contaminants).
Specify available resources	Sampling and analysis budget, scheduling constraints, and available personnel.
Write brief summary of contamination problem	Summary of the subsurface soil contamination problem to be investigated at the site.
Identify the Decision	
Identify decision	Do mean soil concentrations for particular contaminants (e.g., contaminants of potential concern) exceed appropriate SSLs?
Identify alternative actions	Eliminate area from further action or study under CERCLA or Plan and conduct further investigation.
Identify Inputs to the Decision	
Identify decision	Volatile inhalation and migration to ground water SSLs for specified contaminants Measurements of subsurface soil contaminant concentration
Define basis for screening	Soil Screening Guidance
Identify analytical methods	Feasible analytical methods (both field and laboratory) consistent with program-level requirements.
Specify the Study Boundaries	
Define geographic areas of field investigation	The entire NPL site (which may include areas beyond facility boundaries), except for any areas with clear evidence that no contamination has occurred.
Define population of interest	Subsurface soils
Define scale of decision making	Sources (areas of contiguous soil contamination, defined by the area and depth of contamination or to the water table, whichever is more shallow).
Subdivide site into decision units	Individual sources delineated (area and depth) using existing information or field measurements (several nearby sources may be combined into a single source).
Define temporal boundaries of study	Temporal constraints on scheduling field visits.
Identify (list) practical constraints	Potential impediments to sample collection, such as access, health, and safety issues.

Soil Screening DQOs for Subsurface Soils (continued)

Develop a Decision Rule	
Specify parameter of interest	Mean soil contaminant concentration in a source (i.e., discrete contaminant concentrations averaged within each boring).
Specify screening level	SSLs calculated using available parameters and site data (or generic SSLs if site data are unavailable).
Specify “if..., then...” decision rule	If the mean soil concentration exceeds the SSL, then investigate the source further. If mean soil concentration in a source is less than the SSL, then no further investigation is required under CERCLA.
Specify Limits on Decision Errors	
Define QA/QC goals	CLP precision and bias requirements 10% CLP analyses for field methods
Optimize the Design	
Determine how to estimate mean concentration in a source	For each source, the highest mean soil boring concentration (i.e., depth-weighted average of discrete contaminant concentrations within a boring).
Define subsurface sampling strategy by evaluating costs and site-specific conditions	Number of soil borings per source area; number of sampling intervals with depth.
Develop planning documents for the field investigation	Sampling and Analysis Plan (SAP) Quality Assurance Project Plan (QAPjP)

Attachment C

Chemical Properties for SSL Development

Attachment C

Chemical Properties

This attachment provides the chemical properties necessary to calculate inhalation and migration to ground water SSLs (see Section 2.5.2) for 110 chemicals commonly found at Superfund sites. The *Technical Background Document for Soil Screening Guidance* describes the derivation and sources for these property values.

- Table C-1 provides soil organic carbon - water partition coefficients (K_{oc}), air and water diffusivities ($D_{i,a}$ and $D_{i,w}$), water solubilities (S), and dimensionless Henry's law constants (H').

- Table C-2 provides pH-specific K_{oc} values for organic contaminants that ionize under natural pH conditions. Site-specific soil pH measurements (see Section 2.3.5) can be used to select appropriate K_{oc} values for these chemicals. Where site-specific soil pH values are not available, values corresponding to a pH or 6.8 should be used (note that the K_{oc} values for these chemicals in Table C-1 are for a pH of 6.8).

- Table C-3 provides the physical state (liquid or solid) for organic contaminants. A contaminant's liquid or solid state is needed to apply and interpret soil saturation limit (C_{sat}) results (see Section 2.5.2, p.23).

- Table C-4 provides pH-specific soil-water partition coefficients (K_d) for metals. Site-specific soil pH measurements (see Section 2.3.5) can be used to select appropriate K_d values for these metals. Where site-specific soil pH values are not available, values corresponding to a pH of 6.8 should be used.

Except for air and water diffusivities, the chemical properties necessary to calculate SSLs for additional chemicals may be found in the Superfund Chemical Data Matrix (SCDM). Additional air and water diffusivities may be obtained from the CHEMDAT8 and WATER8 models, both of which can be downloaded off EPA's SCRAM electronic bulletin board system. Accessing information is

OAQPS SCRAM BBS
(919)541-5742 (24 hr/d, 7 d/wk except Monday AM)
Line Settings: 8 bits, no parity, 1 stop bit
Terminal emulation: VT100 or ANSI
System Operator: (919)541-5384 (normal business hours EST)

Table C-1. Chemical-Specific Properties used in SSL Calculations

CAS No.	Compound	K_{oc} (L/kg)	$D_{i,a}$ (cm^2/s)	$D_{i,w}$ (cm^2/s)	S (mg/L)	H' (dimensionless)
83-32-9	Acenaphthene	7.08E+03	4.21E-02	7.69E-06	4.24E+00	6.36E-03
67-64-1	Acetone	5.75E-01	1.24E-01	1.14E-05	1.00E+06	1.59E-03
309-00-2	Aldrin	2.45E+06	1.32E-02	4.86E-06	1.80E-01	6.97E-03
120-12-7	Anthracene	2.95E+04	3.24E-02	7.74E-06	4.34E-02	2.67E-03
56-55-3	Benz(*a*)anthracene	3.98E+05	5.10E-02	9.00E-06	9.40E-03	1.37E-04
71-43-2	Benzene	5.89E+01	8.80E-02	9.80E-06	1.75E+03	2.28E-01
205-99-2	Benzo(*b*)fluoranthene	1.23E+06	2.26E-02	5.56E-06	1.50E-03	4.55E-03
207-08-9	Benzo(*k*)fluoranthene	1.23E+06	2.26E-02	5.56E-06	8.00E-04	3.40E-05
65-85-0	Benzoic acid	6.00E-01	5.36E-02	7.97E-06	3.50E+03	6.31E-05
50-32-8	Benzo(*a*)pyrene	1.02E+06	4.30E-02	9.00E-06	1.62E-03	4.63E-05
111-44-4	Bis(2-chloroethyl)ether	1.55E+01	6.92E-02	7.53E-06	1.72E+04	7.38E-04
117-81-7	Bis(2-ethylhexyl)phthalate	1.51E+07	3.51E-02	3.66E-06	3.40E-01	4.18E-06
75-27-4	Bromodichloromethane	5.50E+01	2.98E-02	1.06E-05	6.74E+03	6.56E-02
75-25-2	Bromoform	8.71E+01	1.49E-02	1.03E-05	3.10E+03	2.19E-02
71-36-3	Butanol	6.92E+00	8.00E-02	9.30E-06	7.40E+04	3.61E-04
85-68-7	Butyl benzyl phthalate	5.75E+04	1.74E-02	4.83E-06	2.69E+00	5.17E-05
86-74-8	Carbazole	3.39E+03	3.90E-02	7.03E-06	7.48E+00	6.26E-07
75-15-0	Carbon disulfide	4.57E+01	1.04E-01	1.00E-05	1.19E+03	1.24E+00
56-23-5	Carbon tetrachloride	1.74E+02	7.80E-02	8.80E-06	7.93E+02	1.25E+00
57-74-9	Chlordane	1.20E+05	1.18E-02	4.37E-06	5.60E-02	1.99E-03
106-47-8	*p*-Chloroaniline	6.61E+01	4.83E-02	1.01E-05	5.30E+03	1.36E-05
108-90-7	Chlorobenzene	2.19E+02	7.30E-02	8.70E-06	4.72E+02	1.52E-01
124-48-1	Chlorodibromomethane	6.31E+01	1.96E-02	1.05E-05	2.60E+03	3.21E-02
67-66-3	Chloroform	3.98E+01	1.04E-01	1.00E-05	7.92E+03	1.50E-01
95-57-8	2-Chlorophenol	3.88E+02	5.01E-02	9.46E-06	2.20E+04	1.60E-02
218-01-9	Chrysene	3.98E+05	2.48E-02	6.21E-06	1.60E-03	3.88E-03
72-54-8	DDD	1.00E+06	1.69E-02	4.76E-06	9.00E-02	1.64E-04
72-55-9	DDE	4.47E+06	1.44E-02	5.87E-06	1.20E-01	8.61E-04
50-29-3	DDT	2.63E+06	1.37E-02	4.95E-06	2.50E-02	3.32E-04
53-70-3	Dibenz(*a,h*)anthracene	3.80E+06	2.02E-02	5.18E-06	2.49E-03	6.03E-07
84-74-2	Di-*n*-butyl phthalate	3.39E+04	4.38E-02	7.86E-06	1.12E+01	3.85E-08
95-50-1	1,2-Dichlorobenzene	6.17E+02	6.90E-02	7.90E-06	1.56E+02	7.79E-02
106-46-7	1,4-Dichlorobenzene	6.17E+02	6.90E-02	7.90E-06	7.38E+01	9.96E-02
91-94-1	3,3-Dichlorobenzidine	7.24E+02	1.94E-02	6.74E-06	3.11E+00	1.64E-07
75-34-3	1,1-Dichloroethane	3.16E+01	7.42E-02	1.05E-05	5.06E+03	2.30E-01
107-06-2	1,2-Dichloroethane	1.74E+01	1.04E-01	9.90E-06	8.52E+03	4.01E-02
75-35-4	1,1-Dichloroethylene	5.89E+01	9.00E-02	1.04E-05	2.25E+03	1.07E+00
156-59-2	*cis*-1,2-Dichloroethylene	3.55E+01	7.36E-02	1.13E-05	3.50E+03	1.67E-01
156-60-5	*trans*-1,2-Dichloroethylene	5.25E+01	7.07E-02	1.19E-05	6.30E+03	3.85E-01
120-83-2	2,4-Dichlorophenol	1.47E+02	3.46E-02	8.77E-06	4.50E+03	1.30E-04
78-87-5	1,2-Dichloropropane	4.37E+01	7.82E-02	8.73E-06	2.80E+03	1.15E-01
542-75-6	1,3-Dichloropropene	4.57E+01	6.26E-02	1.00E-05	2.80E+03	7.26E-01
60-57-1	Dieldrin	2.14E+04	1.25E-02	4.74E-06	1.95E-01	6.19E-04
84-66-2	Diethylphthalate	2.88E+02	2.56E-02	6.35E-06	1.08E+03	1.85E-05
105-67-9	2,4-Dimethylphenol	2.09E+02	5.84E-02	8.69E-06	7.87E+03	8.20E-05

Table C-1 (continued)

CAS No.	Compound	K_{oc} (L/kg)	$D_{i,a}$ (cm^2/s)	$D_{i,w}$ (cm^2/s)	S (mg/L)	H' (dimensionless)
51-28-5	2,4-Dinitrophenol	1.00E-02	2.73E-02	9.06E-06	2.79E+03	1.82E-05
121-14-2	2,4-Dinitrotoluene	9.55E+01	2.03E-01	7.06E-06	2.70E+02	3.80E-06
606-20-2	2,6-Dinitrotoluene	6.92E+01	3.27E-02	7.26E-06	1.82E+02	3.06E-05
117-84-0	Di-*n*-octyl phthalate	8.32E+07	1.51E-02	3.58E-06	2.00E-02	2.74E-03
115-29-7	Endosulfan	2.14E+03	1.15E-02	4.55E-06	5.10E-01	4.59E-04
72-20-8	Endrin	1.23E+04	1.25E-02	4.74E-06	2.50E-01	3.08E-04
100-41-4	Ethylbenzene	3.63E+02	7.50E-02	7.80E-06	1.69E+02	3.23E-01
206-44-0	Fluoranthene	1.07E+05	3.02E-02	6.35E-06	2.06E-01	6.60E-04
86-73-7	Fluorene	1.38E+04	3.63E-02	7.88E-06	1.98E+00	2.61E-03
76-44-8	Heptachlor	1.41E+06	1.12E-02	5.69E-06	1.80E-01	4.47E-02
1024-57-3	Heptachlor epoxide	8.32E+04	1.32E-02	4.23E-06	2.00E-01	3.90E-04
118-74-1	Hexachlorobenzene	5.50E+04	5.42E-02	5.91E-06	6.20E+00	5.41E-02
87-68-3	Hexachloro-1,3-butadiene	5.37E+04	5.61E-02	6.16E-06	3.23E+00	3.34E-01
319-84-6	α-HCH (α-BHC)	1.23E+03	1.42E-02	7.34E-06	2.00E+00	4.35E-04
319-85-7	ß-HCH (ß-BHC)	1.26E+03	1.42E-02	7.34E-06	2.40E-01	3.05E-05
58-89-9	γ-HCH (Lindane)	1.07E+03	1.42E-02	7.34E-06	6.80E+00	5.74E-04
77-47-4	Hexachlorocyclopentadiene	2.00E+05	1.61E-02	7.21E-06	1.80E+00	1.11E+00
67-72-1	Hexachloroethane	1.78E+03	2.50E-03	6.80E-06	5.00E+01	1.59E-01
193-39-5	Indeno(1,2,3-*cd*)pyrene	3.47E+06	1.90E-02	5.66E-06	2.20E-05	6.56E-05
78-59-1	Isophorone	4.68E+01	6.23E-02	6.76E-06	1.20E+04	2.72E-04
7439-97-6	Mercury	---	3.07E-02	6.30E-06	---	4.67E-01
72-43-5	Methoxychlor	9.77E+04	1.56E-02	4.46E-06	4.50E-02	6.48E-04
74-83-9	Methyl bromide	1.05E+01	7.28E-02	1.21E-05	1.52E+04	2.56E-01
75-09-2	Methylene chloride	1.17E+01	1.01E-01	1.17E-05	1.30E+04	8.98E-02
95-48-7	2-Methylphenol	9.12E+01	7.40E-02	8.30E-06	2.60E+04	4.92E-05
91-20-3	Naphthalene	2.00E+03	5.90E-02	7.50E-06	3.10E+01	1.98E-02
98-95-3	Nitrobenzene	6.46E+01	7.60E-02	8.60E-06	2.09E+03	9.84E-04
86-30-6	*N*-Nitrosodiphenylamine	1.29E+03	3.12E-02	6.35E-06	3.51E+01	2.05E-04
621-64-7	*N*-Nitrosodi-*n*-propylamine	2.40E+01	5.45E-02	8.17E-06	9.89E+03	9.23E-05
1336-36-3	PCBs	3.09E+05	---	---	7.00E-01	---
87-86-5	Pentachlorophenol	5.92E+02	5.60E-02	6.10E-06	1.95E+03	1.00E-06
108-95-2	Phenol	2.88E+01	8.20E-02	9.10E-06	8.28E+04	1.63E-05
129-00-0	Pyrene	1.05E+05	2.72E-02	7.24E-06	1.35E-01	4.51E-04
100-42-5	Styrene	7.76E+02	7.10E-02	8.00E-06	3.10E+02	1.13E-01
79-34-5	1,1,2,2-Tetrachloroethane	9.33E+01	7.10E-02	7.90E-06	2.97E+03	1.41E-02
127-18-4	Tetrachloroethylene	1.55E+02	7.20E-02	8.20E-06	2.00E+02	7.54E-01
108-88-3	Toluene	1.82E+02	8.70E-02	8.60E-06	5.26E+02	2.72E-01
8001-35-2	Toxaphene	2.57E+05	1.16E-02	4.34E-06	7.40E-01	2.46E-04
120-82-1	1,2,4-Trichlorobenzene	1.78E+03	3.00E-02	8.23E-06	3.00E+02	5.82E-02
71-55-6	1,1,1-Trichloroethane	1.10E+02	7.80E-02	8.80E-06	1.33E+03	7.05E-01
79-00-5	1,1,2-Trichloroethane	5.01E+01	7.80E-02	8.80E-06	4.42E+03	3.74E-02
79-01-6	Trichloroethylene	1.66E+02	7.90E-02	9.10E-06	1.10E+03	4.22E-01
95-95-4	2,4,5-Trichlorophenol	1.60E+03	2.91E-02	7.03E-06	1.20E+03	1.78E-04
88-06-2	2,4,6-Trichlorophenol	3.81E+02	3.18E-02	6.25E-06	8.00E+02	3.19E-04

Table C-1 (continued)

CAS No.	Compound	K_{oc} (L/kg)	$D_{i,a}$ (cm^2/s)	$D_{i,w}$ (cm^2/s)	S (mg/L)	H' (dimensionless)
108-05-4	Vinyl acetate	5.25E+00	8.50E-02	9.20E-06	2.00E+04	2.10E-02
75-01-4	Vinyl chloride	1.86E+01	1.06E-01	1.23E-06	2.76E+03	1.11E+00
108-38-3	*m*-Xylene	4.07E+02	7.00E-02	7.80E-06	1.61E+02	3.01E-01
95-47-6	*o*-Xylene	3.63E+02	8.70E-02	1.00E-05	1.78E+02	2.13E-01
106-42-3	*p*-Xylene	3.89E+02	7.69E-02	8.44E-06	1.85E+02	3.14E-01

K_{oc} = Soil organic carbon/water partition coefficient.
$D_{i,a}$ = Diffusivity in air (25 •C).
$D_{i,w}$ = Diffusivity in water (25 •C).
S = Solubility in water (20-25 •C).
H' = Dimensionless Henry's law constant (HLC [atm-m^3/mol] * 41) (25 •C).
K_d = Soil-water partition coefficient.

Table C-2. Koc Values for Ionizing Organics as a Function of pH

pH	Benzoic Acid	2-Chloro-phenol	2,4-Dichloro-phenol	2,4-Dinitro-phenol	Pentachloro-phenol	2,3,4,5-Tetrachloro-phenol	2,3,4,6-Tetrachloro-phenol	2,4,5-Trichloro-phenol	2,4,6-Trichloro-phenol
4.9	5.54E+00	3.98E+02	1.59E+02	2.94E-02	9.05E+03	1.73E+04	4.45E+03	2.37E+03	1.04E+03
5.0	4.64E+00	3.98E+02	1.59E+02	2.55E-02	7.96E+03	1.72E+04	4.15E+03	2.36E+03	1.03E+03
5.1	3.88E+00	3.98E+02	1.59E+02	2.23E-02	6.93E+03	1.70E+04	3.83E+03	2.36E+03	1.02E+03
5.2	3.25E+00	3.98E+02	1.59E+02	1.98E-02	5.97E+03	1.67E+04	3.49E+03	2.35E+03	1.01E+03
5.3	2.72E+00	3.98E+02	1.59E+02	1.78E-02	5.10E+03	1.65E+04	3.14E+03	2.34E+03	9.99E+02
5.4	2.29E+00	3.98E+02	1.58E+02	1.62E-02	4.32E+03	1.61E+04	2.79E+03	2.33E+03	9.82E+02
5.5	1.94E+00	3.97E+02	1.58E+02	1.50E-02	3.65E+03	1.57E+04	2.45E+03	2.32E+03	9.62E+02
5.6	1.65E+00	3.97E+02	1.58E+02	1.40E-02	3.07E+03	1.52E+04	2.13E+03	2.31E+03	9.38E+02
5.7	1.42E+00	3.97E+02	1.58E+02	1.32E-02	2.58E+03	1.47E+04	1.83E+03	2.29E+03	9.10E+02
5.8	1.24E+00	3.97E+02	1.58E+02	1.25E-02	2.18E+03	1.40E+04	1.56E+03	2.27E+03	8.77E+02
5.9	1.09E+00	3.97E+02	1.57E+02	1.20E-02	1.84E+03	1.32E+04	1.32E+03	2.24E+03	8.39E+02
6.0	9.69E-01	3.96E+02	1.57E+02	1.16E-02	1.56E+03	1.24E+04	1.11E+03	2.21E+03	7.96E+02
6.1	8.75E-01	3.96E+02	1.57E+02	1.13E-02	1.33E+03	1.15E+04	9.27E+02	2.17E+03	7.48E+02
6.2	7.99E-01	3.96E+02	1.56E+02	1.10E-02	1.15E+03	1.05E+04	7.75E+02	2.12E+03	6.97E+02
6.3	7.36E-01	3.95E+02	1.55E+02	1.08E-02	9.98E+02	9.51E+03	6.47E+02	2.06E+03	6.44E+02
6.4	6.89E-01	3.94E+02	1.54E+02	1.06E-02	8.77E+02	8.48E+03	5.42E+02	1.99E+03	5.89E+02
6.5	6.51E-01	3.93E+02	1.53E+02	1.05E-02	7.81E+02	7.47E+03	4.55E+02	1.91E+03	5.33E+02
6.6	6.20E-01	3.92E+02	1.52E+02	1.04E-02	7.03E+02	6.49E+03	3.84E+02	1.82E+03	4.80E+02
6.7	5.95E-01	3.90E+02	1.50E+02	1.03E-02	6.40E+02	5.58E+03	3.27E+02	1.71E+03	4.29E+02
6.8	5.76E-01	3.88E+02	1.47E+02	1.02E-02	5.92E+02	4.74E+03	2.80E+02	1.60E+03	3.81E+02
6.9	5.60E-01	3.86E+02	1.45E+02	1.02E-02	5.52E+02	3.99E+03	2.42E+02	1.47E+03	3.38E+02
7.0	5.47E-01	3.83E+02	1.41E+02	1.02E-02	5.21E+02	3.33E+03	2.13E+02	1.34E+03	3.00E+02
7.1	5.38E-01	3.79E+02	1.38E+02	1.02E-02	4.96E+02	2.76E+03	1.88E+02	1.21E+03	2.67E+02
7.2	5.32E-01	3.75E+02	1.33E+02	1.01E-02	4.76E+02	2.28E+03	1.69E+02	1.07E+03	2.39E+02
7.3	5.25E-01	3.69E+02	1.28E+02	1.01E-02	4.61E+02	1.87E+03	1.53E+02	9.43E+02	2.15E+02
7.4	5.19E-01	3.62E+02	1.21E+02	1.01E-02	4.47E+02	1.53E+03	1.41E+02	8.19E+02	1.95E+02
7.5	5.16E-01	3.54E+02	1.14E+02	1.01E-02	4.37E+02	1.25E+03	1.31E+02	7.03E+02	1.78E+02
7.6	5.13E-01	3.44E+02	1.07E+02	1.01E-02	4.29E+02	1.02E+03	1.23E+02	5.99E+02	1.64E+02
7.7	5.09E-01	3.33E+02	9.84E+01	1.00E-02	4.23E+02	8.31E+02	1.17E+02	5.07E+02	1.53E+02
7.8	5.06E-01	3.19E+02	8.97E+01	1.00E-02	4.18E+02	6.79E+02	1.13E+02	4.26E+02	1.44E+02
7.9	5.06E-01	3.04E+02	8.07E+01	1.00E-02	4.14E+02	5.56E+02	1.08E+02	3.57E+02	1.37E+02
8.0	5.06E-01	2.86E+02	7.17E+01	1.00E-02	4.10E+02	4.58E+02	1.05E+02	2.98E+02	1.31E+02

Table C-3. Physical State of Organic SSL Chemicals

Compounds liquid at soil temperatures			Compounds solid at soil temperatures		
CAS No.	Chemical	Melting Point (˚C)	CAS No.	Chemical	Melting Point (˚C)
67-64-1	Acetone	-94.8	83-32-9	Acenaphthene	93.4
71-43-2	Benzene	5.5	309-00-2	Aldrin	104
117-81-7	Bis(2-ethylhexyl)phthalate	-55	120-12-7	Anthracene	215
111-44-4	Bis(2-chloroethyl)ether	-51.9	56-55-3	Benz(*a*)anthracene	84
75-27-4	Bromodichloromethane	-57	50-32-8	Benzo(*a*)pyrene	176.5
75-25-2	Bromoform	8	205-99-2	Benzo(*b*)fluoranthene	168
71-36-3	Butanol	-89.8	207-08-9	Benzo(*k*)fluoranthene	217
85-68-7	Butyl benzyl phthalate	-35	65-85-0	Benzoic acid	122.4
75-15-0	Carbon disulfide	-115	86-74-8	Carbazole	246.2
56-23-5	Carbon tetrachloride	-23	57-74-9	Chlordane	106
108-90-7	Chlorobenzene	-45.2	106-47-8	*p*-Chloroaniline	72.5
124-48-1	Chlorodibromomethane	-20	218-01-9	Chrysene	258.2
67-66-3	Chloroform	-63.6	72-54-8	DDD	109.5
95-57-8	2-Chlorophenol	9.8	72-55-9	DDE	89
84-74-2	Di-*n*-butyl phthalate	-35	50-29-3	DDT	108.5
95-50-1	1,2-Dichlorobenzene	-16.7	53-70-3	Dibenzo(*a,h*)anthracene	269.5
75-34-3	1,1-Dichloroethane	-96.9	106-46-7	1,4-Dichlorobenzene	52.7
107-06-2	1,2-Dichloroethane	-35.5	91-94-1	3,3-Dichlorobenzidine	132.5
75-35-4	1,1-Dichloroethylene	-122.5	120-83-2	2,4-Dichlorophenol	45
156-59-2	*cis*-1,2-Dichloroethylene	-80	60-57-1	Dieldrin	175.5
156-60-5	*trans*-1,2-Dichloroethylene	-49.8	105-67-9	2,4-Dimethylphenol	24.5
78-87-5	1,2-Dichloropropane	-70	51-28-5	2,4-Dinitrophenol	115-116
542-75-6	1,3-Dichloropropene	NA	121-14-2	2,4-Dinitrotoluene	71
84-66-2	Diethylphthalate	-40.5	606-20-2	2,6-Dinitrotoluene	66
117-84-0	Di-*n*-octyl phthalate	-30	72-20-8	Endrin	200
100-41-4	Ethylbenzene	-94.9	206-44-0	Fluoranthene	107.8
87-68-3	Hexachloro-1,3-butadiene	-21	86-73-7	Fluorene	114.8
77-47-4	Hexachlorocyclopentadiene	-9	76-44-8	Heptachlor	95.5
78-59-1	Isophorone	-8.1	1024-57-3	Heptachlor epoxide	160
74-83-9	Methyl bromide	-93.7	118-74-1	Hexachlorobenzene	231.8
75-09-2	Methylene chloride	-95.1	319-84-6	α-HCH (α-BHC)	160
98-95-3	Nitrobenzene	5.7	319-85-7	ß-HCH (ß-BHC)	315
100-42-5	Styrene	-31	58-89-9	γ-HCH (Lindane)	112.5
79-34-5	1,1,2,2-Tetrachloroethane	-43.8	67-72-1	Hexachloroethane	187
127-18-4	Tetrachloroethylene	-22.3	193-39-5	Indeno(1,2,3-*cd*)pyrene	161.5
108-88-3	Toluene	-94.9	72-43-5	Methoxychlor	87
120-82-1	1,2,4-Trichlorobenzene	17	95-48-7	2-Methylphenol	29.8
71-55-6	1,1,1-Trichloroethane	-30.4	621-64-7	*N*-Nitrosodi-*n*-propylamine	NA
79-00-5	1,1,2-Trichloroethane	-36.6	86-30-6	*N*-Nitrosodiphenylamine	66.5
79-01-6	Trichloroethylene	-84.7	91-20-3	Naphthalene	80.2
108-05-4	Vinyl acetate	-93.2	87-86-5	Pentachlorophenol	174
75-01-4	Vinyl chloride	-153.7	108-95-2	Phenol	40.9
108-38-3	*m*-Xylene	-47.8	129-00-0	Pyrene	151.2
95-47-6	*o*-Xylene	-25.2	8001-35-2	Toxaphene	65-90
106-42-3	*p*-Xylene	13.2	95-95-4	2,4,5-Trichlorophenol	69
			88-06-2	2,4,6-Trichlorophenol	69
			115-29-7	Endosullfan	106

NA = Not available.

Table C-4. Metal K_d Values (L/kg) as a Function of pH[3]

pH	As	Ba	Be	Cd	Cr (+3)	Cr (+6)	Hg	Ni	Ag	Se	Tl	Zn
4.9	2.5E+01	1.1E+01	2.3E+01	1.5E+01	1.2E+03	3.1E+01	4.0E-02	1.6E+01	1.0E-01	1.8E+01	4.4E+01	1.6E+01
5.0	2.5E+01	1.2E+01	2.6E+01	1.7E+01	1.9E+03	3.1E+01	6.0E-02	1.8E+01	1.3E-01	1.7E+01	4.5E+01	1.8E+01
5.1	2.5E+01	1.4E+01	2.8E+01	1.9E+01	3.0E+03	3.0E+01	9.0E-02	2.0E+01	1.6E-01	1.6E+01	4.6E+01	1.9E+01
5.2	2.6E+01	1.5E+01	3.1E+01	2.1E+01	4.9E+03	2.9E+01	1.4E-01	2.2E+01	2.1E-01	1.5E+01	4.7E+01	2.1E+01
5.3	2.6E+01	1.7E+01	3.5E+01	2.3E+01	8.1E+03	2.8E+01	2.0E-01	2.4E+01	2.6E-01	1.4E+01	4.8E+01	2.3E+01
5.4	2.6E+01	1.9E+01	3.8E+01	2.5E+01	1.3E+04	2.7E+01	3.0E-01	2.6E+01	3.3E-01	1.3E+01	5.0E+01	2.5E+01
5.5	2.6E+01	2.1E+01	4.2E+01	2.7E+01	2.1E+04	2.7E+01	4.6E-01	2.8E+01	4.2E-01	1.2E+01	5.1E+01	2.6E+01
5.6	2.6E+01	2.2E+01	4.7E+01	2.9E+01	3.5E+04	2.6E+01	6.9E-01	3.0E+01	5.3E-01	1.1E+01	5.2E+01	2.8E+01
5.7	2.7E+01	2.4E+01	5.3E+01	3.1E+01	5.5E+04	2.5E+01	1.0E+00	3.2E+01	6.7E-01	1.1E+01	5.4E+01	3.0E+01
5.8	2.7E+01	2.6E+01	6.0E+01	3.3E+01	8.7E+04	2.5E+01	1.6E+00	3.4E+01	8.4E-01	9.8E+00	5.5E+01	3.2E+01
5.9	2.7E+01	2.8E+01	6.9E+01	3.5E+01	1.3E+05	2.4E+01	2.3E+00	3.6E+01	1.1E+00	9.2E+00	5.6E+01	3.4E+01
6.0	2.7E+01	3.0E+01	8.2E+01	3.7E+01	2.0E+05	2.3E+01	3.5E+00	3.8E+01	1.3E+00	8.6E+00	5.8E+01	3.6E+01
6.1	2.7E+01	3.1E+01	9.9E+01	4.0E+01	3.0E+05	2.3E+01	5.1E+00	4.0E+01	1.7E+00	8.0E+00	5.9E+01	3.9E+01
6.2	2.8E+01	3.3E+01	1.2E+02	4.2E+01	4.2E+05	2.2E+01	7.5E+00	4.2E+01	2.1E+00	7.5E+00	6.1E+01	4.2E+01
6.3	2.8E+01	3.5E+01	1.6E+02	4.4E+01	5.8E+05	2.2E+01	1.1E+01	4.5E+01	2.7E+00	7.0E+00	6.2E+01	4.4E+01
6.4	2.8E+01	3.6E+01	2.1E+02	4.8E+01	7.7E+05	2.1E+01	1.6E+01	4.7E+01	3.4E+00	6.5E+00	6.4E+01	4.7E+01
6.5	2.8E+01	3.7E+01	2.8E+02	5.2E+01	9.9E+05	2.0E+01	2.2E+01	5.0E+01	4.2E+00	6.1E+00	6.6E+01	5.1E+01
6.6	2.8E+01	3.9E+01	3.9E+02	5.7E+01	1.2E+06	2.0E+01	3.0E+01	5.4E+01	5.3E+00	5.7E+00	6.7E+01	5.4E+01
6.7	2.9E+01	4.0E+01	5.5E+02	6.4E+01	1.5E+06	1.9E+01	4.0E+01	5.8E+01	6.6E+00	5.3E+00	6.9E+01	5.8E+01
6.8	2.9E+01	4.1E+01	7.9E+02	7.5E+01	1.8E+06	1.9E+01	5.2E+01	6.5E+01	8.3E+00	5.0E+00	7.1E+01	6.2E+01
6.9	2.9E+01	4.2E+01	1.1E+03	9.1E+01	2.1E+06	1.8E+01	6.6E+01	7.4E+01	1.0E+01	4.7E+00	7.3E+01	6.8E+01
7.0	2.9E+01	4.2E+01	1.7E+03	1.1E+02	2.5E+06	1.8E+01	8.2E+01	8.8E+01	1.3E+01	4.3E+00	7.4E+01	7.5E+01
7.1	2.9E+01	4.3E+01	2.5E+03	1.5E+02	2.8E+06	1.7E+01	9.9E+01	1.1E+02	1.6E+01	4.1E+00	7.6E+01	8.3E+01
7.2	3.0E+01	4.4E+01	3.8E+03	2.0E+02	3.1E+06	1.7E+01	1.2E+02	1.4E+02	2.0E+01	3.8E+00	7.8E+01	9.5E+01
7.3	3.0E+01	4.4E+01	5.7E+03	2.8E+02	3.4E+06	1.6E+01	1.3E+02	1.8E+02	2.5E+01	3.5E+00	8.0E+01	1.1E+02
7.4	3.0E+01	4.5E+01	8.6E+03	4.0E+02	3.7E+06	1.6E+01	1.5E+02	2.5E+02	3.1E+01	3.3E+00	8.2E+01	1.3E+02
7.5	3.0E+01	4.6E+01	1.3E+04	5.9E+02	3.9E+06	1.6E+01	1.6E+02	3.5E+02	3.9E+01	3.1E+00	8.5E+01	1.6E+02
7.6	3.1E+01	4.6E+01	2.0E+04	8.7E+02	4.1E+06	1.5E+01	1.7E+02	4.9E+02	4.8E+01	2.9E+00	8.7E+01	1.9E+02
7.7	3.1E+01	4.7E+01	3.0E+04	1.3E+03	4.2E+06	1.5E+01	1.8E+02	7.0E+02	5.9E+01	2.7E+00	8.9E+01	2.4E+02
7.8	3.1E+01	4.9E+01	4.6E+04	1.9E+03	4.3E+06	1.4E+01	1.9E+02	9.9E+02	7.3E+01	2.5E+00	9.1E+01	3.1E+02
7.9	3.1E+01	5.0E+01	6.9E+04	2.9E+03	4.3E+06	1.4E+01	1.9E+02	1.4E+03	8.9E+01	2.4E+00	9.4E+01	4.0E+02
8.0	3.1E+01	5.2E+01	1.0E+05	4.3E+03	4.3E+06	1.4E+01	2.0E+02	1.9E+03	1.1E+02	2.2E+00	9.6E+01	5.3E+02

[3]non pH-dependent inorganic K_d values for antimony, cyanide, and vanadium are 45, 9.9, and 1,000 respectively.

Attachment D

Regulatory and Human Health Benchmarks Used for SSL Development

Attachment D

Regulatory and Human Health Benchmarks for SSL Development

This attachment provides regulatory and human health benchmarks necessary to calculate SSLs for 110 chemicals commonly found at National Priority List (NPL) sites. The sources of these values (shown in the following table) are regularly updated by EPA. Prior to calculating SSLs at a site, check all relevant chemical-specific values in this attachment against the most recent version of their sources to ensure that they are up-to-date.

Attachment D. Regulatory and Human Health Benchmarks Used for SSL Development

		Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
CAS Number	Chemical Name	MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
83-32-9	Acenaphthene					2E+00	RfD							6.0E-02	1		
67-64-1	Acetone (2-Propanone)					4E+00	RfD	D			D			1.0E-01	1		
309-00-2	Aldrin					5E-06	SF_o	B2	1.7E+01	1	B2	4.9E-03	1	3.0E-05	1		
120-12-7	Anthracene					1E+01	RfD	D			D			3.0E-01	1		
7440-36-0	Antimony	6.0E-03	3	6.0E-03	3									4.0E-04	1		
7440-38-2	Arsenic			5.0E-02	3			A	1.5E+00	1	A	4.3E-03	1	3.0E-04	1		
7440-39-3	Barium	2.0E+00	3	2.0E+00	3									7.0E-02	1	5.0E-04	2
56-55-3	Benz(*a*)anthracene					1E-04	SF_o	B2	7.3E-01	4	B2						
71-43-2	Benzene			5.0E-03	3			A	2.9E-02	1	A	8.3E-06	1				
205-99-2	Benzo(*b*)fluoranthene					1E-04	SF_o	B2	7.3E-01	4	B2						
207-08-9	Benzo(*k*)fluoranthene					1E-03	SF_o	B2	7.3E-02	4	B2						
65-85-0	Benzoic acid					1E+02	RfD							4.0E+00	1		
50-32-8	Benzo(*a*)pyrene			2.0E-04	3			B2	7.3E+00	1	B2						
7440-41-7	Beryllium	4.0E-03	3	4.0E-03	3			B2	4.3E+00	1	B2	2.4E-03	1	5.0E-03	1		
111-44-4	Bis(2-chloroethyl)ether					8E-05	SF_o	B2	1.1E+00	1	B2	3.3E-04	1				
117-81-7	Bis(2-ethylhexyl)phthalate			6.0E-03	3			B2	1.4E-02	1	B2			2.0E-02	1		
75-27-4	Bromodichloromethane			1.0E-01 *	3			B2	6.2E-02	1	B2			2.0E-02	1		
75-25-2	Bromoform (tribromomethane)			1.0E-01 *	3			B2	7.9E-03	1	B2	1.1E-06	1	2.0E-02	1		
71-36-3	Butanol					4E+00	RfD	D			D			1.0E-01	1		
85-68-7	Butyl benzyl phthalate					7E+00	RfD	C			C			2.0E-01	1		
7440-43-9	Cadmium	5.0E-03	3	5.0E-03	3						B1	1.8E-03	1	1.0E-03**	1		
86-74-8	Carbazole					4E-03	SF_o	B2	2.0E-02	2							
75-15-0	Carbon disulfide					4E+00	RfD							1.0E-01	1	7.0E-01	1
56-23-5	Carbon tetrachloride			5.0E-03	3			B2	1.3E-01	1	B2	1.5E-05	1	7.0E-04	1		
57-74-9	Chlordane			2.0E-03	3			B2	1.3E+00	1	B2	3.7E-04	1	6.0E-05	1		
106-47-8	*p* -Chloroaniline					1E-01	RfD							4.0E-03	1		
108-90-7	Chlorobenzene	1.0E-01	3	1.0E-01	3			D			D			2.0E-02	1	2.0E-02	2
124-48-1	Chlorodibromomethane	6.0E-02	3	1.0E-01 *	3			C	8.4E-02	1	C			2.0E-02	1		
67-66-3	Chloroform			1.0E-01 *	3			B2	6.1E-03	1	B2	2.3E-05	1	1.0E-02	1		
95-57-8	2-Chlorophenol					2E-01	RfD							5.0E-03	1		

* Proposed MCL = 0.08 mg/L, *Drinking Water Regulations and Health Advisories* , U.S. EPA (1995).

** Cadmium RfD is based on dietary exposure.

Attachment D (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
7440-47-3	Chromium	1.0E-01	3	1.0E-01	3			A			A	1.2E-02	1	5.0E-03	1		
16065-83-1	Chromium (III)					4E+01	RfD							1.0E+00	1		
18540-29-9	Chromium (VI)			1.0E-01	3 *			A			A	1.2E-02	1	5.0E-03	1		
218-01-9	Chrysene					1E-02	SF_o	B2	7.3E-03	4							
57-12-5	Cyanide (amenable)	(2.0E-01)	3	(2.0E-01)	3			D			D			2.0E-02	1		
72-54-8	DDD					4E-04	SF_o	B2	2.4E-01	1	B2						
72-55-9	DDE					3E-04	SF_o	B2	3.4E-01	1	B2						
50-29-3	DDT					3E-04	SF_o	B2	3.4E-01	1	B2	9.7E-05	1	5.0E-04	1		
53-70-3	Dibenz(*a,h*)anthracene					1E-05	SF_o	B2	7.3E+00	4	B2						
84-74-2	Di-*n* -butyl phthalate					4E+00	RfD	D			D			1.0E-01	1		
95-50-1	1,2-Dichlorobenzene	6.0E-01	3	6.0E-01	3			D			D			9.0E-02	1	2.0E-01	2
106-46-7	1,4-Dichlorobenzene	7.5E-02	3	7.5E-02	3			B2	2.4E-02	2	B2					8.0E-01	1
91-94-1	3,3-Dichlorobenzidine					2E-04	SF_o	B2	4.5E-01	1	B2						
75-34-3	1,1-Dichloroethane					4E+00	RfD	C			C			1.0E-01	7	5.0E-01	2
107-06-2	1,2-Dichloroethane			5.0E-03	3			B2	9.1E-02	1	B2	2.6E-05	1				
75-35-4	1,1-Dichloroethylene	7.0E-03	3	7.0E-03	3			C	6.0E-01	1	C	5.0E-05	1	9.0E-03	1		
156-59-2	*cis* -1,2-Dichloroethylene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	2		
156-60-5	*trans* -1,2-Dichloroethylene	1.0E-01	3	1.0E-01	3									2.0E-02	1		
120-83-2	2,4-Dichlorophenol					1E-01	RfD							3.0E-03	1		
78-87-5	1,2-Dichloropropane			5.0E-03	3			B2	6.8E-02	2	B2					4.0E-03	1
542-75-6	1,3-Dichloropropene					5E-04	SF_o	B2	1.8E-01	2	B2	3.7E-05	2	3.0E-04	1	2.0E-02	1
60-57-1	Dieldrin					5E-06	SF_o	B2	1.6E+01	1	B2	4.6E-03	1	5.0E-05	1		
84-66-2	Diethylphthalate					3E+01	RfD	D			D			8.0E-01	1		
105-67-9	2,4-Dimethylphenol					7E-01	RfD							2.0E-02	1		
51-28-5	2,4-Dinitrophenol					4E-02	RfD							2.0E-03	1		
121-14-2	2,4-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				2.0E-03	1		
606-20-2	2,6-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				1.0E-03	2		
117-84-0	Di-*n* -octyl phthalate					7E-01	RfD							2.0E-02	2		
115-29-7	Endosulfan					2E-01	RfD							6.0E-03	2		
72-20-8	Endrin	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	1		

* MCL for total chromium is based on Cr (VI) toxicity.

** Cancer Slope Factor is for 2,4-, 2,6-Dinitrotoluene mixture.

Attachment D (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
100-41-4	Ethylbenzene	7.0E-01	3	7.0E-01	3			D			D			1.0E-01	1	1.0E+00	1
206-44-0	Fluoranthene					1E+00	RfD	D			D			4.0E-02	1		
86-73-7	Fluorene					1E+00	RfD	D						4.0E-02	1		
76-44-8	Heptachlor			4.0E-04	3			B2	4.5E+00	1	B2	1.3E-03	1	5.0E-04	1		
1024-57-3	Heptachlor epoxide			2.0E-04	3			B2	9.1E+00	1	B2	2.6E-03	1	1.3E-05	1		
118-74-1	Hexachlorobenzene			1.0E-03	3			B2	1.6E+00	1	B2	4.6E-04	1	8.0E-04	1		
87-68-3	Hexachloro-1,3-butadiene	1.0E-03	3			1E-03	SF_o	C	7.8E-02	1	C	2.2E-05	1	2.0E-04	2		
319-84-6	α-HCH (α-BHC)					1E-05	SF_o	B2	6.3E+00	1	B2	1.8E-03	1				
319-85-7	β-HCH (β-BHC)					5E-05	SF_o	C	1.8E+00	1	C	5.3E-04	1				
58-89-9	γ-HCH (Lindane)	2.0E-04	3	2.0E-04	3			B2	1.3E+00	2	C			3.0E-04	1		
77-47-4	Hexachlorocyclopentadiene	5.0E-02	3	5.0E-02	3			D			D			7.0E-03	1	7.0E-05	2
67-72-1	Hexachloroethane					6E-03	SF_o	C	1.4E-02	1	C	4.0E-06	1	1.0E-03	1		
193-39-5	Indeno(1,2,3-*cd*)pyrene					1E-04	SF_o	B2	7.3E-01	4	B2						
78-59-1	Isophorone					9E-02	SF_o	C	9.5E-04	1	C			2.0E-01	1		
7439-97-6	Mercury	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	2	3.0E-04	2
72-43-5	Methoxychlor	4.0E-02	3	4.0E-02	3			D			D			5.0E-03	1		
74-83-9	Methyl bromide					5E-02	RfD	D			D			1.4E-03	1	5.0E-03	1
75-09-2	Methylene chloride			5.0E-03	3			B2	7.5E-03	1	B2	4.7E-07	1	6.0E-02	1	3.0E+00	2
95-48-7	2-Methylphenol (*o* -cresol)					2E+00	RfD	C			C			5.0E-02	1		
91-20-3	Naphthalene					1E+00	RfD	D			D			4.0E-02	6		
7440-02-0	Nickel					1E-01	HA *	A			A	2.4E-04	1	2.0E-02	1		
98-95-3	Nitrobenzene					2E-02	RfD	D			D			5.0E-04	1	2.0E-03	2
86-30-6	*N* -Nitrosodiphenylamine					2E-02	SF_o	B2	4.9E-03	1	B2						
621-64-7	*N* -Nitrosodi-*n* -propylamine					1E-05	SF_o	B2	7.0E+00	1	B2						
87-86-5	Pentachlorophenol			1.0E-03	3			B2	1.2E-01	1	B2			3.0E-02	1		
108-95-2	Phenol					2E+01	RfD	D			D			6.0E-01	1		
129-00-0	Pyrene					1E+00	RfD	D			D			3.0E-02	1		
7782-49-2	Selenium	5.0E-02	3	5.0E-02	3			D			D			5.0E-03	1		
7440-22-4	Silver					2E-01	RfD	D			D			5.0E-03	1		
100-42-5	Styrene	1.0E-01	3	1.0E-01	3									2.0E-01	1	1.0E+00	1
79-34-5	1,1,2,2-Tetrachloroethane					4E-04	SF_o	C	2.0E-01	1	C	5.8E-05	1				

* Health advisory for nickel (MCL is currently remanded); EPA Office of Science and Technology, 7/10/95.

Attachment D (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
127-18-4	Tetrachloroethylene			5.0E-03	3				5.2E-02	5		5.8E-07	5	1.0E-02	1		
7440-28-0	Thallium	5.0E-04	3	2.0E-03	3												
108-88-3	Toluene	1.0E+00	3	1.0E+00	3			D			D			2.0E-01	1	4.0E-01	1
8001-35-2	Toxaphene			3.0E-03	3			B2	1.1E+00	1	B2	3.2E-04	1				
120-82-1	1,2,4-Trichlorobenzene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	1	2.0E-01	2
71-55-6	1,1,1-Trichloroethane	2.0E-01	3	2.0E-01	3			D			D					1.0E+00	5
79-00-5	1,1,2-Trichloroethane	3.0E-03	3	5.0E-03	3			C	5.7E-02	1	C	1.6E-05	1	4.0E-03	1		
79-01-6	Trichloroethylene	zero	3	5.0E-03	3				1.1E-02	5		1.7E-06	5				
95-95-4	2,4,5-Trichlorophenol					4E+00	RfD							1.0E-01	1		
88-06-2	2,4,6-Trichlorophenol					8E-03	SF_o	B2	1.1E-02	1	B2	3.1E-06	1				
7440-62-2	Vanadium					3E-01	RfD							7.0E-03	2		
108-05-4	Vinyl acetate					4E+01	RfD							1.0E+00	1	2.0E-01	1
75-01-4	Vinyl chloride (chloroethene)			2.0E-03	3			A	1.9E+00	2	A	8.4E-05	2				
108-38-3	*m* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
95-47-6	*o* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
106-42-3	*p* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	1 **		
7440-66-6	Zinc					1E+01	RfD	D			D			3.0E-01	1		

* MCL for total xylenes [1330-20-7] is 10 mg/L.

** RfD for total xylenes is 2 mg/kg-day.

[a] References:
- 1 = IRIS, U.S. EPA (1995)
- 2 = HEAST, U.S. EPA (1995)
- 3 = U.S. EPA (1995)
- 4 = OHEA, U.S. EPA (1993)
- 5 = Interim toxicity criteria provided by Superfund Health Risk Techincal Support Center, Environmental Criteria Assessment Office (ECAO), Cincinnati, OH (1994)
- 6 = ECAO, U.S. EPA (1994i)
- 7 = ECAO, U.S. EPA (1994h)

[b] Health Based Limits calculated for 30-year exposure duration, 10^{-6} risk or hazard quotient = 1.

[c] Categorization of overall weight of evidence for human carcinogenicity:
- Group A: human carcinogen
- Group B: probable human carcinogen
  - B1: limited evidence from epidemiologic studies
  - B2: "sufficient" evidence from animal studies and "inadequate" evidence or "no data" from epidemiologic studies
- Group C: possible human carcinogen
- Group D: not classifiable as to health carcinogenicity
- Group E: evidence of noncarcinogenicity for humans

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Environmental Protection
Agency

Office of Solid Waste and
Emergency Response
Washington, DC 20460

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DISCLAIMER

Notice: The Soil Screening Guidance is based on policies set out in the Preamble to the Final Rule of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which was published on March 8, 1990 (55 *Federal Register* 8666).

This guidance document sets forth recommended approaches based on EPA's best thinking to date with respect to soil screening. Alternative approaches for screening may be found to be more appropriate at specific sites (e.g., where site circumstances do not match the underlying assumptions, conditions, and models of the guidance). The decision whether to use an alternative approach and a description of any such approach should be placed in the Administrative Record for the site.

The policies set out in both the Soil Screening Guidance: User's Guide and the supporting Soil Screening Guidance: Technical Background Document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States government. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change the guidance at any time without public notice.

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PREFACE

This document provides the technical background for the development of methodologies described in the *Soil Screening Guidance: User's Guide* (EPA/540/R-96/018), along with additional information useful for soil screening. Together, these documents define the framework and methodology for developing Soil Screening Levels (SSLs) for chemicals commonly found at Superfund sites. This document is an updated version of the background document developed in support of the December 30, 1994, draft Soil Screening Guidance. The methodologies described in this document and the guidance have been revised in response to public comment and extensive peer review. The revisions, along with other technical analyses conducted to address the comments, are described herein.

This background document is presented in five parts. Part 1 describes the soil screening process and its application and implementation at Superfund sites. Part 2 describes the methodology used to develop SSLs, including the assumptions and theories used. Part 3 provides information on more detailed models that may be used to develop site-specific SSLs. Part 4 addresses sampling schemes for measuring soil contaminant levels during the soil screening process. Part 5 provides technical background on the determination of chemical-specific properties for calculating SSLs.

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Part 1: INTRODUCTION

This document provides the technical background for the Soil Screening Guidance. The Soil Screening Guidance is a tool that the U.S. Environmental Protection Agency (EPA) developed to help standardize and accelerate the evaluation and cleanup of contaminated soils at sites on the National Priorities List (NPL) with anticipated future residential land use scenarios.[1] This guidance provides a methodology for environmental science/engineering professionals to calculate risk-based, site-specific, soil screening levels (SSLs), for contaminants in soil that may be used to identify areas needing further investigation at NPL sites.

SSLs are not national cleanup standards. SSLs alone do not trigger the need for response actions or define "unacceptable" levels of contaminants in soil. "Screening," for the purposes of this guidance, refers to the process of identifying and defining areas, contaminants, and conditions at a particular site that do not require further Federal attention. Generally, at sites where contaminant concentrations fall below SSLs, no further action or study is warranted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). (Some States have developed screening numbers or methodologies that may be more stringent than SSLs; therefore further study may be warranted under State programs.) Where contaminant concentrations equal or exceed the SSLs, further study or investigation, but not necessarily cleanup, is warranted.

The Soil Screening Guidance provides a framework for screening contaminated soils that encompasses both simple and more detailed approaches for calculating site-specific SSLs, and generic SSLs for use where site-specific data are limited. The *Soil Screening Guidance: User's Guide* (U.S. EPA, 1996) focuses on the application of the simple site-specific approach by providing a step-by-step methodology to calculate site-specific SSLs and plan the sampling necessary to apply them. This Technical Background Document describes the development and technical basis of the methodology presented in the User's Guide. It includes detailed modeling approaches for developing screening levels that can take into account more complex site conditions than the simple site-specific methodology emphasized in the User's Guide. It also provides generic SSLs for the most common contaminants found at NPL sites.

1.1 Background

The Soil Screening Guidance is the result of technical analyses and coordination with numerous stakeholders. The effort began in 1991 when the EPA Administrator charged the Office of Solid Waste and Emergency Response (OSWER) with conducting a 30-day study to outline options for accelerating the rate of cleanups at NPL sites. One of the specific proposals of the study was for OSWER to "examine the means to develop standards or guidelines for contaminated soils." Over the past 4 years, several drafts of the guidance and the accompanying technical background document have had widespread reviews both within and outside EPA. In the Spring of 1995, final drafts were released for public comment and external scientific peer review. Many reviewers' comments contributed significantly to the development of this flexible tool that uses site-specific data in a methodology that can be applied consistently across the nation.

1. Note that the Superfund program defines "soil" as having a particle size under 2 millimeters, while the RCRA program allows for particles under 9 millimeters in size.

1.2 Purpose of SSLs

In identifying and managing risks at sites, EPA considers a spectrum of contaminant concentrations. The level of concern associated with those concentrations depends on the likelihood of exposure to soil contamination at levels of potential concern to human health or to ecological receptors. Figure 1 illustrates the spectrum of soil contamination encountered at Superfund sites and the conceptual range of risk management. At one end are levels of contamination that clearly warrant a response action; at the other end are levels that are below regulatory concern. Appropriate cleanup goals for a particular site may fall anywhere within this range depending on site-specific conditions. Screening levels identify the lower bound of the spectrum -- levels below which there is no concern under CERCLA, provided conditions associated with the SSLs are met.

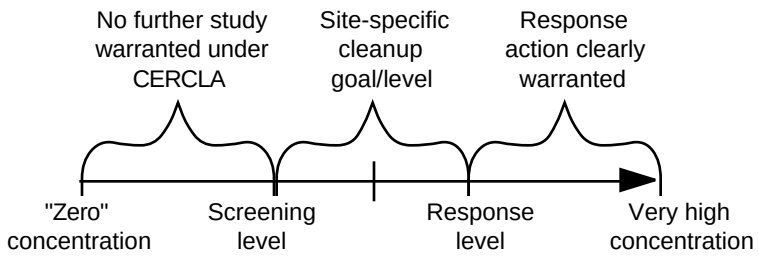

Figure 1. Conceptual Risk Management Spectrum for Contaminated Soil

Although the application of SSLs during site investigations is not mandatory at sites being addressed by CERCLA or RCRA, EPA recommends the use of SSLs as a tool to facilitate prompt identification of contaminants and exposure areas of concern. EPA developed the Soil Screening Guidance to be consistent with and to enhance the current Superfund investigation process and anticipates its primary use during the early stages of a remedial investigation (RI) at NPL sites. It does not replace the Remedial Investigation/Feasibility Study (RI/FS) or risk assessment, but use of screening levels can focus the RI and risk assessment on aspects of the site that are more likely to be a concern under CERCLA. By screening out areas of sites, potential chemicals of concern, or exposure pathways from further investigation, site managers and technical experts can limit the scope of the remedial investigation or risk assessment. SSLs can save resources by helping to determine which areas do not require additional Federal attention early in the process. Furthermore, data gathered during the soil screening process can be used in later Superfund phases, such as the baseline risk assessment, feasibility study, treatability study, and remedial design. This guidance may also be appropriate for use by the removal program when demarcation of soils above residential risk-based numbers coincides with the purpose and scope of the removal action. EPA created the Soil Screening Guidance to be consistent with and to enhance current Superfund processes.

The process presented in this guidance to develop and apply simple, site-specific soil screening levels is likely to be most useful where it is difficult to determine whether areas of soil are contaminated to an extent that warrants further investigation or response (e.g., whether areas of soil at an NPL site require further investigation under CERCLA through an RI/FS). The screening levels have been developed assuming future residential land use assumptions and related exposure scenarios. Although some of the models and methods presented in this guidance could be modified to address exposures

under other land uses, EPA has not yet standardized assumptions for those other uses. Using this guidance for sites where residential land use assumptions do not apply could result in overly conservative screening levels. However, EPA recognizes that some parties responsible for sites with non-residential land use might still benefit from using SSLs as a tool to conduct conservative initial screening.

EPA created the *Soil Screening Guidance: User's Guide* (U.S. EPA, 1996) to be easy to use: it provides a simple step-by-step methodology for calculating SSLs that are specific to the user's site. Applying site-specific screening levels involves developing a conceptual site model (CSM), collecting a few easily obtained site-specific soil parameters (such as the dry bulk density and percent soil moisture), and sampling soil to measure contaminant levels in surface and subsurface soils. Often, much of the information needed to develop the CSM can be derived from previous site investigations (e.g., the preliminary assessment/site inspection [PA/SI]) and, if properly planned, SSL sampling can be accomplished in one mobilization.

SSLs can be used as Preliminary Remediation Goals (PRGs) provided appropriate conditions are met (i.e., conditions found at a specific site are similar to conditions assumed in developing the SSLs). The concept of calculating risk-based soil levels for use as PRGs (or "draft" cleanup levels) was introduced in the *Risk Assessment Guidance for Superfund* (RAGS)*, Volume I, Human Health Evaluation Manual* (HHEM)*, Part B* (U.S. EPA, 1991b). PRGs are risk-based values that provide a reference point for establishing site-specific cleanup levels. The models, equations, and assumptions presented in the Soil Screening Guidance and described herein to address inhalation exposures supersede those described in RAGS HHEM, Part B, for residential soils. **In addition, this guidance presents methodologies to address the leaching of contaminants through soil to an underlying potable aquifer. This pathway should be addressed in the development of PRGs.**

EPA emphasizes that SSLs are **not** cleanup standards. SSLs should not be used as site-specific cleanup levels unless a site-specific nine-criteria evaluation using SSLs as PRGs for soils indicates that a selected remedy achieving the SSLs is protective, compliant with applicable or relevant and appropriate requirements (ARARs), and appropriately balances the other criteria, including cost. PRGs may then be converted into final cleanup levels based on the nine-criteria analysis described in the National Contingency Plan (NCP; Section 300.430 (3)(2)(A)). The directive entitled *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (U.S. EPA, 1991c) discusses the modification of PRGs to generate cleanup levels.

The generic SSLs provided in Appendix A are calculated from the same equations used in the simple site-specific methodology, but are based on a number of default assumptions chosen to be protective of human health for most site conditions. Generic SSLs can be used in place of site-specific screening levels; however, they are expected to be generally more conservative than site-specific levels. The site manager should weigh the cost of collecting the data necessary to develop site-specific SSLs with the potential for deriving a higher SSL that provides an appropriate level of protection.

1.3 Scope of Soil Screening Guidance

The Soil Screening Guidance incorporates readily obtainable site data into simple, standardized equations to derive site-specific screening levels for selected contaminants and exposure pathways. Key attributes of the Soil Screening Guidance are given in Highlight 1.

Highlight 1: Key Attributes of the Soil Screening Guidance

- Standardized equations are presented to address human exposure pathways in a residential setting consistent with Superfund's concept of "Reasonable Maximum Exposure" (RME).
- Source size (area and depth) can be considered on a site-specific basis using mass-limit models.
- Parameters are identified for which site-specific information is needed to develop site-specific SSLs.
- Default values are provided to calculate generic SSLs where site-specific information is not available.
- SSLs are generally based on a 10^{-6} risk for carcinogens, or a hazard quotient of 1 for noncarcinogens; SSLs for migration to ground water are based on (in order of preference): nonzero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or the aforementioned risk-based targets.

1.3.1 Exposure Pathways. In a residential setting, potential pathways of exposure to contaminants in soil are as follows (see Figure 2):

- Direct ingestion
- Inhalation of volatiles and fugitive dusts
- Ingestion of contaminated ground water caused by migration of chemicals through soil to an underlying potable aquifer
- Dermal absorption
- Ingestion of homegrown produce that has been contaminated via plant uptake
- Migration of volatiles into basements

The Soil Screening Guidance addresses each of these pathways to the greatest extent practical. The first three pathways -- direct ingestion, inhalation of volatiles and fugitive dusts, and ingestion of potable ground water, are the most common routes of human exposure to contaminants in the residential setting. These pathways have generally accepted methods, models, and assumptions that lend themselves to a standardized approach. The additional pathways of exposure to soil contaminants, dermal absorption, plant uptake, and migration of volatiles into basements, may also contribute to the risk to human health from exposure to specific contaminants in a residential setting. This guidance addresses these pathways to a limited extent based on available empirical data (see Part 2 for further discussion).

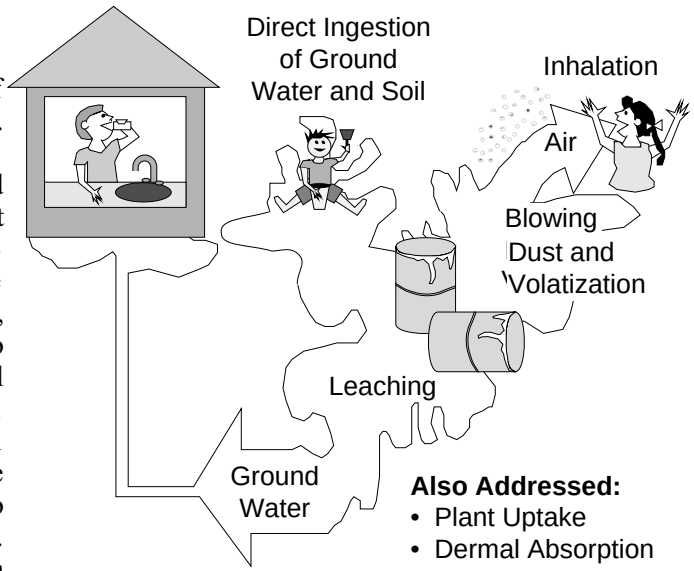

Figure 2. Exposure Pathways Addressed by SSLs.

The Soil Screening Guidance addresses the human exposure pathways listed previously and will be appropriate for most residential settings. The presence of additional pathways or unusual site conditions does not preclude the use of SSLs in areas of the site that are currently residential or likely to be residential in the future. However, the risks associated with these additional pathways or conditions (e.g., fish consumption, raising of livestock, heavy truck traffic on unpaved roads) should be considered in the remedial investigation/feasibility study (RI/FS) to determine whether SSLs are adequately protective.

An ecological assessment should also be performed as part of the RI/FS to evaluate potential risks to ecological receptors.

The Soil Screening Guidance should not be used for areas with radioactive contaminants.

1.3.2 Exposure Assumptions. SSLs are risk-based concentrations derived from equations combining exposure assumptions with EPA toxicity data. The models and assumptions used to calculate SSLs were developed to be consistent with Superfund's concept of "reasonable maximum exposure" (RME) in the residential setting. The Superfund program's method to estimate the RME for chronic exposures on a site-specific basis is to combine an average exposure point concentration with reasonably conservative values for intake and duration in the exposure calculations (U.S. EPA, 1989b; U.S. EPA, 1991a). The default intake and duration assumptions presented in U.S. EPA (1991a) were chosen to represent individuals living in a small town or other nontransient community. (Exposure to members of a more transient community is assumed to be shorter and thus associated with lower risk.) Exposure point concentrations are either measured at the site (e.g., ground water concentrations at a receptor well) or estimated using exposure models with site-specific model inputs. An average concentration term is used in most assessments where the focus is on estimating long-term, chronic exposures. Where the potential for acute toxicity is of concern, exposure estimates based on maximum concentrations may be more appropriate.

The resulting site-specific estimate of RME is then compared with a chemical-specific toxicity criterion such as a reference dose (RfD) or a reference concentration (RfC). EPA recommends using criteria from the Integrated Risk Information System (IRIS) (U.S. EPA, 1995b) and Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1995d), although values from other sources may be used in appropriate cases.

SSLs are concentrations of contaminants in soil that are designed to be protective of exposures in a residential setting. A site-specific risk assessment is an evaluation of the risk posed by exposure to site contaminants in various media. To calculate SSLs, the exposure equations and pathway models are run in reverse to backcalculate an “acceptable level” of a contaminant in soil corresponding to a specific level of risk.

1.3.3 Risk Level. For the ingestion, dermal, and inhalation pathways, toxicity criteria are used to define an acceptable level of contamination in soil, based on a one-in-a-million (10^{-6}) individual excess cancer risk for carcinogens and a hazard quotient (HQ) of 1 for non-carcinogens. SSLs are backcalculated for migration to ground water pathways using ground water concentration limits [nonzero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or health-based limits (HBLs) (10^{-6} cancer risk or a HQ of 1) where MCLs are not available].

The potential for additive effects has not been "built in" to the SSLs through apportionment. For carcinogens, EPA believes that setting a 10^{-6} risk level for individual chemicals and pathways will generally lead to cumulative risks within the risk range (10^{-4} to 10^{-6}) for the combinations of

chemicals typically found at Superfund sites. For noncarcinogens, additive risks should be considered only for those chemicals with the same toxic endpoint or mechanism of action (see Section 2.1).

1.3.4 SSL Model Assumptions. The models used to calculate inhalation and migration to ground water SSLs were designed for use at an early stage of site investigation when site information may be limited. Because of this constraint, they incorporate a number of simplifying assumptions.

The models assume that the source is infinite. Although the assumption is highly conservative, a finite source model cannot be applied unless there are accurate data regarding source size and volume. EPA believes it to be unlikely that such data will be available from the limited subsurface sampling that is done to apply SSLs. However, EPA also recognizes that infinite source models can violate mass balance (i.e., can release more contaminants than are present) for certain contaminants and site conditions (e.g., small sources). To address this problem, this guidance includes simple models that provide a mass-based limit for the inhalation and migration to ground water SSLs (see Section 2.6). **A site-specific estimate of source depth and area are required to calculate SSLs using these models**.

The infinite source assumption leads to several other simplifying assumptions. Fractionation of contaminant mass between the inhalation and migration to ground water pathways cannot be addressed with infinite source models. For the migration to ground water pathway, an infinite source overrides adsorption in the unsaturated zone or in the aquifer. The models also assume that contamination is evenly distributed throughout the source (i.e., homogeneous) and that no biological or chemical degradation occurs in the soil or in the aquifer. Again, models capable of addressing heterogeneities or degradation processes require collection of site-specific data that is well beyond the scope of the Soil Screening Guidance.

Although the Soil Screening Guidance encourages the use of site-specific data to calculate SSLs, conservative default parameters are provided for use where site-specific data are not available. These defaults are described in Part 2 of this document. Appendix A provides an example set of "generic" SSLs for 110 chemicals that are calculated using these defaults. Because they are designed to be protective of most site conditions across the nation, they are conservative.

A default 0.5 acre source area is used to calculate the generic SSLs. A 30 acre source size was used in the December 1994 guidance. EPA received an overwhelming number of comments that suggest that most contaminated soil sources addressed under the Superfund program are 0.5 acres or smaller. Because of the infinite source assumption, generic SSLs based on a 0.5 acre source size can be protective of larger sources as well (see Appendix A). However, this hypothesis should be examined on a case-by-case basis before applying the generic SSLs to sources larger than 0.5 acre.

1.4 Organization of the Document

Part 2 of this document describes the development of the simple equations used to calculate SSLs. It describes and supports the assumptions behind these equations and presents the results of analyses conducted to develop the SSL methodology. Some of the more sensitive parameters are identified for which site-specific data are likely to have a significant impact. Default values are provided along with their sources and limitations.

Part 3 presents information on other, more complex models that can be used to calculate inhalation and migration to ground water SSLs when more extensive site data are available or can be obtained.

Some of these models can consider a finite source and fractionation between exposure pathways. They also can model more complex site conditions than the simple SSL equations, including conditions that can lead to higher, yet still protective, SSLs (e.g., thick unsaturated zones, biological and chemical degradation, layered soils).

Part 4 provides the technical background for the development of the soil sampling design methodology for SSL application. It addresses methods for surface soil, including a test based on a maximum soil composite sample and the Chen method, which allows decision errors to be controlled. Part 4 also provides simulation results that measure the performance of these methods and sample size tables for different contaminant distributions and compositing schemes. Step-by-step guidance is provided for developing sample designs using each statistical procedure.

Part 5 describes the selection and development of the chemical properties used to calculate SSLs.

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Figure 2. Exposure Pathways Addressed
by SSLs. 4

Part 2: DEVELOPMENT OF PATHWAY-SPECIFIC SOIL SCREENING LEVELS

This part of the Technical Background Document describes the methods used to calculate SSLs for residential exposure pathways, along with their technical basis and limitations associated with their use. Simple, standardized equations have been developed for three common exposure pathways at Superfund sites:

- Ingestion of soil (Section 2.2)
- Inhalation of volatiles and fugitive dust (Section 2.4)
- Ingestion of contaminated ground water caused by migration of contaminants through soil to an underlying potable aquifer (Section 2.5).

The equations were developed under the following constraints:

- They should be consistent with current Superfund risk assessment methodologies and guidance.
- To be appropriate for early-stage application, they should be simple and easy to apply.
- They should allow the use of site-specific data where they are readily available or can be easily obtained.
- The process of developing and applying SSLs should generate information that can be used and built upon as a site evaluation progresses.

The equations for the inhalation and migration to ground water pathways include easily obtained site-specific input parameters. Conservative default values have been developed for use where site-specific data are not available. Generic SSLs, calculated for 110 chemicals using these default values, are presented in Appendix A. The generic SSLs are conservative, since the default values are designed to be protective at most sites across the country.

The inhalation and migration to ground water pathway equations assume an infinite source. As pointed out by several commenters to the December 1994 draft Soil Screening Guidance (U.S. EPA, 1994h), SSLs developed using these models may violate mass-balance for certain contaminants and site conditions (e.g., small sources). To address this concern, EPA has incorporated simple mass-limit models for these pathways assuming that the entire volume of contamination either volatilizes or leaches over the duration of exposure and that the level of contaminant at the receptor does not exceed the health-based limit (Section 2.6). **Because they require a site-specific estimate of source depth, these models cannot be used to calculate generic SSLs.**

Dermal adsorption, consumption of garden vegetables grown in contaminated soil, and migration of volatiles into basements also may contribute significantly to the risk to human health from exposure to soil contaminants in a residential setting. These pathways have been incorporated into the Soil Screening Guidance to the greatest extent practical.

Although methods for quantifying dermal exposures are available, their use for calculating SSLs is limited by the amount of data available on dermal absorption of specific chemicals (Section 2.3). Screening equations have been developed to estimate human exposure from the uptake of soil contaminants by garden plants (Section 2.7). As with dermal absorption, the number of chemicals for which adequate empirical data on plant uptake are limited. An approach to address migration of volatiles into basements is presented in Section 2.8, and limitations of the approach are discussed.

Section 2.1 describes the human health basis of the Soil Screening Guidance and provides the human toxicity and health benchmarks necessary to calculate SSLs. The selection and development of the chemical properties required to calculate SSLs are described in Part 5 of this document.

2.1 Human Health Basis

Table 1 lists the regulatory and human health benchmarks necessary to calculate SSLs for 110 chemicals including:

- Ingestion SSLs: oral cancer slope factors (SF_o) and noncancer reference doses (RfDs)
- Inhalation SSLs: inhalation unit risk factors (URFs) and reference concentrations (RfCs)
- Migration to ground water SSLs: drinking water standards (MCLGs and MCLs) and drinking water health-based levels (HBLs).

The human health benchmarks in Table 1 were obtained from IRIS (U.S. EPA, 1995b) or HEAST (U.S. EPA, 1995d) unless otherwise indicated. MCLGs and MCLs were obtained from U.S. EPA (1995a). Each of these references is updated regularly. **Prior to calculating SSLs, the values in Table 1 should be checked against the most recent version of these sources to ensure that they are up-to-date.**

2.1.1 Additive Risk. For soil ingestion and inhalation of volatiles and fugitive dusts, SSLs correspond to a 10^{-6} risk level for carcinogens and a hazard quotient of 1 for noncarcinogens. For carcinogens, EPA believes that setting a 10^{-6} risk level for individual chemicals and pathways generally will lead to cumulative risks within the 10^{-4} to 10^{-6} range for the combinations of chemicals typically found at Superfund sites.

Whereas the carcinogenic risks of multiple chemicals are simply added together, the issue of additive risk is much more complex for noncarcinogens because of the theory that a threshold exists for noncancer effects. This threshold level, below which adverse effects are not expected to occur, is the basis for EPA's RfD and RfC. Since adverse effects are not expected to occur at the RfD or RfC and the SSLs were derived by setting the potential exposure dose equal to the RfD or RfC (i.e., an HQ equal to 1), it is difficult to address the risk of exposure to multiple chemicals at levels where the individual chemicals alone would not be expected to cause any harmful effect. However, problems may arise when multiple chemicals produce related toxic effects.

EPA believes, and the Science Advisory Board (SAB) agrees (U.S. EPA, 1993e), that HQs should be added only for those chemicals with the same toxic endpoint and/or mechanism of action.

Table 1. Regulatory and Human Health Benchmarks Used for SSL Development

		Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
CAS Number	Chemical Name	MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
83-32-9	Acenaphthene					2E+00	RfD							6.0E-02	1		
67-64-1	Acetone (2-Propanone)					4E+00	RfD	D			D			1.0E-01	1		
309-00-2	Aldrin					5E-06	SF_o	B2	1.7E+01	1	B2	4.9E-03	1	3.0E-05	1		
120-12-7	Anthracene					1E+01	RfD	D			D			3.0E-01	1		
7440-36-0	Antimony	6.0E-03	3	6.0E-03	3									4.0E-04	1		
7440-38-2	Arsenic			5.0E-02	3			A	1.5E+00	1	A	4.3E-03	1	3.0E-04	1		
7440-39-3	Barium	2.0E+00	3	2.0E+00	3									7.0E-02	1	5.0E-04	2
56-55-3	Benz(*a*)anthracene					1E-04	SF_o	B2	7.3E-01	4	B2						
71-43-2	Benzene			5.0E-03	3			A	2.9E-02	1	A	8.3E-06	1				
205-99-2	Benzo(*b*)fluoranthene					1E-04	SF_o	B2	7.3E-01	4	B2						
207-08-9	Benzo(*k*)fluoranthene					1E-03	SF_o	B2	7.3E-02	4	B2						
65-85-0	Benzoic acid					1E+02	RfD							4.0E+00	1		
50-32-8	Benzo(*a*)pyrene			2.0E-04	3			B2	7.3E+00	1	B2						
7440-41-7	Beryllium	4.0E-03	3	4.0E-03	3			B2	4.3E+00	1	B2	2.4E-03	1	5.0E-03	1		
111-44-4	Bis(2-chloroethyl)ether					8E-05	SF_o	B2	1.1E+00	1	B2	3.3E-04	1				
117-81-7	Bis(2-ethylhexyl)phthalate			6.0E-03	3			B2	1.4E-02	1	B2			2.0E-02	1		
75-27-4	Bromodichloromethane			1.0E-01 *	3			B2	6.2E-02	1	B2			2.0E-02	1		
75-25-2	Bromoform (tribromomethane)			1.0E-01 *	3			B2	7.9E-03	1	B2	1.1E-06	1	2.0E-02	1		
71-36-3	Butanol					4E+00	RfD	D			D			1.0E-01	1		
85-68-7	Butyl benzyl phthalate					7E+00	RfD	C			C			2.0E-01	1		
7440-43-9	Cadmium	5.0E-03	3	5.0E-03	3						B1	1.8E-03	1	1.0E-03**	1		
86-74-8	Carbazole					4E-03	SF_o	B2	2.0E-02	2							
75-15-0	Carbon disulfide					4E+00	RfD							1.0E-01	1	7.0E-01	1
56-23-5	Carbon tetrachloride			5.0E-03	3			B2	1.3E-01	1	B2	1.5E-05	1	7.0E-04	1		
57-74-9	Chlordane			2.0E-03	3			B2	1.3E+00	1	B2	3.7E-04	1	6.0E-05	1		
106-47-8	*p* -Chloroaniline					1E-01	RfD							4.0E-03	1		
108-90-7	Chlorobenzene	1.0E-01	3	1.0E-01	3			D			D			2.0E-02	1	2.0E-02	2
124-48-1	Chlorodibromomethane	6.0E-02	3	1.0E-01 *	3			C	8.4E-02	1	C			2.0E-02	1		
67-66-3	Chloroform			1.0E-01 *	3			B2	6.1E-03	1	B2	2.3E-05	1	1.0E-02	1		
95-57-8	2-Chlorophenol					2E-01	RfD							5.0E-03	1		

* Proposed MCL = 0.08 mg/L, *Drinking Water Regulations and Health Advisories* , U.S. EPA (1995).

** Cadmium RfD is based on dietary exposure.

Table 1 (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
7440-47-3	Chromium	1.0E-01	3	1.0E-01	3			A			A	1.2E-02	1	5.0E-03	1		
16065-83-1	Chromium (III)					4E+01	RfD							1.0E+00	1		
18540-29-9	Chromium (VI)			1.0E-01	3 *			A			A	1.2E-02	1	5.0E-03	1		
218-01-9	Chrysene					1E-02	SF_o	B2	7.3E-03	4							
57-12-5	Cyanide (amenable)	(2.0E-01)	3	(2.0E-01)	3			D			D			2.0E-02	1		
72-54-8	DDD					4E-04	SF_o	B2	2.4E-01	1	B2						
72-55-9	DDE					3E-04	SF_o	B2	3.4E-01	1	B2						
50-29-3	DDT					3E-04	SF_o	B2	3.4E-01	1	B2	9.7E-05	1	5.0E-04	1		
53-70-3	Dibenz(*a,h*)anthracene					1E-05	SF_o	B2	7.3E+00	4	B2						
84-74-2	Di-*n* -butyl phthalate					4E+00	RfD	D			D			1.0E-01	1		
95-50-1	1,2-Dichlorobenzene	6.0E-01	3	6.0E-01	3			D			D			9.0E-02	1	2.0E-01	2
106-46-7	1,4-Dichlorobenzene	7.5E-02	3	7.5E-02	3			B2	2.4E-02	2	B2					8.0E-01	1
91-94-1	3,3-Dichlorobenzidine					2E-04	SF_o	B2	4.5E-01	1	B2						
75-34-3	1,1-Dichloroethane					4E+00	RfD	C			C			1.0E-01	7	5.0E-01	2
107-06-2	1,2-Dichloroethane			5.0E-03	3			B2	9.1E-02	1	B2	2.6E-05	1				
75-35-4	1,1-Dichloroethylene	7.0E-03	3	7.0E-03	3			C	6.0E-01	1	C	5.0E-05	1	9.0E-03	1		
156-59-2	*cis* -1,2-Dichloroethylene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	2		
156-60-5	*trans* -1,2-Dichloroethylene	1.0E-01	3	1.0E-01	3									2.0E-02	1		
120-83-2	2,4-Dichlorophenol					1E-01	RfD							3.0E-03	1		
78-87-5	1,2-Dichloropropane			5.0E-03	3			B2	6.8E-02	2	B2					4.0E-03	1
542-75-6	1,3-Dichloropropene					5E-04	SF_o	B2	1.8E-01	2	B2	3.7E-05	2	3.0E-04	1	2.0E-02	1
60-57-1	Dieldrin					5E-06	SF_o	B2	1.6E+01	1	B2	4.6E-03	1	5.0E-05	1		
84-66-2	Diethylphthalate					3E+01	RfD	D			D			8.0E-01	1		
105-67-9	2,4-Dimethylphenol					7E-01	RfD							2.0E-02	1		
51-28-5	2,4-Dinitrophenol					4E-02	RfD							2.0E-03	1		
121-14-2	2,4-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				2.0E-03	1		
606-20-2	2,6-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				1.0E-03	2		
117-84-0	Di-*n* -octyl phthalate					7E-01	RfD							2.0E-02	2		
115-29-7	Endosulfan					2E-01	RfD							6.0E-03	2		
72-20-8	Endrin	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	1		

* MCL for total chromium is based on Cr (VI) toxicity.

** Cancer Slope Factor is for 2,4-, 2,6-Dinitrotoluene mixture.

Table 1 (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
100-41-4	Ethylbenzene	7.0E-01	3	7.0E-01	3			D			D			1.0E-01	1	1.0E+00	1
206-44-0	Fluoranthene					1E+00	RfD	D			D			4.0E-02	1		
86-73-7	Fluorene					1E+00	RfD	D						4.0E-02	1		
76-44-8	Heptachlor			4.0E-04	3			B2	4.5E+00	1	B2	1.3E-03	1	5.0E-04	1		
1024-57-3	Heptachlor epoxide			2.0E-04	3			B2	9.1E+00	1	B2	2.6E-03	1	1.3E-05	1		
118-74-1	Hexachlorobenzene			1.0E-03	3			B2	1.6E+00	1	B2	4.6E-04	1	8.0E-04	1		
87-68-3	Hexachloro-1,3-butadiene	1.0E-03	3			1E-03	SF_o	C	7.8E-02	1	C	2.2E-05	1	2.0E-04	2		
319-84-6	α-HCH (α-BHC)					1E-05	SF_o	B2	6.3E+00	1	B2	1.8E-03	1				
319-85-7	β-HCH (β-BHC)					5E-05	SF_o	C	1.8E+00	1	C	5.3E-04	1				
58-89-9	γ-HCH (Lindane)	2.0E-04	3	2.0E-04	3			B2	1.3E+00	2	C			3.0E-04	1		
77-47-4	Hexachlorocyclopentadiene	5.0E-02	3	5.0E-02	3			D			D			7.0E-03	1	7.0E-05	2
67-72-1	Hexachloroethane					6E-03	SF_o	C	1.4E-02	1	C	4.0E-06	1	1.0E-03	1		
193-39-5	Indeno(1,2,3-*cd*)pyrene					1E-04	SF_o	B2	7.3E-01	4	B2						
78-59-1	Isophorone					9E-02	SF_o	C	9.5E-04	1	C			2.0E-01	1		
7439-97-6	Mercury	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	2	3.0E-04	2
72-43-5	Methoxychlor	4.0E-02	3	4.0E-02	3			D			D			5.0E-03	1		
74-83-9	Methyl bromide					5E-02	RfD	D			D			1.4E-03	1	5.0E-03	1
75-09-2	Methylene chloride			5.0E-03	3			B2	7.5E-03	1	B2	4.7E-07	1	6.0E-02	1	3.0E+00	2
95-48-7	2-Methylphenol (*o* -cresol)					2E+00	RfD	C			C			5.0E-02	1		
91-20-3	Naphthalene					1E+00	RfD	D			D			4.0E-02	6		
7440-02-0	Nickel					1E-01	HA *	A			A	2.4E-04	1	2.0E-02	1		
98-95-3	Nitrobenzene					2E-02	RfD	D			D			5.0E-04	1	2.0E-03	2
86-30-6	*N* -Nitrosodiphenylamine					2E-02	SF_o	B2	4.9E-03	1	B2						
621-64-7	*N* -Nitrosodi-*n* -propylamine					1E-05	SF_o	B2	7.0E+00	1	B2						
87-86-5	Pentachlorophenol			1.0E-03	3			B2	1.2E-01	1	B2			3.0E-02	1		
108-95-2	Phenol					2E+01	RfD	D			D			6.0E-01	1		
129-00-0	Pyrene					1E+00	RfD	D			D			3.0E-02	1		
7782-49-2	Selenium	5.0E-02	3	5.0E-02	3			D			D			5.0E-03	1		
7440-22-4	Silver					2E-01	RfD	D			D			5.0E-03	1		
100-42-5	Styrene	1.0E-01	3	1.0E-01	3									2.0E-01	1	1.0E+00	1
79-34-5	1,1,2,2-Tetrachloroethane					4E-04	SF_o	C	2.0E-01	1	C	5.8E-05	1				

* Health advisory for nickel (MCL is currently remanded); EPA Office of Science and Technology, 7/10/95.

Table 1 (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
127-18-4	Tetrachloroethylene			5.0E-03	3				5.2E-02	5		5.8E-07	5	1.0E-02	1		
7440-28-0	Thallium	5.0E-04	3	2.0E-03	3												
108-88-3	Toluene	1.0E+00	3	1.0E+00	3			D			D			2.0E-01	1	4.0E-01	1
8001-35-2	Toxaphene			3.0E-03	3			B2	1.1E+00	1	B2	3.2E-04	1				
120-82-1	1,2,4-Trichlorobenzene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	1	2.0E-01	2
71-55-6	1,1,1-Trichloroethane	2.0E-01	3	2.0E-01	3			D			D					1.0E+00	5
79-00-5	1,1,2-Trichloroethane	3.0E-03	3	5.0E-03	3			C	5.7E-02	1	C	1.6E-05	1	4.0E-03	1		
79-01-6	Trichloroethylene	zero	3	5.0E-03	3				1.1E-02	5		1.7E-06	5				
95-95-4	2,4,5-Trichlorophenol					4E+00	RfD							1.0E-01	1		
88-06-2	2,4,6-Trichlorophenol					8E-03	SF_o	B2	1.1E-02	1	B2	3.1E-06	1				
7440-62-2	Vanadium					3E-01	RfD							7.0E-03	2		
108-05-4	Vinyl acetate					4E+01	RfD							1.0E+00	1	2.0E-01	1
75-01-4	Vinyl chloride (chloroethene)			2.0E-03	3			A	1.9E+00	2	A	8.4E-05	2				
108-38-3	*m* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
95-47-6	*o* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
106-42-3	*p* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	1 **		
7440-66-6	Zinc					1E+01	RfD	D			D			3.0E-01	1		

* MCL for total xylenes [1330-20-7] is 10 mg/L.

** RfD for total xylenes is 2 mg/kg-day.

[a] References:
- 1 = IRIS, U.S. EPA (1995b)
- 2 = HEAST, U.S. EPA (1995d)
- 3 = U.S. EPA (1995a)
- 4 = OHEA, U.S. EPA (1993c)
- 5 = Interim toxicity criteria provided by Superfund Health Risk Techincal Support Center, Environmental Criteria Assessment Office (ECAO), Cincinnati, OH (1994)
- 6 = ECAO, U.S. EPA (1994g)
- 7 = ECAO, U.S. EPA (1994f)

[b] Health Based Limits calculated for 30-year exposure duration, 10^{-6} risk or hazard quotient = 1.

[c] Categorization of overall weight of evidence for human carcinogenicity:
- Group A: human carcinogen
- Group B: probable human carcinogen
  - B1: limited evidence from epidemiologic studies
  - B2: "sufficient" evidence from animal studies and "inadequate" evidence or "no data" from epidemiologic studies
- Group C: possible human carcinogen
- Group D: not classifiable as to health carcinogenicity
- Group E: evidence of noncarcinogenicity for humans

Additivity of the SSLs for noncarcinogenic chemicals is further complicated by the fact that not all SSLs are based on toxicity. Some SSLs are determined instead by a "ceiling limit" concentration (C_{sat}) above which these chemicals may occur as nonaqueous phase liquids (NAPLs) in soil (see Section 2.4.4). Therefore, the potential for additive effects must be carefully evaluated at every site by considering the total Hazard Index (HI) for chemicals with RfDs or RfCs based on the same endpoint of toxicity (i.e., has the same critical effect as defined by the Reference Dose Methodology), excluding chemicals with SSLs based on C_{sat}. Table 2 lists several SSL chemicals with RfDs/RfCs, grouping those chemicals whose RfDs or RfCs are based on toxic effects in the same target organ or system. However, this list is limited, and a toxicologist should be consulted prior to addressing additive risks at a specific site.

2.1.2 Apportionment and Fractionation. EPA also has evaluated the SSLs for noncarcinogens in light of two related issues: apportionment and fractionation. **Apportionment** is typically used as the percentage of a regulatory health-based level that is allocated to the source/pathway being regulated (e.g., 20 percent of the RfD for the migration to ground water pathway). Apportioning risk assumes that the applied dose from the source, in this case contaminated soils, is only one portion of the total applied dose received by the receptor. In the Superfund program, EPA has traditionally focused on quantifying exposures to a receptor that are clearly site-related and has not included exposures from other sources such as commercially available household products or workplace exposures. Depending on the assumptions concerning other source contributions, apportionment among pathways and sources at a site may result in **more conservative** regulatory levels (e.g., levels that are below an HQ of 1). Depending on site conditions, this may be appropriate on a site-specific basis.

In contrast to apportionment, **fractionation** of risk may lead to **less conservative** regulatory levels because it assumes that some fraction of the contaminant does not reach the receptor due to partitioning into another medium. For example, if only one-fifth of the source is assumed to be available to the ground water pathway, and the remaining four-fifths is assumed to be released to air or remain in the soil, an SSL for the migration to ground water pathway could be set at five times the HQ of 1 due to the decrease in exposure (since only one-fifth of the possible contaminant is available to the pathway). However, the data collected to apply SSLs generally will not support the finite source models necessary for partitioning contaminants between pathways.

2.1.3 Acute Exposures. The exposure assumptions used to develop SSLs are representative of a chronic exposure scenario and do not account for situations where high-level exposures may lead to acute toxicity. For example, in some cases, children may ingest large amounts of soil (e.g., 3 to 5 grams) in a single event. This behavior, known as pica, may result in relatively high short-term exposures to contaminants in soils. Such exposures may be of concern for contaminants that primarily exhibit acute health effects. Review of clinical reports on contaminants addressed in this guidance suggests that acute effects of **cyanide** and **phenol** may be of concern in children exhibiting pica behavior. If soils containing cyanide and phenol are present at a site, the protectiveness of the chronic ingestion SSLs for these chemicals should be reconsidered.

Although the Soil Screening Guidance instructs site managers to consider the potential for acute exposures on a site-specific basis, there are two major impediments to developing **acute** SSLs. First, although data are available on chronic exposures (i.e., RfDs, RfCs, cancer slope factors), there is a paucity of data relating the potential for acute effects for most Superfund chemicals. Specifically, there is no scale to evaluate the severity of acute effects (e.g., eye irritation vs. dermatitis), no consensus on how to incorporate the body's recovery mechanisms following acute exposures, and no toxicity benchmarks to apply for short-term exposures (e.g., a 7-day RfD for a critical endpoint).

Table 2. SSL Chemicals with Noncarcinogenic Effects on Specific Target Organ/System

Target Organ/System	Effect
Kidney	
Acetone	Increased weight; nephrotoxicity
1,1-Dichloroethane	Kidney damage
Cadmium	Significant proteinuria
Chlorobenzene	Kidney effects
Di-*n*-octyl phthalate	Kidney effects
Endosulfan	Glomerulonephrosis
Ethylbenzene	Kidney toxicity
Fluoranthene	Nephropathy
Nitrobenzene	Renal and adrenal lesions
Pyrene	Kidney effects
Toluene	Changes in kidney weights
2,4,5-Trichlorophenol	Pathology
Vinyl acetate	Altered kidney weight
Liver	
Acenaphthene	Hepatotoxicity
Acetone	Increased weight
Butyl benzyl phthalate	Increased liver-to-body weight and liver-to-brain weight ratios
Chlorobenzene	Histopathology
Di-*n*-octyl phthalate	Increased weight; increased SGOT and SGPT activity
Endrin	Mild histological lesions in liver
Flouranthene	Increased liver weight
Nitrobenzene	Lesions
Styrene	Liver effects
Toluene	Changes in liver weights
2,4,5-Trichlorophenol	Pathology
Central Nervous System	
Butanol	Hypoactivity and ataxia
Cyanide (amenable)	Weight loss, myelin degeneration
2,4 Dimethylphenol	Prostatration and ataxia
Endrin	Occasional convulsions
2-Methylphenol	Neurotoxicity
Mercury	Hand tremor, memory disturbances
Styrene	Neurotoxicity
Xylenes	Hyperactivity
Adrenal Gland	
Nitrobenzene	Adrenal lesions
1,2,4-Trichlorobenzene	Increased adrenal weights; vacuolization in cortex

Table 2: (continued)

Target Organ/System	Effect
Circulatory System	
Antimony	Altered blood chemistry and myocardial effects
Barium	Increased blood pressure
trans-1,2-Dichloroethene	Increased alkaline phosphatase level
cis-1,2-Dichloroethylene	Decreased hematocrit and hemoglobin
2,4-Dimethylphenol	Altered blood chemistry
Fluoranthene	Hematologic changes
Fluorene	Decreased RBC and hemoglobin
Nitrobenzene	Hematologic changes
Styrene	Red blood cell effects
Zinc	Decrease in erythrocyte superoxide dismutase (ESOD)
Reproductive System	
Barium	Fetotoxicity
Carbon disulfide	Fetal toxicity and malformations
2-Chlorophenol	Reproductive effects
Methoxychlor	Excessive loss of litters
Phenol	Reduced fetal body weight in rats
Respiratory System	
1,2-Dichloropropane	Hyperplasia of the nasal mucosa
Hexachlorocyclopentadiene	Squamous metaplasia
Methyl bromide	Lesions on the olfactory epithelium of the nasal cavity
Vinyl acetate	Nasal epithelial lesions
Gastrointestinal System	
Hexachlorocyclopentadiene	Stomach lesions
Methyl bromide	Epithelial hyperplasia of the forestomach
Immune System	
2,4-Dichlorophenol	Altered immune function
p-Chloroaniline	Nonneoplastic lesions of splenic capsule

Source: U.S. EPA, 1995b, U.S. EPA, 1995d.

Second, the inclusion of acute SSLs would require the development of acute exposure scenarios that would be acceptable and applicable nationally. Simply put, the methodology and data necessary to address acute exposures in a standard manner analogous to that for chronic exposures have not been developed.

2.1.4 Route-to-Route Extrapolation. For a number of the contaminants commonly found at Superfund sites, inhalation benchmarks for toxicity are not available from IRIS or HEAST (see Table 1). Given that many of these chemicals exhibit systemic toxicity, EPA recognizes that the lack of such benchmarks could result in an underestimation of risk from contaminants in soil through the inhalation pathway. As pointed out by commenters to the December 1994 draft Soil Screening Guidance, ingestion SSLs tend to be higher than inhalation SSLs for most volatile chemicals with both inhalation and ingestion benchmarks. This suggests that ingestion SSLs may not be adequately protective for inhalation exposure to chemicals without inhalation benchmarks.

However, with the exception of vinyl chloride (which is gaseous at ambient temperatures), migration to ground water SSLs are significantly lower than inhalation SSLs for volatile organic chemicals (see the generic SSLs presented in Appendix A). Thus, at sites where ground water is of concern, migration to ground water SSLs generally will be protective from the standpoint of inhalation risk. However, if the ground water pathway is not of concern at a site, the use of SSLs for soil ingestion may not be adequately protective for the inhalation pathway.

To address this concern, OERR evaluated potential approaches for deriving inhalation benchmarks using route-to-route extrapolation from oral benchmarks (e.g., RfC_{inh} from RfD_{oral}). EPA evaluated a number of issues concerning route-to-route extrapolation, including: the potential reactivity of airborne toxicants (e.g., portal-of-entry effects), the pharmacokinetic behavior of toxicants for different routes of exposure (e.g., absorption by the gut versus absorption by the lung), and the significance of physicochemical properties in determining dose (e.g., vapor pressure, solubility). During this process, OERR consulted with staff in the EPA Office of Research and Development (ORD) to identify the most appropriate techniques for route-to-route extrapolation. Appendix B describes this analysis and its results.

As part of this analysis, inhalation benchmarks were derived using simple route-to-route extrapolation for 50 contaminants lacking inhalation benchmarks. A review of SSLs calculated from these extrapolated benchmarks indicated that for 36 of the 50 contaminants, inhalation SSLs exceed the soil saturation concentration (C_{sat}), often by several orders of magnitude. Because maximum volatile emissions occur at C_{sat} (see Section 2.4.4), these 36 contaminants are not likely to pose significant risks through the inhalation pathway at any soil concentration and the lack of inhalation benchmarks is not likely to underestimate risks. All of the 14 remaining contaminants with extrapolated inhalation SSLs below C_{sat} have inhalation SSLs above generic SSLs for the migration to ground water pathway (dilution attenuation factor [DAF] of 20). This suggests that migration to ground water SSLs will be adequately protective of volatile inhalation risks at sites where ground water is of concern.

At sites where ground water is not of concern (e.g., where ground water beneath or adjacent to the site is not a potential source of drinking water), the Appendix B analysis suggests that for certain contaminants, ingestion SSLs may not be protective of inhalation risks for contaminants lacking inhalation benchmarks. The analysis indicates that the extrapolated inhalation SSL values are below SSL values based on direct ingestion for the following chemicals: acetone, bromodichloromethane, chlorodibromomethane, *cis*-1,2-dichloroethylene, and *trans*-1,2-dichloroethylene. This supports the **possibility** that the SSLs based on direct ingestion for the listed chemicals may not be adequately protective of inhalation exposures. However, because this analysis is based on simplified route-to-route extrapolation methods, a more rigorous evaluation of route-to-route extrapolation methods may be warranted, especially at sites where ground water is not of concern.

Based on these results, EPA reached the following conclusions regarding the route-to-route extrapolation of inhalation benchmarks for the development of inhalation SSLs. First, it is reasonable to assume that, for some volatile contaminants, the lack of inhalation benchmarks may underestimate risks due to inhalation of volatile contaminants at a site. However, the analysis in Appendix B suggests that this issue is only of concern for sites where the exposure potential for the inhalation pathway approaches that for ingestion of ground water or at sites where the migration to ground water pathway is not of concern.

Second, the **extrapolated** inhalation SSL values are not intended to be used as generic SSLs for site investigations; the **extrapolated** inhalation SSLs are useful in determining the potential for inhalation risks but should not be misused as SSLs. The extrapolated inhalation benchmarks, used to calculate extrapolated inhalation SSLs, simply provide an estimate of the air concentration ($\mu g/m^3$)

required to produce an inhaled dose equivalent to the dose received via oral administration, and lack the scientific rigor required by EPA for route-to-route extrapolation. Route-to-route extrapolation methods must account for a relationship between physicochemical properties, absorption and distribution of toxicants, the significance of portal-of-entry effects, and the potential differences in metabolic pathways associated with the intensity and duration of inhalation exposures. However, methods required to develop sufficiently rigorous inhalation benchmarks have only recently been developed by the ORD. EPA's ORD has made available a guidance document that addresses many of the issues critical to the development of inhalation benchmarks. The document, entitled *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (U.S. EPA, 1994d), presents methods for applying inhalation dosimetry to derive inhalation reference concentrations and represents the current state-of-the-science at EPA with respect to inhalation benchmark development. The fundamentals of inhalation dosimetry are presented with respect to the toxicokinetic behavior of contaminants and the physicochemical properties of chemical contaminants.

Thus, at sites where the migration to ground water pathway is not of concern and a site manager determines that the inhalation pathway may be significant for contaminants lacking inhalation benchmarks, route-to-route extrapolation may be performed using EPA-approved methods on a case-by-case basis. Chemical-specific route-to-route extrapolations should be accompanied by a complete discussion of the data, underlying assumptions, and uncertainties identified in the extrapolation process. Extrapolation methods should be consistent with the EPA guidance presented in *Methods for Derivation of Inhalation Reference Concentrations and Applications of Inhalation Dosimetry* (U.S. EPA, 1994d). If a route-to-route extrapolation is found not to be appropriate based on the ORD guidance, the information on extrapolated SSLs may be included as part of the uncertainty analysis of the baseline risk assessment for the site.

2.2 Direct Ingestion

Calculation of SSLs for direct ingestion of soil is based on the methodology presented for residential land use in RAGS HHEM, Part B (U.S. EPA, 1991b). Briefly, this methodology backcalculates a soil concentration level from a target risk (for carcinogens) or hazard quotient (for noncarcinogens). A number of studies have shown that inadvertent ingestion of soil is common among children 6 years old and younger (Calabrese et al., 1989; Davis et al., 1990; Van Wijnen et al., 1990). Therefore, the approach uses an age-adjusted soil ingestion factor that takes into account the difference in daily soil ingestion rates, body weights, and exposure duration for children from 1 to 6 years old and others from 7 to 31 years old. The higher intake rate of soil by children and their lower body weights lead to a lower, or more conservative, risk-based concentration compared to an adult-only assumption. RAGS HHEM, Part B uses this age-adjusted approach for both noncarcinogens and carcinogens.

For noncarcinogens, the definition of an RfD has led to debates concerning the comparison of less-than-lifetime estimates of exposure to the RfD. Specifically, it is often asked whether the comparison of a 6-year exposure, estimated for children via soil ingestion, to the chronic RfD is unnecessarily conservative.

In their analysis of the issue, the SAB indicates that, for most chemicals, the approach of combining the higher 6-year exposure for children with chronic toxicity criteria is overly protective (U.S. EPA, 1993e). However, they noted that there are instances when the chronic RfD may be based on endpoints of toxicity that are specific to children (e.g., fluoride and nitrates) or when the dose-response curve is steep (i.e., the dosage difference between the no-observed-adverse-effects level [NOAEL] and an adverse effects level is small). Thus, for the purposes of screening, OERR opted to base the generic SSLs for noncarcinogenic contaminants on the more conservative “childhood only”

exposure (Equation 1). The issue of whether to maintain this more conservative approach throughout the baseline risk assessment and establishing remediation goals will depend on how the toxicology of the chemical relates to the issues raised by the SAB.

Screening Level Equation for Ingestion of Noncarcinogenic Contaminants in Residential Soil
(Source: RAGS HHEM, Part B; U.S. EPA, 1991b)

$$\text{Screening Level (mg/kg)} = \frac{THQ \times BW \times AT \times 365\ d/yr}{1/RfD_o \times 10^{-6}\ kg/mg \times EF \times ED \times IR} \quad \textbf{(1)}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	15
AT/averaging time (yr)	6[a]
RfD_o /oral reference dose (mg/kg-d)	chemical-specific
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	6
IR/soil ingestion rate (mg/d)	200

[a] For noncarcinogens, averaging time is equal to exposure duration. Unlike RAGS HHEM, Part B, SSLs are calculated only for 6-year childhood exposure.

For carcinogens, both the magnitude and duration of exposure are important. Duration is critical because the toxicity criteria are based on "lifetime average daily dose." Therefore, the total dose received, whether it be over 5 years or 50 years, is averaged over a lifetime of 70 years. To be protective of exposures to carcinogens in the residential setting, RAGS HHEM, Part B (U.S. EPA, 1991b) and EPA focus on exposures to individuals who may live in the same residence for a "high-end" period of time (e.g., 30 years). As mentioned above, exposure to soil is higher during childhood and decreases with age. Thus, Equation 2 uses the RAGS HHEM, Part B time-weighted average soil ingestion rate for children and adults; the derivation of this factor is shown in Equation 3.

Screening Level Equation for Ingestion of Carcinogenic Contaminants in Residential Soil
(Source: RAGS HHEM, Part B; U.S. EPA, 1991b)

$$\text{Screening Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{SF_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil/adj}} \quad \textbf{(2)}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (yr)	70
SF_o /oral slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific
EF/exposure frequency (d/yr)	350
$IF_{soil/adj}$ /age-adjusted soil ingestion factor (mg-yr/kg-d)	114

Equation for Age-Adjusted Soil Ingestion Factor, $IF_{soil/adj}$

$$\underset{(mg\text{-}yr/kg\text{-}d)}{IF_{soil/adj}} = \frac{IR_{soil/age1\text{-}6} \times ED_{age1\text{-}6}}{BW_{age1\text{-}6}} + \frac{IR_{soil/age7\text{-}31} \times ED_{age7\text{-}31}}{BW_{age7\text{-}31}} \qquad \textbf{(3)}$$

Parameter/Definition (units)	Default
$IF_{soil/adj}$ /age-adjusted soil ingestion factor (mg-yr/kg-d)	114
$IR_{soil/age1\text{-}6}$ /ingestion rate of soil age 1-6 (mg/d)	200
$ED_{age1\text{-}6}$ /exposure duration during ages 1-6 (yr)	6
$IR_{soil/age7\text{-}31}$ /ingestion rate of soil age 7-31 (mg/d)	100
$ED_{age7\text{-}31}$ /exposure duration during ages 7-31 (yr)	24
$BW_{age1\text{-}6}$ /average body weight from ages 1-6 (kg)	15
$BW_{age7\text{-}31}$ /average body weight from ages 7-31 (kg)	70

Source: RAGS HHEM, Part B (U.S. EPA, 1991b).

Because of the impracticability of developing site-specific input parameters (e.g., soil ingestion rates, chemical-specific bioavailability) for direct soil ingestion, SSLs are calculated using the defaults listed in Equations 1, 2, and 3. Appendix A lists these generic SSLs for direct ingestion of soil.

2.3 Dermal Absorption

Incorporation of dermal exposures into the Soil Screening Guidance is limited by the amount of data available to quantify dermal absorption from soil for specific chemicals. EPA's ORD evaluated the available data on absorption of chemicals from soil in the document *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA, 1992b). This document also presents calculations comparing the potential dose of a chemical in soil from oral routes with that from dermal routes of exposure.

These calculations suggest that, assuming 100 percent absorption of a chemical via ingestion, absorption via the dermal route must be greater than 10 percent to equal or exceed the ingestion exposure. Of the 110 compounds evaluated, available data are adequate to show greater than 10 percent dermal absorption only for pentachlorophenol (Wester et al., 1993). Therefore, the ingestion SSL for pentachlorophenol is adjusted to account for this additional exposure (i.e., the ingestion SSL has been divided in half to account for increased exposure via the dermal route). Limited data suggest that dermal absorption of other semivolatile organic chemicals (e.g., benzo(*a*)pyrene) from soil may exceed 10 percent (Wester et al., 1990) but EPA believes that

further investigation is needed. As adequate dermal absorption data are developed for such chemicals the ingestion SSLs may need to be adjusted. EPA will provide updates on this issue as appropriate.

2.4 Inhalation of Volatiles and Fugitive Dusts

EPA toxicity data indicate that risks from exposure to some chemicals via inhalation far outweigh the risks via ingestion; therefore, the SSLs have been designed to address this pathway as well. The models and assumptions used to calculate SSLs for inhalation of volatiles are updates of risk assessment methods presented in RAGS HHEM, Part B (U.S. EPA, 1991b). RAGS HHEM, Part B evaluated the contribution to risk from the inhalation and ingestion pathways simultaneously. Because toxicity criteria for oral exposures are presented as administered doses (in mg/kg-d) and criteria for inhalation exposures are presented as concentrations in air (in $\mu g/m^3$), conversion of air concentrations was required to estimate an administered dose comparable to the oral route. However, EPA's ORD now believes that, due to portal-of-entry effects and differences in absorption in the gut versus the lungs, the conversion from concentration in air to internal dose is not always appropriate and suggests evaluating these exposure routes separately.

The models and assumptions used to calculate SSLs for the inhalation pathway are presented in Equations 4 through 12, along with the default parameter values used to calculate the generic SSLs presented in Appendix A. Particular attention is given to the volatilization factor (VF), saturation limit (C_{sat}), and the dispersion portion of the VF and particulate emission factor (PEF) equations, all of which have been revised since originally presented in RAGS HHEM, Part B. The available chemical-specific human health benchmarks used in these equations are presented in Section 2.1. Part 5 presents the chemical properties required by these equations, along with the rationale for their selection and development.

2.4.1 Screening Level Equations for Direct Inhalation. Equations 4 and 5 are used to calculate SSLs for the inhalation of carcinogenic and noncarcinogenic contaminants, respectively. Each equation addresses volatile compounds and fugitive dusts separately for developing screening levels based on inhalation risk for subsurface soils and surface soils.

Separate VF-based and PEF-based equations were developed because the SSL sampling strategy addresses surface and subsurface soils separately. Inhalation risk from fugitive dusts results from particle entrainment from the soil surface; thus contaminant concentrations in the surface soil horizon (e.g., the top 2 centimeters) are of primary concern for this pathway. The entire column of contaminated soil can contribute to volatile emissions at a site. However, the top 2 centimeters are likely to be depleted of volatile contaminants at most sites. Thus, contaminant concentrations in subsurface soils, which are measured using core samples, are of primary concern for quantifying the risk from volatile emissions.

Screening Level Equation for Inhalation of Carcinogenic Contaminants in Residential Soil

$$\text{Volatile Screening Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{URF \times 1{,}000\ \mu g/mg \times EF \times ED \times \left[\frac{1}{VF}\right]} \quad \textbf{(4)}$$

$$\text{Particulate Screening Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{URF \times 1{,}000\ \mu g/mg \times EF \times ED \times \left[\frac{1}{PEF}\right]}$$

Parameter/Definition (units)	Default
TR/target cancer risk (unitless)	10^{-6}
AT/averaging time (yr)	70
URF/inhalation unit risk factor $(\mu g/m^3)^{-1}$	chemical-specific
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
VF/soil-to-air volatilization factor (m^3/kg)	chemical-specific
PEF/particulate emission factor (m^3/kg)	1.32×10^9

Source: RAGS HHEM, Part B (U.S. EPA, 1991b).

Screening Level Equation for Inhalation of Noncarcinogenic Contaminants in Residential Soil

$$\text{Volatile Screening Level (mg/kg)} = \frac{THQ \times AT \times 365\ d/yr}{EF \times ED \times \left(\frac{1}{RfC} \times \frac{1}{VF}\right)} \quad \textbf{(5)}$$

$$\text{Particulate Screening Level (mg/kg)} = \frac{THQ \times AT \times 365\ d/yr}{EF \times ED \times \left(\frac{1}{RfC} \times \frac{1}{PEF}\right)}$$

Parameter/Definition (units)	Default
THQ/target hazard quotient (unitless)	1
AT/averaging time (yr)	30
EF/exposure frequency (d/yr)	350
ED/exposure duration (yr)	30
RfC/inhalation reference concentration (mg/m^3)	chemical-specific
VF/soil-to-air volatilization factor (m^3/kg)	chemical-specific
PEF/particulate emission factor (m^3/kg) (Equation 10)	1.32×10^9

Source: RAGS HHEM, Part B (U.S. EPA, 1991b).

To calculate inhalation SSLs, the volatilization factor and particulate emission factor must be calculated. The derivations of VF and PEF have been updated since RAGS HHEM, Part B was published and are discussed fully in Sections 2.4.2 and 2.4.5, respectively. The VF and PEF equations can be broken into two separate models: models to estimate the emissions of volatiles and dusts, and a dispersion model (reduced to the term Q/C) that simulates the dispersion of contaminants in the atmosphere.

2.4.2 Volatilization Factor. The soil-to-air VF is used to define the relationship between the concentration of the contaminant in soil and the flux of the volatilized contaminant to air. VF is calculated from Equation 6 using chemical-specific properties (see Part 5) and either site-measured or default values for soil moisture, dry bulk density, and fraction of organic carbon in soil. The User's Guide (U.S. EPA, 1996) describes how to develop site measured values for these parameters.

Derivation of Volatilization Factor

$$VF\ (m^3/kg) = Q/C \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4} (m^2/cm^2) \qquad \textbf{(6)}$$

where

$$D_A = \frac{\left[(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2\right]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter/Definition (units)	Default	Source
VF/volatilization factor (m^3/kg)	–	–
D_A /apparent diffusivity (cm^2/s)	–	–
Q/C/inverse of the mean conc. at center of square source (g/m^2-s per kg/m^3)	68.81	Table 3 (for 0.5-acre source in Los Angeles, CA)
T/exposure interval (s)	9.5×10^8	U.S. EPA (1991b)
ρ_b/dry soil bulk density (g/cm^3)	1.5	U.S. EPA (1991b)
θ_a /air-filled soil porosity (L_{air}/L_{soil})	0.28	n - θ_w
n/total soil porosity (L_{pore}/L_{soil})	0.43	1 - (ρ_b/ρ_s)
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.15	EQ, 1994
ρ_s /soil particle density (g/cm^3)	2.65	U.S. EPA (1991b)
D_i /diffusivity in air (cm^2/s)	chemical-specific	see Part 5
H′/dimensionless Henry's law constant	chemical-specific	see Part 5
D_w /diffusivity in water (cm^2/s)	chemical-specific	see Part 5
K_d /soil-water partition coefficient (cm^3/g) = K_{oc} f_{oc}	chemical-specific	see Part 5
K_{oc} /soil organic carbon-water partition coefficient (cm^3/g)	chemical-specific	see Part 5
f_{oc}/organic carbon content of soil (g/g)	0.006 (0.6%)	Carsel et al. (1988)

The VF equation presented in Equation 6 is based on the volatilization model developed by Jury et al. (1984) for infinite sources and is theoretically consistent with the Jury et al. (1990) finite source volatilization model (see Section 3.1). This equation represents a change in the fundamental volatilization model used to derive the VF equation used in RAGS HHEM, Part B and in the December 1994 draft Soil Screening Guidance (U.S. EPA, 1994h).

The VF equation presented in RAGS HHEM, Part B is based on the volatilization model developed by Hwang and Falco (1986) for dry soils. During the reevaluation of RAGS HHEM, Part B, EPA sponsored a study (see the December 1994 draft Technical Background Document, U.S. EPA, 1994i) to validate the VF equation by comparing the modeled results with data from (1) a bench-scale pesticide study (Farmer and Letey, 1974) and (2) a pilot-scale study measuring the rate of loss of benzene, toluene, xylenes, and ethylbenzene from soils using an isolation flux chamber (Radian, 1989). The results of the study verified the need to modify the VF equation in Part B to take into account the decrease in the rate of flux due to the effect of soil moisture content on effective diffusivity (D_{ei}).

In the December 1994 version of this background document (U.S. EPA, 1994i), the Hwang and Falco model was modified to account for the influence of soil moisture on the effective diffusivity using the Millington and Quirk (1961) equation. However, inconsistencies were discovered in the modified Hwang and Falco equations. Additionally, even a correctly modified Hwang and Falco model does not consider the influence of the liquid phase on the local equilibrium partitioning. Consequently, EPA evaluated the Jury model for its ability to predict emissions measured in pilot-scale volatilization studies (Appendix C; EQ, 1995). The infinite source Jury model emission rate predictions were consistently within a factor of 2 of the emission rates measured in the pilot-scale volatilization studies. Because the Jury model predicts well the available measured soil contaminant volatilization rates, eliminates the inconsistencies of the modified Hwang and Falco model, and considers the

influence of the liquid phase on the local equilibrium partitioning, it was selected to replace the modified Hwang and Falco model for the derivation of the VF equation.

Defaults. Other than initial soil concentration, air-filled soil porosity is the most significant soil parameter affecting the final steady-state flux of volatile contaminants from soil (U.S. EPA, 1980). In other words, the higher the air-filled soil porosity, the greater the emission flux of volatile constituents. Air-filled soil porosity is calculated as:

$$\theta_a = n - \theta_w \tag{7}$$

where

θ_a = air-filled soil porosity (L_{air}/L_{soil})
n = total soil porosity (L_{pore}/L_{soil})
θ_w = water-filled soil porosity (L_{water}/L_{soil})

and

$$n = 1 - (\rho_b/\rho_s) \tag{8}$$

where

ρ_b = dry soil bulk density (g/cm^3)
ρ_s = soil particle density (g/cm^3).

Of these parameters, water-filled soil porosity (θ_w) has the most significant effect on air-filled soil porosity and hence volatile contaminant emissions. Sensitivity analyses have shown that soil bulk density (ρ_b) has too limited a range for surface soils (generally between 1.3 and 1.7 g/cm^3) to affect results with nearly the significance of soil moisture conditions. Therefore, a default bulk density of 1.50 g/cm^3, the mode of the range given for U.S. soils in the *Superfund Exposure Assessment Manual* (U.S. EPA, 1988), was chosen to calculate generic SSLs. This value is also consistent with the mean porosity (0.43) for loam soil presented in Carsel and Parrish (1988).

The default value of θ_w (0.15) corresponds to an average annual soil water content of 10 weight percent. This value was chosen as a conservative compromise between that required to achieve a monomolecular layer of water on soil particles (approximately 2 to 5 weight percent) and that required to reduce the air-filled porosity to zero (approximately 29 weight percent). In this manner, nonpolar or weakly polar contaminants are desorbed readily from the soil organic carbon as water competes for sorption sites. At the same time, a soil moisture content of 10 percent yields a relatively conservative air-filled porosity (0.28 or 28 percent by volume). A water-filled soil porosity (θ_w) of 0.15 lies about halfway between the mean wilting point (0.09) and mean field capacity (0.20) reported for Class B soils by Carsel et al. (1988). Class B soils are soils with moderate hydrologic characteristics whose average characteristics are well represented by a loam soil type.

The default value of ρ_s (2.65 g/cm^3) was taken from U.S. EPA (1988) as the particle density for most soil mineral material. The default value for f_{oc} (0.006 or 0.6 percent) is the mean value for the top 0.3 m of Class B soils from Carsel et al. (1988).

2.4.3 Dispersion Model. The box model in RAGS HHEM, Part B has been replaced with a Q/C term derived from a modeling exercise using meteorologic data from 29 locations across the United States.

The dispersion model used in the Part B guidance is based on the assumption that emissions into a hypothetical box will be distributed uniformly throughout the box. To arrive at the volume within the box, it is necessary to assign values to the length, width, and height of the box. The length (LS) was the length of a side of a contaminated site with a default value of 45 m; the width was based on the windspeed in the mixing zone (V) with a default value of 2.25 m (based on a windspeed of 2.25 m/s); and the height was the diffusion height (DH) with a default value of 2 m.

However, the assumptions and mathematical treatment of dispersion used in the box model may not be applicable to a broad range of site types and meteorology and do not utilize state-of-the-art techniques developed for regulatory dispersion modeling. EPA was very concerned about the defensibility of the box model and sought a more defensible dispersion model that could be used as a replacement to the Part B guidance and had the following characteristics:

- Dispersion modeling from a ground-level area source
- Onsite receptor
- A long-term/annual average exposure point concentration
- Algorithms for calculating the exposure point concentration for area sources of different sizes and shapes.

To identify such a model, EPA held discussions with the EPA Office of Air Quality Planning and Standards (OAQPS) concerning recent efforts to develop a new algorithm for estimating ambient air concentrations from low or ground-level, nonbuoyant sources of emissions. The new algorithm is incorporated into the Industrial Source Complex Model (ISC2) platform in both a short-term mode (AREA-ST) and a long-term mode (AREA-LT). Both models employ a double numerical integration over the source in the upwind and crosswind directions. Wind tunnel tests have shown that the new algorithm performs well with onsite and near-field receptors. In addition, subdivision of the source is not required for these receptors.

Because the new algorithm provides better concentration estimates for onsite and for near-field receptors, a revised dispersion analysis was performed for both volatile and particulate matter contaminants (Appendix D; EQ, 1994). The AREA-ST model was run for 0.5-acre and 30-acre square sources with a full year of meteorologic data for 29 U.S locations selected to be representative of the national range of meteorologic conditions (EQ, 1993). Additional modeling runs were conducted to address a range of square area sources from 0.5 to 30 acres in size (Table 3). The Q/C values in Table 3 for 0.5- and 30-acre sources differ slightly from the values in Appendix D due to differences in rounding conventions used in the final model runs.

To calculate site-specific SSLs, select a Q/C value from Table 3 that best represents a site's size and meteorologic condition.

To develop a reasonably conservative default Q/C for calculating generic SSLs, a default site (Los Angeles, CA) was chosen that best approximated the 90th percentile of the 29 normalized concentrations (kg/m^3 per g/m^2-s). The inverse of this concentration results in a default VF Q/C value of 68.81 g/m^2-s per kg/m^3 for a 0.5-acre site.

Table 3. Q/C Values by Source Area, City, and Climatic Zone

	Q/C (g/m^2-s per kg/m^3)					
	0.5 Acre	1 Acre	2 Acre	5 Acre	10 Acre	30 Acre
Zone I						
Seattle	82.72	72.62	64.38	55.66	50.09	42.86
Salem	73.44	64.42	57.09	49.33	44.37	37.94
Zone II						
Fresno	62.00	54.37	48.16	41.57	37.36	31.90
Los Angeles	68.81	60.24	53.30	45.93	41.24	35.15
San Francisco	89.51	78.51	69.55	60.03	53.95	46.03
Zone III						
Las Vegas	95.55	83.87	74.38	64.32	57.90	49.56
Phoenix	64.04	56.07	49.59	42.72	38.35	32.68
Albuquerque	84.18	73.82	65.40	56.47	50.77	43.37
Zone IV						
Boise	69.41	60.88	53.94	46.57	41.87	35.75
Winnemucca	69.23	60.67	53.72	46.35	41.65	35.55
Salt Lake City	78.09	68.47	60.66	52.37	47.08	40.20
Casper	100.13	87.87	77.91	67.34	60.59	51.80
Denver	75.59	66.27	58.68	50.64	45.52	38.87
Zone V						
Bismark	83.39	73.07	64.71	55.82	50.16	42.79
Minneapolis	90.80	79.68	70.64	61.03	54.90	46.92
Lincoln	81.64	71.47	63.22	54.47	48.89	41.65
Zone VI						
Little Rock	73.63	64.51	57.10	49.23	44.19	37.64
Houston	79.25	69.47	61.53	53.11	47.74	40.76
Atlanta	77.08	67.56	59.83	51.62	46.37	39.54
Charleston	74.89	65.65	58.13	50.17	45.08	38.48
Raleigh-Durham	77.26	67.75	60.01	51.78	46.51	39.64
Zone VII						
Chicago	97.78	85.81	76.08	65.75	59.16	50.60
Cleveland	83.22	73.06	64.78	55.99	50.38	43.08
Huntington	53.89	47.24	41.83	36.10	32.43	27.67
Harrisburg	81.90	71.87	63.72	55.07	49.56	42.40
Zone VIII						
Portland	74.23	65.01	57.52	49.57	44.49	37.88
Hartford	71.35	62.55	55.40	47.83	43.00	36.73
Philadelphia	90.24	79.14	70.14	60.59	54.50	46.59
Zone IX						
Miami	85.61	74.97	66.33	57.17	51.33	43.74

2.4.4 Soil Saturation Limit. The soil saturation concentration (C_{sat}) corresponds to the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil pore water, and saturation of soil pore air have been reached. Above this concentration, the soil contaminant may be present in free phase, i.e., nonaqueous phase liquids (NAPLs) for contaminants that are liquid at ambient soil temperatures and pure solid phases for compounds that are solid at ambient soil temperatures.

Derivation of the Soil Saturation Limit

$$C_{sat} = \frac{S}{\rho_b}\left(K_d\,\rho_b + \theta_w + H'\,\theta_a\right) \qquad \textbf{(9)}$$

Parameter/Definition (units)	Default	Source
C_{sat}/soil saturation concentration (mg/kg)	–	
S/solubility in water (mg/L-water)	chemical-specific	see Part 5
ρ_b/dry soil bulk density (kg/L)	1.5	U.S. EPA, 1991b
K_d/soil-water partition coefficient (L/kg)	$K_{oc} \times f_{oc}$ (organics)	
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	chemical-specific	see Part 5
f_{oc}/fraction organic carbon of soil (g/g)	0.006 (0.6%)	Carsel et al., 1988
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.15	EQ, 1994
H′/dimensionless Henry's law constant	H x 41, where 41 is a conversion factor	U.S. EPA, 1991b
H/Henry's law constant (atm-m^3/mol)	chemical-specific	see Part 5
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.28	n - θ_w
n/total soil porosity (L_{pore}/L_{soil})	0.43	1 - ρ_b/ρ_s
ρ_s/soil particle density (kg/L)	2.65	U.S. EPA, 1991b

Equation 9 is used to calculate C_{sat} for each site contaminant. As an update to RAGS HHEM, Part B, this equation takes into account the amount of contaminant that is in the vapor phase in the pore spaces of the soil in addition to the amount dissolved in the soil's pore water and sorbed to soil particles.

Chemical-specific C_{sat} concentrations must be compared with each volatile inhalation SSL because a basic principle of the SSL volatilization model (Henry's law) is not applicable when free-phase contaminants are present (i.e., the model cannot predict an accurate VF or SSL above C_{sat}). Thus, the VF-based inhalation SSLs are applicable only if the soil concentration is at or below C_{sat}. When calculating volatile inhalation SSLs, C_{sat} values also should be calculated using the same site-specific soil characteristics used to calculate SSLs (i.e., bulk density, average water content, and organic carbon content).

At C_{sat} the emission flux from soil to air for a chemical reaches a plateau. Volatile emissions will not increase above this level no matter how much more chemical is added to the soil. Table 3-A shows that for compounds with generic volatile inhalation SSLs greater than C_{sat}, the risks at C_{sat} are significantly below the screening risk of 1×10^{-6} and an HQ of 1. Since C_{sat} corresponds to maximum

volatile emissions, the inhalation route is not likely to be of concern for those chemicals with SSLs exceeding C_{sat} concentrations.

Table 3-A. Risk Levels Calculated at C_{sat} for Contaminants that have SSL_{inh} Values Greater than C_{sat}

Chemical name	URF ($\mu g/m^3$)$^{-1}$	RfC (mg/m^3)	VF (m^3/kg)	C_{sat} (mg/kg)	Carcinogenic Risk	Non-Carcinogenic Risk
DDT	9.7E-05	---	3.0E+07	4.0E+02	5.2E-07	---
1,2-Dichlorobenzene	---	2.0E-01	1.5E+04	6.0E+02	---	0.2
1,4-Dichlorobenzene	---	8.0E-01	1.3E+04	2.8E+02	---	0.03
Ethylbenzene	---	1.0E+00	5.4E+03	4.0E+02	---	0.07
β-HCH (β-BHC)	5.3E-04	---	1.3E+06	2.0E+00	3.4E-07	---
Styrene	---	1.0E+00	1.3E+04	1.5E+03	---	0.1
Toluene	---	4.0E-01	4.0E+03	6.5E+02	---	0.4
1,2,4-Trichlorobenzene	---	2.0E-01	4.3E+04	3.2E+03	---	0.4
1,1,1-Trichloroethane	---	1.0E+00	2.2E-03	1.2E+03	---	0.5

Table 4 provides the physical state (i.e. liquid or solid) for various compounds at ambient soil temperature. When the inhalation SSL exceeds C_{sat} for liquid compounds, the SSL is set at C_{sat}. This is because, for compounds that are liquid at ambient soil temperature, concentrations above C_{sat} indicate a potential for free liquid phase contamination to be present, and the possible presence of NAPLs. EPA believes that further investigation is warranted when free nonaqueous phase liquids may be present in soils at a site.

Table 4. Physical State of Organic SSL Chemicals

Compounds liquid at soil temperatures			Compounds solid at soil temperatures		
CAS No.	Chemical	Melting Point (˚C)	CAS No.	Chemical	Melting Point (˚C)
67-64-1	Acetone	-94.8	83-32-9	Acenaphthene	93.4
71-43-2	Benzene	5.5	309-00-2	Aldrin	104
117-81-7	Bis(2-ethylhexyl)phthalate	-55	120-12-7	Anthracene	215
111-44-4	Bis(2-chloroethyl)ether	-51.9	56-55-3	Benz(*a*)anthracene	84
75-27-4	Bromodichloromethane	-57	50-32-8	Benzo(*a*)pyrene	176.5
75-25-2	Bromoform	8	205-99-2	Benzo(*b*)fluoranthene	168
71-36-3	Butanol	-89.8	207-08-9	Benzo(*k*)fluoranthene	217
85-68-7	Butyl benzyl phthalate	-35	65-85-0	Benzoic acid	122.4
75-15-0	Carbon disulfide	-115	86-74-8	Carbazole	246.2
56-23-5	Carbon tetrachloride	-23	57-74-9	Chlordane	106
108-90-7	Chlorobenzene	-45.2	106-47-8	*p*-Chloroaniline	72.5
124-48-1	Chlorodibromomethane	-20	218-01-9	Chrysene	258.2
67-66-3	Chloroform	-63.6	72-54-8	DDD	109.5

Table 4. (continued)

Compounds liquid at soil temperatures			Compounds solid at soil temperatures		
CAS No.	Chemical	Melting Point (˚C)	CAS No.	Chemical	Melting Point (˚C)
95-57-8	2-Chlorophenol	9.8	72-55-9	DDE	89
84-74-2	Di-*n*-butyl phthalate	-35	50-29-3	DDT	108.5
95-50-1	1,2-Dichlorobenzene	-16.7	53-70-3	Dibenzo(*a,h*)anthracene	269.5
75-34-3	1,1-Dichloroethane	-96.9	106-46-7	1,4-Dichlorobenzene	52.7
107-06-2	1,2-Dichloroethane	-35.5	91-94-1	3,3-Dichlorobenzidine	132.5
75-35-4	1,1-Dichloroethylene	-122.5	120-83-2	2,4-Dichlorophenol	45
156-59-2	*cis*-1,2-Dichloroethylene	-80	60-57-1	Dieldrin	175.5
156-60-5	*trans*-1,2-Dichloroethylene	-49.8	105-67-9	2,4-Dimethylphenol	24.5
78-87-5	1,2-Dichloropropane	-70	51-28-5	2,4-Dinitrophenol	115-116
542-75-6	1,3-Dichloropropene	NA	121-14-2	2,4-Dinitrotoluene	71
84-66-2	Diethylphthalate	-40.5	606-20-2	2,6-Dinitrotoluene	66
117-84-0	Di-*n*-octyl phthalate	-30	72-20-8	Endrin	200
100-41-4	Ethylbenzene	-94.9	206-44-0	Fluoranthene	107.8
87-68-3	Hexachloro-1,3-butadiene	-21	86-73-7	Fluorene	114.8
77-47-4	Hexachlorocyclopentadiene	-9	76-44-8	Heptachlor	95.5
78-59-1	Isophorone	-8.1	1024-57-3	Heptachlor epoxide	160
74-83-9	Methyl bromide	-93.7	118-74-1	Hexachlorobenzene	231.8
75-09-2	Methylene chloride	-95.1	319-84-6	α-HCH (α-BHC)	160
98-95-3	Nitrobenzene	5.7	319-85-7	ß-HCH (ß-BHC)	315
100-42-5	Styrene	-31	58-89-9	γ-HCH (Lindane)	112.5
79-34-5	1,1,2,2-Tetrachloroethane	-43.8	67-72-1	Hexachloroethane	187
127-18-4	Tetrachloroethylene	-22.3	193-39-5	Indeno(1,2,3-*cd*)pyrene	161.5
108-88-3	Toluene	-94.9	72-43-5	Methoxychlor	87
120-82-1	1,2,4-Trichlorobenzene	17	95-48-7	2-Methylphenol	29.8
71-55-6	1,1,1-Trichloroethane	-30.4	621-64-7	*N*-Nitrosodi-*n*-propylamine	NA
79-00-5	1,1,2-Trichloroethane	-36.6	86-30-6	*N*-Nitrosodiphenylamine	66.5
79-01-6	Trichloroethylene	-84.7	91-20-3	Naphthalene	80.2
108-05-4	Vinyl acetate	-93.2	87-86-5	Pentachlorophenol	174
75-01-4	Vinyl chloride	-153.7	108-95-2	Phenol	40.9
108-38-3	*m*-Xylene	-47.8	129-00-0	Pyrene	151.2
95-47-6	*o*-Xylene	-25.2	8001-35-2	Toxaphene	65-90
106-42-3	*p*-Xylene	13.2	95-95-4	2,4,5-Trichlorophenol	69
			88-06-2	2,4,6-Trichlorophenol	69
			115-29-7	Endosullfan	106

NA = Not available.

When free phase liquid contaminants are suspected, *Estimating the Potential for Occurrence of DNAPL at Superfund Sites* (U.S. EPA, 1992c) provides information on determining the likelihood of dense nonaqueous phase liquid (DNAPL) occurrence in the subsurface. Free-phase contaminants may also be present at concentrations lower than C_{sat} if multiple component mixtures are present. The DNAPL guidance (U.S. EPA, 1992c) also addresses the likelihood of free-phase contaminants when multiple contaminants are present at a site.

For compounds that are solid at ambient soil temperatures (e.g., DDT), Table 3-A indicates that the inhalation risks are well below the screening targets (i.e., these chemicals do not appear to be of concern for the inhalation pathway). Thus, when inhalation SSLs are above C_{sat} for solid compounds, soil screening decisions should be based on the appropriate SSLs for other pathways of concern at the site (e.g., migration to ground water, ingestion).

2.4.5 Particulate Emission Factor. The particulate emission factor relates the concentration of contaminant in soil with the concentration of dust particles in the air. This guidance addresses dust generated from open sources, which is termed "fugitive" because it is not discharged into the atmosphere in a confined flow stream. Other sources of fugitive dusts that may lead to higher emissions due to mechanical disturbances include unpaved roads, tilled agricultural soils, and heavy construction operations.

Both the emissions portion and the dispersion portion of the PEF equation have been updated since RAGS HHEM, Part B.

As in Part B, the emissions part of the PEF equation is based on the "unlimited reservoir" model from Cowherd et al. (1985) developed to estimate particulate emissions due to wind erosion. The unlimited reservoir model is most sensitive to the threshold friction velocity, which is a function of the mode of the size distribution of surface soil aggregates. This parameter has the greatest effect on the emissions and resulting concentration. For this reason, a conservative mode soil aggregate size of 500 µm was selected as the default value for calculating generic SSLs.

The mode soil aggregate size determines how much wind is needed before dust is generated at a site. A mode soil aggregate size of 500 µm yields an **uncorrected** threshold friction velocity of 0.5 m/s. This means that the windspeed must be at least 0.5 m/s before any fugitive dusts are generated. However, the threshold friction velocity **should be corrected** to account for the presence of nonerodible elements. In Cowherd et al. (1985), nonerodible elements are described as

. . . clumps of grass or stones (larger than about 1 cm in diameter) on the surface (that will) consume part of the shear stress of the wind which otherwise would be transferred to erodible soil.

Cowherd et al. describe a study by Marshall (1971) that used wind tunnel studies to quantify the increase in the threshold friction velocity for different kinds of nonerodible elements. His results are presented in Cowherd et al. as a graph showing the rate of corrected to uncorrected threshold friction velocity vs. L_c, where L_c is a measure of nonerodible elements vs. bare, loose soil. Thus, the ratio of corrected to uncorrected threshold friction velocity is directly related to the amount of nonerodible elements in surface soils.

Using a ratio of corrected to uncorrected threshold friction velocity of 1, or no correction, is roughly equivalent to modeling "coal dust on a concrete pad," whereas using a correction factor of 2 corresponds to a windspeed of 19 m/s at a height of 10 m. This means that about a 43-mph wind would be required to produce any particulate emissions. Given that the 29 meteorologic data sets used in this modeling effort showed few windspeeds at, or greater than, 19 m/s, EPA felt that it was necessary to choose a default correction ratio between 1 and 2. A value of 1.25 was selected as a

reasonable number that would be at the more conservative end of the range. This equates to a corrected threshold friction velocity of 0.625 m/s and an equivalent windspeed of 11.3 m/s at a height of 7 meters.

As with the VF model, Q/C values are needed to calculate the PEF (Equation 10); use the QC value in Table 3 that best represents a site's size and meteorologic conditions (i.e., the same value used to calculate the VF; see Section 2.4.2). Cowherd et al. (1985) describe how to obtain site-specific estimates of V, U_m, U_t, and F(x).

Unlike volatile contaminants, meteorologic conditions (i.e., the intensity and frequency of wind) affect both the dispersion and emissions of particulate matter. For this reason, a separate default Q/C value was derived for particulate matter [nominally 10 µm and less (PM_{10})] emissions for the generic SSLs. The PEF equation was used to calculate annual average concentrations for each of 29 sites across the country. To develop a reasonably conservative default Q/C for calculating generic SSLs, a default site (Minneapolis, MN) was selected that best approximated the 90th percentile concentration.

The results produced a revised default PEF Q/C value of 90.80 g/m^2-s per kg/m^3 for a 0.5-acre site (see Appendix D; EQ, 1994). The generic PEF derived using the default values in Equation 10 is 1.32 x 10^9 m^3/kg, which corresponds to a receptor point concentration of approximately 0.76 µg/m^3. This represents an annual average emission rate based on wind erosion that should be compared with chronic health criteria; it is **not** appropriate for evaluating the potential for more acute exposures.

Derivation of the Particulate Emission Factor

$$\text{PEF}\ (\text{m}^3/\text{kg}) = Q/C \times \frac{3{,}600\ \text{s/h}}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)} \qquad \textbf{(10)}$$

Parameter/Definition (units)	Default	Source
PEF/particulate emission factor (m^3/kg)	1.32 x 10^9	--
Q/C/inverse of mean conc. at center of square source (g/m^2-s per kg/m^3)	90.80	Table 3 (for 0.5-acre source in Minneapolis, MN)
V/fraction of vegetative cover (unitless)	0.5 (50%)	U.S. EPA, 1991b
U_m/mean annual windspeed (m/s)	4.69	EQ, 1994
U_t/equivalent threshold value of windspeed at 7 m (m/s)	11.32	U.S. EPA, 1991b
F(x)/function dependent on U_m/U_t derived using Cowherd et al. (1985) (unitless)	0.194	U.S. EPA, 1991b

2.5 Migration to Ground Water

The methodology for calculating SSLs for the migration to ground water pathway was developed to identify chemical concentrations in soil that have the potential to contaminate ground water.

Migration of contaminants from soil to ground water can be envisioned as a two-stage process: (1) release of contaminant in soil leachate and (2) transport of the contaminant through the underlying soil and aquifer to a receptor well. The SSL methodology considers both of these fate and transport mechanisms.

The methodology incorporates a standard linear equilibrium soil/water partition equation to estimate contaminant release in soil leachate (see Sections 2.5.1 through 2.5.4) and a simple water-balance equation that calculates a dilution factor to account for dilution of soil leachate in an aquifer (see Section 2.5.5). The dilution factor represents the reduction in soil leachate contaminant concentrations by mixing in the aquifer, expressed as the ratio of leachate concentration to the concentration in ground water at the receptor point (i.e., drinking water well). Because the infinite source assumption can result in mass-balance violations for soluble contaminants and small sources, mass-limit models are provided that limit the amount of contaminant migrating from soil to ground water to the total amount of contaminant present in the source (see Section 2.6).

SSLs are backcalculated from acceptable ground water concentrations (i.e., nonzero MCLGs, MCLs, or HBLs; see Section 2.1). First, the acceptable ground water concentration is multiplied by a dilution factor to obtain a target leachate concentration. For example, if the dilution factor is 10 and the acceptable ground water concentration is 0.05 mg/L, the target soil leachate concentration would be 0.5 mg/L. The partition equation is then used to calculate the total soil concentration (i.e., SSL) corresponding to this soil leachate concentration.

The methodology for calculating SSLs for the migration to ground water pathway was developed under the following constraints:

- Because of the large nationwide variability in ground water vulnerability, the methodology should be flexible, allowing adjustments for site-specific conditions if adequate information is available.

- To be appropriate for early-stage application, the methodology needs to be simple, requiring a minimum of site-specific data.

- The methodology should be consistent with current understanding of subsurface processes.

- The process of developing and applying SSLs should generate information that can be used and built upon as a site evaluation progresses.

Flexibility is achieved by using readily obtainable site-specific data in standardized equations; conservative default input parameters are also provided for use when site-specific data are not available. In addition, more complex unsaturated zone fate-and-transport models have been identified that can be used to calculate SSLs when more detailed site-specific information is available or can be obtained (see Part 3). These models can extend the applicability of SSLs to subsurface conditions that are not adequately addressed by the simple equations (e.g., deep water tables; clay layers or other unsaturated zone characteristics that can attenuate contaminants before they reach ground water).

The SSL methodology was designed for use during the early stages of a site evaluation when information about subsurface conditions may be limited. Because of this constraint, the methodology is based on conservative, simplifying assumptions about the release and transport of contaminants in the subsurface (see Highlight 2).

Highlight 2: Simplifying Assumptions for the Migration to Ground Water Pathway

- The source is infinite (i.e., steady-state concentrations will be maintained in ground water over the exposure period of interest).
- Contaminants are uniformly distributed throughout the zone of contamination.
- Soil contamination extends from the surface to the water table (i.e., adsorption sites are filled in the unsaturated zone beneath the area of contamination).
- There is no chemical or biological degradation in the unsaturated zone.
- Equilibrium soil/water partitioning is instantaneous and linear in the contaminated soil.
- The receptor well is at the edge of the source (i.e., there is no dilution from recharge downgradient of the site) and is screened within the plume.
- The aquifer is unconsolidated and unconfined (surficial).
- Aquifer properties are homogeneous and isotropic.
- There is no attenuation (i.e., adsorption or degradation) of contaminants in the aquifer.
- NAPLs are not present at the site.

Although simplified, the SSL methodology described in this section is theoretically and operationally consistent with the more sophisticated investigation and modeling efforts that are conducted to develop soil cleanup goals and cleanup levels for protection of ground water at Superfund sites. SSLs developed using this methodology can be viewed as evolving risk-based levels that can be refined as more site information becomes available. The early use of the methodology at a site will help focus further subsurface investigations on areas of true concern with respect to ground water quality and will provide information on soil characteristics, aquifer characteristics, and chemical properties that can be built upon as a site evaluation progresses.

2.5.1 Development of Soil/Water Partition Equation. The methodology used to estimate contaminant release in soil leachate is based on the Freundlich equation, which was developed to model sorption from liquids to solids. The basic Freundlich equation applied to the soil/water system is:

$$K_d = C_s / C_w^n \qquad \textbf{(11)}$$

where

K_d = Freundlich soil/water partition coefficient (L/kg)
C_s = concentration sorbed on soil (mg/kg)
C_w = solution concentration (mg/L)
n = Freundlich exponent (dimensionless).

Assuming that adsorption is linear with respect to concentration (n=1)* and rearranging to backcalculate a sorbed concentration (C_s):

$$C_s = (K_d)\ C_w \tag{12}$$

For SSL calculation, C_w is the target soil leachate concentration.

Adjusting Sorbed Soil Concentrations to Total Concentrations. To develop a screening level for comparison with contaminated soil samples, the sorbed concentration derived above (C_s) must be related to the total concentration measured in a soil sample (C_t). In a soil sample, contaminants can be associated with the solid soil materials, the soil water, and the soil air as follows (Feenstra et al., 1991):

$$M_t = M_s + M_w + M_a \tag{13}$$

where

M_t = total contaminant mass in sample (mg)
M_s = contaminant mass sorbed on soil materials (mg)
M_w = contaminant mass in soil water (mg)
M_a = contaminant mass in soil air (mg).

Furthermore,

$$M_t = C_t\ \rho_b\ V_{sp}\ , \tag{14}$$

$$M_s = C_s\ \rho_b\ V_{sp}\ , \tag{15}$$

$$M_w = C_w\ \theta_w\ V_{sp}\ , \tag{16}$$

and

$$M_a = C_a\ \theta_a\ V_{sp}\ , \tag{17}$$

where

ρ_b = dry soil bulk density (kg/L)
V_{sp} = sample volume (L)
θ_w = water-filled porosity (L_{water}/L_{soil})
C_a = concentration on soil pore air (mg/L_{soil})
θ_a = air-filled soil porosity (L_{air}/L_{soil}).

For contaminated soils (with concentrations below C_{sat}), C_a may be determined from C_w and the dimensionless Henry's law constant (H') using the following relationship:

$$C_a = C_w\ H' \tag{18}$$

---

* The linear assumption will tend to overestimate sorption and underestimate desorption for most organics at higher concentrations (i.e., above 10^{-5} M for organics) (Piwoni and Banerjee, 1989).

thus

$$M_a = C_w H' \theta_a V_{sp} \tag{19}$$

Substituting into Equation 13:

$$C_t = \frac{C_s \rho_b + C_w \theta_w + C_w H' \theta_a}{\rho_b} \tag{20}$$

or

$$C_s = C_t - C_w \left(\frac{\theta_w + \theta_a H'}{\rho_b} \right) \tag{21}$$

Substituting into Equation 12 and rearranging:

Soil-Water Partition Equation for Migration to Ground Water Pathway: Inorganic Contaminants

$$C_t = C_w \left(K_d + \frac{\theta_w + \theta_a H'}{\rho_b} \right) \tag{22}$$

Parameter/Definition (units)	Default	Source
C_t/screening level in soil (mg/kg)	–	–
C_w/target soil leachate concentration (mg/L)	(nonzero MCLG, MCL, or HBL) × 20 DAF	Table 1 (nonzero MCLG, MCL); Section 2.5.6 (DAF for 0.5-acre source)
K_d/soil-water partition coefficient (L/kg)	chemical-specific	see Part 5
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.3 (30%)	U.S. EPA/ORD
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.13	n - θ_w
n/total soil porosity (L_{pore}/L_{soil})	0.43	1 - ρ_b/ρ_s
ρ_b/dry soil bulk density (kg/L)	1.5	U.S. EPA, 1991b
ρ_s/soil particle density (kg/L)	2.65	U.S. EPA, 1991b
H′/dimensionless Henry's law constant	H × 41, where 41 is a conversion factor	U.S. EPA, 1991b
H/Henry's law constant (atm-m^3/mol)	chemical-specific	see Part 5

Equation 22 is used to calculate SSLs (total soil concentrations, C_t) corresponding to soil leachate concentrations (C_w) equal to the target contaminant soil leachate concentration. The equation assumes that soil water, solids, and gas are conserved during sampling. If soil gas is lost during sampling, θ_a should be assumed to be zero. Likewise, for inorganic contaminants except mercury, there is no significant vapor pressure and H' may be assumed to be zero.

The User's Guide (U.S. EPA, 1996) describes how to develop site-specific estimates of the soil parameters needed to calculate SSLs. Default soil parameter values for the partition equation are the same as those used for the VF equation (see Section 2.4.2) except for average water-filled soil porosity (θ_w). A conservative value (0.15) was used in the VF equation because the model is most sensitive to this parameter. Because migration to ground water SSLs are not particularly sensitive to soil water content (see Section 2.5.7), a value that is more typical of subsurface conditions (0.30) was used. This value is between the mean field capacity (0.20) of Class B soils (Carsel et al., 1988) and the saturated volumetric water content for loam (0.43).

K_d varies by chemical and soil type. Because of different influences on K_d values, derivations of K_d values for organic compounds and metals were treated separately in the SSL methodology.

2.5.2 Organic Compounds—Partition Theory. Past research has demonstrated that, for hydrophobic organic chemicals, soil organic matter is the dominant sorbing component in soil and that K_d is linear with respect to soil organic carbon content (OC) as long as OC is above a critical level (Dragun, 1988). Thus, K_d can be normalized with respect to soil organic carbon to K_{oc}, a chemical-specific partitioning coefficient that is independent of soil type, as follows:

$$K_d = K_{oc}\, f_{oc} \tag{23}$$

where

K_{oc} = organic carbon partition coefficient (L/kg)
f_{oc} = fraction of organic carbon in soil (mg/mg)

Substituting into Equation 22:

Soil-Water Partition Equation for Migration to Ground Water Pathway: Organic Contaminants

$$C_t = C_w \left((K_{oc}\, f_{oc}) + \frac{\theta_w + \theta_a H'}{\rho_b} \right) \tag{24}$$

Parameter/Definition (units)	Default	Source
C_t/screening level in soil mg/kg)	--	--
C_w/target leachate concentration (mg/L)	(nonzero MCLG, MCL, or HBL) $\times$ 20 DAF	Table 1 (MCL, nonzero MCLG); Section 2.5.6 (DAF for a 0.5-acre source)
K_{oc}/soil organic carbon-water partition coefficient (L/kg)	chemical-specific	see Part 5
f_{oc}/organic carbon content of soil (kg/kg)	0.002 (0.2%)	Carsel et al., 1988
θ_w/water-filled soil porosity (L_{water}/L_{soil})	0.3 (30%)	U.S. EPA/ORD
θ_a/air-filled soil porosity (L_{air}/L_{soil})	0.13	$n - \theta_w$
n/total soil porosity (L_{pore}/L_{soil})	0.43	$1 - \rho_b/\rho_s$
ρ_b/dry soil bulk density (kg/L)	1.5	U.S. EPA, 1991b
ρ_s/soil particle density (kg/L)	2.65	U.S. EPA, 1991b
H′/dimensionless Henry's law constant	H $\times$ 41, where 41 is a conversion factor	U.S. EPA, 1991b
H/Henry's law constant (atm-m^3/mol)	chemical-specific	see Part 5

Part 5 of this document provides K_{oc} values for organic chemicals and describes their development.

The critical organic carbon content, f_{oc}^* , represents OC below which sorption to mineral surfaces begins to be significant. This level is likely to be variable and to depend on both the properties of the soil and of the chemical sorbate (Curtis et al., 1986). Attempts to quantitatively relate f_{oc}^* to such properties have been made (see McCarty et al., 1981), but at this time there is no reliable method for estimating f_{oc}^* for specific chemicals and soils. Nevertheless, research has demonstrated that, for volatile halogenated hydrocarbons, f_{oc}^* is about 0.001, or 0.1 percent OC, for many low-carbon soils and aquifer materials (Piwoni and Banerjee, 1989; Schwarzenbach and Westall, 1981).

If soil OC is below this critical level, Equation 24 should be used with caution. This is especially true if soils contain significant quantities of fine-grained minerals with high sorptive properties (e.g., clays). If sorption to minerals is significant, Equation 24 will underpredict sorption and overpredict contaminant concentrations in soil pore water. However, this f_{oc}^* level is by no means the case for all soils; Abdul et al. (1987) found that, for certain organic compounds and aquifer materials, sorption was linear and could be adequately modeled down to $f_{oc} = 0.0003$ by considering K_{oc} alone.

For soils with significant inorganic and organic sorption (i.e., soils with $f_{oc} < 0.001$), the following equation has been developed (McCarty et al., 1981; Karickhoff, 1984):

$$K_d = (K_{oc}\, f_{oc}) + (K_{io}\, f_{io}) \qquad \textbf{(25)}$$

where

K_{io} = soil inorganic partition coefficient
f_{io} = fraction of inorganic material
$f_{io} + f_{oc}$ = 1.

Although this equation is considered conceptually valid, K_{io} values are not available for the subject chemicals. Attempts to estimate K_{io} values by relating sorption on low-carbon materials to properties such as clay-size fraction, clay mineralogy, surface area, or iron-oxide content have not revealed any consistent correlations, and semiquantitative methods are probably years away (Piwoni and Banerjee, 1989). However, Piwoni and Banerjee developed the following empirical correlation (by linear regression, $r^2 = 0.85$) that can be used to estimate K_d values for hydrophobic organic chemicals from K_{ow} for low-carbon soils:

$$\log K_d = 1.01 \log K_{ow} - 0.36 \qquad \textbf{(26)}$$

where

K_{ow} = octanol/water partition coefficient.

The authors indicate that this equation should provide a K_d estimate that is within a factor of 2 or 3 of the actual value for nonpolar sorbates with $\log K_{ow} < 3.7$. This K_d estimate can be used in Equation 22 for soils with f_{oc} values less than 0.001. If sorption to inorganics is not considered for low-carbon soils where it is significant, Equation 24 will underpredict sorption and overpredict contaminant concentrations in soil pore water (i.e., it will provide a conservative estimate).

The use of fixed K_{oc} values in Equation 24 is valid only for hydrophobic, nonionizing organic chemicals. Several of the organic chemicals of concern ionize in the soil environment, existing in both neutral and ionized forms within the normal soil pH range. The relative amounts of the ionized and neutral species are a function of pH. Because the sorptive properties of these two forms differ, it is important to consider the relative amounts of the neutral and ionized species when determining K_{oc} values at a particular pH. Lee et al. (1990) developed a theoretically based algorithm, developed from thermodynamic equilibrium equations, and demonstrated that the equation adequately predicts laboratory-measured K_{oc} values for pentachlorophenol (PCP) and other ionizing organic acids as a function of pH.

The equation assumes that sorbent organic carbon determines the extent of sorption for both the ionized and neutral species and predicts the overall sorption of a weak organic acid ($K_{oc,p}$) as follows:

$$K_{oc,p} = K_{oc,n}\,\Phi_n + K_{oc,i}\,(1 - \Phi_n) \qquad \textbf{(27)}$$

where

$K_{oc,n}$, $K_{oc,i}$ = sorption coefficients for the neutral and ionized species (L/kg)
Φ_n = $(1 + 10^{pH - pKa})^{-1}$
pKa = acid dissociation constant.

This equation was used to develop K_{oc} values for ionizing organic acids as a function of pH, as described in Part 5. The User's Guide (U.S. EPA, 1996) provides guidance on conducting site-specific measurements of soil pH for estimating K_{oc} values for ionizing organic compounds. Because a national distribution of soil pH values is not available, a median U.S. ground water pH (6.8) from the STORET database (U.S. EPA, 1992a) is used as a default soil pH value that is representative of subsurface pH conditions.

2.5.3 Inorganics (Metals)—Partition Theory. Equation 22 is used to estimate SSLs for metals for the migration to ground water pathway. The derivation of K_d values is much more complicated for metals than for organic compounds. Unlike organic compounds, for which K_d values are largely controlled by a single parameter (soil organic carbon), K_d values for metals are significantly affected by a variety of soil conditions. The most significant parameters are pH, oxidation-reduction conditions, iron oxide content, soil organic matter content, cation exchange capacity, and major ion chemistry. The number of significant influencing parameters, their variability in the field, and differences in experimental methods result in a wide range of K_d values for individual metals reported in the literature (over 5 orders of magnitude). Thus, it is much more difficult to derive generic K_d values for metals than for organics.

The K_d values used to generate SSLs for Ag, Ba, Be, Cd, Cr^{+3}, Cu, Hg, Ni, and Zn were developed using an equilibrium geochemical speciation model (MINTEQ2). The values for As, Cr^{6+}, Se, and Th were taken from empirical, pH-dependent adsorption relationships developed by EPA/ORD. Metal K_d values for SSL application are presented in Part 5, along with a description of their development and limitations. As with the ionizing organics, K_d values are selected as a function of site-specific soil pH, and metal K_d values corresponding to a pH of 6.8 are used as defaults where site-specific pH measurements are not available.

2.5.4 Assumptions for Soil/Water Partition Theory. The following assumptions are implicit in the SSL partitioning methodology. *These assumptions and their implications for SSL accuracy should be read and understood before using this methodology to calculate SSLs.*

1. **There is no contaminant loss due to volatilization or degradation.** The source is considered to be infinite; i.e., these processes do not reduce soil leachate concentrations over time. This is a **conservative** assumption, especially for smaller sites.

2. **Adsorption is linear with concentration.** The methodology assumes that adsorption is independent of concentration (i.e., the Freundlich exponent = 1). This has been reported to be true for various halogenated hydrocarbons, polynuclear aromatic hydrocarbons, benzene, and chlorinated benzenes. In addition, this assumption is valid at low concentrations (e.g., at levels close to the MCL) for most chemicals. As concentrations increase, however, the adsorption isotherm can depart from the linear.

   Studies on trichloroethane (TCE) and chlorobenzene indicate that departure from linear is in the **nonconservative** direction, with adsorbed concentrations being lower than predicted by a linear isotherm. However, adequate information is not available to establish nonlinear adsorption isotherms for the chemicals of interest. Furthermore, since the SSLs are derived at relatively low target soil leachate concentrations, departures from the linear at high concentrations do not significantly influence the accuracy of the results.

3. **The system is at equilibrium with respect to adsorption.** This ignores adsorption/desorption kinetics by assuming that the soil and pore water concentrations are at equilibrium levels. In other words, the pore-water residence time is assumed to be longer than the time it takes for the system to reach equilibrium conditions.

   This assumption is **conservative**. If equilibrium conditions are not met, the concentration in the pore water will be less than that predicted by the methodology. The kinetics of adsorption are not adequately understood for a sufficient number of chemicals and site conditions to consider equilibrium kinetics in the methodology.

4. **Adsorption is reversible.** The methodology assumes that desorption processes operate in the same way as adsorption processes, since most of the K_{oc} values are measured by adsorption experiments rather than by desorption experiments. In actuality, desorption is slower to some degree than adsorption and, in some cases, organics can be irreversibly bound to the soil matrix. In general, the significance of this effect increases with K_{ow}.

   This assumption is **conservative**. Slower desorption rates and irreversible sorption will result in lower pore-water concentrations than that predicted by the methodology. Again, the level of knowledge on desorption processes is not sufficient to consider desorption kinetics and degree of reversibility for all of the subject chemicals.

2.5.5 Dilution/Attenuation Factor Development. As contaminants in soil leachate move through soil and ground water, they are subjected to physical, chemical, and biological processes that tend to reduce the eventual contaminant concentration at the receptor point (i.e., drinking water well). These processes include adsorption onto soil and aquifer media, chemical transformation (e.g., hydrolysis, precipitation), biological degradation, and dilution due to mixing of the leachate with ambient ground water. The reduction in concentration can be expressed succinctly by a DAF, which is defined as the ratio of contaminant concentration in soil leachate to the concentration in ground water at the receptor point. When calculating SSLs, a DAF is used to backcalculate the target soil leachate concentration from an acceptable ground water concentration (e.g., MCLG). For example, if the acceptable ground water concentration is 0.05 mg/L and the DAF is 10, the target leachate concentration would be 0.5 mg/L.

The SSL methodology addresses only one of these dilution-attenuation processes: contaminant dilution in ground water. A simple equation derived from a geohydrologic water-balance relationship has been developed for the methodology, as described in the following subsection. The ratio factor calculated by this equation is referred to as a dilution factor rather than a DAF because it does not consider processes that attenuate contaminants in the subsurface (i.e., adsorption and degradation processes). This simplifying assumption was necessary for several reasons.

First, the infinite source assumption results in all subsurface adsorption sites being eventually filled and no longer available to attenuate contaminants. Second, soil contamination extends to the water table, eliminating attenuation processes in the unsaturated zone. Additionally, the receptor well is assumed to be at the edge of the source, minimizing the opportunity for attenuation in the aquifer. Finally, chemical-specific biological and chemical degradation rates are not known for many of the SSL chemicals; where they are available they are usually based on laboratory studies under simplified, controlled conditions. Because natural subsurface conditions such as pH, redox conditions, soil mineralogy, and available nutrients have been shown to markedly affect natural chemical and biological degradation rates, and because the national variability in these properties is significant and has not been characterized, EPA does not believe that it is possible at this time to incorporate these degradation processes into the simple site-specific methodology for national application.

If adsorption or degradation processes are expected to significantly attenuate contaminant concentrations at a site (e.g., for sites with deep water tables or soil conditions that will attenuate contaminants), the site manager is encouraged to consider the option of using more sophisticated fate and transport models. Many of these models can consider adsorption and degradation processes and can model transient conditions necessary to consider a finite source size. Part 3 of this document presents information on the selection and use of such models for SSL application.

The dilution factor model assumes that the aquifer is unconfined and unconsolidated and has homogeneous and isotropic properties. Unconfined (surficial) aquifers are common across the country, are vulnerable to contamination, and can be used as drinking water sources by local residents. Dilution model results may not be applicable to fractured rock or karst aquifer types. The site manager should consider use of more appropriate models to calculate a dilution factor (or DAF) for such settings.

In addition, the simple dilution model does not consider facilitated transport. This ignores processes such as colloidal transport, transport via solvents other than water (e.g., NAPLs), and transport via dissolved organic matter (DOM). These processes have greater impact as K_{ow} (and hence, K_{oc}) increases. However, the transport via solvents other than water is operative only if certain site-specific conditions are present. Transport by DOM and colloids has been shown to be potentially significant under certain conditions in laboratory and field studies. Although much research is in progress on these processes, the current state of knowledge is not adequate to allow for their consideration in SSL calculations.

If there is the potential for the presence of NAPLs in soils at the site or site area in question, SSLs should not be used for this area (i.e., further investigation is required). The C_{sat} equation (Equation 9) presented in Section 2.4.4 can be used to estimate the contaminant concentration at which the presence of pure-phase NAPLs may be suspected for contaminants that are liquid at soil temperature. If NAPLs are suspected in site soils, refer to U.S. EPA (1992c) for additional guidance on how to estimate the potential for DNAPL occurrence in the subsurface.

Dilution Model Development. EPA evaluated four simple water balance models to adjust SSLs for dilution in the aquifer. Although written in different terms, all four options reviewed can be expressed as the same simple water balance equation to calculate a dilution factor, as follows:

Option 1 (ASTM):

$$\text{dilution factor} = (1 + U_{gw}\, d/IL) \qquad \textbf{(28)}$$

where

U_{gw}	=	Darcy ground water velocity (m/yr)
d	=	mixing zone depth (m)
I	=	infiltration rate (m/yr)
L	=	length of source parallel to flow (m).

For Darcy velocity:

$$U_{gw} = Ki \qquad \textbf{(29)}$$

where

K	=	aquifer hydraulic conductivity (m/yr)
i	=	hydraulic gradient (m/m).

Thus

$$\text{dilution factor} = 1 + (Kid/IL) \qquad \textbf{(30)}$$

Option 2 (EPA Ground Water Forum):

$$\text{dilution factor} = (Q_p + Q_A)/Q_p \quad \textbf{(31)}$$

where

Q_p = percolation flow rate (m^3/yr)
Q_A = aquifer flow rate (m^3/yr)

For percolation flow rate:

$$Q_p = IA \quad \textbf{(32)}$$

where

A = facility area (m^2) = WL.

For aquifer flow rate:

$$Q_A = WdKi \quad \textbf{(33)}$$

where

W = width of source perpendicular to flow (m)
d = mixing zone depth (m).

Thus

$$\text{dilution factor} = (IA + WdKi)/IWL$$

$$= 1 + (Kid/IL) \quad \textbf{(34)}$$

Option 3 (Summers Model):

$$C_w = (Q_p\, C_p)/(Q_p + Q_A) \quad \textbf{(35)}$$

where

C_w = ground water contaminant concentration (mg/L)
C_p = soil leachate concentration (mg/L)

given that

$$C_w = C_p/\text{dilution factor}$$

$$1/\text{dilution factor} = Q_p/(Q_p + Q_A)$$

or

$$\text{dilution factor} = (Q_p + Q_A)/Q_p \text{ (see } \textbf{Option 2}\text{)}$$

Option 4 (EPA ORD/RSKERL):

$$\text{dilution factor} = (Q_p + Q_A)/Q_p = RX/RL \qquad \textbf{(36)}$$

where

R	=	recharge rate (m/yr) = infiltration rate (I, m/yr)
X	=	distance from receptor well to ground water divide (m)

(Note that the intermediate equation is the same as **Option 2**.)

This option is a longer-term option that is not considered further in this analysis because valid X values are not currently available either nationally or for specific sites. EPA is considering developing regional estimates for these parameters.

Dilution Model Input Parameters. As shown, all three options for calculating contaminant dilution in ground water can be expressed as the same equation:

Ground Water Dilution Factor

$$\text{dilution factor} = 1 + (Kid/IL) \qquad \textbf{(37)}$$

Parameter/Definition (units)
K/aquifer hydraulic conductivity (m/yr)
i/hydraulic gradient (m/m)
d/mixing zone depth (m)
I/infiltration rate (m/yr)
L/source length parallel to ground water flow (m)

Mixing Zone Depth (d). Because of its dependence on the other variables, mixing zone depth is estimated with the method used for the MULTIMED model (Sharp-Hansen et al., 1990). The MULTIMED estimation method was selected to be consistent with that used by EPA's Office of Solid Waste for the EPA Composite Model for Landfills (EPACML). The equation for estimating mixing zone depth (d) is as follows:

$$d = (2\alpha_v L)^{0.5} + d_a \{1 - \exp[(-LI)/(V_s n_e d_a)]\} \qquad \textbf{(38)}$$

where

α_v	=	vertical dispersivity (m/m)
V_s	=	horizontal seepage velocity (m/yr)
n_e	=	effective aquifer porosity ($L_{pore}/L_{aquifer}$)
d_a	=	aquifer depth (m).

The first term, $(2\alpha_v L)^{0.5}$, estimates the depth of mixing due to vertical dispersivity ($d_{\alpha v}$) along the length of ground water travel. Defining the point of compliance with ground water standards at the downgradient edge of the source, this travel distance becomes the length of the source parallel to flow L. Vertical dispersivity can be estimated by the following relationship (Gelhar and Axness, 1981):

$$\alpha_v = 0.056\ \alpha_L \qquad \textbf{(39)}$$

where

α_L	=	longitudinal dispersivity = 0.1 x_r
x_r	=	horizontal distance to receptor (m).

Because the potential receptor is assumed to have a well at the edge of the facility, $x_r = L$ and

$$\alpha_v = 0.0056\ L \qquad \textbf{(40)}$$

Thus

$$d_{\alpha v} = (0.0112\ L^2)^{0.5} \qquad \textbf{(41)}$$

The second term, $d_a\ \{1 - \exp[(-LI) / (V_s n_e d_a)]\}$, estimates the depth of mixing due to the downward velocity of infiltrating water, d_{Iv}. In this equation, the following substitution may be made:

$$V_s = Ki/n_e \qquad \textbf{(42)}$$

so

$$d_{Iv} = d_a\ \{1 - \exp[(-LI)/(Kid_a)]\} \qquad \textbf{(43)}$$

Thus, mixing zone depth is calculated as follows:

$$d = d_{\alpha v} + d_{Iv} \qquad \textbf{(44)}$$

Estimation of Mixing Zone Depth

$$d = (0.0112\ L^2)^{0.5} + d_a\ \{1 - \exp[(-LI)/(Kid_a)]\} \qquad \textbf{(45)}$$

Parameter/Definition (units)
d/mixing zone depth (m) L/source length parallel to ground water flow (m) I/infiltration rate (m/yr) K/aquifer hydraulic conductivity (m/yr) d_a/aquifer thickness (m)

Incorporation of this equation for mixing zone depth into the SSL dilution equation results in five parameters that must be estimated to calculate dilution: source length (L), infiltration rate (I), aquifer hydraulic conductivity (K), aquifer hydraulic gradient (i), and aquifer thickness (d_a). Aquifer thickness also serves as a limit for mixing zone depth. The User's Guide (U.S. EPA, 1996) describes how to develop site-specific estimates for these parameters. Parameter definitions and defaults used to develop generic SSLs are as follows:

- **Source Length (L)** is the length of the source (i.e., area of contaminated soil) parallel to ground water flow and affects the flux of contaminant released in soil leachate (IL) as well as the depth of mixing in the aquifer. The default option for this parameter assumes a square, 0.5-acre contaminant source. This default was changed from 30 acres in response to comments to be more representative of actual contaminated soil sources (see Section 1.3.4). Increasing source area (and thereby area) may result in a lower dilution factor. Appendix A includes an analysis of the conservatism associated with the 0.5-acre source size.

- **Infiltration Rate (I)**. Infiltration rate times the source area determines the amount of contaminant (in soil leachate) that enters the aquifer over time. Thus, increasing infiltration decreases the dilution factor. Two options can be used to generate infiltration rate estimates for SSL calculation. The first assumes that infiltration rate is equivalent to recharge. This is generally true for uncontrolled contaminated soil sites but would be conservative for capped sites (infiltration < recharge) and nonconservative for sites with an additional source of infiltration, such as surface impoundments (infiltration > recharge). Recharge estimates for this option can be obtained from Aller et al. (1987) by hydrogeologic setting, as described in Section 2.5.6.

  The second option is to use the HELP model to estimate infiltration, as was done for OSW's EPACML and EPA's Composite Model for Leachate Migration with Transformation Products (EPACMTP) modeling efforts. The Soil Screening Guidance (U.S. EPA, 1995c) provides information on obtaining and using the HELP model to estimate site-specific infiltration rates.

- **Aquifer Parameters**. Aquifer parameters needed for the dilution factor model include hydraulic conductivity (K, m/yr), hydraulic gradient (i, m/m), and aquifer thickness (d_a, m). The User's Guide (U.S. EPA, 1996) describes how to develop aquifer parameter estimates for calculating a site-specific dilution factor.

2.5.6 Default Dilution-Attenuation Factor. EPA has selected a default DAF of 20 to account for contaminant dilution and attenuation during transport through the saturated zone to a compliance point (i.e., receptor well). At most sites, this adjustment will more accurately reflect a contaminant's threat to ground water resources than assuming a DAF of 1 (i.e., no dilution or attenuation). EPA selected a DAF of 20 using a "weight of evidence" approach. This approach

considers results from OSW's EPACMTP model as well as results from applying the SSL dilution model described in Section 2.5.5 to 300 ground water sites across the country.

The default DAF of 20 represents an adjustment from the DAF of 10 presented in the December 1994 draft Soil Screening Guidance (U.S. EPA, 1994h) to reflect a change in default source size from 30 acres to 0.05 acre. A DAF of 20 is protective for sources up to 0.5 acre in size. Analyses presented in Appendix A indicate that it can be protective of larger sources as well. However, this hypothesis should be examined on a case-by-case basis before applying a DAF of 20 to sources larger than 0.5 acre.

EPACMTP Modeling Effort. One model considered during selection of the default DAF is described in *Background Document for EPA's Composite Model for Leachate Migration with Transformation Products* (U.S. EPA, 1993a). EPACMTP has a three-dimensional module to simulate ground water flow that can account for mounding under waste sites. The model also has a three-dimensional transport module and both linear and nonlinear adsorption in the unsaturated and saturated zones and can simulate chain decay, thus allowing the simulation of the formation and the fate and transport of daughter (transformation) products of degrading chemicals. The model can also be used to simulate a finite source scenario.

EPACMTP is comprised of three main interconnected modules:

- An unsaturated zone flow and contaminant fate and transport module
- A saturated zone ground water flow and contaminant fate and transport module
- A Monte Carlo driver module, which generates model parameters from nationwide probability distributions.

The unsaturated and saturated zone modules simulate the migration of contaminants from initial release from the soil to a downgradient receptor well. More information on the EPACMTP model is provided in Appendix E.

EPA has extensively verified both the unsaturated and saturated zone modules of the EPACMTP against other available analytical and numerical models to ensure accuracy and efficiency. Both the unsaturated zone and the saturated zone modules of the EPACMTP have been reviewed by the EPA Science Advisory Board and found to be suitable for generic applications such as the derivation of nationwide DAFs.

EPACMTP Model Inputs (SSL Application). For nationwide Monte Carlo model applications, the input to the model is in the form of probability distributions of each of the model input parameters. The output from the model consists of the probability distribution of DAF values, representing the likelihood that the DAF will not be less than a certain value. For instance, a 90th percentile DAF of 10 means that the DAF will be 10 or higher in at least 90 percent of the cases.

For each model input parameter, a probability distribution is provided, describing the nationwide likelihood that the parameter has a certain value. The parameters are divided into four main groups:

- Source-specific parameters, e.g., area of the waste unit, infiltration rate
- Chemical-specific parameters, e.g., hydrolysis constants, organic carbon partition coefficient

- Unsaturated zone-specific parameters, e.g., depth to water table, soil hydraulic conductivity

- Saturated zone-specific parameters, e.g., saturated zone thickness, ambient ground water flow rate, location of nearest receptor well.

Probability distributions for each parameter used in the model have been derived from nationwide surveys of waste sites, such as EPA's landfill survey (53 FR 28692). During the Monte Carlo simulation, values for each model parameter are randomly drawn from their respective probability distributions. In the calculation of the DAFs for generic SSLs, site data from over 1,300 municipal landfill sites in OSW's Subtitle D Landfill Survey were used to define parameter ranges and distributions. Each combination of randomly drawn parameter values represents one out of a practically infinite universe of possible waste sites. The fate and transport modules are executed for the specific set of model parameters, yielding a corresponding DAF value. This procedure is repeated, typically on the order of several thousand times, to ensure that the entire universe of possible parameter combinations (waste sites) is adequately sampled. In the derivation of DAFs for generic SSLs, the model simulations were repeated 15,000 times for each scenario investigated. At the conclusion of the analysis, a cumulative frequency distribution of DAF values was constructed and plotted.

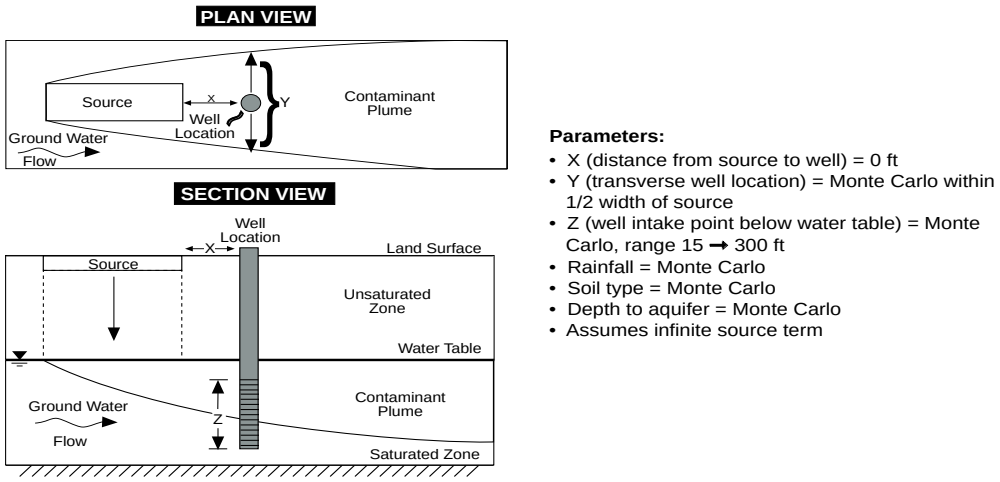


Figure 3. Migration to ground water pathway—EPACMTP modeling effort.

EPA assumed an infinite waste source of fixed area for the generic SSL modeling scenario. EPA chose this relatively conservative assumption because of limited information on the nationwide distribution of the volumes of contaminated soil sources. For the SSL modeling scenario, EPA performed a number of sensitivity analyses consisting of fixing one parameter at a time to determine the parameters that have the greatest impact on DAFs. The results of the sensitivity analyses indicate that the climate (net precipitation), soil types, and size of the contaminated area have the greatest effect on the DAFs. The EPA feels that the size of the contaminated area lends itself most readily to practical application to SSLs.

To calculate DAFs for the SSL scenario, the receptor point was taken to be a domestic drinking water well located on the downgradient edge of the contaminated area. The location of the intake point (receptor well screen) was assumed to vary between 15 and 300 feet below the water table (these

values are based on empirical data reflecting a national sample distribution of depth of residential drinking water wells). The location of the intake point allows for mixing within the aquifer. EPA believes that this is a reasonable assumption because there will always be some dilution attributed to the pumping of water for residential use from an aquifer. The horizontal placement of the well was assumed to vary uniformly along the center of the downgradient edge of the source within a width of one-half of the width of the source. Degradation and retardation of contaminants were not considered in this analysis. Figure 3 is a schematic showing aspects of the subsurface SSL conceptual model used in the EPACMTP modeling effort. Appendix E is the background document prepared by EPA/OSW for this modeling effort.

EPACMTP Model Results. The results of the EPACMTP analyses indicate a DAF of about 170 for a 0.5-acre source at the 90th percentile protection level (Table 5). If a 95th percentile protection level is used, a DAF of 7 is protective for a 0.5-acre source.

Table 5. Variation of DAF with Size of Source Area for SSL EPACMTP Modeling Effort

	DAF		
Area (acres)	85th	90th	95th
0.02	1.42E+07	2.09E+05	946
0.04	9.19E+05	2.83E+04	211
0.11	5.54E+04	2.74E+03	44
0.23	1.16E+04	644	15
0.50	2.50E+03	170	7.0
0.69	1.43E+03	120	4.5
1.1	668	60	3.1
1.6	417	38	2.5
1.8	350	33	2.3
3.4	159	18	1.7
4.6	115	13	1.6
11.5	41	5.5	1.2
23	21	3.5	1.2
30	16	3.0	1.1
46	12	2.4	1.1
69	8.7	2.0	1.1

Dilution Factor Modeling Effort. To gain further information on the national range and distribution of DAF values, EPA also applied the simple SSL water balance dilution model to ground water sites included in two large surveys of hydrogeologic site investigations. These were American Petroleum Institute's (API's) hydrogeologic database (HGDB) and EPA's database of conditions at Superfund sites contaminated with DNAPL.

The HGDB contains the results of a survey sponsored by API and the National Water Well Association (NWWA) to determine the national variability in simple hydrogeologic parameters (Newell et al., 1989). The survey was conducted to validate EPA's use of the EPACML model as a screening tool for the land disposal of hazardous wastes. The survey involved more than 400 ground

water professionals who submitted data on aquifer characteristics from field investigations at actual waste sites and other ground water projects. The information was compiled in HGDB, which is available from API and is included in OASIS, an EPA-sponsored ground water decision support system. Newell et al. (1990) also present these data as "national average" conditions and by hydrogeologic settings based on those defined by Aller et al. (1987) for the DRASTIC modeling effort. Aller et al. (1987) defined these settings within the overall framework defined by Heath's ground water regions (Heath, 1984). The HGDB estimates of hydraulic conductivity and hydraulic gradient show reasonable agreement with those in Aller et al. (1987), which serves as another source of estimates for these parameters.

The SSL dilution factor model (including the associated mixing zone depth model) requires estimates for five parameters:

d_a	=	aquifer thickness (m)
L	=	length of source parallel to flow (m)
I	=	infiltration rate (m/yr)
K	=	aquifer hydraulic conductivity (m/yr)
i	=	hydraulic gradient (m/m).

Dilution factors were calculated by individual HGDB or DNAPL site to retain as much site-correlated parameter information as possible. The HGDB contains estimates of aquifer thickness (d_a), aquifer hydraulic conductivity (K), and aquifer hydraulic gradient (i) for 272 ground water sites. The aquifer hydraulic conductivity estimates were examined for these sites, and sites with reported values less than 5×10^{-5} cm/s were culled from the database because formations with lower hydraulic conductivity values are not likely to be used as drinking water sources. In addition, sites in fractured rock or solution limestone settings were removed because the dilution factor model does not adequately address such aquifers. This resulted in 208 sites remaining in the HGDB. The DNAPL site database contains 92 site estimates of seepage velocity ($\bar{V}$), which can be related to hydraulic conductivity and hydraulic gradient by the following relationship:

$$\bar{V} = Ki / n_e \qquad \textbf{(46)}$$

where

n_e = effective porosity.

Effective porosity (n_e) was assumed to be 0.35, which is representative of sand and gravel aquifers (the most prevalent aquifer type in the HGDB). Thus, for the DNAPL sites, $0.35 \times \bar{V}$ was substituted for Ki in the dilution factor equation.

Estimates of the other parameters required for the modeling effort are described below. Site-specific values were used where available. Because the modeling effort uses a number of site-specific modeling results to determine a nationwide distribution of dilution factors, typical values were used to estimate parameters for sites without site-specific estimates.

Source Length (L). The contaminant source (i.e., area of soil contamination) was assumed to be square. This assumption may be conservative for sites with their longer dimensions perpendicular to ground water flow or nonconservative for sites with their longer dimensions parallel to ground water flow. The source length was calculated as the square root of the source area for the source sizes in question. To cover a range of contaminated soil source area sizes, five source sizes were modeled: 0.5 acre, 10 acres, 30 acres, 60 acres, and 100 acres.

Infiltration Rate (I). Infiltration rate estimates were not available in either database. Recharge estimates for individual hydrogeologic settings from Aller et al. (1987) were used as infiltration estimates (i.e., it was assumed that infiltration = recharge). Because of differences in database contents, it was necessary to use different approaches to obtaining recharge/infiltration estimates for the HGDB and DNAPL sites.

The HGDB places each of its sites in one of the hydrogeologic settings defined by Aller et al. (1987). A recharge estimate for each HGDB site was simply extracted for the appropriate setting from Aller et al. The median of the recharge range presented was used (Table 6).

The DNAPL database does not contain sufficient hydrogeologic information to place each site into the Aller et al. settings. Instead, each of the 92 DNAPL sites was placed in one of Heath's ground water regions. The sites were found to lie within five hydrogeologic regions: nonglaciated central, glaciated central, piedmont/blue ridge, northeast and superior uplands, and Atlantic/Gulf coastal plain. Recharge was estimated for each region by averaging the median recharge value from all hydrogeologic settings except for those with steep slopes. The appropriate Heath region recharge estimate was then used for each DNAPL site in the dilution factor calculations.

Aquifer Parameters. All aquifer parameters needed for the SSL dilution model are included in the HGDB. Because hydraulic conductivity and gradient are included in the seepage velocity estimates in the DNAPL site database, only aquifer thickness was unknown for these sites. Aquifer thickness for all DNAPL sites was set at 9.1 m, which is the median value for the "national average" condition in the HGDB (Newell et al., 1990).

Dilution Modeling Results. Table 7 presents summary statistics for the 92 DNAPL sites, the 208 HGDB sites, and all 300 sites. One can see that the HGDB sites generally have lower dilution factors than the DNAPL sites, although the absolute range in values is greater in the HGDB. However, the available information for these sites is insufficient to fully explain the differences in these data sets. The wide range of dilution factors for these sites reflects the nationwide variability in hydrogeologic conditions affecting this parameter. The large difference between the average and geometric mean statistics indicates a distribution skewed toward the lower dilution factor values. The geometric mean represents a better estimate of the central tendency of such skewed distributions. Appendix F presents the dilution modeling inputs and results for the HGDB and DNAPL sites, tabulated by individual site.

Selection of the Default DAF. The default DAF was selected considering the evidence of the national DAF and dilution factor estimates described above. A DAF of 10 was selected in the December 1994 draft Soil Screening Guidance to be protective of a 30-acre source size. The EPACMTP model results showed a DAF of 3 for 30 acres at the 90th percentile. The SSL dilution model results have geometric mean dilution factors for a 30-acre source of 10 and 7 for DNAPL sites and HGDB sites, respectively. In a weight of evidence approach, more weight was given to the results of the DNAPL sites because they are representative of the kind of sites to which SSLs are likely to be applied. Considering the conservative assumptions in the SSL dilution factor model (see Section 2.5.5), and the conservatism inherent in the soil partition methodology (see Section 2.5.4), EPA believes (1) that these results support the use of a DAF of 10 for a 30-acre source, and (2) that this DAF will protect human health from exposure through this pathway at most Superfund sites across the Nation

Table 6. Recharge Estimates for DNAPL Site Hydrogeologic Regions

Hydrogeologic setting	Recharge (m/yr) Min.	Max.	Avg.
Nonglaciated Central (Region 6)			
Alluvial Mountain Valleys	0.10	0.18	0.14
Alter. SS/LS/Sh., Thin Soil	0.10	0.18	0.14
Alter. SS/LS/Sh., Deep Regolith	0.10	0.18	0.14
Solution Limestone*	0.25	0.38	0.32
Alluvium w/ Overbank Deposits	0.18	0.25	0.22
Alluvium w/o Overbank Deposits	0.18	0.25	0.22
Braided River Deposits	0.10	0.18	0.14
Triassic Basins	0.10	0.18	0.14
Swamp/Marsh	0.10	0.18	0.14
Met./Ig. Domes & Fault Blocks	0.00	0.05	0.03
Unconsol./Semiconsol. Aquifers	0.00	0.05	0.03
	Overall Average:		*0.15*
Glaciated Central (Region 7)			
Glacial Till Over Bedded Rock	0.10	0.18	0.14
Glacial Till Over Outwash	0.10	0.18	0.14
Glacial Till Over Sol. Limestone	0.10	0.18	0.14
Glacial Till Over Sandstone	0.10	0.18	0.14
Glacial Till Over Shale	0.10	0.18	0.14
Outwash	0.18	0.25	0.22
Outwash Over Bedded Rock*	0.25	0.38	0.32
Outwash Over Solution Limestone*	0.25	0.38	0.32
Moraine	0.18	0.25	0.22
Buried Valley	0.18	0.25	0.22
Alluvium w/ Overbank Deposits	0.10	0.18	0.14
Alluvium w/o Overbank Deposits*	0.25	0.38	0.32
Glacial Lake Deposits	0.10	0.18	0.14
Thin Till Over Bedded Rock	0.18	0.25	0.22
Beaches, B. Ridges, Dunes*	0.25	0.38	0.32
Swamp/Marsh	0.10	0.18	0.14
	Overall Average:		*0.20*

Hydrogeologic setting	Recharge (m/yr) Min.	Max.	Avg.
Piedmont/Blue Ridge (Region 8)			
Alluvial Mountain Valleys	0.18	0.25	0.22
Regolith	0.10	0.18	0.14
River Alluvium	0.18	0.25	0.22
Mountain Crests	0.00	0.05	0.03
Swamp/Marsh	0.10	0.18	0.14
	Overall Average:		*0.15*
Northeast & Superior Uplands (Region 9)			
Alluvial Mountain Valleys	0.18	0.25	0.22
Till Over Crystalline Bedrock	0.18	0.25	0.22
Glacial Till Over Outwash	0.18	0.25	0.22
Outwash*	0.25	0.38	0.32
Moraine	0.18	0.25	0.22
Alluvium w/ Overbank Deposits	0.18	0.25	0.22
Alluvium w/o Overbank Deposits*	0.25	0.38	0.32
Swamp/Marsh	0.10	0.18	0.14
Bedrock Uplands	0.10	0.18	0.14
Glacial Lake/Marine Deposits	0.10	0.18	0.14
Beaches, B. Ridges, Dunes*	0.25	0.38	0.32
	Overall Average:		*0.22*
Atlantic/Gulf Coastal Plain (Region 10)			
Regional Aquifers	0.00	0.05	0.03
Un./Semiconsol. Surficial Aquifer*	0.25	0.38	0.32
Alluvium w/ Overbank Deposits	0.18	0.25	0.22
Alluvium w/o Overbank Deposits*	0.25	0.38	0.32
Swamp*	0.25	0.38	0.32
	Overall Average:		*0.24*

Source: Aller et al. (1987); hydrogeologic regions from Heath (1984).
** 0.25 m to 0.38 m (9.8 in to 15 in) used as recharge range for 25+ m setting values from Aller et al. (1987).*

Table 7. SSL Dilution Factor Model Results: DNAPL and HGDB Sites

	Source area (acres)				
	0.5	10	30	100	600
DNAPL Sites (92)					
Geomean	34	15	10	6	4
Average	321	138	80	44	19
10th percentile	3	2	1	1	1
25th percentile	8	4	3	2	1
Median	30	13	8	5	3
75th percentile	140	60	35	20	9
90th percentile	336	144	84	46	20
HGDB sites (208)					
Geomean	16	10	7	5	3
Average	958	829	561	371	159
10th percentile	2	1	1	1	1
25th percentile	3	2	1	1	1
Median	10	6	5	3	2
75th percentile	56	30	19	12	5
90th percentile	240	134	90	51	21
All 300 sites					
Geomean	20	11	8	6	3
Average	763	617	414	271	116
10th percentile	2	1	1	1	1
25th percentile	4	2	2	1	1
Median	15	8	5	4	2
75th percentile	70	35	23	13	6
90th percentile	292	144	88	49	21

DNAPL = DNAPL Site Survey (EPA/OERR).
HGDB = Hydrogeologic database (API).

To adjust the 30-acre DAF for a 0.5-acre source, EPA considered the geomean 0.5-acre dilution factors for the DNAPL sites (34), HGDB sites (16), and all 300 sites (20). A default DAF of 20 was selected as a conservative value for a 0.5-acre source size.

This value also reflects the ratio between 0.5-acre and 30-acre geomean and median dilution factors calculated for the HGDB sites (2.2 and 2.0, respectively). The HGDB data reflect the influence of source size on actual dilution factors more accurately than the DNAPL site data because the HGDB includes site-specific estimates of aquifer thickness. As shown in the following section, aquifer thickness has a strong influence on the effect of source size on the dilution factor since it provides an upper limit on mixing zone depth. Increasing source area increases infiltration, which lowers the dilution factor, but also increases mixing zone depth, which increases the dilution factor. For an infinitely thick aquifer, these effects tend to cancel each other, resulting in similar dilution factors for 0.5 and 30 acres. Thin aquifers limit mixing depth for larger sources; thus the added infiltration predominates and lowers the dilution factors for the larger source. Since the DNAPL dilution factor

analyses use a fixed aquifer depth, they tend to overestimate the reduction in dilution factors that result from a smaller source.

2.5.7 Sensitivity Analysis. A sensitivity analysis was conducted to examine the effects of site-specific parameters on migration to ground water SSLs. Both the partition equation and the dilution factor model were considered in this analysis. Because an adequate database of national distributions of these parameters was not available, a nominal range method was used to conduct the analysis. In this analysis, independent parameters were selected and each was taken to maximum and minimum values while keeping all other parameters at their nominal, or default, values.

Overall, SSLs are most sensitive to changes in the dilution factor. As shown in Table 7, the 10th to 90th percentile dilution factors vary from 2 to 292 for the 300 DNAPL and HGDB sites. Much of this variability can be attributed to the wide range of aquifer hydraulic conductivity across the Nation. In contrast, the most sensitive parameter in the partition equation (f_{oc}) only affects the SSL by a factor of 1.5.

Partition Equation. The partition equation requires the following site-specific inputs: fraction organic carbon, average annual soil moisture content, and soil bulk density. Although volumetric soil moisture content is somewhat dependent on bulk density (in terms of the porosity available to be filled with water), calculations were conducted to ensure that the parameter ranges selected do not result in impossible combinations of these parameters. Because the effects of the soil parameters on the SSLs are highly dependent on chemical properties, the analysis was conducted on four organic chemicals spanning the range of these properties: chloroform, trichloroethylene, naphthalene, and benzo(*a*)pyrene.

The range used for soil moisture conditions was 0.02 to 0.43 L water/L soil. The lower end of this range represents a likely residual moisture content value for sand, as might be found in the drier regions of the United States. The higher value (0.43) represents full saturation conditions for a loam soil. The range of bulk density (1.25 to 1.75) was obtained from the Patriot soils database, which contains bulk density measurements for over 20,000 soil series across the United States.

Establishing a range for subsurface organic carbon content (f_{oc}) was more difficult. In spite of an extensive literature review and contacts with soil scientists, very little information was found on the distribution of this parameter with depth in U.S. soils. The range used was 0.001 to 0.003 g carbon / g soil. The lower limit represents the critical organic carbon content below which the partition equation is no longer applicable. The upper limit was obtained from EPA's Environmental Research Laboratory in Ada, Oklahoma, as an expert opinion. Generally, soil organic carbon content falls off rapidly with depth. Since the typical value used as an SSL default for surface soils is 0.006, and 0.002 is used for subsurface soils, this limited range is consistent with the other default assumptions used in the Soil Screening Guidance.

The results of the partition equation sensitivity analysis are shown in Table 8.

For volatile chemicals, the model is somewhat sensitive to water content, with up to 54 and 19 percent change in SSLs for chloroform and trichloroethylene, respectively. The model is less sensitive to bulk density, with a high percent change of 18 for chloroform and 14 for trichloroethylene. Organic carbon content has the greatest effect on SSLs for all chemicals except chloroform. As expected, the effect of f_{oc} increases with increasing K_{oc}. The greatest effect was seen for benzo(*a*)pyrene whose SSL showed a 50 percent increase at an f_{oc} of 0.03. An f_{oc} of 0.005 will increase the benzo(*a*)pyrene SSL by 150 percent.

Table 8. Sensitivity Analysis for SSL Partition Equation

Parameter assignments	Chloroform SSL (mg/kg)	Chloroform Percent change	Trichloroethylene SSL (mg/kg)	Trichloroethylene Percent change	Naphthalene SSL (mg/kg)	Naphthalene Percent change	Benzo(*a*)pyrene SSL (mg/kg)	Benzo(*a*)pyrene Percent change
All default parameter values	0.59	—	0.057	—	84	—	8	—
Less conservative parameter value								
Organic carbon	0.67	14	0.074	29	124	48	12	50
Bulk density	0.69	18	0.065	14	85	1	8	0
Soil moisture	0.74	26	0.062	9	86	2	8	0
More conservative parameter value								
Organic carbon	0.51	-14	0.040	-29	44	-48	4	-50
Bulk density	0.51	-13	0.051	-10	83	-1	8	0
Soil moisture	0.27	-54	0.046	-19	80	-4	8	0

Input parameters	Conservatism: Less	Nominal	More
Fraction org. carbon (g/g)	0.003	0.002	0.001
Bulk density (kg/L)	1.25[a]	1.50	1.75[b]
Average soil moisture (L/L)	0.43	0.30	0.02

[a] n = 0.53; q_a = 0.23.
[b] n = 0.34; q_a = 0.04.

Chemical-specific parameters	Chloroform	Trichloroethylene	Naphthalene	Benzo(*a*)pyrene
K_{oc}	3.98E+01	1.66E+02	2.00E+03	1.02E+06
H'	1.50E-01	4.22E-01	1.98E-02	4.63E-05
C_w	2.0[c]	0.1[c]	20[d]	0.004[c]

[c] MCL × 20 DAF.
[d] HBL (HQ=1) × 20 DAF.

Dilution Factor. Site-specific parameters for the dilution factor model include aquifer hydraulic conductivity (K), hydraulic gradient (i), infiltration rate (I), aquifer thickness (d), and source length parallel to ground water flow (L). Because they are somewhat dependent, hydraulic conductivity and hydraulic gradient were treated together as Darcy velocity ($K \times i$). The parameter ranges used for the dilution factor analysis represent the 10th and 90th percentile values taken from the HGDB and DNAPL site databases, with the geometric mean serving as the nominal value, as shown in Table 9.

Source length was varied by assuming square sources of 0.5 to 30 acres in size. Bounding estimates were conducted for each of these source sizes.
The results in Table 9 show that Darcy velocity has the greatest effect on the dilution factor, with a range of dilution factors from 1.2 to 85 for a 30-acre source and 2.1 to 263 for a 0.5-acre source. Infiltration rate has the next highest effect, followed by source size and aquifer thickness. Note that aquifer thickness has a profound effect on the influence of source size on the dilution factor. Thick aquifers show no source size effect because the increase in infiltration flux from a larger source is balanced by the increase in mixing zone depth, which increases dilution in the aquifer. For very thin aquifers, the mixing zone depth is limited by the aquifer thickness and the increased infiltration flux predominates, decreasing the dilution factor for larger sources.

2.6 Mass-Limit Model Development

This section describes the development of models to solve the mass-balance violations inherent in the infinite source models used to calculate SSLs for the inhalation and migration to ground water exposure pathways. The models developed are not finite source models per se, but are designed for use with the current infinite source models to provide a lower, mass-based limit for SSLs for the migration to ground water and inhalation exposure pathways for volatile and leachable contaminants. For each pathway, the mass-limit model calculates a soil concentration that corresponds to the release of all contaminants present within the source, at a constant health-based concentration, over the duration of exposure. These mass-based concentration limits are used as a minimum concentration for each SSL; below this concentration, a receptor point concentration time-averaged over the exposure period cannot exceed the health-based concentration on which it is based.

2.6.1 Mass Balance Issues. Infinite source models are subject to mass balance violations under certain conditions. Depending on a compound's volatility and solubility and the size of the source, modeled volatilization or leaching rates can result in a source being depleted in a shorter time than the exposure duration (or the flux over a 30- or 70-year duration would release a greater mass of contaminants than are present). Several commenters to the December 1994 draft Soil Screening Guidance expressed concern that it is unrealistic for total emissions over the duration of exposure to exceed the total mass of contaminants in a source. Using the soil saturation concentration (C_{sat}) and a 5- to 10-meter contaminant depth, one commentor calculated that mass balance would be violated by the SSL volatilization model for 25 percent of the SSL chemicals.

Short of finite source modeling, the limitations of which in soil screening are discussed in the draft *Technical Background Document for Soil Screening Guidance* (U.S. EPA, 1994i), there were two options identified for addressing mass-balance violations within the soil screening process:

- Shorten the exposure duration to a value that would reflect mass limitations given the volatilization rate calculated using the current method

Table 9. Sensitivity Analysis for SSL Dilution Factor Model

Parameter assignments	Dilution Factor: Source area: 30-acre	Dilution Factor: Source area: 0.5-acre	Dilution Factor: Ratio of 0.5-acre/30-acre	Mixing depth (m): 30-acre	Mixing depth (m): 0.5 acre
All central parameters	5.2	15	2.9	12	5.1
Less conservative					
Darcy velocity	85	263	3.1	12	4.8
Aquifer thickness	15	15	1.0	40	5.1
Infiltration rate	39	118	3.0	12	4.8
More conservative					
Darcy velocity	1.2	2.1	1.8	12	12
Aquifer thickness	2.1	9.1	4.3	3.0	3.0
Infiltration rate	3.2	8.7	2.7	12	5.5

Input parameters	Conservatism: Less	Conservatism: Nominal	Conservatism: More
Darcy velocity (DV, m/yr)	442	22	0.8
Aquifer thickness (da, m)	46	12	3
Infiltration rate (m/yr)	0.02	0.18	0.35

Parameter sources		
Percentile	DV[a] (m/yr)	da[b] (m)
10th	0.8	3.0
25th	4	5.5
50th	22	11
75th	121	23
90th	442	46
Average:	800	28
Geomean:	22	12

[a] 300 DNAPL & HGDB sites.
[b] 208 HGDB sites.

- Change the volatilization rate to a value corresponding to the uniform release of the total mass of contaminants over the period of exposure.

The latter approach was taken in the draft Risk-Based Corrective Action (RBCA) screening methodology developed by the American Society for Testing and Materials (ASTM) (ASTM, 1994). As stated on page B6 of the RBCA guidance (B.6.6.6):

> In the event that the time-averaged flux exceeds that which would occur if all chemicals initially present in the surficial soil zone volatilized during the exposure period, then the volatilization factor is determined from a mass balance assuming that all chemical initially present in the surficial soil zone volatilizes during the exposure period.

This was selected over the exposure duration option because it is reasonably conservative for screening purposes (obviously, more contaminant cannot possibly volatilize from the soil) and it avoided the uncertainties associated with applying the current models to estimate source depletion rates.

In summary, the mass-limit approach offers the following advantages:

- It corrects the possible mass-balance violation in the infinite-source SSLs.
- It does not require development of a finite source model to calculate SSLs.
- It is appropriate for screening, being based on the conservative assumption that all of the contaminant present leaches or volatilizes over the period of exposure.
- It is easy to develop and implement, requiring only very simple algebraic equations and input parameters that are, with the exception of source depth, already used to calculate SSLs.

The derivation of these models is described below. It should be noted that the American Industrial Health Council (AIHC) independently developed identical models to solve the mass-balance violation as part of their public comments on the Soil Screening Guidance.

2.6.2 Migration to Ground Water Mass-Limit Model. For the migration to ground water pathway, the mass of contaminant leached from a contaminant source over a fixed exposure duration (ED) period can be calculated as

$$M_l = C_w \times I \times A_s \times ED \qquad \textbf{(47)}$$

where

M_l = mass of contaminant leached (g)
C_w = leachate contaminant concentration (mg/L or g/m^3)
I = infiltration rate (m/yr)
A_s = source area (m^2)
ED = exposure duration (yr).

The total mass of contaminants present in a source can be expressed as

$$M_T = C_t \times \rho_b \times A_s \times d_s \quad \textbf{(48)}$$

where

M_T = total mass of contaminant present (g)
C_t = total soil contaminant concentration (mg/kg or g/Mg, dry basis)
ρ_b = dry soil bulk density (kg/L or Mg/m^3)
A_s = source area (m^2)
d_s = source depth (m).

To avoid a mass balance violation, the mass of contaminant leached cannot exceed the total mass of contaminants present (i.e., M_l cannot exceed M_T). Therefore, the maximum possible contaminant mass that can be leached from a source (assuming no volatilization or degradation) is M_T and the upper limit for M_l is

$$M_l = M_T$$

or

$$C_w \times I \times A_s \times ED = C_t \times \rho_b \times A_s \times d_s$$

Rearranging to solve for the total soil concentration (C_t) corresponding to this situation (i.e., maximum possible leaching)

Mass-Limit Model for Migration to Ground Water Pathway

$$C_t = (C_w \times I \times ED)/(\rho_b \times d_s) \quad \textbf{(49)}$$

Parameter/Definition (units)	Default
C_t/screening level in soil (mg/kg)	--
C_w/target soil leachate concentration (mg/L)	(nonzero MCLG, MCL, or HBL) × 20 DAF
I/infiltration rate (m/yr)	site-specific
ED/exposure duration (yr)	70
ρ_b/dry soil bulk density (kg/L)	1.5
d_s/average source depth (m)	site-specific

This soil concentration (C_t) represents a lower limit for soil screening levels calculated for the migration to ground water pathway. It represents the soil concentration corresponding to complete release of soil contaminants over the ED time period at a constant soil leachate concentration (C_w). Below this C_t, the soil leachate concentration averaged over the ED time period cannot exceed C_w.

2.6.3 Inhalation Mass-Limit Model. The volatilization factor (VF) is basically the ratio of the total soil contaminant concentration to the air contaminant concentration. VF can be calculated as

$$VF = (Q/C) \times (C_T{}^o/J_s{}^{ave}) \times 10^{-10}\ m^2kg/cm^2mg \qquad \textbf{(50)}$$

where

VF = volatilization factor (m^3/kg)
Q/C = inverse concentration factor for air dispersion (g/m^2-s per kg/m^3)
$C_T{}^o$ = total soil contaminant concentration at t=0 (mg/kg or g/Mg, dry basis)
$J_s{}^{ave}$ = average rate of contaminant flux from the soil to the air (g/cm^2-s).

The total amount of contaminant contained within a finite source can be written as

$$M_t = C_T{}^o \times \rho_b \times A_s \times d_s \qquad \textbf{(51)}$$

where

M_t = total mass of contaminant within the source (g)
$C_T{}^o$ = total soil contaminant concentration at t=0 (mg/kg or g/Mg, dry basis)
ρ_b = soil dry bulk density (kg/L = Mg/m^3)
A_s = area of source (m^2)
d_s = depth of source (m).

If all of the contaminant contained within a finite source is volatilized over a given averaging time period, the average volatilization flux can be calculated as

$$J_s{}^{ave} = M_t/[(A_s \times 10^4\ cm^2/m^2) \times (T \times 3.15E7\ s/yr)] \qquad \textbf{(52)}$$

where

T = exposure period (yr).

Substituting Equation 51 for M_t in Equation 52 yields

$$J_s{}^{ave} = (C_T{}^o \times \rho_b \times d_s) / (10^4\ cm^2/m^2 \times T \times 3.15E7\ s/yr) \qquad \textbf{(53)}$$

Rearranging Equation 53 yields

$$C_T{}^o/J_s{}^{ave} = (10^4\ cm^2/m^2 \times T \times 3.15E7\ s/yr)/(\rho_b \times d_s) \quad \textbf{(54)}$$

Substituting Equation 54 into Equation 50 yields

Mass-Limit Model for Inhalation of Volatiles

$$VF = (Q/C) \times [(T \times 3.15E7\ s/yr)/(\rho_b \times d_s \times 10^6\ g/Mg)] \quad \textbf{(55)}$$

Parameter/Definition (units)	Default
VF/volatilization factor (m^3/kg)	–
Q/C/inverse of mean conc. at center of source (g/m^2-s per kg/m^3)	Table 3
T/exposure interval (yr)	30
ρ_b/dry soil bulk density (kg/L)	1.5
d_s/average source depth (m)	site-specific

If the VF calculated using an infinite source volatilization model for a given contaminant is less than the VF calculated using Equation 55, then the assumption of an infinite source may be too conservative for that specific contaminant at that source. Consequently, VF, as calculated in Equation 55, could be considered a minimum value for VF.

2.7 Plant Uptake

Commentors have raised concerns that the ingestion of contaminated produce from homegrown gardens may be a significant exposure pathway. EPA evaluated empirical data on plant uptake, particularly the data presented in the *Technical Support Document for Land Application of Sewage Sludge*, often referred to as the "Sludge Rule" (U.S. EPA, 1992d).

EPA found that empirical plant uptake-response slopes were available for selected metals but that available data were insufficient to estimate plant uptake of organics. In an effort to obtain additional empirical data, EPA has jointly funded research with the State of California on plant uptake of organic contaminants. These studies support ongoing revisions to the indirect, multimedia exposure model CalTOX.

The Sludge Rule identified six metals of concern with empirical plant uptake data: arsenic, cadmium, mercury, nickel, selenium, and zinc. Plant uptake-response slopes were given for seven plant categories such as grains and cereals, leafy vegetables, root vegetables, and garden fruits. EPA evaluated the study conditions (e.g., soil pH, application matrix) and methods (e.g., geometric mean, default values) used to calculate the plant uptake-response slopes for each plant category and determined that the geometric mean slopes were generally appropriate for calculating SSLs for the soil-plant-human exposure pathway.

However, the geometric mean of empirical uptake-response slopes from the Sludge Rule must be interpreted with caution for several reasons. First, the dynamics of sludge-bound metals may differ from the dynamics of metals at contaminated sites. For example, the empirical data were derived

from a variety of studies at different soil conditions using different forms of the metal (i.e., salt vs. nonsalt). In studies where the application matrix was sludge, the adsorption power of sludge in the presence of calcium ions may have reduced the amount of metal that is bioavailable to plants and, therefore, plant uptake may be greater in non-sludge-amended soils.

In addition to these confounding conditions, default values of 0.001 were assigned for plant uptake in studies where the measured value was below 0.001. A default value was needed to calculate the geometric mean uptake-response slope values. Moreover, considerable study-to-study variability is shown in the plant uptake-response slope values (up to 3 orders of magnitude for certain plant/metal combinations). This variability could result from varying soil characteristics or experimental conditions, but models have not been developed to relate changes in plant uptake to such conditions. Thus, the geometric mean values represent "typical" values from the experiments; actual values at specific sites could show marked variation depending on soil composition, chemistry, and/or plant type.

OERR has used the information in the Sludge Rule to identify six metals (arsenic, cadmium, mercury, nickel, selenium, and zinc) of potential concern through the soil-plant-human exposure pathway for consideration on a site-specific basis. The fact that these metals have been identified should not be misinterpreted to mean that other contaminants are not of potential concern for this pathway. Other EPA offices are looking at empirical data and models for estimating plant uptake of organic contaminants from soils and OERR will incorporate plant uptake of organics once these efforts are reviewed and finalized.

Methods for evaluating the soil-plant-human pathway are presented in Appendix G. Generic screening levels are calculated based on the uptake factors (i.e., bioconcentration factors [Br]) presented in the Sludge Rule. Generic plant SSLs are compared with generic SSLs based on direct ingestion as well as levels of inorganics in soil that have been reported to cause phytotoxicity (Will and Suter, 1994). Although site-specific factors such as soil type, pH, plant type, and chemical form will determine the significance of this pathway, the results of our analysis suggest that the soil-plant-human pathway may be of particular concern for sites with soils contaminated with arsenic or cadmium. Likewise, the potential for phytotoxicity will be greatly influenced by site-specific factors; however, the data presented by Will and Suter (1994) suggest that, with the exception of arsenic, the levels of inorganics that are considered toxic to plants are well below the levels that may impact human health via the soil-plant-human pathway.

2.8 Intrusion of Volatiles into Basements: Johnson and Ettinger Model

Concern about the potential impact of contaminated soil on indoor air quality prompted EPA to consider the Johnson and Ettinger (1991) model, a heuristic model for estimating the intrusion rate of contaminant vapors from soil into buildings. The model is a closed-form analytical solution for both convective and diffusive transport of vapor-phase contaminants into enclosed structures located above the contaminated soil. The model may be solved for both steady-state (i.e., infinite source) or quasi-steady-state (i.e., finite source) conditions. The model incorporates a number of key assumptions, including no leaching of contaminant to ground water, no sinks in the building, and well-mixed air volume within the building.

To evaluate the effects of using the Johnson and Ettinger model on SSLs for volatile organic contaminants, EPA contracted Environmental Quality Management, Inc. (EQ), to construct a case example to estimate a high-end exposure point concentration for residential land use (Appendix H; EQ and Pechan, 1994). The case example models a contaminant source relatively close or directly beneath a building where the soil beneath the building is very permeable and the building is

underpressurized, tending to pull contaminants into the basement. Where possible and appropriate, values of model variables were taken directly from Johnson and Ettinger (1991). Using both steady-state and quasi-steady-state formulations, building air concentrations of each of 42 volatile SSL chemicals were calculated. The inverses of these concentrations were substituted into the inhalation SSL equations (Equations 4 or 5) as an indoor volatilization factor (VF_{indoor}) to calculate carcinogenic or noncarcinogenic SSLs based on migration of contaminants into basements (i.e., "indoor inhalation" SSLs).

Results showed a difference of up to 2 orders of magnitude between the steady-state and quasi-steady-state results for the indoor inhalation SSLs. Infinite source indoor inhalation SSLs were less than the corresponding "outdoor" inhalation SSLs by as much as 3 orders of magnitude for highly volatile constituents. For low-volatility constituents, the difference was considerably less, with no difference in the indoor and outdoor SSLs in some cases. The EQ study also indicated that the most important input parameters affecting long-term building concentration (and thus the SSL) are building ventilation rate, distance from the source (i.e., source-building separation), soil permeability to vapor flow, and source depth. For lower-permeability soils, the number and size of cracks in the basement walls may be more significant, although this was not a significant variable for the permeable soils considered in the study.

EPA decided against using the Johnson and Ettinger model to calculate **generic** SSLs due to the sensitivity of the model to parameters that do not lend themselves to standardization on a national basis (e.g., source depth, the number and size of cracks in basement walls). In addition, the only formal validation study identified by EPA compares model results with measured radon concentrations from a highly permeable soil. Although these results compare favorably, it is not clear how applicable they are to less permeable soils and compounds not already present in soil as a gas (as radon is).

The model can be applied on a site-specific basis in conjunction with the results of a soil gas survey. Where land use is currently residential, a soil gas survey can be used to measure the vapor phase concentrations at the foundation of buildings, thereby eliminating the need to model partitioning of contaminants, migration from the source to the basement, and soil permeability.

For future use scenarios, although some site-specific data are available, the difficulties are similar to those encountered with generic application of the model. Predictions must be made regarding the distance from the source to the basement and the permeability of the soil, basement floor, and walls. EQ's report models the potential impact of placing a structure directly above the source. Depending on the permeability of the surrounding soils, the results suggest that the level of residual contamination would have to be extremely low to allow for such a scenario. Distance from the source can have a dramatic impact on the results and should be considered in more detailed investigations involving future residential use scenarios.

Part 3: MODELS FOR DETAILED ASSESSMENT

The Soil Screening Guidance addresses the inhalation and migration to ground water exposure pathways with simple equations that require a small number of easily obtained soil parameters, meteorologic conditions, and hydrogeologic parameters. These equations incorporate a number of conservative simplifying assumptions—an infinite source, no fractionation between pathways, no biological or chemical degradation, no adsorption—conditions that can be addressed with more complicated models. Applying such models will more accurately define the risk of exposure via the inhalation or the migration to ground water pathway and, depending on site conditions, can lead to higher SSLs that are still protective. However, input data requirements and modeling costs make this option more expensive to implement than the SSL equations.

This part of the Technical Background Document presents information on the selection and use of more complex fate and transport models for calculating SSLs. Generally, the decision to use these models will involve balancing costs: if the models and assumptions used to develop simple site-specific SSLs are overly conservative with respect to site conditions (e.g., a thick unsaturated zone), the additional cost and time required to apply these models may be offset by the potential cost savings associated with higher, but still protective, SSLs.

Sections 3.1 and 3.2 include information on equations and models that can accommodate finite contaminant sources and fractionate contaminants between pathways (e.g., VLEACH and EMSOFT) and predict the subsequent impact on either ambient air or ground water. However, when using a finite source model, the site manager should recognize the uncertainties inherent in site-specific estimates of subsurface contaminant distributions and use conservative estimates of source size and concentrations to allow for such uncertainties. In addition, model predictions should be validated against actual site conditions to the extent possible.

3.1 Inhalation of Volatiles: Detailed Models

Developing SSLs for the inhalation of volatiles involves calculating a site-specific volatilization factor (VF) and dispersion factor (Q/C). This section provides a brief description of finite source volatilization models with potential applicability to SSL development and information on site-specific application of the AREA-ST dispersion model for estimating the Q/C values needed to calculate both VF and PEF. It should not be viewed as an official endorsement of these models (other volatilization models may be available with applicability to SSL development).

3.1.1 Finite Source Volatilization Models. To identify suitable models for addressing a finite contaminant source, EPA contracted Environmental Quality Management, Inc. (EQ), to conduct a preliminary evaluation of a number of soil volatilization models, including volatilization models developed by Hwang and Falco (1986), as modified by EQ (1992), and by Jury et al. (1983, 1984, and 1990) and VLEACH, a multipathway model developed primarily to assess exposure through the ground water pathway. Study results (EQ and Pechan, 1994) show reasonable agreement (within a factor of 2) between emission predictions using the modified Hwang and Falco or Jury models, but consistently lower predictions from VLEACH. However, Shan and Stephens (1995) discovered an error in the VLEACH calculation of the apparent diffusivity, which has been subsequently corrected. The corrected VLEACH model, version 2.2, appears to provide emission estimates similar to the Jury and the modified Hwang and Falco models. The revised VLEACH (v.2.2)

program is available from the Center for Subsurface Modeling Support (CSMOS) at EPA's Environmental Research Laboratory in Ada, Oklahoma (WWW.EPA.GOV/ADA/ CSMOS.HTML), and is discussed further in Section 3.2.

For certain contaminant conditions, Jury et al. (1990) present a simplified equation (Jury's Equation B1) for estimating the flux of a contaminant from a finite source of contaminated soil. The following assumptions were used to derive this simplified flux equation:

- Uniform soil properties (e.g., homogeneous average soil water content, bulk density, porosity, and fraction organic carbon)
- Instantaneous linear equilibrium adsorption
- Linear equilibrium liquid-vapor partitioning (Henry's law)
- Uniform initial contaminant incorporation at t=0
- Chemicals in a dissolved form only (i.e., soil contaminant concentrations are below C_{sat})
- No boundary layer thickness at ground level (no stagnant air layer)
- No water evaporation or leaching
- No chemical reactions, biodegradation, or photolysis
- $d_s >> (4D_A t)^{1/2}$ (ramifications of this are discussed below).

Under these assumptions, the Jury et al. (1990) simplified finite source model is

$$J_s = C_o(D_A/\pi t)^{1/2}[1-\exp(-d_s^2/4D_A t)] \quad \textbf{(56)}$$

where

J_s = contaminant flux at ground surface (g/cm^2-s)
C_o = uniform contaminant concentration at t=0 (g/cm^3)
D_A = apparent diffusivity (cm^2/s)
π = 3.14
t = time (s)
d_s = depth of uniform soil contamination at t=0 (cm),

and

$$D_A = [(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2]/(\rho_b K_d + \theta_w + \theta_a H') \quad \textbf{(57)}$$

where

θ_a = air-filled soil porosity (L_{air}/L_{soil}) = $n - \theta_w$
n = total soil porosity (L_{pore}/L_{soil}) = $1 - (\rho_b/\rho_s)$
θ_w = water-filled soil porosity (L_{water}/L_{soil}) = $w\rho_b/\rho_w$
ρ_b = soil dry bulk density (g/cm^3)
ρ_s = soil particle density (g/cm^3)
w = average soil moisture content (g/g)

ρ_w = water density (g/cm^3)
D_i = diffusivity in air (cm^2/s)
H' = dimensionless Henry's law constant = 41 × HLC
HLC = Henry's law constant (atm-m^3/mol)
D_w = diffusivity in water (cm^2/s)
K_d = soil-water partition coefficient (cm^3/g) = K_{oc} f_{oc}
K_{oc} = soil organic carbon partition coefficient (cm^3/g)
f_{oc} = organic carbon content of soil (g/g).

To estimate the average contaminant flux over 30 years, the time-dependent contaminant flux **must be solved for various times and the results averaged**. A simple computer program or spreadsheet can be used to calculate the instantaneous flux of contaminants at set intervals and numerically integrate the results to estimate the average contaminant flux. However, the time-step interval must be small enough (e.g., 1-day intervals) to ensure that the cumulative loss through volatilization is less than the total initial mass. Inadequate time steps can lead to mass-balance violations.

To address this problem, EPA/ORD's National Center for Environmental Assessment has developed a computer modeling program, EMSOFT. The computer program provides an average emission flux over time by using an analytical solution to the integral, thereby eliminating the problem of establishing adequate time steps for numerical integration. In addition, the EMSOFT model can account for water convection (i.e., leaching), and the impact of a soil-air boundary layer on the flux of contaminants with low Henry's law constants. EMSOFT will be available through EPA's National Center for Environmental Assessment (NCEA) in Washington, DC.

Once the average contaminant flux is calculated, VF is calculated as:

$$VF = (Q/C) \times (C_o/\rho_b) \times (1/J_s^{ave}) \times 10^{-4}\ m^2/cm^2 \qquad \textbf{(58)}$$

where

VF = volatilization factor (m^3/kg)
Q/C = inverse concentration factor for air dispersion (g/m^2-s per kg/m^3)
C_o = uniform contaminant concentration at t=0 (g/cm^3)
ρ_b = soil dry bulk density (g/cm^3)
J_s^{ave} = average rate of contaminant flux (g/cm^2-s).

3.1.2 Air Dispersion Models. The inverse concentration factor for air dispersion, Q/C, is used in the determination of both VF and PEF. For a detailed site-specific assessment of the inhalation pathway, a site-specific Q/C can be determined using the Industrial Source Complex Model platform in the short-term mode (ISCST3). Only a very brief overview of the application, assumptions, and input requirements for the model as used to determine Q/C is provided in this section. This model is the final regulatory version of the ISCST3 model.

The ISCST3 model FORTRAN code, executable versions, sample input and output files, description, and documentation can be downloaded from the "Other Models" section of the Office of Air Quality Planning and Standards (OAQPS) Support Center for Regulatory Air Models bulletin board system (SCRAM BBS). To access information, call:

OAQPS SCRAM BBS
(919) 541-5742 (24 hours/day, 7 days/week except Monday AM)
1,200–9,600, 14,400 baud
Line Settings: 8 bits, no parity, 1 stop bit
Terminal Emulation: VT100 or ANSI
System Operator: (919) 541-5384 (normal business hours EST).

The user registers in the first call and then has full access to the BBS.

The ISCST3 model will output an air concentration (in $\mu g/m^3$) when the concentration model option is selected (e.g., CO MODELOPT DFAULT CONC rural/urban). The surface area of the contaminated soil source must be determined. For the ISCST3 model, the source location of an area source is defined by the coordinates of the southwest corner of the square (e.g., SO LOCATION sourcename AREA $-^1/_2$length $-^1/_2$width height=0). For the source parameter input line, the contaminant's area emission rate (in units of g/m^2-s) must be entered. The area emission rate is the site-specific average emission flux rate, as calculated in Equation 56, converted to units of g/m^2-s (i.e., Aremis = $J_s^{ave} \times 10^4$ cm^2/m^2). Alternatively, an area emission rate of 1 g/m^2-s can be assumed. A grid or circular series of receptor sites should be used in and around the area source to identify the point of maximum contaminant air concentration. Hourly meteorologic data (*.MET files) for the nearest city (i.e., airport) of similar terrain and the preprocessor PCRAMMET also can be downloaded from the SCRAM BBS.

The ISCST3 model output concentration is then used to calculate Q/C as

$$Q/C = (J_s^{ave} \times 10^4\ cm^2/m^2)/(C_{air} \times 10^{-9}\ kg/\mu g) \qquad \textbf{(59)}$$

where

Q/C = inverse concentration factor for air dispersion (g/m^2-s per kg/m^3)
J_s^{ave} = average rate of contaminant flux (g/cm^2-s)
C_{air} = ISC output maximum contaminant air concentration ($\mu g/m^3$).

Note: If an area emission rate of 1 g/m^2-s is assumed, then ($J_s^{ave} \times 10^4$ cm^2/m^2) = 1, and Equation 59 simplifies to simply the inverse of the maximum contaminant air concentration (in kg/m^3).

3.2 Migration to Ground Water Pathway

For the migration to ground water pathway, the SSL equations assume an infinite source, contamination extending to the water table, and no attenuation due to degradation or adsorption in the unsaturated zone. At sites with small sources, deep water tables, confining layers in the unsaturated zone that can block contaminant transport, or contaminants that degrade through biological or chemical mechanisms, more complex models that can address such site conditions can be used to calculate higher SSLs that still will be protective of ground water quality. This section provides information on the use of such models in the soil screening process to calculate a dilution-attenuation factor (Section 3.2.1) and to estimate contaminant release in leachate and transport through the unsaturated zone (Section 3.2.2).

3.2.1 Saturated Zone Models. EPA has developed guidance for the selection and application of saturated zone transport and fate models and for interpretation of model applications. The user is referred to *Ground Water Modeling Compendium, Second Edition 1994* (U.S. EPA, 1994b) and *Framework for Assessing Ground Water Modeling Applications* (U.S. EPA, 1994a) for further information.

More complex saturated zone models can be used to calculate a dilution-attenuation factor (DAF) that, unlike the SSL dilution model, can consider attenuation in the aquifer. Some can handle a finite source through a transient mode that requires a time-stepped concentration from a finite-source unsaturated zone model (see Section 3.2.2). In general, to calculate a DAF using such models, the contaminant concentration at the water table under the source (C_w) is set to unity (e.g., 1 mg/L). The DAF is the reciprocal of the predicted concentration at the receptor point (C_{RP}) as follows:

$$DAF = C_w / C_{RP} = 1/C_{RP} \quad \textbf{(60)}$$

3.2.2 Unsaturated Zone Models. In an effort to provide useful information for model application, EPA's ORD laboratories in Ada, Oklahoma, and Athens, Georgia, conducted an evaluation of nine unsaturated zone fate and transport models (Criscenti et al., 1994; Nofziger et al., 1994). The results of this effort are summarized here. The models reviewed are only a subset of the potentially appropriate models available to the public and are not meant to be construed as having received EPA approval. Other models also may be applicable to SSL development, depending on site-specific circumstances.

Each of the unsaturated zone models selected for evaluation are capable, to varying degrees, of simulating the transport and transformation of chemicals in the subsurface. Even the most unique site conditions can be simulated by either a single model or a combination of models. However, the intended uses and the required input parameters of these models vary. The models evaluated include:

- RITZ (Regulatory and Investigative Treatment Zone model)
- VIP (Vadose zone Interactive Process model)
- CMLS (Chemical Movement in Layered Soils model)
- HYDRUS
- SUMMERS (named after author)
- MULTIMED (MULTIMEDia exposure assessment model)
- VLEACH (Vadose zone LEACHing model)
- SESOIL (SEasonal SOIL compartment model)
- PRZM-2 (Pesticide Root Zone Model).

RITZ, VIP, CMLS, and HYDRUS were evaluated by Nofziger et al. (1994). SUMMERS, MULTIMED, VLEACH, SESOIL, and PRZM-2 were evaluated by Criscenti et al. (1994). These documents should be consulted for further information on model application and use.

The applications, assumptions, and input requirements for the nine models evaluated are described in this section. The model descriptions include model solution method (i.e., analytical, numerical), the

purpose of the model, and descriptions of the methods used by the model to simulate water/contaminant transport and contaminant transformation. Each description is accompanied by a table of required input parameters. Input parameters discussed include soil properties, chemical properties, meteorologic data, and other site information. In addition, certain input control parameters may be required such as time stepping, grid discretization information, and output format.

Information on determining general applicability of the models to subsurface conditions is provided, followed by an assessment of each model's potential applicability to the soil screening process.

RITZ. Information on the RITZ model was obtained primarily from Nofziger et al. (1994). RITZ is a steady-state analytical model used to simulate the transport and fate of chemicals mixed with oily wastes (sludge) and disposed of by land treatment. RITZ simulates two layers of the soil column with uniform properties. The soil layers consist of: (1) the upper plow zone where the oily waste is applied and (2) the treatment zone. The bottom of the treatment zone is the water table. It is assumed in the model that the oily waste is completely mixed in and does not migrate out of the plow zone, which represents the contaminant source at an initial time. RITZ also assumes an infinite source (i.e., a continuous flux at constant concentration). The flux of water is assumed to be constant with time and depth and the Clapp-Hornberger constant is used in defining the soil water content resulting from a specified recharge rate. Sorption, vapor transport, volatilization, and biochemical degradation are also considered (van der Heijde, 1994). Partitioning between phases is instantaneous, linear, and reversible. Input parameters required for the RITZ model are presented in Table 10. Biochemical degradation of the oil and contaminant is considered to be a first-order process, and dispersion in the water phase is ignored.

Table 10. Input Parameters Required for RITZ Model

Soil properties	Site characteristics	Pollutant properties	Oil properties
Percent organic carbon	Plow zone depth	Concentration in sludge	Concentration of oil in sludge
Bulk density	Treatment zone depth	K_{oc}	Density of oil
Saturated water content	Recharge rate (constant)	K_{ow}	Degradation half-life of oil
Saturated hydraulic conductivity	Evaporation rate (constant)	Henry's law constant	---
Clapp-Hornberger constant	Air temperature (constant)	Degradation half-life (constant)	---
---	Relative humidity (constant)	Diffusion coefficient (in air)	---
---	Sludge application rate	---	---
---	Diffusion coefficient (water vapor in oil)	---	---

VIP. Information on the VIP model was obtained from Nofziger et al. (1994). The VIP model is a one-dimensional, numerical (finite-difference) fate and transport model also designed for simulating the movement of compounds in the unsaturated zone resulting from land application of oily wastes. Like the RITZ model, VIP considers dual soil zones (a plow zone and a treatment zone) and considers

the source to be infinite. VIP differs from RITZ in that it solves the governing differential equations numerically, which allows variability in the flux of water and chemicals over time. Advection and hydrodynamic dispersion are the primary transport mechanisms for the contaminant in water (van der Heijde, 1994). Instead of assuming instantaneous, linear equilibrium between all phases, VIP considers the partitioning rates between the air, oil, soil, water, and vapor-phase transport. Contaminant transformation processes include hydrolysis, volatilization, and sorption. Oxygen-limited degradation and diffusion of the contaminant in the air phases are also considered. Sorption is instantaneous as described for the RITZ model. The input parameters required for the VIP model are presented in Table 11.

Table 11. Input Parameters Required for VIP Model

Soil properties	Site characteristics	Pollutant properties	Oxygen properties	Oil properties
Porosity	Plow zone depth	Concentration in sludge	Oil-air partition coefficient[a]	Density of oil
Bulk density	Treatment zone depth	Oil-water partition coefficient[a]	Water-air partition coefficient[a]	Degradation rate constant of oil
Saturated hydraulic conductivity	Mean daily recharge rate	Air-water partition coefficient[a]	Oxygen half-saturation constant in air phase [a]	---
Clapp-Hornberger constant	Temperature (each layer)	Soil-water partition coefficient[a]	Oxygen half-saturation constant in oil phase [a]	---
---	Sludge application rate	Degradation constant in oil[a]	Oxygen half-saturation constant in water phase[a]	---
---	Sludge density	Degradation constant in water[a]	Oxygen half-saturation constant (oil degradation)	---
---	Application period and frequency in period	Dispersion coefficient	Stoichiometric ratio of oxygen to pollutant consumed	---
---	Weight fraction water in sludge	Adsorption-desorption rate constant (water/oil)	Stoichiometric ratio of oxygen to oil consumed	---
---	Weight fraction oil in waste	Adsorption-desorption rate constant (water/soil)	Oxygen transfer rate coefficient between oil and air phases	---
---	---	Adsorption-desorption rate constant (water/air)	Oxygen transfer rate coefficient between water and air phases	---

[a] Parameters required for plow zone and treatment zone.

CMLS. Information on CMLS was obtained from Nofziger et al. (1994). CMLS is an analytical model developed as a management tool to describe the fate and transport of pesticides in layered soils and to estimate the amount of chemical at a certain position at a certain time. The model allows designation of up to 20 soil layers with uniform soil and chemical properties defined for each layer.

Water in the soil system is "pushed ahead" of new water (recharge) entering the system. The water content is reduced to the field capacity after each infiltration event, and water is removed from the root zone in proportion to the available water stored in that layer (Nofziger et al., 1994). CMLS assumes movement of the chemical in liquid phase only and allows a finite source. Chemical partitioning between the soil and the water is assumed to be linear, instantaneous, and reversible. Volatilization is not considered. Dispersion and diffusion of the chemical is ignored and degradation is defined as a first-order process. The input parameters required for the CMLS model are presented in Table 12.

Table 12. Input Parameters Required for CMLS

Soil properties	Site characteristics	Chemical properties
Depth of bottom of soil layers	Daily infiltration or precipitation	Degradation half-life (each soil layer)
Organic carbon content	Daily evapotranspiration	Amount applied
Bulk density	---	Depth of application
Saturated water content	---	Date of application
Field capacity	---	K_{oc}
Permanent wilting point	---	---

HYDRUS. Information on the HYDRUS model was obtained from Nofziger et al. (1994). HYDRUS is a finite-element model for one-dimensional solute fate and transport simulations. The boundary conditions for flow, as well as soil and chemical properties, can therefore vary with time. A finite source also can be modeled. Soil parameters are described by the van Genuchten parameters. The model also considers root uptake and hysteresis in the water movement properties. Solute transport and transformation incorporates molecular diffusion, hydrodynamic dispersion, linear or nonlinear equilibrium partitioning (sorption), and first-order decay (van der Heijde, 1994). Volatilization is not considered. The input parameters required by HYDRUS are presented in Table 13.

SUMMERS. Information on the SUMMERS model was obtained from Criscenti et al. (1994). SUMMERS is a one-dimensional analytical model that simulates one-dimensional, nondispersive transport in a single layer of soil from an infinite source. It was developed to determine the contaminant concentrations in soil that would result in ground water contamination above specified levels for evaluating geothermal energy sites. The model is similar to the SSL equations in that it assumes steady-state water movement and equilibrium partitioning of the contaminant in the unsaturated zone and performs a mass-balance calculation of mixing in an underlying aquifer. For the saturated zone, the model assumes a constant flux from the surface source and instantaneous, complete mixing in the aquifer. The mixing depth is therefore defined by the thickness of the aquifer. The model does not account for volatilization. The input parameters required for SUMMERS are listed in Table 14.

Table 13. Input Parameters Required for HYDRUS

Soil properties	Site characteristics	Pollutant properties	Root uptake parameters
Depth of soil layers	Uniform or stepwise rainfall intensity	Molecular diffusion coefficient	Power function in stress-response function
Saturated water content	Contaminant concentrations in soil	Dispersivity	Pressure head where transpiration is reduced by 50%
Saturated hydraulic conductivity	---	Decay coefficient (dissolved)	Root density as a function of depth
Bulk density	---	Decay coefficient (adsorbed)	---
Retention parameters	---	Freundlich isotherm coefficients	---
Residual water content	---	---	---

Table 14. Input Parameters Required for SUMMERS

Parameters required	
Target concentration in ground water	Thickness of aquifer
Volumetric infiltration rate into aquifer	Width of pond/spill perpendicular to flow
Downward porewater velocity	Initial (background) concentration
Ground water seepage velocity	Equilibrium partition coefficient
Void fraction	Darcy velocity in aquifer
Horizontal area of pond or spill	Volumetric ground water flow rate

MULTIMED. Information on the MULTIMED model was obtained from Criscenti et al. (1994) and Salhotra et al. (1990). MULTIMED was developed as a multimedia fate and transport model to simulate contaminant migration from a waste disposal unit. For this review, only the fate and transport of pollutants from the soil to migration to ground water pathway was considered in detail.

In MULTIMED, infiltration of waste into the unsaturated or saturated zones can be simulated using a landfill module or by direct infiltration to the unsaturated or saturated zones. Flow in the unsaturated zone and for the landfill module is simulated by a one-dimensional, semianalytical module. Transport in the unsaturated zone considers the effects of dispersion, sorption, volatilization, biodegradation, and first-order chemical decay. The saturated transport module is also one-dimensional, but considers three-dimensional dispersion, linear adsorption, first-order decay, and dilution due to recharge. Mixing in the underlying saturated zone is based on the vertical dispersivity specified, the length of the disposal facility parallel to the flow direction, the thickness of the saturated zone, the ground water velocity, and the infiltration rate. The saturated zone module can simulate steady-state and transient ground water flow and thus can consider a finite source assumption through a leachate "pulse duration." The parameters required for the unsaturated and saturated zone transport in MULTIMED are presented in Table 15.

Table 15. Input Parameters Required for MULTIMED

Unsaturated zone parameters		
Saturated hydraulic conductivity	Thickness of each layer	Reference temperature for air diffusion
Porosity	Longitudinal dispersivity	Molecular weight
Air entry pressure head	Percent organic matter	Infiltration rate
Depth of unsaturated zone	Soil bulk density	Area of waste disposal unit
Residual water content	Biological decay coefficient	Duration of pulse
Number of porous materials	Acid, base, and neutral hydrolysis rates	Source decay constant
Number of layers	Reference temperature	Initial concentration at landfill
Alpha coefficient	Normalized distribution coefficient	Particle diameter
van Genuchten exponent	Air diffusion coefficient	---
Saturated zone parameters		
Recharge rate	Longitudinal dispersivity	Organic carbon content
First-order decay coefficient	Transverse dispersivity	Well distance from site
Biodegradation coefficient	Vertical dispersivity	Angle off-center of well
Aquifer thickness	Temperature of aquifer	Well vertical distance
Hydraulic gradient	pH	---

VLEACH. Information on the VLEACH model was obtained from Criscenti et al. (1994). VLEACH is a one-dimensional, finite difference model developed to simulate the transport of contaminants displaying linear partitioning behavior through the vadose zone to the water table by aqueous advection and diffusion. Multiple layers can be modeled and are expressed as polygons with different soil properties and recharge rates. Water flow is assumed to be steady state. Linear equilibrium partitioning is used to determine chemical concentrations between the aqueous, gaseous, and adsorbed phases (sorption and volatilization), and a finite source can be considered. Chemical or biological degradation is not considered. The input parameters required for VLEACH are presented in Table 16.

Table 16. Input Parameters Required for VLEACH

Soil properties	Chemical characteristics	Site properties
Dry bulk density	K_{oc}	Recharge rate
Total porosity	Henry's law constant	Contaminant concentrations in recharge
Volumetric water content	Aqueous solubility	Depth to ground water
Fractional organic carbon	Free air diffusion coefficient	Dimensions of "polygons"

SESOIL. Information on the SESOIL model was obtained from Criscenti et al. (1994). SESOIL is a one-dimensional, finite difference flow and transport model developed for evaluating the movement of contaminants through the vadose zone. The model contains three components: (1) hydrologic cycle, (2) sediment cycle, and (3) pollutant fate cycle. The model estimates the rate of vertical solute transport and transformation from the land surface to the water table. Up to four layers can be simulated by the model and each layer can be subdivided into 10 compartments with uniform soil characteristics. Hydrologic data can be included using either monthly or annual data options. Solute transport is simulated for ground water and surface runoff including eroded sediment. Pollutant fate considers equilibrium partitioning to soil and air phases (sorption and diffusion), volatilization from the surface layer, first-order chemical degradation, biodegradation, cation exchange, hydrolysis, and metal complexation and allows for a stationary free phase. The required input parameters for SESOIL are presented in Table 17 for the monthly option.

Table 17. Input Parameters Required for SESOIL (Monthly Option)

Climate data	Soil data	Chemical data	Application data
Mean air temperature[a]	Number of layers and sublayers	Solubility in water	Application area
Mean cloud cover fraction[a]	Thickness of layers	Air diffusion coefficient	Site latitude
Mean relative humidity[a]	pH of each layer	Henry's law constant	Spill index
Short wave albedo fraction[a]	Bulk density	Organic carbon adsorption ratio	Pollutant load
Total precipitation	Intrinsic permeability	Soil adsorption coefficient	Mass removed or transformed
Mean storm duration	Pore disconnectedness index	Molecular weight	Index of volatile diffusion
Number of storm events	Effective porosity	Valence	Index of transport in surface runoff
---	Organic carbon content	Hydrolysis constants (acid, base, neutral)	Ratio pollutant conc. in rain to solubility
---	Cation exchange capacity	Biodegradation rates (liquid, solid)	Washload area
---	Freundlich exponent	Ligand stability constant	Average slope and slope length
---	Silt, sand, and clay fractions	Moles ligand per mole compound	Erodibility factor
---	Soil loss ratio	Molecular weight of ligand	Practice factor
---	---	Ligand mass	Manning coefficient

[a] SESOIL uses these parameters to calculate evapotranspiration if an evapotranspiration value is not specified.

PRZM-2. Information on PRZM-2 was obtained from Criscenti et al. (1994). PRZM-2 is a combination of two models developed to simulate the one-dimensional movement of chemicals in the unsaturated and saturated zones. The first model, PRZM, is a finite difference model that simulates water flow and detailed pesticide fate and transformation in the unsaturated zone. The second model, VADOFT, is a one-dimensional finite element model with more detailed water movement simulation capabilities. The coupling of these models results in a detailed representation of contaminant transport and transformation in the unsaturated zone.

PRZM has been used predominantly for evaluation of pesticide leaching in the root zone. PRZM uses detailed meteorologic and surface hydrology data for the hydrologic simulations. Runoff, erosion, plant uptake, leaching, decay, foliar washoff, and volatilization are considered in the surface hydrologic and chemical transport components. Chemical transport and fate in the subsurface is simulated by advection, dispersion, molecular diffusion, first-order chemical decay, biodegradation, daughter compound progeny, and soil sorption. The input parameters required for PRZM are presented in Table 18.

VADOFT can be run independently of PRZM and output from the PRZM model can be used to set the boundary conditions for VADOFT. The lower boundaries could also be specified as a constant pressure head or zero velocity. Transport simulations consider advection and diffusion with sorption and first-order decay. The input requirements for VADOFT are presented in Table 19.

Considerations for Unsaturated Zone Model Selection. The accuracy of a model in a site-specific application depends on simplifications and assumptions implicit in the model and their relationship to site-specific conditions. Additional error may be introduced from assumptions made when deriving input parameters. Although each of the nine models evaluated has been tested and validated for simulation of water and contaminant movement in the unsaturated zone, they are different in purpose and complexity, with certain models designed to simulate very specific scenarios.

A model should be selected to accommodate a site-specific scenario as closely as possible. For example, if contaminant volatilization is of concern, the model should consider volatilization and vapor phase transport. After a model is determined to be appropriate for a site, contaminant(s), and conditions to be modeled, the site-specific information available (or potentially available) should be compared to the input requirements for the model to ensure that adequate inputs can be developed.

The unsaturated zone models addressed in this study use either analytical, semianalytical, or numerical solution methods. Analytical models represent the simplest models, requiring the least number of input parameters. They use a closed-form solution for the pertinent equations. In analytical models, certain assumptions have to be made with respect to the geometry of the system and external stresses. For this reason, there are few analytical flow models (van der Heijde, 1994). Analytical solutions are common, however, for fate and transport problems by solution of convection-dispersion equations. Analytical models require the assumption of uniform flow conditions, both spatially and temporally.

Semianalytical models approximate complex analytical solutions using numerical techniques (van der Heijde, 1994). Transient or steady-state conditions can be approximated using a semianalytical model. However, spatial variability in soil or aquifer conditions cannot be accommodated.

Numerical models use approximations of pertinent partial differential equations usually by finite-difference or finite-element methods. The resolution of the area and time of simulation is defined by the modeler. Numerical models may be used when simulating time-dependent scenarios, spatially variable soil conditions, and unsteady flow (van der Heijde, 1994).

Table 18. Input Parameters Required for PRZM

Daily climate data			
Pan evaporation and pan factor	Precipitation	Windspeed	Snowmelt factor
Temperature	Monthly daylight hours	Solar radiation	Minimum evaporation extraction depth
Erosion data			
Topographic factor/soil erodibility	Average duration of rainfall	Field area	Practice factor
Crop data			
Surface condition of crop	Maximum interception storage	Maximum rooting depth	Maximum canopy coverage
Maximum dry weight of crop after harvest	---	Emergence, maturation, and harvest dates	---
Pesticide data			
Application quantity	Number of applications (50 maximum)	Number of chemicals (3 maximum)	Application dates
Foliar extraction coefficient	Incorporation depth	Plant uptake factor	Foliar decay rates
Diffusion coefficient in air	Enthalpy of vaporization	K_d and K_{oc}	Henry's law constant
Initial concentration levels	Parent/daughter transform rates	Aqueous, sorbed, vapor decay rates	
Soil data			
Compartment thicknesses	Runoff curve numbers	Core depth	Number and thickness of horizons
Soil drainage parameter	Hydrodynamic dispersion	Bulk density	Initial soil water content
Wilting point	Percent organic carbon	Field capacity	---
Soil temperature			
Heat capacity per unit volume	Albedo	Reflectivity of soil surface	Height of windspeed measurement
Thermal conductivity of horizon	Avgerage monthly bottom boundary temperature	Initial horizon temperature	Sand and clay content
Biodegradation and irrigation parameters (not presented)			

Table 19. Input Parameters Required for VADOFT

Pesticide data	Soil data	
Number of chemicals	Number of soil horizons	Relative permeability vs. saturation
Aqueous decay rate	Horizon thicknesses	Pressure head vs. saturation
Initial concentration	Saturated hydraulic conductivity	Residual water phase saturation
Longitudinal dispersivity	Effective porosity	Brooks and Corey n
Retardation coefficient	Air entry pressure head	van Genuchten alpha
Molecular diffusion	---	---
Conc. flux at first node (if independent of PRZM)	Input flux or head at first node (if independent of PRZM)	

In certain cases, input parameters to be used in a model are not definitively known. Some models allow some input parameters to be expressed as probability distributions rather than a single value, referred to as Monte Carlo simulations. This method can provide an estimate of the uncertainty of the model output (i.e., percent probability that a contaminant will be greater than a certain concentration at a depth), but requires knowledge of the parameter distributions. Alternatively, a bounding approach can be used to estimate the effects of likely parameter ranges on model results where there is uncertainty in input parameter values.

Model Applicability to SSLs. The unsaturated models evaluated herein can provide inputs necessary for soil screening by calculating leachate concentrations at the water table or by calculating infiltration rates. In the former application, they produce results comparable to the leach test option. As with the leach test, the leachate concentration from the model is **divided** by the dilution factor to obtain an estimated ground water concentration at the receptor well. This receptor point concentration is then compared with the acceptable ground water concentration to determine if a site's soils exceed SSLs.

Table 20 summarizes characteristics and capabilities of the models evaluated for this study. All nine of the models can calculate contaminant concentrations in leachate that has infiltrated down to the water table from the vadose zone, although CMLS requires a separate calculation to estimate leachate concentration. If there is reliable site data indicating significant degradation in soil, several of the models can consider biological and/or chemical degradation processes. The models also can address contaminant adsorption; those that can model layered soils can be especially useful in settings where low-permeability clay layers may attenuate contaminants through adsorption. Finally, several of the models can address a finite source if the size of the source is accurately known.

The average annual infiltration rate at a site is difficult to measure in the field yet is required for estimating a dilution factor or DAF. Four of the models evaluated, CMLS, HYDRUS, SESOIL, and PRZM, can calculate infiltration rates given either daily or monthly rainfall data.

Two models, VLEACH and SESOIL, address volatilization from the soil surface along with leachate emissions and therefore may be useful for SSL development for the volatilization and migration to ground water pathways. The volatile emission portion of VLEACH is discussed in Section 3.1.

Table 20. Characteristics of Unsaturated Zone Models Evaluated

	Type			Fate and Transport Processes Considered														Other		
Model	Analytical	Semianalytical	Numerical	Finite source	Partitioning with oil phase	Volatilization	Vapor phase transport	Hydrodynamic dispersion	Diffusion	Sorption	Nonequilibrium partitioning	Hydrolysis (1st-order decay)	Biodegradation	Layered soils	Root zone uptake	Runoff	Erosion	Saturated zone included	Monte Carlo analysis	Water balance calculations
RITZ	•				•	•			•	•		•	•							
VIP			•		•	•	•	•		•	•	•								
CMLS	•			•						•		•		•						•
HYDRUS			•	•				•	•	•		•		•	•					•
MULTIMED		•				•		•		•	•	•	•	•				•	•	
SUMMERS	•									•								•		
PRZM-2			•	•		•		•	•	•		•	•	•	•	•	•		•	•
SESOIL			•	•		•		•	•	•	•	•	•	•		•	•			•
VLEACH			•	•		•	•		•	•	•			•						

Table 20 addresses only unsaturated zone fate and transport model components, although two models (MULTIMED and SUMMERS) have saturated zone flow and transport capabilities. The following text highlights some of the differences between the models, outlines their advantages and disadvantages, and describes appropriate scenarios for model application.

RITZ. RITZ was designed to model land treatment units and is appropriate for sites where oily wastes are present (it includes sorption on an immobile oil phase as well as onto soil particles). Sorption, degradation, volatilization, and first-order decay processes are considered in the subsurface simulations. The most significant drawback for the model is the limit on the number of soil layers. Optimally, RITZ would be recommended for modeling chemical migration in a uniform unsaturated zone as a result of land application. Although the oil phase can be omitted for simulations of scenarios without oily materials, the RITZ model's focus on oily waste degradation in land treatment units limits its utility for soil screening (SSLs are not applicable when soils contain a separate oil phase).

VIP. VIP also is appropriate for sites where release of oily wastes has occurred. Some of the limitations described in RITZ also apply to the VIP model. VIP could be used as a followup model to RITZ since variable chemical and water fluxes can be simulated. In this case, significant additional

input parameters are required to simulate transient partitioning between the air, soil, water, and oil phases. Like RITZ, VIP's focus on land treatment of oily waste limits its application to SSLs.

CMLS. CMLS differs from RITZ and VIP in that it allows designation of up to 20 soil layers with different properties. It does not consider nonaqueous phase liquids, dispersion, diffusion, or vapor phase transport, but a finite source can be modeled. CMLS estimates the location of the peak concentration of contaminants through a layered soil system. A limitation of the CMLS model for SSL application is that it does not calculate leachate concentrations. Instead, it calculates the amount of chemical at a certain depth at a certain time. The user must estimate the concentration based on the amount of chemical present and the total flux of water in the system (Nofziger et al., 1994). The model is typically used to estimate the time for a chemical entering the unsaturated zone to reach a certain depth.

HYDRUS. Like CMLS, the HYDRUS model can also simulate chemical movement in layered soils and can consider a finite source, but also includes dispersion and diffusion as well as sorption and first-order decay. In addition, HYDRUS outputs the chemical concentration in the soil water as a function of time and depth along with the amount of chemical remaining in the soil. The model considers root zone uptake, but other models such as PRZM should be used if the comprehensive effects of plant uptake are to be considered in the simulations. Because it can estimate infiltration from rainfall contaminant concentrations, HYDRUS may be useful in SSL applications.

SUMMERS. The SUMMERS model is a relatively simple model designed to simulate leaching in the unsaturated zone and is essentially identical to the SSL migration to ground water equations in assumptions and limitations. It is appropriate for use as an initial screening model where site data are limited and where volatilization is not of concern. However, since attenuation processes such as biodegradation, first-order decay, volatilization, or other attenuation processes (other than sorption) are not considered, it is a quite conservative model. Since volatilization is not considered, it cannot be used to simulate migration of volatile compounds to the atmosphere. Because of its similarities to the SSL migration to ground water equations, the SUMMERS model is not suitable for a more detailed assessment of site conditions.

MULTIMED. MULTIMED simulates simple vertical water movement in the unsaturated zone. Since an initial soil concentration cannot be specified, either the soil/water partition equation or a leaching test (SPLP) must be used to estimate soil leachate contaminant concentrations. MULTIMED is appropriate for simulating contaminant migration in soil and can be used to model vadose zone attenuation of leachate concentrations derived from a partition equation (see Section 2.5.1). In addition, since it links the output from the unsaturated zone transport module with a saturated zone module, it can be used to determine the concentration of a contaminant in a well located downgradient from a contaminant source. MULTIMED is appropriate for early-stage site simulations because the input parameters required are typically available and uncertainty analyses can be performed using Monte Carlo simulations for those parameters for which reliable values are not known.

VLEACH. In VLEACH, biological or chemical degradation is not considered. It therefore provides conservative estimates of contaminant migration in soil. This model may be appropriate as an initial screening tool for sites for which there is little information available. VLEACH can estimate volatile emissions (see Section 3.1) and can consider a finite source. It is therefore potentially applicable to both subsurface pathways addressed by the soil screening process.

SESOIL. SESOIL was designed as a screening tool, but it is actually more complex than some of the models described. Some of the input data would be cumbersome to obtain, especially for use as an initial screening tool. It is applicable for simulating spill sites since it allows consideration of surface transport by erosion and runoff and can utilize detailed meteorologic information to estimate infiltration. In the soil zone, several fate and transport options are available such as metal complexation, hydrolysis, cation exchange, and degradation. This model is especially applicable to sites where significant subsurface and meteorologic information is available. Although the model does consider volatilization from surface soils, the available documentation (Criscenti et al., 1994) is not clear as to whether it produces an output of volatile flux to the atmosphere.

PRZM-2. PRZM-2 is a relatively detailed model as a result of the coupling of the two models PRZM and VADOFT. Although PRZM is predominantly used as a pesticide leaching model, it could also be used for simulation of transport of other chemicals. Because detailed meteorology and surface application parameters can be included, it is appropriate for simulation of surface spills or land disposal scenarios. In addition, uncertainty analyses can be performed based on Monte Carlo simulations. Numerous subsurface fate and transport options exist in PRZM. Water movement is somewhat simplified in PRZM, and it may not be applicable for low-permeability soils (Criscenti et al., 1994). However, water flow simulation is more detailed in the VADOFT module of the PRZM-2 program. The combination of these programs makes PRZM-2 a relatively complex model. This model is especially applicable to sites for which significant site and meteorologic data are available.

Part 4: MEASURING CONTAMINANT CONCENTRATIONS IN SOIL

The Soil Screening Guidance includes a sampling strategy for implementing the soil screening process. Section 4.1 presents the sampling approach for surface soils. This approach provides a simple decision rule based on comparing the maximum contaminant concentrations of composite samples with surface soil screening levels (the Max test) to determine whether further investigation is needed for a particular exposure area (EA). In addition, this section presents a more complex strategy (the Chen test) that allows the user to design a site-specific quantitative sampling strategy by varying decision error limits and soil contaminant variability to optimize the number of samples and composites. Section 4.2 provides a subsurface soil sampling strategy for developing SSLs and applying the screening procedure for the volatilization and migration to ground water exposure pathways.

Section 4.3 describes the technical details behind the development of the SSL sampling strategy, including analyses and response to public and peer-review comments received on the December 1994 draft guidance.

The sampling strategy for the soil screening process is designed to achieve the following objectives:

- Estimate mean concentrations of contaminants of concern for comparison with SSLs

- Fill in the data gaps in the conceptual site model necessary to develop SSLs.

The soils of interest for the first objective differ according to the exposure pathway being addressed. For the direct ingestion, dermal, and fugitive dust pathways, EPA is concerned about surface soils. The sampling goal is to determine average contaminant concentrations of surface soils in exposure areas of concern. For inhalation of volatiles, migration to ground water and, in some cases, plant uptake, subsurface soils are the primary concern. For these pathways, the average contaminant concentration through each source is the parameter of interest.

The second objective (filling in the data gaps) applies primarily to the inhalation and migration to ground water pathways. For these pathways, the source area and depth as well as average soil properties within the source are needed to calculate the pathway-specific SSLs. Therefore, the sampling strategy needs to address collection of these site-specific data.

Because of the difference in objectives, the sampling strategies for the ingestion pathway and for the inhalation and migration to ground water pathways are addressed separately. If both surface and subsurface soils are a concern, then surface soils should be sampled first because the results of surface soil analyses may help delineate source areas to target for subsurface sampling.

At some sites, a third sampling objective may be appropriate. As discussed in the Soil Screening Guidance, SSLs may not be useful at sites where background contaminant levels are above the SSLs. Where sampling information suggests that background contaminant concentrations may be a concern, background sampling may be necessary. *Methods for Evaluating the Attainment of Cleanup Standards - Volume 3: Reference-Based Standards for Soil and Solid Media* (U.S. EPA, 1994e) provides further information on sampling soils to determine background conditions at a site.

In order to accurately represent contaminant distributions at a site, EPA used the Data Quality Objectives (DQO) process (Figure 4) to develop a sampling strategy that will satisfy Superfund program objectives. The DQO process is a systematic data collection planning process developed by EPA to ensure that the right type, quality, and quantity of data are collected to support EPA decision making. As shown in Sections 4.1.1 through 4.1.6, most of the key outputs of the DQO process already have been developed as part of the Soil Screening Guidance. The DQO activities addressed in this section are described in detail in the *Data Quality Objectives for Superfund: Interim Final Guidance* (U.S. EPA, 1993b) and the *Guidance for the Data Quality Objectives Process* (U.S. EPA, 1994c). Refer to these documents for more information on how to complete each DQO activity or how to develop other, site-specific sampling strategies.

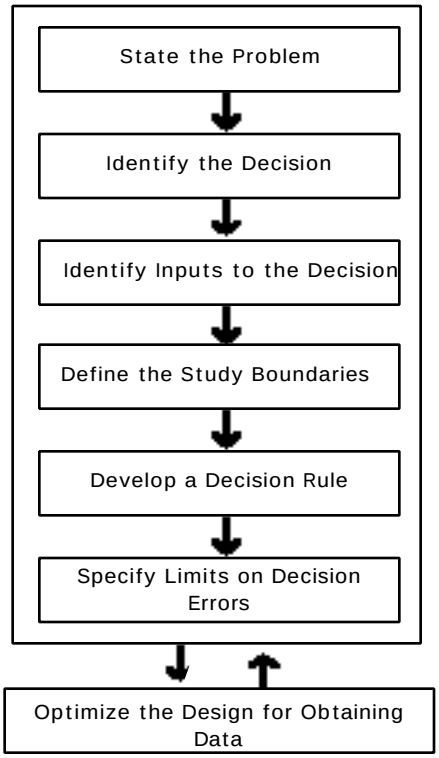


Figure 4. The Data Quality Objectives process.

4.1 Sampling Surface Soils

A sampling strategy for surface soils is presented in this section, organized by the steps of the DQO process. The first five steps of this process, from defining the problem through developing the basic decision rule, are summarized in Table 21, and are described in detail in the first five subsections. The details of the two remaining steps of the DQO process, specifying limits on decision errors and optimizing the design, have been developed separately for two alternative hypothesis testing procedures (the Max test and the Chen method) and are presented in four (4.1.6, 4.1.7, 4.1.9, and 4.1.10) subsections. In addition, a data quality assessment (DQA) follows the DQO process step for optimizing the design. The DQA ensures that site-specific error limits are achieved. Sections 4.1.8 and 4.1.11 describe the DQA for the Max and Chen tests, respectively. The technical details behind the development of the surface soil sampling design strategy are explained in Section 4.3.

4.1.1 State the Problem. In screening, the problem is to identify the contaminants and exposure areas (EAs) that do not pose significant risk to human health so that future investigations can be focused on the areas and contaminants of concern at a site.

The main site-specific activities involved in this first step of the DQO process include identifying the data collection planning team (including technical experts and key stakeholders) and specifying the available resources. The list of technical experts and stakeholders should contain all key personnel who are involved with applying the Soil Screening Guidance at the site. Other activities in this step include developing the conceptual site model (CSM), identifying exposure scenarios, and preparing a summary description of the surface soil contamination problem. The User's Guide (U.S. EPA, 1996) describes these activities in with more detail.

4.1.2 Identify the Decision. The decision is to determine whether the mean surface soil concentrations exceed surface soil screening levels for specific contaminants within EAs. If so, the EA must be investigated further. If not, no further action is necessary under CERCLA for the specific contaminants in the surface soils of those EAs.

Table 21. Sampling Soil Screening DQOs for Surface Soils

DQO Process Steps	Soil Screening Inputs/Outputs
State the Problem	
Identify scoping team	Site manager and technical experts (e.g., toxicologists, risk assessors, statisticians, soil scientists)
Develop conceptual site model (CSM)	CSM development (described in Step 1 of the User's Guide, U.S. EPA, 1996)
Define exposure scenarios	Direct ingestion and inhalation of fugitive particulates in a residential setting; dermal contact and plant uptake for certain contaminants
Specify available resources	Sampling and analysis budget, scheduling constraints, and available personnel
Write brief summary of contamination problem	Summary of the surface soil contamination problem to be investigated at the site
Identify the Decision	
Identify decision	Do mean soil concentrations for particular contaminants (e.g., contaminants of potential concern) exceed appropriate screening levels?
Identify alternative actions	Eliminate area from further study under CERCLA or Plan and conduct further investigation
Identify Inputs to the Decision	
Identify inputs	Ingestion and particulate inhalation SSLs for specified contaminants Measurements of surface soil contaminant concentration
Define basis for screening	Soil Screening Guidance
Identify analytical methods	Feasible analytical methods (both field and laboratory) consistent with program-level requirements
Define the Study Boundaries	
Define geographic areas of field investigation	The entire NPL site (which may include areas beyond facility boundaries), except for any areas with clear evidence that no contamination has occurred
Define population of interest	Surface soils (usually the top 2 centimeters, but may be deeper where activities could redistribute subsurface soils to the surface)
Divide site into strata	Strata may be defined so that contaminant concentrations are likely to be relatively homogeneous within each stratum based on the CSM and field measurements
Define scale of decision making	Exposure areas (EAs) no larger than 0.5 acre each (based on residential land use)
Define temporal boundaries of study	Temporal constraints on scheduling field visits
Identify practical constraints	Potential impediments to sample collection, such as access, health, and safety issues
Develop a Decision Rule	
Specify parameter of interest	"True mean" (μ) individual contaminant concentration in each EA. (since the determination of the "true mean" would require the collection and analysis of many samples, the "Max Test" uses another sample statistic, the maximum composite concentration).
Specify screening level	Screening levels calculated using available parameters and site data (or generic SSLs if site data are unavailable).
Specify "if..., then..." decision rule	If the "true mean" EA concentration exceeds the screening level, then investigate the EA further. If the "true mean" is less than the screening level, then no further investigation of the EA is required under CERCLA.

4.1.3 Identify Inputs to the Decision. This step of the DQO process requires identifying the inputs to the decision process, including the basis for further investigation and the applicable analytical methods. The inputs for deciding whether to investigate further are the ingestion, dermal, and fugitive dust inhalation SSLs calculated for the site contaminants as described in Part 2 of this document, and the surface soil concentration measurements for those same contaminants. Therefore, the remaining task is to identify Contract Laboratory Program (CLP) methods and/or field methods for which the quantitation limits (QLs) are less than the SSLs. EPA recommends the use of field methods, such as soil gas surveys, immunoassays, or X-ray fluorescence, where applicable and appropriate as long as quantitation limits are below the SSLs. At least 10 percent of field samples should be split and sent to a CLP laboratory for confirmatory analysis (U.S. EPA, 1993d).

4.1.4 Define the Study Boundaries. This step of the DQO process defines the sample population of interest, subdivides the site into appropriate exposure areas, and specifies temporal or practical constraints on the data collection. The description of the population of interest must include the surface soil depth.

Sampling Depth. When measuring soil contamination levels at the surface for the ingestion and inhalation pathways, the top 2 centimeters is usually considered surface soil, as defined by *Urban Soil Lead Abatement Project* (U.S. EPA 1993f). However, additional sampling beyond this depth may be appropriate for surface soils under a future residential use scenario in areas where major soil disturbances can reasonably be expected as a result of landscaping, gardening, or construction activities. In this situation, contaminants that were at depth can be moved to the surface. Thus, it is important to be cognizant of local residential construction practices when determining the depth of surface soil sampling and to weigh the likelihood of that area being developed.

Subdividing the Site. This step involves dividing the site into areas or strata depending on the likelihood of contamination and identifying areas with similar contaminant patterns. These divisions can be based on process knowledge, operational units, historical records, and/or prior sampling. Partitioning the site into such areas and strata can lead to a more efficient sampling design for the entire site.

For example, the site manager may have documentation that large areas of the site are unlikely to have been used for waste disposal activities. These areas would be expected to exhibit relatively low variability and the sampling design could involve a relatively small number of samples. The greatest intensity of sampling effort would be expected to focus on areas of the site where there is greater uncertainty or greater variability associated with contamination patterns. When relatively large variability in contaminant concentrations is expected, more samples are required to determine with confidence whether the EA should be screened out or investigated further.

Initially, the site may be partitioned into three types of areas:

1. Areas that are not likely to be contaminated
2. Areas that are known to be highly contaminated
3. Areas that are suspected to be contaminated and cannot be ruled out.

Areas that are not likely to be contaminated generally will not require further investigation if this assumption is based on historical site use information or other site data that are reasonably complete and accurate. (However, the site manager may also want take a few samples to confirm this assumption). These may be parts of the site that are within the legal boundaries of the property but

were completely undisturbed by hazardous-waste-generating activities. All other areas need investigation.

Areas that are known to be highly contaminated (i.e., sources) are targeted for subsurface sampling. The information collected on source area and depth is used to calculate site-specific SSLs for the inhalation and migration to ground water pathways (see Section 4.2 for more information).

Areas that are suspected to be contaminated (and cannot be ruled out for screening) are the primary subjects of the surface soil investigation. If a geostatistician is available, a geostatistical model may be used to characterize these areas (e.g., kriging model). However, guidance for this type of design is beyond the scope of the current guidance (see Chapter 10 of U.S. EPA, 1989a).

Defining Exposure Areas. After the site has been partitioned into relatively homogeneous areas, each region that is targeted for surface soil sampling is then subdivided into EAs. An EA is defined as that geographical area in which an individual may be exposed to contamination over time. Because the SSLs were developed for a residential scenario, EPA assumes the EA is a suburban residential lot corresponding to 0.5 acre. For soil screening purposes, each EA should be 0.5 acre or less. To the extent possible, EAs should be constructed as square or rectangular areas that can be subdivided into squares to facilitate compositing and grid sampling. If the site is currently residential, then the EA should be the actual residential lot size. The exposure areas should not be laid out in such a way that they unnecessarily combine areas of high and low levels of contamination. The orientation and exact location of the EA, relative to the distribution of the contaminant in the soil, can lead to instances where sampling of the EA may lead to results above the mean, and other instances, to results below the mean. Try to avoid straddling contaminant “distribution units” within the 0.5 acre EA.

The sampling strategy for surface soils allows investigators to determine mean soil contaminant concentration across an EA of interest. An arithmetic mean concentration for an EA best represents the exposure to site contaminants over a long period of time. For risk assessment purposes, an individual is assumed to move randomly across an EA over time, spending equivalent amounts of time in each location. Since reliable information about specific patterns of nonrandom activity for future use scenarios is not available, random exposure appears to be the most reasonable assumption for a residential exposure scenario. Therefore, spatially averaged surface soil concentrations are used to estimate mean exposure concentrations.

Because all the EAs within a given stratum should exhibit similar contaminant concentrations, one site-specific sampling design can be developed for all EAs within that stratum. As discussed above, some strata may have relatively low variability and other strata may have relatively high variability. Consequently, a different sampling design may be necessary for each stratum, based upon the stratum-specific estimate of the contaminant variability.

4.1.5 Develop a Decision Rule. Ideally, the decision rule for surface soils is:

> If the mean contaminant concentration within an EA exceeds the screening level, then investigate that EA further.

This "screening level" is the actual numerical value used to compare against the site contamination data. It may be identical to the SSL, or it may be a multiple of the SSL (e.g., 2 SSL) for a hypothesis test designed to achieve specified decision error rates in a specified region above and below the SSL. In addition, another sample statistic (e.g., the maximum concentration) may be used as an estimate of the mean for comparison with the "screening level."

4.1.6 Specify Limits on Decision Errors for the Max Test. Sampling data will be used to support a decision about whether an EA requires further investigation. Because of variability in contaminant concentrations within an EA, practical constraints on sample sizes, and sampling or measurement error, the data collected may be inaccurate or nonrepresentative and may mislead the decision maker into making an incorrect decision. A decision error occurs when sampling data mislead the decision maker into choosing a course of action that is different from or less desirable than the course of action that would have been chosen with perfect information (i.e., with no constraints on sample size and no measurement error).

EPA recognizes that data obtained from sampling and analysis are never perfectly representative and accurate, and that the costs of trying to achieve near-perfect results can outweigh the benefits. Consequently, EPA acknowledges that uncertainty in data must be tolerated to some degree. The DQO process controls the degree to which uncertainty in data affects the outcomes of decisions that are based on those data. This step of the DQO process allows the decision maker to set limits on the probabilities of making an incorrect decision.

The DQO process utilizes hypothesis tests to control decision errors. When performing a hypothesis test, a presumed or baseline condition, referred to as the "null hypothesis" (H_o), is established. This baseline condition is presumed to be true unless the data conclusively demonstrate otherwise, which is called "rejecting the null hypothesis" in favor of an alternative hypothesis. For the Soil Screening Guidance, the baseline condition, or H_o, is that **the site needs further investigation.**

When the hypothesis test is performed, two possible decision errors may occur:

1. Decide not to investigate an EA further (i.e., "walk away") when the correct decision (with complete and perfect information) would be to "investigate further"

2. Decide to investigate further when the correct decision would be to "walk away."

Since the site is on the NPL, site areas are presumed to need further investigation. Therefore, the data must provide clear evidence that it would be acceptable to "walk away." This presumption provides the basis for classifying the two types of decision errors. The "incorrectly walk away" decision error is designated as the Type I decision error because one has incorrectly rejected the baseline condition (null hypothesis). Correspondingly, the "unnecessarily investigate further" decision error is designated as the Type II decision error.

To complete the specification of limits on decision errors, Type I and Type II decision error probability limits must be defined in relation to the SSL. First a "gray region" is specified with respect to the mean contaminant concentration within an EA. The gray region represents the range of contaminant levels near the SSL, where uncertainty in the data (i.e., the variability) can make the decision "too close to call." In other words, when the average of the data values is very close to the SSL, it would be too expensive to generate a data set of sufficient size and precision to resolve what the correct determination should be. (i.e., Does the average concentration fall "above" or "below" the SSL?)

The Soil Screening Guidance establishes a default range for the width and location of the "gray region": from one-half the SSL (0.5 SSL) to two times the SSL (2 SSL). By specifying the upper edge of the gray region as twice the SSL, it is possible that exposure areas with mean values slightly higher than the SSL may be screened from further study. However, EPA believes that the exposure scenario

and assumptions used to derive SSLs are sufficiently conservative to be protective in such cases.

On the lower side of the gray region, the consequences of decision errors at one-half the SSL are primarily financial. If the lower edge of the gray region were to be moved closer to the SSL, then more exposure areas that were truly below the SSL would be screened out, but more money would be spent on sampling to make this determination. If the lower edge of the gray region were to be moved closer to zero, then less money could be spent on sampling, but fewer EAs that were truly below the SSLs would be screened out, leading to unnecessary investigation of EAs. The Superfund program chose the gray region to be one-half to two times the SSL after investigating several different ranges. This range for the gray region represents a balance between the costs of collecting and analyzing soil samples and making incorrect decisions. While it is desirable to estimate exactly the exposure area mean, the number of samples required are much more than project managers are generally willing to collect in a "screening" effort. Although some exposure areas will have contaminant concentrations that are between the SSL and twice the SSL and will be screened out, human health will still be protected given the conservative assumptions used to derive the SSLs.

The Soil Screening Guidance establishes the following goals for Type I and Type II decision error rates:

- Prob ("walk away" when the true EA mean is 2 SSL) = 0.05
- Prob ("investigate further" when the true EA mean is 0.5 SSL) = 0.20.

This means that there should be no more than a 5 percent chance that the site manager will "walk away" from an EA where the true mean concentration is 2 SSL or more. In addition, there should be no more than a 20 percent chance that the site manager will unnecessarily investigate an EA when the mean is 0.5 SSL or less.

These decision error limits are general goals for the soil screening process. Consistent with the DQO process, these goals may be adjusted on a site-specific basis by considering the available resources (i.e., time and budget), the importance of screening surface soil relative to other potential exposure pathways, consequences of potential decision errors, and consistency with other relevant EPA guidance and programs.

Table 22 summarizes this step of the DQO process for the Max test, specifying limits on the decision error rates, and the final step of the DQO process for the Max test, optimizing the design. Figure 5 illustrates the gray region for the decision error goals: a Type I decision error rate of 0.05 (5 percent) at 2 SSL and a Type II decision error rate of 0.20 (20 percent) at 0.5 SSL.

4.1.7 Optimize the Design for the Max Test. This section provides instructions for developing an optimum sampling strategy for screening surface soils. It discusses compositing, the selection of sampling points for composited and uncomposited surface soil sampling, and the recommended procedures for determining the sample sizes necessary to achieve specified limits on decision errors using the Max test.

Table 22. Sampling Soil Screening DQOs for Surface Soils under the Max Test

DQO Process Steps	Soil Screening Inputs/Outputs
Specify Limits on Decision Errors*	
Define baseline condition (null hypothesis)	The EA needs further investigation
Define the gray region**	From 0.5 SSL to 2 SSL
Define Type I and Type II decision errors	Type I error: Do not investigate further ("walk away from") an EA whose true mean exceeds the screening level of 2 SSL Type II error: Investigate further when an EA's true mean falls below the screening level of 0.5 SSL
Identify consequences	Type I error: potential public health consequences Type II error: unnecessary expenditure of resources to investigate further
Assign acceptable probabilities of Type I and Type II decision errors	Goals: Type I: 0.05 (5%) probability of not investigating further when “true mean” of the EA is 2 SSL Type II: 0.20 (20%) probability of investigating further when “true mean” of the EA is 0.5 SSL
Define QA/QC goals	CLP precision and bias requirements 10% CLP analyses for field methods
Optimize the Design	
Determine how to best estimate “true mean”	Samples composited across the EA estimate the EA mean ($\bar{x}$). Use maximum composite concentration as a conservative estimate of the true EA mean.
Determine expected variability of EA surface soil contaminant concentrations	A conservatively large expected coefficient of variation (CV) from prior data for the site, field measurements, or data from other comparable sites and expert judgment. A minimum default CV of 2.5 should be used when information is insufficient to estimate the CV.
Design sampling strategy by evaluating costs and performance of alternatives	Lowest cost sampling design option (i.e., compositing scheme and number of composites) that will achieve acceptable decision error rates
Develop planning documents for the field investigation	Sampling and Analysis Plan (SAP) Quality Assurance Project Plan (QAPjP)

* Since the DQO process controls the degree to which uncertainty in data affects the outcome of decisions that are based on that data, specifying limits on decision errors will allow the decision maker to control the probability of making an incorrect decision when using the DQOs.

** The gray region represents the area where the consequences of decision errors are minor (and uncertainty in sampling data makes decisions too close to call).

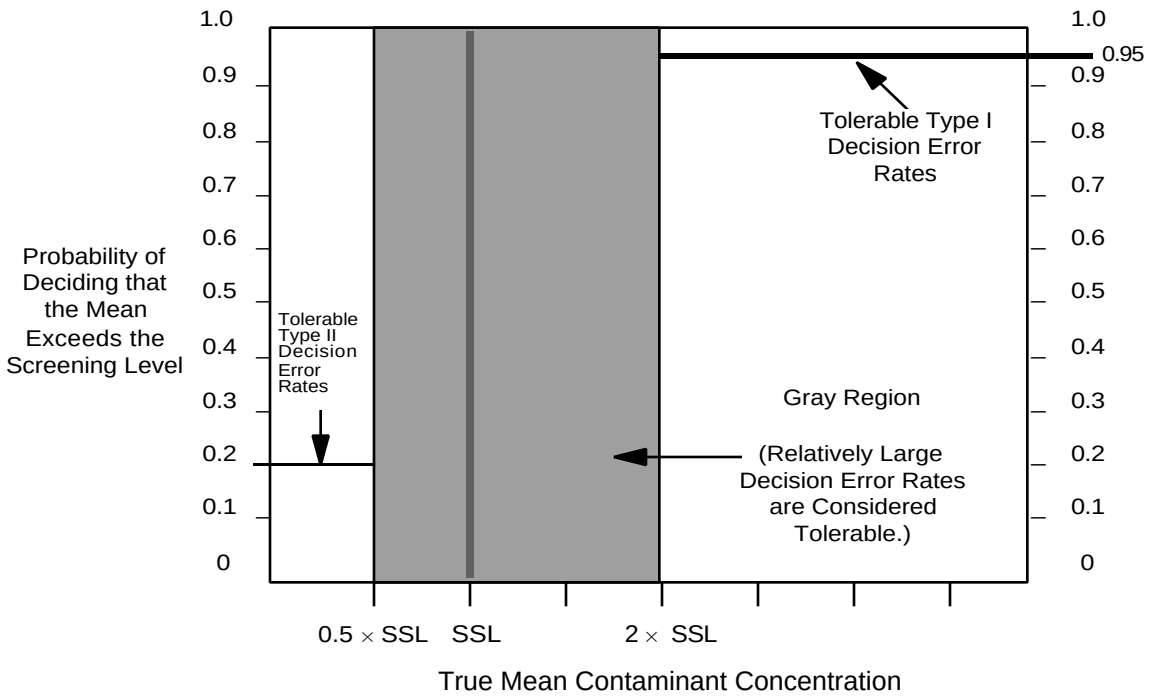


Figure 5. Design performance goal diagram.

Note that the size, shape, and orientation of sampling volume (i.e., "support") for heterogenous media have a significant effect on reported measurement values. For instance, particle size has a varying affect on the transport and fate of contaminants in the environment and on the potential receptors. Because comparison of data from methods that are based on different supports can be difficult, defining the sampling support is important in the early stages of site characterization. This may be accomplished through the DQO process with existing knowledge of the site, contamination, and identification of the exposure pathways that need to be characterized. Refer to *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies* (U.S. EPA, 1992f) for more information about soil sampling support.

The SAP developed for surface soils should specify sampling and analytical procedures as well as the development of QA/QC procedures. To identify the appropriate analytical procedures, the screening levels must be known. If data are not available to calculate site-specific SSLs, then the generic SSLs in Appendix A should be used.

Compositing. Because the objective of surface soil screening is to ensure that the mean contaminant concentration does not exceed the screening level, the physical "averaging" that occurs during compositing is consistent with the intended use of the data. Compositing allows a larger number of locations to be sampled while controlling analytical costs because several discrete samples are physically mixed (homogenized) and one or more subsamples are drawn from the mixture and submitted for analysis. If the individual samples in each composite are taken across the EA, each composite represents an estimate of the EA mean.

A practical constraint to compositing in some situations is the heterogeneity of the soil matrix. The

efficiency and effectiveness of the mixing process may be hindered when soil particle sizes vary widely or when the soil matrix contains foreign objects, organic matter, viscous fluids, or sticky material. Soil samples should not be composited if matrix interference among contaminants is likely (e.g., when the presence of one contaminant biases analytical results for another).

Before individual specimens are composited for chemical analysis, the site manager should consider homogenizing and splitting each specimen. By compositing one portion of each specimen with the other specimens and storing one portion for potential future analysis, the spatial integrity of each specimen is maintained. If the concentration of a contaminant in a composite sample is high, the splits of the individual specimens from which it was composed can be analyzed discretely to determine which individual specimen(s) have high concentrations of the contaminant. This will permit the site manager to determine which portion within an EA is contaminated without making a repeat visit to the site.

Sample Pattern. The Max test should only be applied using composite samples that are representative of the entire EA. However, the Chen test (see Section 4.1.9) can be applied with individual, uncomposited samples. There are several options for developing a sampling pattern for compositing that produce samples that should be representative. If individual, uncomposited samples will be analyzed for contaminant concentrations, the N sample points can be selected using either (1) simple random sampling (SRS), (2) stratified SRS, or (3) systematic grid sampling (square or rectangular grid) with a random starting point (SyGS/rs). Step-by-step procedures for selecting SRS and SyGS/rs samples are provided in Chapter 5 of the U.S. EPA (1989a) and Chapter 5 of U.S. EPA (1994e). If stratified random sampling is used, the sampling rate must be the same in every sector, or stratum of the EA. Hence, the number of sampling points assigned to a stratum must be directly proportional to the surface area of the stratum.

Systematic grid sampling with a random starting point is generally preferred because it ensures that the sample points will be dispersed across the entire EA. However, if the boundaries of the EA are irregular (e.g., around the perimeter of the site or the boundaries of a stratum within which the EAs were defined), the number of grid sample points that fall within the EA depends on the random starting point selected. Therefore, for these irregularly shaped EAs, SRS or stratified SRS is recommended. Moreover, if a systematic trend of contamination is suspected across the EA (e.g., a strip of higher contamination), then SRS or stratified SRS is recommended again. In this case, grid sampling would be likely to result in either over- or under representation of the strip of higher contaminant levels, depending on the random starting point.

For composite sampling, the sampling pattern used to locate the discrete sample specimens that form each composite sample (N) is important. The composite samples should be formed in a manner that is consistent with the assumptions underlying the sample size calculations. In particular, each composite sample should provide an unbiased estimate of the mean contaminant concentration over the entire EA. One way to construct a valid composite of C specimens is to divide the EA into C sectors, or strata, of equal area and select one point at random from each sector. If sectors (strata) are of unequal sizes, the simple average is no longer representative of the EA as a whole.

Five valid sampling patterns and compositing schemes for selecting N composite samples that each consist of C specimens are listed below:

1. Select an SRS consisting of C points and composite all specimens associated with these points into a sample. Repeat this process N times, discarding any points that were used in a previous sample.

2. Select an SyGS/rs of C points and composite all specimens associated with the points in this sample. Repeat this process N times, using a new randomly selected starting point each time.

3. Select a single SyGS/rs of C×N points and use the systematic compositing scheme that is described in Highlight 3 to form N composites, as illustrated in Figure 6.

4. Select a single SyGS/rs of C×N points and use the random compositing scheme that is described in Highlight 4 to form N composites, as illustrated in Figure 7.

5. Select a stratified random sample of C×N points and use a random compositing scheme, as described in Highlight 5, to form N composites, as illustrated in Figure 8.

Methods 1, 2, and 5 are the most statistically defensible, with method 5 used as the default method in the Soil Screening Guidance. However, given the practical limits of implementing these methods, either method 3 or 4 is generally recommended for EAs with regular boundaries (e.g., square or rectangular). As noted above, if the boundaries of the EA are irregular, SyGS/rs sampling may not result in exactly C×N sample points. Therefore, for EAs with irregular boundaries, method 5 is recommended. Alternatively, a combination of methods 4 and 5 can be used for EAs that can be partitioned into C sectors of equal area of which K have regular boundaries and the remaining C - K have irregular boundaries.

Additionally, compositing within sectors to indicate whether one sector of the EA exceeds SSLs is an option that may also be considered. See Section 4.3.6 for a full discussion.

Sample Size. This section presents procedures to determine sample size requirements for the Max test that achieve the site-specific decision error limits discussed in Section 4.1.6. The Max test is based on the maximum concentration observed in N composite samples that each consist of C individual specimens. The individual specimens are selected so that each of the N composite samples is representative of the site as a whole, as discussed above. Hence, this section addresses determining the sample size pair, C and N, that achieves the site-specific decision error limits. Directions for performing the Max test in a manner that is consistent with DQOs established for a site are presented later in this section.

Table 23 presents the probabilities of Type I errors at 2 SSL and Type II errors at 0.5 SSL (the boundary points of the gray region discussed in Section 4.1.6) for several sample size options when the variability for concentrations of individual measurements across the EA ranges from 100 percent to 400 percent (CV = 1.0 to 4.0). Two choices for the number, C, of specimens per composite are shown in this table: 4 and 6. Fewer than four specimens per composite is not considered sufficient for the Max test. Fewer than four specimens per composite does not achieve the decision error limit goals for the level of variability generally encountered at CERCLA sites. More than six specimens may be more than can be effectively homogenized into a composite sample.

The number, N, of composite samples shown in Table 23 ranges from 4 to 9. Fewer than four samples is not considered sufficient because, considering decision error rates from simulation results (Section 4.3), the Max text should be based on at least four independent estimates of the EA mean. More than nine composite samples per EA is generally unlikely for screening surface soils at Superfund sites. However, additional sample size options can be determined from the simulation results reported in Appendix I.

Highlight 3: Procedure for Compositing of Specimens from a Grid Sample Using a Systematic Scheme (Figure 6)

1. Lay out a square or triangular grid sample over the EA, using a random start. Step-by-step procedures can be found in Chapter 5 of U.S. EPA (1989a). The number of points in the grid should be equal to C×N, where C is the desired number of specimens per composite and N is the desired number of composites.

2. Divide the EA into C sectors (strata) of equal area and shape such that each sector contains the same number of sample points. The number of sectors (C) should be equal to the number of specimens in each composite (since one specimen per area will be used in each composite) and the number of points within each sector, N, should equal the desired number of composite samples.

3. Label the points within one sector in any arbitrary fashion from 1 to N. Use the same scheme for each of the other sectors.

4. Form composite number 1 by compositing specimens with the '1' label, form composite number 2 by compositing specimens with the '2' label, etc. This leads to N composite samples that are subjected to chemical analysis.

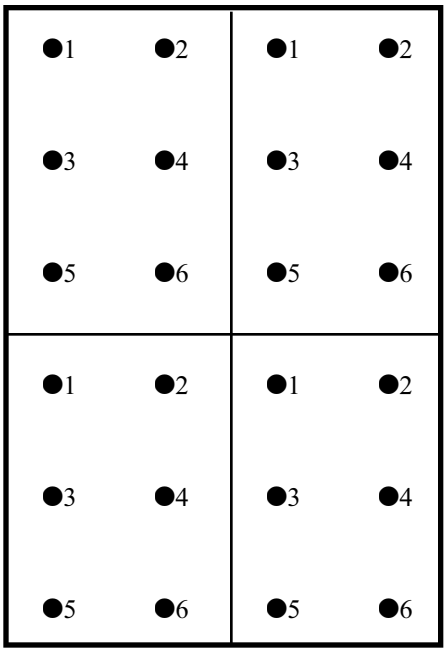


Figure 6. Systematic (square grid points) sample with systematic compositing scheme (6 composite samples consisting of 4 specimens).

Highlight 4: Procedure for Compositing of Specimens from a Grid Sample Using a Random Scheme (Figure 7)

1. Lay out a square or triangular grid sample over the EA, using a random start. Step-by-step procedures can be found in Chapter 5 of U.S. EPA (1989a). The number of points in the grid should be equal to C×N, where C is the desired number of specimens per composite and N is the desired number of composites.

2. Divide the EA into C sectors (strata) of equal area and shape such that each sector contains the same number of sample points. The number of sectors (C) should be equal to the number of specimens in each composite (since one specimen per area will be used in each composite) and the number of points within each sector, N, should equal the desired number of composite samples.

3. Use a random number table or random number generator to establish a set of labels for the N points within each sector. This is done by first labeling the points in a sector in an arbitrary fashion (say, points A, B, C,...) and associating the first random number with point A, the second with point B, etc. Then rank the points in the sector according to the set of random numbers and relabel each point with its rank. Repeat this process for each sector.

4. Form composite number 1 by compositing specimens with the '1' label, form composite number 2 by compositing specimens with the '2' label, etc. This leads to N composite samples that are subjected to chemical analysis.

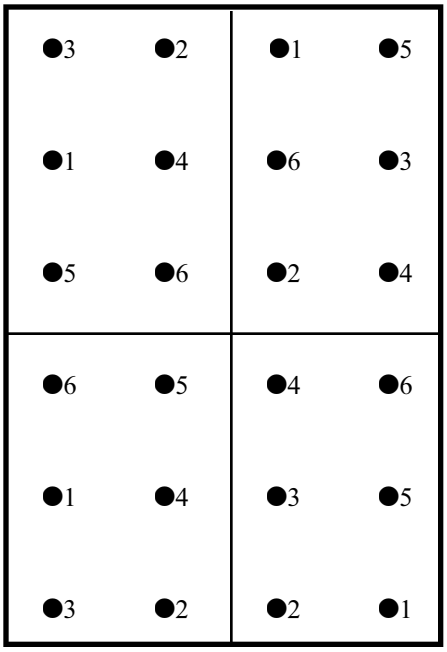


Figure 7. Systematic (square grid points) sample with random compositing scheme (6 composite samples consisting of 4 specimens).

Highlight 5: Procedure for Compositing of Specimens from a Stratified Random Sample Using a Random Scheme (Figure 8)

1. Divide the EA into C sectors (strata) of equal area, where C is equal to the number of specimens to be in each composite (since one specimen per stratum will be used in each composite).

2. Within each stratum, choose N random locations, where N is the desired number of composites. Step-by-step procedures for choosing random locations can be found in Chapter 5 of U.S. EPA (1989a).

3. Use a random number table or random number generator to establish a set of labels for the N points within each sector. This is done by first labeling the points in a sector in an arbitrary fashion (say, points A, B, C,...) and associating the first random number with point A, the second with point B, etc. Then rank the points in the sector according to the set of random numbers and relabel each point with its rank. Repeat this process for each sector.

4. Form composite number 1 by compositing specimens with the '1' label, form composite number 2 by compositing specimens with the '2' label, etc. This leads to N composite samples that are subjected to chemical analysis.

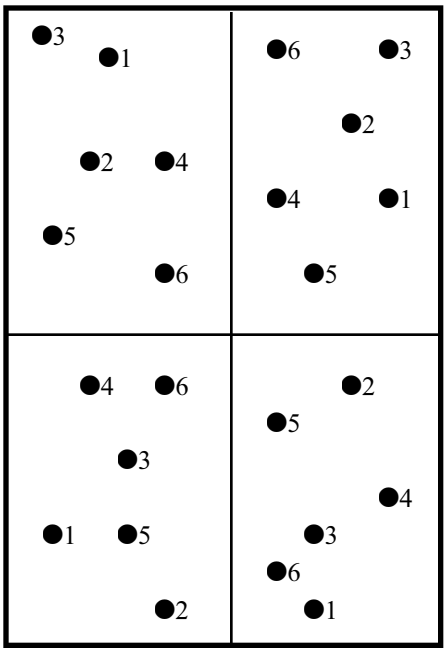


Figure 8. Stratified random sample with random compositing scheme (6 composite samples consisting of 4 specimens).

Table 23. Probability of Decision Error at 0.5 SSL and 2 SSL Using Max Test

	CV=1.0[a]		CV=1.5		CV=2.0		CV=2.5		CV=3.0		CV=3.5		CV=4.0	
Sample Size[b]	$E_{0.5}$[c]	$E_{2.0}$[d]	$E_{0.5}$	$E_{2.0}$	$E_{0.5}$	$E_{2.0}$	$E_{0.5}$	$E_{2.0}$	$E_{0.5}$	$E_{2.0}$	$E_{0.5}$	$E_{2.0}$	$E_{0.5}$	$E_{2.0}$
	C = 4 specimens per composite[e]													
4	<.01	0.08	0.02	0.11	0.09	0.13	0.14	0.19	0.19	0.20	0.24	0.26	0.25	0.30
5	<.01	0.05	0.02	0.06	0.11	0.10	0.15	0.10	0.26	0.17	0.26	0.18	0.31	0.25
6	<.01	0.03	0.02	0.04	0.11	0.06	0.21	0.08	0.28	0.11	0.31	0.11	0.35	0.16
7	<.01	0.01	0.03	0.02	0.12	0.04	0.25	0.05	0.31	0.08	0.36	0.09	0.41	0.15
8	<.01	0.01	0.03	0.01	0.16	0.02	0.25	0.04	0.36	0.05	0.42	0.07	0.41	0.09
9	<.01	0.01	0.05	0.01	0.16	0.01	0.28	0.03	0.36	0.04	0.44	0.07	0.48	0.08
	C = 6 specimens per composite													
4	<.01	0.08	<.01	0.11	0.03	0.12	0.08	0.16	0.15	0.17	0.26	0.20	0.23	0.27
5	<.01	0.05	<.01	0.06	0.04	0.09	0.11	0.09	0.17	0.13	0.22	0.15	0.25	0.20
6	<.01	0.03	0.01	0.04	0.06	0.04	0.14	0.06	0.19	0.09	0.25	0.09	0.29	0.12
7	<.01	0.01	0.01	0.02	0.06	0.02	0.14	0.04	0.23	0.06	0.29	0.08	0.37	0.08
8	<.01	0.01	0.01	0.01	0.06	0.02	0.15	0.02	0.25	0.03	0.30	0.04	0.40	0.06
9	<.01	0.01	0.01	0.01	0.06	0.01	0.18	0.02	0.28	0.03	0.34	0.03	0.39	0.04

[a] The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA, including measurement error.
[b] Sample size (N) = number of composite samples.
[c] $E_{0.5}$ = Probability of requiring further investigation when the EA mean is 0.5 SSL.
[d] $E_{2.0}$ = Probability of not requiring further investigation when the EA mean is 2.0 SSL.
[e] C = number of specimens per composite sample, where each composite consists of points from a stratified random or systematic grid sample from across the entire EA.

NOTE: All decision error rates are based on 1,000 simulations that assume that each composite is representative of the entire EA, that half the EA has concentrations below the quantitation limit (i.e., SSL/100), and half the EA has concentrations that follow a gamma distribution (a conservative distributional assumption).

The error rates shown in Table 23 are based on the simulations presented in Appendix I. These simulations are based on the following assumptions:

1. Each of the N composite samples is based on C specimens selected to be representative of the EA as a whole, as specified above (C = number of sectors or strata).

2. One-half the EA has concentrations below the quantitation limit (which is assumed to be SSL/100).

3. One-half the EA has concentrations that follow a gamma distribution (see Section 4.3 for additional discussion).

4. Each chemical analysis is subject to a 20 percent measurement error.

The error rates presented in Table 23 are based on the above assumptions which make them robust for most potential distributions of soil contaminant concentrations. Distribution assumptions 2 and 3 were used because they were found in the simulations to produce high error rates relative to other potential contaminant distributions (see Section 4.3). If the proportion of the site below the quantitation limit (QL) is less than half or if the distribution of the concentration measurements is some other distribution skewed to the right (e.g., lognormal), rather than gamma, then the error rates achieved are likely to be no worse than those cited in Table 23. Although the actual contaminant distribution may be different from those cited above as the basis for Table 23, only extensive investigations will usually generate sufficient data to determine the actual distribution for each EA.

Using Table 23 to determine the sample size pair (C and N) needed to achieve satisfactory error rates with the Max test requires an *a priori* estimate of the coefficient of variation for measurements of the contaminant of interest across the EA. The coefficient of variation (CV) is the ratio of the standard deviation of contaminant concentrations for individual, uncomposited specimens divided by the EA mean concentration. As discussed in Section 4.1.4, the EAs should be constructed within strata expected to have relatively homogeneous concentrations so that an estimate of the CV for a stratum may be applicable for all EAs in that stratum. The site manager should use a conservatively large estimate of the CV for determining sample size requirements because additional sampling will be needed if the data suggest that the true CV is greater than that used to determine the sample sizes.

Potential sources of information for estimating the EA or stratum means, variances, and CVs include the following (in descending order of desirability):

- Data from a pilot study conducted at the site
- Prior sampling data from the site
- Data from similar sites
- Professional judgment.

For more information on estimating variability, see Section 6.3.1 of U.S. EPA (1989a).

4.1.8 Using the DQA Process: Analyzing Max Test Data. This section provides guidance for analyzing the data for the Max test.

The hypothesis test for the Max test is very simple to implement, which is one reason that the Max test is attractive as a surface soil screening test. If x_1, x_2, ..., x_N represent concentration measurements for N composite samples that each consist of C specimens selected so that each

composite is representative of the EA as a whole (as described in Section 4.1.7), the Max test is implemented as follows:

> If Max (x_1, x_2, ..., x_N) $\geq$ 2 SSL, then investigate the EA further;
> If Max (x_1, x_2, ..., x_N) < 2 SSL, and the data quality assessment (DQA) indicates that the sample size was adequate, then no further investigation is necessary.

In addition, the step-by-step procedures presented in Highlight 6 must be implemented to ensure that the site-specific error limits, as discussed in Section 4.1.6, are achieved.

If the EA mean is below 2 SSL, the DQA process may be used to determine if the sample size was sufficiently large to justify the decision to not investigate further. To use Table 23 to check whether the sample size is adequate, an estimate of the CV is needed for each EA. The first four steps of Highlight 6, the DQA process for the Max test, present a process for the computation of a sample CV for an EA based on the N composite samples that each consist of C specimens.

However, the sample CV can be quite large when all the measurements are very small (e.g., well below the SSL) because CV approaches infinity as the EA sample mean ($\bar{x}$) approaches zero. Thus, when the composite concentration values for an EA are all near zero, the sample CV may be questionable and therefore unreliable for determining if the original sample size was sufficient (i.e., it could lead to further sampling when the EA mean is well below 2 SSL). To protect against unnecessary additional sampling in such cases, compare all composites against the equation given in Step 5 of Highlight 6. If the maximum composite sample concentration is below the value given by the equation, then the sample size may be assumed to be adequate and no further DQA is necessary.

To develop Step 5, EPA decided that if there were no compositing (C=1) and all the observations (based on a sample size appropriate for a CV of 2.5) were less than the SSL, then one can reasonably assume that the EA mean was not greater than 2 SSL. Likewise, because the standard error for the mean of C specimens, as represented by the composite sample, is proportional to $1/\sqrt{C}$, the comparable condition for composite observations is that one can reasonably assume that the EA mean was not greater than 2 SSL when all composite observations were less than SSL/$\sqrt{C}$. If this is the case for an EA sample set, the sample size can be assumed to be adequate and no further DQA is needed. Otherwise (when at lease one composite observation is not this small), use Table 23 with the sample CV for the EA to determine whether a sufficient number of samples were taken to achieve DQOs.

In addition to being simple to implement, the Max test is recommended because it provides good control over the Type I error rates at 2 SSL with small sample sizes. It also does not need any assumptions regarding observations below the QL. Moreover, the Max test error rates at 2 SSL are fairly robust against alternative assumptions regarding the distribution of surface soil concentrations in the EA. The simulations in Appendix I show that these error rates are rather stable for lognormal or Weibull contaminant concentration distributions and for different assumptions about portions of the site with contaminant concentrations below the QL.

Highlight 6: Directions for Data Quality Assessment for the Max Test

Let $x_1, x_2, ..., x_N$ represent contaminant concentration measurements for N composite samples that each consist of C specimens selected so that each composite is representative of the EA as a whole. The following describes the steps required to ensure that the Max test achieves the DQOs established for the site.

STEP 1: The site manager determines the Type I error rate to be achieved at 2 SSL and the Type II error rate to be achieved at 0.5 SSL, as described in Section 4.1.6.

STEP 2: Calculate the sample mean $\bar{x} = \left[\sum_{i=1}^{N} x_i \right] \frac{1}{N}$

STEP 3: Calculate the sample standard deviation

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} \left(x_i - \bar{x} \right)^2}$$

STEP 4: Calculate the sample estimate of the coefficient of variation, CV, for individual concentration measurements from across the EA.

$$CV = \frac{\sqrt{C}\ s}{\bar{x}}$$

NOTE: This is a conservation approximation of the CV for individual measurements.

STEP 5: If Max $(x_1, x_2, ..., x_N) < \frac{SSL}{\sqrt{C}}$, then no further data quality assessment is needed and the EA needs no further investigation.

Otherwise proceed to Step 6.

STEP 6: Use the value of the sample CV calculated in Step 4 as the true CV of concentrations to determine which column of Table 23 is applicable for determining sample size requirements. Using the error limits established in Step 1, determine the sample size requirements from this table. If the required sample size is greater than that implemented, further investigation of the EA is necessary. The further investigation may consist of selecting a supplemental sample and repeating the Max test with the larger, combined sample.

A limitation of the Max test is that it does not provide as good control over the Type II error rates at 0.5 SSL as it does for Type I error rates at 2 SSL. In fact, for a fixed number, C, of specimens per composite, the Type II error rate increases as the number of composite samples, N, increases. As the sample size increases, the likelihood of observing an unusual sample with the maximum exceeding 2 SSL increases. However, the Type II error rate can be decreased by increasing the number of

specimens per composite. This unusual performance of the Max test as a hypothesis testing procedure occurs because the rejection region is fixed below 2 SSL and thus does not depend on the sample size (as it does for typical hypothesis testing procedures).

4.1.9 Specify Limits on Decision Errors for Chen Test. Although the Max test is adequate and appropriate for selecting a sample size for site screening, there are other alternate methods of screening surface soils. One such alternate method is the Chen test. In general, the Chen test differs from the Max test in its basic assumption about site contamination and the purpose of soil sampling. Because of this variation, these two methods have different null hypotheses and different decision error types.

There are two formulations of the statistical hypothesis test concerning the true (but unknown) mean contaminant concentration, μ, that achieve the Soil Screening Guidance decision error rate goals specified in Section 4.1.6. They are:

1. Test the null hypothesis, H_0: $\mu \geq 2$ SSL, versus the alternative hypothesis, H_1: $\mu < 2$ SSL, at the 5 percent significance level using a sample size chosen to achieve a Type II error rate of 20 percent at 0.5 SSL.

2. Test the null hypothesis, H_0: $\mu \leq 0.5$ SSL, versus the alternative hypothesis, H_1: $\mu > 0.5$ SSL, at the 20 percent significance level using a sample size chosen to achieve a Type II error rate of 5 percent at 2 SSL.

The first formulation of the problem (which is commonly used in the Superfund program) has the advantage that the error rate that has potential public health consequences is controlled directly via the significance level of the test. The error rate that has primarily cost consequences can be reduced by increasing the sample size above the minimum requirement. However, EPA has identified a new test procedure, the Chen test (Chen, 1995), which requires the second formulation but is less sensitive to assumptions regarding the distribution of the contaminant measurements than the Land procedure used in the December 1994 draft Technical Background Document (see Section 4.3). This section provides guidance regarding application of the Chen test and is, therefore, based on the second formulation of the hypothesis test.

A disadvantage of the second formulation is its performance when the true EA mean is between 0.5 SSL and the SSL. In this case, as the sample size increases, the test indicates the decision to investigate further, even though the mean is less than the SSL. In fact, no test procedure with feasible sample sizes performs well when the true EA mean is in the "gray region" between 0.5 SSL and 2 SSL (see Section 4.3). Whenever large sample sizes are feasible, one should modify the problem statement and test the null hypothesis, H_0: $\mu \leq$ SSL, instead of H_0: $\mu \leq 0.5$ SSL. One would then develop appropriate DQOs for this modified hypothesis test (e.g., significance level of 20 percent at the SSL and 5 percent probability of decision error at 2 SSL).

When the true mean of an EA is compared with the screening level, there are two possible decision errors that may occur: (1) decide not to investigate an EA further (i.e., "walk away") when the correct decision would be to "investigate further"; and (2) decide to investigate further when the correct decision would be to "walk away." For the Chen test, the "incorrectly walk away" decision error is designated as the Type II decision error because it occurs when we incorrectly accept the null hypothesis. Correspondingly, the "unnecessarily investigate further" decision error is designated as the Type I decision error because it occurs when we incorrectly reject the null hypothesis.

As discussed in Section 4.1.6, the Soil Screening Guidance specifies a default gray region for decision errors from 0.5 SSL to 2 SSL and sets the following goals for Type I and Type II error rates:

- Prob ("investigate further" when the true EA mean is 0.5 SSL) = 0.20
- Prob ("walk away" when the true EA mean is 2 SSL) = 0.05.

Table 24 summarizes this step of the DQO process for the Chen test, specifying limits on the decision error rates, and the final step of the DQO process, optimizing the design.

4.1.10 Optimize the Design Using the Chen Test. This section includes guidance on developing an optimum sampling strategy for screening surface soils. It discusses compositing, the selection of sampling points for composited and uncomposited surface soil sampling, and the recommended procedures for determining the sample sizes necessary to achieve specified limits on decision errors using the Chen test.

Note that the size, shape, and orientation of sampling volume (i.e., "support") for heterogenous media have a significant effect on reported measurement values. For instance, particle size has a varying affect on the transport and fate of contaminants in the environment and on the potential receptors. Because comparison of data from methods that are based on different supports can be difficult, defining the sampling support is important in the early stages of site characterization. This may be accomplished through the DQO process with existing knowledge of the site, contamination, and identification of the exposure pathways that need to be characterized. Refer to *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies* (U.S. EPA, 1992f) for more information about soil sampling support.

The SAP developed for surface soils should specify sampling and analytical procedures as well as the development of QA/QC procedures. To identify the appropriate analytical procedures, the screening levels must be known. If data are not available to calculate site-specific SSLs, then the generic SSLs in Appendix A should be used.

Compositing. Because the objective of surface soil screening is to ensure that the mean contaminant concentration does not exceed the screening level, the physical "averaging" that occurs during compositing is consistent with the intended use of the data. Compositing allows a larger number of locations to be sampled while controlling analytical costs because several discrete samples are physically mixed (homogenized) and one or more subsamples are drawn from the mixture and submitted for analysis. If the individual samples in each composite are taken across the EA, each composite represents an estimate of the EA mean.

A practical constraint to compositing in some situations is the heterogeneity of the soil matrix. The efficiency and effectiveness of the mixing process may be hindered when soil particle sizes vary widely or when the soil matrix contains foreign objects, organic matter, viscous fluids, or sticky material. Soil samples should not be composited if matrix interference among contaminants is likely (e.g., when the presence of one contaminant biases analytical results for another).

Table 24. Sampling Soil Screening DQOs for Surface Soils under Chen Test

DQO Process Steps	Soil Screening Inputs/Outputs
Specify Limits on Decision Errors	
Define baseline condition (null hypothesis)	EA needs no further investigation
Define gray region	From 0.5 SSL to 2 SSL
Define Type I and Type II decision errors	Type I error: Investigate further when an EA's true mean concentration is below 0.5 SSL Type II error: Do not investigate further ("walk away from") when an EA true mean concentration is above 2 SSL
Identify consequences	Type I error: unnecessary expenditure of resources to investigate further Type II error: potential public health consequences
Assign acceptable probabilities of Type I and Type II decision errors	Goals: Type I: 0.20 (20%) probability of investigating further when EA mean is 0.5 SSL Type II: 0.05 (5%) probability of not investigating further when EA mean is 2 SSL
Optimize the Design	
Determine expected variability of EA surface soil contaminant concentrations	A conservatively large expected coefficient of variation (CV) from prior data for the site, field measurements, or data from other comparable sites and expert judgment
Design sampling strategy by evaluating costs and performance of alternatives	Lowest cost sampling design option (i.e., compositing scheme and number of composites) that will achieve acceptable decision error rates
Develop planning documents for the field investigation	Sampling and Analysis Plan (SAP) Quality Assurance Project Plan (QAPjP)

Before individual specimens are composited for chemical analysis, the site manager should consider homogenizing and splitting each specimen. By compositing one portion of each specimen with the other specimens and storing one portion for potential future analysis, the spatial integrity of each specimen is maintained. If the concentration in a composite is high, the splits of the individual specimens of which it was composed can be analyzed subsequently to determine which individual specimen(s) have high concentrations. This will permit the site manager to determine which portion within an EA is contaminated without making a repeat visit to the site.

Sample Pattern. The Chen test can be applied using composite samples that are representative of the entire EA or with individual uncomposited samples.

Systematic grid sampling (SyGS) generally is preferred because it ensures that the sample points will be dispersed across the entire EA. However, if the boundaries of the EA are irregular (e.g., around the perimeter of the site or the boundaries of a stratum within which the EAs were defined), the number of grid sample points that fall within the EA depends on the random starting point selected. Therefore, for these irregularly shaped EAs, SRS or stratified SRS is recommended. Moreover, if a systematic trend of contamination is suspected across the EA (e.g., a strip of higher contamination),

then SRS or stratified SRS is recommended again. In this case, grid sampling would be likely to result in either over- or under representation of the strip of higher contaminant levels, depending on the random starting point.

For composite sampling, the sampling pattern used to locate the C discrete sample specimens that form each composite sample is important. The composite samples must be formed in a manner that is consistent with the assumptions underlying the sample size calculations. In particular, each composite sample must provide an unbiased estimate of the mean contaminant concentration over the entire EA. One way to construct a valid composite of C specimens is to divide the EA into C sectors, or strata, of equal area and select one point at random from each sector. If sectors (strata) are of unequal sizes, the simple average is no longer representative of the EA as a whole.

Valid sampling patterns and compositing schemes for selecting N composite samples that each consist of C specimens include the following:

1. Select an SRS consisting of C points and composite all specimens associated with these points into a sample. Repeat this process N times, discarding any points that were used in a previous sample.

2. Select an SyGS/rs of C points and composite all specimens associated with the points in this sample. Repeat this process N times, using a new randomly selected starting point each time.

3. Select a single SyGS/rs of CN points and use the systematic compositing scheme that is described in Highlight 3 to form N composites, as illustrated in Figure 6.

4. Select a single SyGS/rs of C×N points and use the random compositing scheme that is described in Highlight 4 to form N composites, as illustrated in Figure 7.

5. Select a stratified random sample of C×N points and use a random compositing scheme, as described in Highlight 5, to form N composites, as illustrated in Figure 8.

Methods 1, 2, and 5 are the most statistically defensible, with method 5 used as the default method in the Soil Screening Guidance. However, given the practical limits of implementing these methods, either method 3 or 4 is generally recommended for EAs with regular boundaries (e.g., square or rectangular). As noted above, if the boundaries of the EA are irregular, SyGS/rs sampling may not result in exactly C×N sample points. Therefore, for EAs with irregular boundaries, method 5 is recommended. Alternatively, a combination of methods 4 and 5 can be used for EAs that can be partitioned into C sectors of equal area of which K have regular boundaries and the remaining C - K have irregular boundaries.

Sample Size. This section provides procedures to determine sample size requirements for the Chen test that achieve the site-specific decision error limits discussed in Section 4.1.6. The Chen test is an upper-tail test for the mean of positively skewed distributions, like the lognormal (Chen, 1995). It is based on the mean concentration observed in a simple random sample, or equivalent design, selected from a distribution with a long right-hand tail.

The Chen procedure is a hypothesis testing procedure that is robust among the family of right-skewed distributions (see Section 4.3). That is, decision error rates for a given sample size are relatively insensitive to the particular right-skewed distribution that generated the data. This

robustness is important in the context of surface soil screening because the number of surface soil samples will usually not be sufficient to determine the distribution of the concentration measurements.

The procedures presented above for selecting composited or uncomposited simple random or systematic grid samples can all be used to generate samples for application of the Chen test. The Chen procedure is based on a simple random sample, or one that can be analyzed as if it were an SRS. Directions for performing the Chen test in a manner that is consistent with the DQOs that have been established for a site are presented later.

Tables 25 through 30 provide the sample sizes required for the Chen test performed at the 10, 20, or 40 percent levels of significance (probability of Type I error at 0.5 SSL) and achieve, at most, a 5 or 10 percent probability of (Type II) error at 2 SSL. The Type II error rates at 2 SSL are based on the simulations presented in Appendix I. These simulations are based on the following assumptions:

1. Each of the N composite samples is based on C specimens selected to be representative of the EA as a whole, as specified above.

2. One-half the EA has concentrations below the quantitation limit (which is assumed to be SSL/100).

3. One-half the EA has concentrations that follow a gamma distribution.

4. Measurements below the QL are replaced by 0.5 QL for computation of the Chen test statistic.

5. Each chemical analysis is subject to a 20 percent measurement error.

Distributional assumptions 2 and 3 were used as the basis for the Type II error rates at 2 SSL (shown in Tables 25 through 30) because they were found in the simulations to produce high error rates relative to other potential contaminant distributions. If the proportion of the site below the QL is less than half or if the distribution of the concentration measurements is some other right-skewed distribution (e.g., lognormal), rather than gamma, then the Type II error rates achieved are likely to be no worse than those cited in Tables 25 through 30. No sample sizes, N, less than four are shown in these tables (irrespective of the number of specimens per composite) because consideration of the simulation results presented in Section 4.3 has led to a program-level decision that at least four separate analyses are required to adequately characterize the mean of an EA. No sample sizes in excess of nine are presented because of a program-level decision that more than nine samples per exposure area is generally unlikely for screening surface soils at Superfund sites. However, additional sample size options can be determined from the simulations reported in Appendix I.

When using Tables 25 through 30 to determine the sample size pair (C and N) needed to achieve satisfactory error rates with the Chen test, investigators must have an *a priori* estimate of the CV for measurements of the contaminant of interest across the EA. As previously discussed for the Max test, the site manager should use a conservatively large estimate of the CV for determining sample size requirements because additional sampling will be required if the data suggest that the true CV is greater than that used to determine the sample sizes.

Table 25. Minimum Sample Size for Chen Test at 10 Percent Level of Significance to Achieve a 5 Percent Chance of "Walking Away" When EA Mean is 2.0 SSL, Given Expected CV for Concentrations Across the EA

Number of specimens per composite[b]	Coefficient of variation (CV)[a]				
	1.0	1.5	2.0	2.5	3.0
2	7	9	>9	>9	>9
3	5	7	9	>9	>9
4	4	6	8	>9	>9
5	4	5	6	8	>9
6	4	4	5	7	9

[a]The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA and includes measurement error.
[b]Each composite consists of points from a stratified random or systematic grid sample across the entire EA.
NOTE: Sample sizes are based on 1,000 simulations that assume that each composite is representative of the entire EA, that half the EA has concentrations below the limit of detection, and that half the EA has concentrations following a gamma distribution (a conservative distributional assumption).

Table 26. Minimum Sample Size for Chen Test at 20 Percent Level of Significance to Achieve a 5 Percent Chance of "Walking Away" When EA Mean is 2.0 SSL, Given Expected CV for Concentrations Across the EA

Number of specimens per composite[b]	Coefficient of variation (CV)[a]					
	1.0	1.5	2.0	2.5	3.0	3.5
1	9	>9	>9	>9	>9	>9
2	5	7	>9	>9	>9	>9
3	4	5	7	9	>9	>9
4	4	4	6	7	>9	>9
5	4	4	4	6	8	>9
6	4	4	4	5	8	9

[a]The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA and includes measurement error.
[b]Each composite consists of points from a stratified random or systematic grid sample across the entire EA.
NOTE: Sample sizes are based on 1,000 simulations that assume that each composite is representative of the entire EA, that half the EA has concentrations below the limit of detection, and that half the EA has concentrations following a gamma distribution (a conservative distributional assumption).

Table 27. Minimum Sample Size for Chen Test at 40 Percent Level of Significance to Achieve a 5 Percent Chance of "Walking Away" When EA Mean is 2.0 SSL, Given Expected CV for Concentrations Across the EA

Number of specimens per composite[b]	Coefficient of variation (CV)[a]						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1	5	9	>9	>9	>9	>9	>9
2	4	4	8	9	>9	>9	>9
3	4	4	5	7	>9	>9	>9
4	4	4	4	5	8	>9	>9
5	4	4	4	5	6	9	>9
6	4	4	4	4	5	8	9

[a]The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA and includes measurement error.
[b]Each composite consists of points from a stratified random or systematic grid sample across the entire EA.
NOTE: Sample sizes are based on 1,000 simulations that assume that each composite is representative of the entire EA, that half the EA has concentrations below the limit of detection, and that half the EA has concentrations following a gamma distribution (a conservative distributional assumption).

Table 28. Minimum Sample Size for Chen Test at 10 Percent Level of Significance to Achieve a 10 Percent Chance of "Walking Away" When EA Mean is 2.0 SSL, Given the Expected CV for Concentrations Across the EA

Number of specimens per composite[b]	Coefficient of variation (CV)[a]					
	1.0	1.5	2.0	2.5	3.0	3.5
2	6	7	>9	>9	>9	>9
3	4	5	7	>9	>9	>9
4	4	4	6	7	>9	>9
5	4	4	5	6	8	>9
6	4	4	4	5	7	9

[a]The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA and includes measurement error.
[b]Each composite consists of points from a stratified random or systematic grid sample across the entire EA.
NOTE: Sample sizes are based on 1,000 simulations that assume that each composite is representative of the entire EA, that half the EA has concentrations below the limit of detection, and that half the EA has concentrations following a gamma distribution (a conservative distributional assumption).

Table 29. Minimum Sample Size for Chen Test at 20 Percent Level of Significance to Achieve a 10 Percent Chance of "Walking Away" When EA Mean is 2.0 SSL, Given Expected CV for Concentrations Across the EA

Number of specimens per composite[b]	Coefficient of variation (CV)[a]						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1	7	9	>9	>9	>9	>9	>9
2	4	5	8	>9	>9	>9	>9
3	4	4	5	8	>9	>9	>9
4	4	4	4	5	8	>9	>9
5	4	4	4	5	6	8	>9
6	4	4	4	4	5	7	9

[a]The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA and includes measurement error.
[b]Each composite consists of points from a stratified random or systematic grid sample across the entire EA.
NOTE: Sample sizes are based on 1,000 simulations that assume that each composite is representative of the entire EA, that half the EA has concentrations below the limit of detection, and that half the EA has concentrations following a gamma distribution (a conservative distributional assumption).

Table 30. Minimum Sample Size for Chen Test at 40 Percent Level of Significance to Achieve a 10 Percent Chance of "Walking Away" When EA Mean is 2.0 SSL, Given Expected CV for Concentrations Across the EA

Number of specimens per composite[b]	Coefficient of variation (CV)[a]						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
1	4	7	9	>9	>9	>9	>9
2	4	4	5	8	9	>9	>9
3	4	4	4	5	7	9	>9
4	4	4	4	4	5	7	>9
5	4	4	4	4	5	6	8
6	4	4	4	4	4	5	6

[a]The CV is the coefficient of variation for individual, uncomposited measurements across the entire EA and includes measurement error.
[b]Each composite consists of points from a stratified random or systematic grid sample across the entire EA.
NOTE: Sample sizes are based on 1,000 simulations that assume that each composite is representative of the entire EA, that half the EA has concentrations below the limit of detection, and that half the EA has concentrations following a gamma distribution (a conservative distributional assumption).

Given an *a priori* estimate of the CV of concentration measurements in the EA, the site manager can use Table 26 to determine a sample size option that achieves the decision error goals for surface soil screening presented in Section 4.1.6 (i.e., not more than 20 percent chance of error at 0.5 SSL and not more than 5 percent at 2 SSL). For example, suppose that the site manager expects that the maximum true CV for concentration measurements in an EA is 2. Then Table 26 shows that six composite samples, each consisting of four specimens, will be sufficient to achieve the decision error limit goals.

4.1.11 Using the DQA Process: Analyzing Chen Test Data. Step-by-step instructions for using the Chen test to analyze data from both discrete random samples and pseudo-random samples (e.g., composite samples constructed as described previously) are provided in Highlight 7. This method for analyzing the data is a robust procedure for an upper-tailed test for the mean of a positively skewed distribution. As explained by Chen (1995), this procedure is a robust generalization of the familiar Student's t-test; it further generalizes a method developed by Johnson (1978) for asymmetric distributions.

The only assumption necessary for valid application of the Chen procedure is that the sample be a random sample from a right-skewed distribution. This robustness within the broad family of right-skewed distributions is appropriate for screening surface soil because the distribution of concentrations within an EA may depart from the common assumption of lognormality.

Computation of the Chen test statistic, as shown in Highlight 7, requires that concentration values be available for all N individual or composite samples analyzed for the contaminant of interest. If an analytical test result is reported below the quantitation limit, it should be used in the computations. For results below detection, substitute one-half the QL.

A disadvantage of the Chen procedure is that the hypothesis, "the EA needs no further investigation," must be treated as the alternative hypothesis, rather than as the null hypothesis. As a result, the Type I error rate at 0.5 SSL is controlled via the significance level of the test, rather than the error rate at 2 SSL, which may have public health consequences. Hence, if the sample sizes (C and N) are based on an assumed CV that is too small, the desired error rate at 2 SSL is likely not to be achieved. Therefore, it is important to perform the data quality assurance check specified in Steps 6 through 8 of Highlight 7 to ensure that the desired error rate at 2 SSL is achieved. Moreover, it is important that the site manager base the initial EA sample sizes on a conservatively large estimate of the CV so that this process will not result in the need for additional sampling.

4.1.12 Special Considerations for Multiple Contaminants. If the surface soil samples collected for an EA will be tested for multiple contaminants, be aware that the expected CVs for the different contaminants may not all be identical. A conservative approach is to base the sample sizes for all contaminants on the largest expected CV.

4.1.13 Quality Assurance/Quality Control Requirements. Regardless of the sampling approach used, the Superfund quality assurance program guidance must be followed to ensure that measurement error rates are documented and within acceptable limits (U.S. EPA, 1993d).

Highlight 7: Directions for the Chen Test Using Simple Random Sample Scheme

Let $x_1, x_2, \ldots, x_N$, represent concentration measurements for N random sampling points or N pseudo-random sampling points (i.e., from a design that can be analyzed as if it were a simple random sample). The following describes the steps for a one-sample test for H_o: $\mu \leq 0.5$ SSL at the 100α% significance level that is designed to achieve a 100ß% chance of incorrectly accepting H_o when $\mu = 2$ SSL.

STEP 1: Calculate the sample mean $\bar{x} = \left[\sum_{i=1}^{N} x_i\right] \frac{1}{N}$

STEP 2: Calculate the sample standard deviation

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} \left(x_i - \bar{x}\right)^2}$$

STEP 3: Calculate the sample skewness

$$b = N \frac{\sum_{i=1}^{N} \left(x_i - \bar{x}\right)^3}{(N-1)\ (N-2)\ s^3}$$

STEP 4: Calculate the Chen test statistic, t_2, as follows:

$$a = \frac{b}{6\sqrt{N}}$$

$$t = \frac{\bar{x} - 0.5\ \text{SSL}}{s\ /\ \sqrt{N}}$$

$$t_2 = t + a\left(1 + 2t^2\right) + 4a^2\left(t + 2t^3\right)$$

STEP 5: Compare t_2 to z_α, the $100(1 - \alpha)$ percentile of the standard normal probability distribution.

If $t_2 > z_\alpha$, the null hypothesis is rejected, and the EA needs further investigation.

If $t_2 \leq z_\alpha$, there is insufficient evidence to reject the null hypothesis. Proceed to Step 6 to determine if the sample size is sufficient to achieve a 100ß% or less chance of incorrectly accepting the H_o when $\mu = 2$ SSL.

Highlight 7: Directions for the Chen Test Using Simple Random Sample Scheme (continued)

STEP 6: Let C represent the number of specimens composited to form each of the N samples, where each of $x_1, x_2, \ldots, x_N$ is a composite sample consisting of C specimens selected so that each composite is representative of the EA as a whole. (If each of $x_1, x_2, \ldots, x_N$ is an individual random or pseudo-random sampling point, then C = 1.)

If Max $(x_1, x_2, \ldots, x_N) < \frac{SSL}{\sqrt{C}}$, then no further data quality assessment is needed and the EA needs no further investigation.

Otherwise proceed to Step 7.

STEP 7: Calculate the sample estimate of the coefficient of variation, CV, for individual concentration measurements from across the EA.

$$CV = \frac{\sqrt{C}\ s}{\bar{x}}$$

NOTE: This calculation ignores measurement error, which results in conservatively large sample size requirements.

STEP 8: Use the value of the sample CV calculated in Step 7 as the true CV of concentrations in Tables 25 through 30 to determine the minimum sample size, N^*, necessary to achieve a 100ß% or less chance of incorrectly accepting H_o when $\mu = 2$ SSL.

If $N \geq N^*$, the EA needs no further investigation.

If $N < N^*$, further investigation of the EA is necessary. The further investigation may consist of selecting a supplemental sample and repeating this hypothesis testing procedure with the larger, combined sample.

4.1.14 Final Analysis. After either the Max test or the Chen test has been performed for each EA of interest (0.5 acre or less) at an NPL site, the pattern of decisions for individual EAs (to "walk away" or to "investigate further") should be examined. If some EAs for which the decision was to "walk away" are surrounded by EAs for which the decision was to "investigate further," it may be more efficient to identify an area including all these EAs for further study and develop a global investigation strategy.

4.1.15 Reporting. The decision process for surface soil screening should be thoroughly documented as part of the RI/FS process. This documentation should include a map of the site

(showing the boundaries of the EAs and the sectors, or strata, within EAs that were used to select sampling points within the EAs); documentation of how composite samples were formed and the number of composite samples that were analyzed for each EA; the raw analytical data; the results of all hypothesis tests; and the results of all QA/QC analyses.

4.2 Sampling Subsurface Soils

Subsurface soil sampling is conducted to estimate the mean concentrations of contaminants in each source at a site for comparison to inhalation and migration to ground water SSLs. Measurements of soil properties and estimates of the area and depth of contamination in each source are also needed to calculate SSLs for these pathways. Table 31 shows the steps in the DQO process necessary to develop a sampling strategy to meet these objectives. Each of these steps is described below.

4.2.1 State the Problem. Contaminants present in subsurface soils at the site may pose significant risk to human health and the environment through the inhalation of volatiles or by the migration of contaminants through soils to an underlying potable aquifer. The problem is to identify the contaminants and source areas that do not pose significant risk to human health through either of these exposure pathways so that future investigations may be focused on areas and contaminants of true concern.

Site-specific activities in this step include identifying the data collection planning team (including technical experts and key stakeholders) and specifying the available resources (i.e., the cost and time available for sampling). The list of technical experts and stakeholders should contain all key personnel who are involved with applying SSLs to the site. Other activities include developing the conceptual site model and identifying exposure scenarios, which are fully addressed in the *Soil Screening Guidance: User's Guide* (U.S. EPA, 1996).

4.2.2 Identify the Decision. The decision is to determine whether mean soil concentrations in each source area exceed inhalation or migration to ground water SSLs for specific contaminants. If so, the source area will be investigated further. If not, no further action will be taken under CERCLA.

4.2.3 Identify Inputs to the Decision. Site-specific inputs to the decision include the average contaminant concentrations within each source area and the inhalation and migration ground water SSLs. Calculation of the SSLs for the two pathways of concern also requires site-specific measurements of soil properties (i.e., bulk density, fraction organic carbon content, pH, and soil texture class) and estimates of the areal extent and depth of contamination.

A list of feasible sampling and analytical methods should be assembled during this step. EPA recommends the use of field methods where applicable and appropriate. Verify that Contract Laboratory Program (CLP) methods and field methods for analyzing the samples exist and that the analytical method detection limits or field method detection limits are appropriate for the site-specific or generic SSL. The *Sampler's Guide to the Contract Laboratory Program* (U.S. EPA, 1990) and the *User's Guide to the Contract Laboratory Program* (U.S. EPA, 1991d) contain further information on CLP methods.

Table 31. Soil Screening DQOs for Subsurface Soils

DQO Process Steps	Soil Screening Inputs/Outputs
State the Problem	
Identify scoping team	Site manager and technical experts (e.g., toxicologists, risk assessors, hydrogeologists, statisticians).
Develop conceptual site model (CSM)	CSM development (described in Step 1 of the User's Guide, U.S. EPA, 1996).
Define exposure scenarios	Inhalation of volatiles and migration of contaminants from soil to potable ground water (and plant uptake for certain contaminants).
Specify available resources	Sampling and analysis budget, scheduling constraints, and available personnel.
Write brief summary of contamination problem	Summary of the subsurface soil contamination problem to be investigated at the site.
Identify the Decision	
Identify decision	Do mean soil concentrations for particular contaminants (e.g., contaminants of potential concern) exceed appropriate SSLs?
Identify alternative actions	Eliminate area from further action or study under CERCLA or Plan and conduct further investigation.
Identify Inputs to the Decision	
Identify decision	Volatile inhalation and migration to ground water SSLs for specified contaminants Measurements of subsurface soil contaminant concentration
Define basis for screening	Soil Screening Guidance
Identify analytical methods	Feasible analytical methods (both field and laboratory) consistent with program-level requirements.
Specify the Study Boundaries	
Define geographic areas of field investigation	The entire NPL site (which may include areas beyond facility boundaries), except for any areas with clear evidence that no contamination has occurred.
Define population of interest	Subsurface soils
Define scale of decision making	Sources (areas of contiguous soil contamination, defined by the area and depth of contamination or to the water table, whichever is more shallow).
Subdivide site into decision units	Individual sources delineated (area and depth) using existing information or field measurements (several nearby sources may be combined into a single source).
Define temporal boundaries of study	Temporal constraints on scheduling field visits.
Identify (list) practical constraints	Potential impediments to sample collection, such as access, health, and safety issues.
Develop a Decision Rule	
Specify parameter of interest	Mean soil contaminant concentration in a source (as represented by discrete contaminant concentrations averaged within soil borings).
Specify screening level	SSLs calculated using available parameters and site data (or generic SSLs if site data are unavailable).
Specify "if..., then..." decision rule	If the mean soil concentration exceeds the SSL, then investigate the source further. If the mean soil boring concentration is less than the SSL, then no further investigation is required under CERCLA.

Table 31. (continued)

Specify Limits on Decision Errors	
Define QA/QC goals	CLP precision and bias requirements 10% CLP analyses for field methods
Optimize the Design	
Determine how to estimate mean concentration in a source	For each source, the highest mean soil core concentration (i.e., depth-weighted average of discrete contaminant concentrations within a boring).
Define subsurface sampling strategy by evaluating costs and site-specific conditions	Number of soil borings per source area; number of sampling intervals with depth.
Develop planning documents for the field investigation	Sampling and Analysis Plan (SAP) Quality Assurance Project Plan (QAPjP)

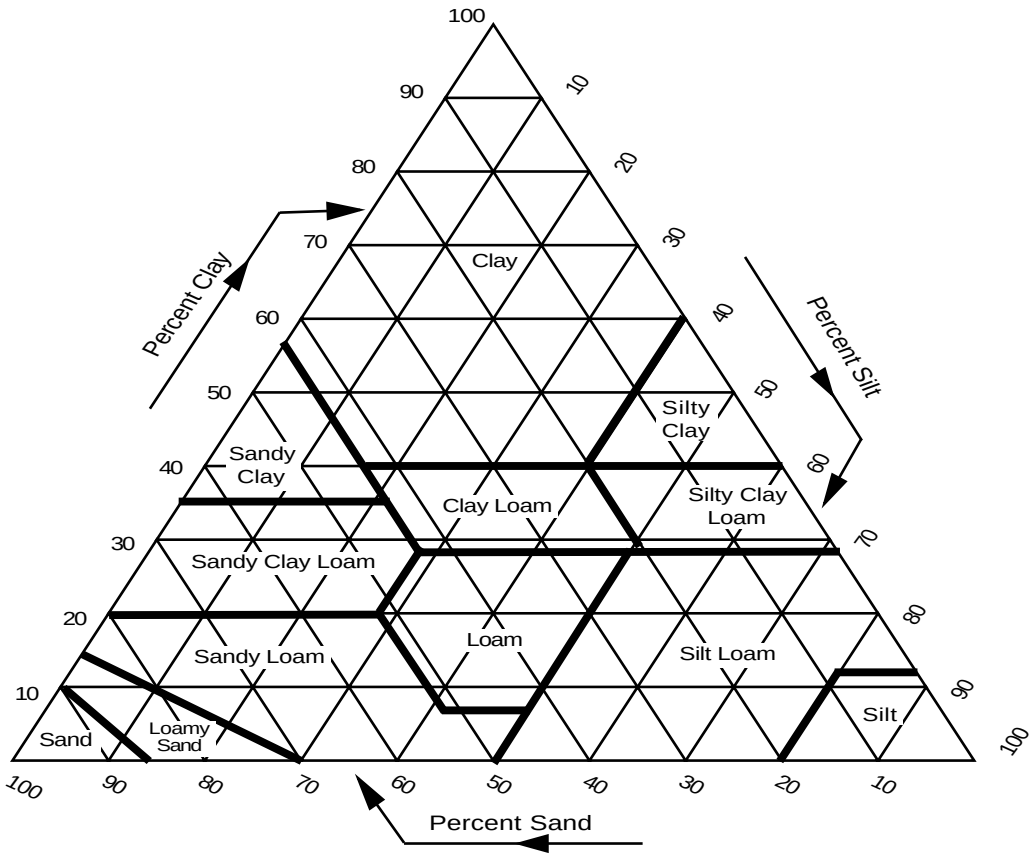
Field methods will be useful in defining the study boundaries (i.e., area and depth of contamination) during site reconnaissance and during the sampling effort. For example, soil gas survey is an ideal method for determining the extent of volatile contamination in the subsurface. EPA expects field methods will become more prevalent and useful because the design and capabilities of field portable instrumentation are rapidly evolving. Documents on standard operating procedures (SOPs) for field methods are available through NTIS and should be referenced in soil screening documentation if these methods are used.

Soil parameters necessary for SSL calculation are soil texture, bulk density, and soil organic carbon. Some of these parameters can be measured in the field, others require laboratory measurement. Although laboratory measurements of these parameters cannot be obtained under the Superfund Contract Laboratory Program, they are readily available from soil testing laboratories across the country.

Note that the size, shape, and orientation of sampling volume (i.e., "support") for heterogenous media have a significant effect on reported measurement values. For instance, particle size has a varying affect on the transport and fate of contaminants in the environment and on the potential receptors. Comparison of data from methods that are based on different supports can be difficult. Defining the sampling support is important in the early stages of site characterization. This may be accomplished through the DQO process with existing knowledge of the site, contamination, and identification of the exposure pathways that need to be characterized. Refer to *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies* (U.S. EPA, 1992f) for more information about soil sampling support.

Soil Texture. The soil texture class (e.g., loam, sand, silt loam) is necessary to estimate average soil moisture conditions and to estimate infiltration rates. A soil's texture classification is determined from a particle size analysis and the U.S. Department of Agriculture (USDA) soil textural triangle shown at the top of Figure 9. This classification system is based on the USDA soil particle size classification at the bottom of Figure 9. The particle size analysis method in Gee and Bauder (1986) can provide this particle size distribution also. Other particle size analysis methods may be used as long as they provide the same particle size breakpoints for sand/silt (0.05 mm) and silt/clay (0.002 mm). Field methods are an alternative for determining soil textural class; an example from Brady (1990) is also presented in Figure 9.

Figure 9: U.S. Department of Agriculture soil texture classification.



Criteria Used with the Field Method for Determining Soil Texture Classes (Source: Brady, 1990)

Criterion	Sand	Sandy loam	Loam	Silt loam	Clay loam	Clay
1. Individual grains visible to eye	Yes	Yes	Some	Few	No	No
2. Stability of dry clods	Do not form	Do not form	Easily broken	Moderately easily broken	Hard and stable	Very hard and stable
3. Stability of wet clods	Unstable	Slightly stable	Moderately stable	Stable	Very stable	Very stable
4. Stability of "ribbon" when wet soil rubbed between thumb and fingers	Does not form	Does not form	Does not form	Broken appearance	Thin, will break	Very long, flexible

Particle Size, mm

	0.002		0.05	0.10	0.25	0.5	1.0	2.0	
U.S. Department of Agriculture	Clay	Silt	Very Fine	Fine	Med.	Coarse	Very Coarse		Gravel
			Sand						

Source: USDA.

Dry Bulk Density. Dry soil bulk density (ρ_b) is used to calculate total soil porosity and can be determined for any soil horizon by weighing a thin-walled tube soil sample (e.g., Shelby tube) of known volume and subtracting the tube weight to estimate field bulk density (ASTM D 2937). A moisture content determination (ASTM 2216) is then made on a subsample of the tube sample to adjust field bulk density to dry bulk density. The other methods (e.g., ASTM D 1556, D 2167, D 2922) are not generally applicable to subsurface soils. ASTM soil testing methods are readily available in the *Annual Book of ASTM Standards, Volume 4.08, Soil and Rock; Building Stones*, which is available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA, 19428.

Organic Carbon and pH. Soil organic carbon is measured by burning off soil carbon in a controlled-temperature oven (Nelson and Sommers, 1982). This parameter is used to determine soil-water partition coefficients from the organic carbon soil-water partition coefficient, K_{oc}. Soil pH is used to select site-specific partition coefficients for metals and ionizing organic compounds (see Part 5). This simple measurement is made with a pH meter in a soil/water slurry (McLean, 1982) and may be measured in the field using a portable pH meter.

4.2.4 Define the Study Boundaries. As discussed in Section 4.1.4, areas that are known to be highly contaminated (i.e., sources) are targeted for subsurface sampling. The information collected on source area and depth is used to calculate site-specific SSLs for the inhalation and migration to ground water pathways. Contamination is defined by the lower of the CLP practical quantitation limit for each contaminant or the SSL. For the purposes of this guidance, source areas are defined by area and depth as contiguous zones of contamination. However, discrete sources that are near each other may be combined and investigated as a single source if site conditions warrant.

4.2.5 Develop a Decision Rule. The decision rule for subsurface soils is:

> If the mean concentration of a contaminant within a source area exceeds the screening level, then investigate that area further.

In this case "screening level" means the SSL. As explained in Section 4.1.5, statistics other than the mean (e.g., the maximum concentration) may be used as estimates of the mean in this comparison as long as they represent valid or conservative estimates of the mean.

4.2.6 Specify Limits on Decision Errors. EPA recognizes that data obtained from sampling and analysis can never be perfectly representative or accurate and that the costs of trying to achieve near-perfect results can outweigh the benefits. Consequently, EPA acknowledges that uncertainty in data must be tolerated to some degree. The DQO process attempts to control the degree to which uncertainty in data affects the outcomes of decisions that are based on data.

The sampling intensity necessary to accurately determine the mean concentration of subsurface soil contamination within a source with a specified level of confidence (e.g., 95 percent) is impracticable for screening due to excessive costs and difficulties with implementation. Therefore, EPA has developed an alternative decision rule based on average concentrations within individual soil cores taken in a source:

> If the mean concentration within **any** soil core taken in a source exceeds the screening level, then investigate that source further.

For each core, the mean core concentration is defined as the depth-weighted average concentration within the zone of contamination (see Section 4.2.7). Since the soil cores are taken in the area(s) of highest contamination within each source, the highest average core concentration among a set of core samples serves as a conservative estimate of the mean source concentration. Because this rule is not a statistical decision, it is not possible to statistically define limits on decision errors.

Standard limits on the precision and bias of sampling and analytical operations conducted during the sampling program do apply. These are specified by the Superfund quality assurance program requirements (U.S. EPA, 1993d), which must be followed during the subsurface sampling effort.

If field methods are used, at least 10 percent of field samples should be split and sent to a CLP laboratory for confirmatory analysis (U.S. EPA, 1993d).

Although the EPA does not require full CLP sample tracking and quality assurance/quality control (QA/QC) procedures for measurement of soil properties, routine EPA QA/QC procedures are recommended, including a Quality Assurance Project Plan (QAPjP), chain-of-custody forms, and duplicate analyses.

4.2.7 Optimize the Design. Within each source, the Soil Screening Guidance suggests taking two to three soil cores using split spoon or Shelby tube samplers. For each soil core, samples should begin at the ground surface and continue at approximately 2-foot intervals until no contamination is encountered or to the water table, whichever is shallower. **Subsurface sampling depths and intervals can be adjusted at a site to accommodate site-specific information on surface and subsurface contaminant distributions and geological conditions** (e.g., large vadose zones in the West).

The number and location of subsurface soil sampling (i.e., soil core) locations should be based on knowledge of likely surface soil contamination patterns and subsurface conditions. This usually means that core samples should be taken directly beneath areas of high surface soil contamination. Surface soils sampling efforts and field measurements (e.g., soil gas surveys) taken during site reconnaissance will provide information on source areas and high contaminant concentrations to help target subsurface sampling efforts. Information in the CSM also will provide information on areas likely to have the highest levels of contamination. Note that there may be sources buried in subsurface soils that are not discernible at the surface. Information on past practices at the site included in the CSM can help identify such areas. Surface geophysical methods also can aid in identifying such areas (e.g., magnetometry to detect buried drums).

The intensity of the subsurface soil sampling needed to implement the soil screening process typically will not be sufficient to fully characterize the extent of subsurface contamination. In these cases, conservative assumptions should be used to develop hypotheses on likely contaminant distributions (e.g., the assumption that soil contamination extends to the water table). Along with knowledge of subsurface hydrogeology and stratigraphy, geostatistics can be a useful tool in developing subsurface contaminant distributions from limited data and can provide information to help guide additional sampling efforts. However, instructions on the use of geostatistics is beyond the scope of this guidance.

Samples for measuring soil parameters should be collected when taking samples for measuring contaminant concentrations. If possible, consider splitting single samples for contaminant and soil parameter measurements. Many soil testing laboratories have provisions in place for handling and testing contaminated samples. However, if testing contaminated samples is a problem, samples may be taken from clean areas of the site as long as they represent the same soil texture and series and are

taken from the same depth as the contaminant concentration samples.

The SAP developed for subsurface soils should specify sampling and analytical procedures as well as the development of QA/QC procedures. To identify the appropriate analytical procedures, the screening levels must be known. If data are not available to calculate site-specific SSLs, then the generic SSLs in Appendix A should be used.

Finally, soil investigation for the migration to ground water pathway should not be conducted independently of ground water investigations. Contaminated ground water may indicate the presence of a nearby source area, with contaminants leaching from soil into the aquifer.

4.2.8 Analyzing the Data. The mean soil contaminant concentration for each soil core should be compared to the SSL for the contaminant. The soil core average should be obtained by averaging analyses results for the discrete samples taken along the entire soil core within the zone of contamination (compositing will prevent the evaluation of contaminant concentration trends with depth).

If each subsurface soil core segment represents the same subsurface soil interval (e.g., 2 feet), then the average concentration from the surface to the depth of contamination is the simple arithmetic average of the concentrations measured for core samples representative of each of the 2-foot segments from the surface to the depth of contamination or to the water table. However, if the intervals are not all of the same length (e.g., some are 2 feet while others are 1 foot or 6 inches), then the calculation of the average concentration in the total core must account for the different lengths of the intervals.

If c_i is the concentration measured in a core sample representative of a core interval of length l_i, and the n-th interval is considered to be the last interval in the source area (i.e., the n-th sample represents the depth of contamination), then the average concentration in the core from the surface to the depth of contamination should be calculated as the following depth-weighted average ($\bar{c}$),

$$\bar{c} = \frac{\sum_{i=1}^{n} l_i c_i}{\sum_{i=1}^{n} l_i} \qquad \textbf{(61)}$$

If the leach test option is used, a sample representing the average contaminant concentration within the zone of contamination should be formed for each soil core by combining discrete samples into a composite sample for the test. The composites should include only samples taken within the zone of contamination (i.e., clean soil below the lower limit of contamination should not be mixed with contaminated soil).

As with any Superfund sampling effort, all analytical data should be reviewed to ensure that Superfund quality assurance program requirements are met (U.S. EPA, 1993d).

4.2.9 Reporting. The decision process for subsurface soil screening should be thoroughly documented. This documentation should contain as a minimum: a map of the site showing the contaminated soil sources and any areas assumed not to be contaminated, the soil core sampling points within each source, and the soil core sampling points that were compared with the SSLs; the depth and area assumed for each source and their basis; the average soil properties used to calculate

SSLs for each source; a description of how samples were taken and (if applicable) how composite samples were formed; the raw analytical data; the average soil core contaminant concentrations compared with the SSLs for each source; and theresults of all QA/QC analyses.

4.3 Basis for the Surface Soil Sampling Strategies: Technical Analyses Performed

This section describes a series of technical analyses conducted to support the sampling strategy for surface soils outlined in the Soil Screening Guidance. Section 4.3.1 describes the sample design procedure presented in the December 1994 draft guidance (U.S. EAP, 1994h). The remaining sections describe the technical analyses conducted to develop the final SSL sampling strategy. Section 4.3.2 describes an alternative, nonparametric procedure that EPA considered but **rejected** for the soil screening strategy.

Section 4.3.3 describes the simulations conducted to support the selection of the Max test and the Chen test in the final Soil Screening Guidance. These simulation results also can be used to determine sample sizes for site conditions not adequately addressed by the tables in Section 4.1. Quantitation limit and multiple comparison issues are discussed in Sections 4.3.4 and 4.3.5, respectively. Section 4.3.6 describes a limited investigation of compositing samples within individual EA sectors or strata.

4.3.1 1994 Draft Guidance Sampling Strategy. The DQO-based sampling strategy in the 1994 draft Soil Screening Guidance assumed a lognormal distribution for contaminant levels over an EA and derived sample size determinations from lognormal confidence interval procedures by C. E. Land (1971). This section summarizes the rationale for this approach and technical issues raised by peer review.

For the 1994 draft Soil Screening Guidance, EPA based the surface soil SSL methodology on the comparison of the arithmetic mean concentration over an EA with the SSL. As explained in Section 4.1, this approach reflects the type of exposure to soil under a future residential land use scenario. A person moving randomly across a residential lot would be expected to experience an average concentration of contaminants in soil.

Generally speaking, there are few nonparametric approaches to statistical inference about a mean unless a symmetric distribution (e.g., normal) is assumed, in which case the mean and median are identical and inference about the median is the same as inference about the mean. However, environmental contaminant concentration distributions over a surface area tend to be skewed with a long right tail, so symmetry is not plausible. In this case the main options for inference about means are inherently parametric, i.e., they are based on an assumed family of probability distributions.

In addition to being skewed with a long right tail, environmental contaminant concentration data must be positive because concentration measurements cannot be negative. Several standard two-parameter probability models are nonnegative and skewed to the right, including the gamma, lognormal, and Weibull distributions. The properties of these distributions are summarized in Chapter 12 of Gilbert (1987).

The lognormal distribution is the distribution most commonly used for environmental contaminant data (see, e.g., Gilbert, 1987, page 164). The lognormal family can be easy to work with in some respects, due to the work of Land (1971, 1975) on estimating confidence intervals for lognormal parameters, which are also described in Gilbert (1987).

The equation for estimating the Land upper confidence limit (UL) for a lognormal mean has the form

$$UL = \exp\left(\bar{y} + \frac{s_y^2}{2} + \frac{s_y H}{\sqrt{n-1}} \right) \quad \textbf{(62)}$$

where $\bar{y}$ and s_y are the average and standard deviation of the sample log concentrations. The lower confidence limit (LL) has a similar form. The factor H depends on s_y and n and is tabulated in Gilbert (1987) and Land (1975). If the data truly follow a lognormal distribution, then the Land confidence limits are exact (i.e., the coverage probability of a 95 percent confidence interval is 0.95).

The problem formulation used to develop SSL DQOs in the 1994 draft Soil Screening Guidance tested the null hypothesis H_0: $\mu \geq 2$ SSL versus the alternative hypothesis H_1: $\mu < 2$ SSL, with a Type I error rate of 0.05 (at 2 SSL), and a Type II error rate of 0.20 at 0.5 SSL (μ represents the true EA mean). That is, the probability of incorrectly deciding not to investigate further when the true mean is 2 SSL was set not to exceed 0.05, and the probability of incorrectly deciding to investigate further when the true mean is 0.5 SSL was not to exceed 0.20.

This null hypothesis can be tested at the 5 percent level of significance by calculating Land's upper 95 percent confidence limit for a lognormal mean, if one assumes that the true EA concentrations are lognormally distributed. The null hypothesis is rejected if the upper confidence limit falls below 2 SSL.

Simulation studies of the Land procedure were used to obtain sample size estimates that achieve these DQOs for different possible values of the standard deviation of log concentrations. Additional simulation studies were conducted to calculate sample sizes and to investigate the properties of the Land procedure in situations where specimens are composited.

All of these simulation studies assumed a lognormal distribution of site concentrations. If the underlying site distribution is lognormal, then the composites, viewed as physical averages, are not lognormal (although they may be approximately lognormal). Hence, correction factors are necessary to apply the Land procedure with compositing, if the individual specimen concentrations are assumed lognormal. The correction factors were also developed through simulations. The correction factors are multiplied by the sample standard deviation, s_y, before calculating the confidence limit and conducting the test.

Procedures for estimating sample sizes and testing hypotheses about the site mean using the Land procedure, with and without compositing, are described in the 1994 draft Technical Background Document (U.S. EPA, 1994i).

A peer review of the draft Technical Background Document identified several issues of concern:

- The use of a procedure relying strongly on the assumption of a lognormal distribution
- Quantitation limit issues
- Issues associated with multiple hypothesis tests where multiple contaminants are present in site soils.

The first issue is of concern because the small sample sizes appropriate for surface soil screening will not provide sufficient data to validate this assumption. To address this issue, EPA considered several alternative approaches and performed extensive analyses. These analyses are described in Sections 4.3.2 and 4.3.3. Section 4.3.3 describes extensive simulation studies involving a variety of distributions that were done to compare the Land, Chen, and Max tests and to develop the latter two as options for soil screening.

4.3.2 Test of Proportion Exceeding a Threshold. One of the difficulties noted for the Land test, described in Section 4.3.1, is its strong reliance on an assumption of lognormality (see Section 4.3.3). Even in cases where the assumption may hold, there will rarely be sufficient information to test it.

A second criticism of applying the Land test (or another test based on estimating the mean) is that values must be substituted for values reported as less than a quantitation limit (<QL). (As noted in Section 4.3.4, how one does this substitution is of little relevance if the SSL is much larger than the QL. However, even if a moderate proportion of the data values fall below the QL and are censored, then the lognormal distribution may not be a good model for the observed concentrations.)

A third criticism of using the Land test for screening is its requirement for large sample sizes when the contaminant variability across the EA is expected to be large (e.g., a large coefficient of variation). Because of these drawbacks to applying the Land procedure, EPA considered alternative, nonparametric procedures. One such alternative that was considered is the test described below.

For a given contaminant, let P represent the proportion of all possible sampling units across the EA for which the concentration exceeds 2 SSL. In essence, P represents the proportion of the EA with true contaminant levels above 2 SSL. A nonparametric test involving P was developed as follows.

Let P_0 be a fixed proportion of interest chosen in such a way that if that proportion (or more) of the EA has contamination levels above 2 SSL, then that EA should be investigated further. One way to obtain a rough equivalence between the test for a mean greater than 2 SSL and a test involving P is to choose $1-P_0$ to correspond to the percentile of the lognormal distribution at which the mean occurs. One can show that this is equivalent to choosing

$$P_0 = 1 - \Phi\left[0.5\sigma\right] = 1 - \Phi\left[0.5\sqrt{1n\left(1+CV^2\right)}\right] \qquad \textbf{(63)}$$

where

σ	=	assumed standard deviation of the logarithms of the concentrations
CV	=	assumed coefficient of variation of the contaminant concentrations
Φ	=	distribution function of the standard normal distribution.

Here, the fixed proportion P_0 will be less than one-half. The hypotheses are framed as

H_0: $P \geq P_0$ (EA needs further investigation)

versus

H_1: $P < P_0$ (EA does not need further investigation).

The test is based on concentration data from a grid sample of N points in the EA (without compositing). Let p represent the proportion of these n points with observed concentrations greater than or equal to 2 SSL. The test is carried out by choosing a critical value, p_c, to meet the desired Type I error rate, that is,

$$\alpha = \text{Prob}\ (p < p_c \mid P = P_0) = 0.05. \quad \textbf{(64)}$$

The sample size should be chosen to satisfy the Type II error rate at some specified alternative value P_1, where $P_1 < P_0$. For example, to have an 80 percent power at P_1:

$$1-\beta = \text{Prob}\ (p < p_c \mid P = P_1) = 0.80. \quad \textbf{(65)}$$

If the same type of rationale for choosing P_0 (corresponding to 2 SSL) is used to make P_1 correspond to 0.5 SSL, then one would choose

$$P_1 = 1 - \Phi\ [0.5\ \sigma + 1.386/\sigma]. \quad \textbf{(66)}$$

Sample sizes for this test were developed based on the preceding formulation and were found to be approximately the same as those required by the Land procedure, though they tended to be slightly higher than the Land sample sizes for small σ, and slightly smaller for large σ.

The major advantage of this test, in contrast to the Land procedure, for example, is its generality; the only assumption required is that random sampling be used to select the sample points. Its principal disadvantages are:

- Compositing of samples cannot be included (since the calculation of p requires the count of the number of units with observed levels at or above 2 SSL).
- The test does not deal directly with the mean contaminant level at the EA, which is the fundamental parameter for risk calculations.
- Because the test does not depend directly on the magnitude of the concentrations, it is possible that the test will give misleading results relative to a test based on a mean. This can occur, for example, when only a small portion of the EA has very high levels (i.e., a hot spot). In that case, the observed p will converge for increasing n to that proportion of the EA that is contaminated; it would do the same if the concentration levels in that same portion were just slightly above 2 SSL. A test based on a mean for large samples, however, is able to distinguish between these two situations; by its very nature, a test based on a proportion of measurements exceeding a single threshold level cannot.

For these reasons, the test described here based on the proportion of observations exceeding 2 SSL was not selected for inclusion in the current guidance.

4.3.3 Relative Performance of Land, Max, and Chen Tests. A simulation study was conducted to compare the Land, Chen, and Max tests and to determine sample sizes necessary to achieve DQOs. This section describes the design of the simulation study and summarizes its results. Detailed output from the simulations is presented in Appendix I.

Treatment of Data Below the Quantitation Limit. Review of quantitation limits for 110 chemicals showed that for more than 90 percent of the chemicals, the quantitation limit was less than 1 percent of the ingestion SSL. In such cases, the treatment of values below the QL is not expected to have much effect, as long as all data are used in the analysis, with concentrations assigned to results below the QL in some reasonable way. In the simulations, the QL was assumed to be SSL/100 and any simulated value below the QL was set equal to 0.5 QL. This is a conservative assumption based on the comparison of ingestion SSLs with QLs.

Decision Rules. For the **Land procedure**, as discussed in Section 4.3.1, the null hypothesis H_0: $\mu \geq 2$ SSL (where μ represents the true mean concentration for the EA) can be tested at the 5 percent level by calculating Land's upper 95 percent confidence limit for a lognormal mean. The null hypothesis is rejected (i.e., surface soil contaminant concentrations are less than 2 SSL), if this upper confidence limit falls below 2 SSL. This application of the Land (1971) procedure, as described in the draft 1994 Guidance, will be referred to as the "SSL DQOs" and the "original Land procedure."

For the **Max test**, one decides to walk away if the maximum concentration observed in composite samples taken from the EA does not exceed 2 SSL. As indicated in Section 4.1.6, it is viewed as providing a test of the original null hypothesis, H_0: $\mu \geq 2$ SSL. The Max test does not inherently control either type of error rate (i.e., its critical region is always the region below 2 SSL, not where concentrations below a threshold that achieve a specified Type I error rate). However, control of error rates for the Max test can be achieved through the DQO process by choice of design (i.e., by choice of the number N of composite samples and choice of the number C of specimens per composite).

The **Chen test** requires that the null hypothesis have the form H_0: $\mu \leq \mu_0$, with the alternative hypothesis as H_1: $\mu > \mu_0$ (Chen, 1995). Hypotheses or DQOs of this form are referred to as "flipped hypotheses" or "flipped DQOs" because they represent the inverse of the actual hypothesis for SSL decisions. In the simulations, the Chen method was applied with $\mu_0 = 0.5$ SSL at significance levels (Type I error rates) of 0.4, 0.3, 0.2, 0.1, 0.05, 0.025, and 0.01. In this formulation, a Type I error occurs if one decides incorrectly to investigate further when the true site mean, μ, is at or below 0.5 SSL.

The two formulations of the hypotheses are equivalent in the sense that both allow achievement of soil screening DQOs. That is, working with either formulation, it is possible to control the probability of incorrectly deciding to walk away when the true site mean is 2 SSL and to also control the probability of incorrectly deciding to investigate further when the true site mean is 0.5 SSL.

In addition to the original Land procedure, the Chen test, and the Max test, the simulations also include the Land test of the flipped null hypothesis H_0: $\mu \leq 0.5$ SSL at the 10 percent significance level. This Land test of the flipped hypothesis was included to investigate how interchanging the null and alternative hypotheses affected sample sizes for the Land and Chen procedures.

Simulation Distributions. In the following description of the simulations, parameter acronyms used as labels in the tables of results are indicated by capital letters enclosed in parentheses.

Each distribution used for simulation is a mixture of a lower concentration distribution and a higher concentration distribution. The lower distribution represents the EA in its natural (unpolluted) state, and the higher distribution represents contaminated areas. Typically, all measurements of pollutants in uncontaminated areas are below the QL. Accordingly, the lower distribution is assumed to be completely below the QL. For the purposes of this analysis, it is unnecessary to specify any other aspect of the lower distribution, because any measurement below the QL is set equal to 0.5 QL.

A parameter between 0 and 1, called the mixing proportion (MIX), specifies the probability allocated to the lower distribution. The remaining probability (1-MIX) is spread over higher values according to either a lognormal, gamma, or Weibull distribution. The parameters of the higher distribution are chosen so that the overall mixture has a given true EA mean (MU) and a given coefficient of variation (CV). Where s is the sample standard deviation, $\bar{x}$ is the sample mean, and C is the number of specimens per composite sample, CV is defined as:

$$CV = \frac{s}{\bar{x}} \quad \text{or} \quad CV = \frac{\left(\sqrt{C}\right)s}{\bar{x}}.$$

The following parameter values were used in the simulations:

EA mean (MU) = 0.5 SSL or 2 SSL

EA coefficient of variation (CV) = 1, 1.5, 2, 2.5, 3, 3.5, 4, 5, or 6 (i.e., 100 to 600 percent)

Number of specimens per composite (C) = 1, 2, 3, 4, 5, 6, 8, 9, 12, or 16

Number of composites chemically analyzed (N) = 4, 5, 6, 7, 8, 9, 12, or 16.

The true EA mean was set equal to 0.5 SSL or 2 SSL in order to estimate the two error rates of primary concern. Most CVs encountered in practice probably will lie between 1 and 2.5 (i.e., variability between 100 and 250 percent). This expectation is based on data from the Hanford site (see Hardin and Gilbert, 1993) and the Piazza Road site (discussed in Section 4.3.6). EPA believes that the most practical choices for the number of specimens per composite will be four and six. In some cases, compositing may not be appropriate (the case C = 1 corresponds to no compositing). EPA also believes that for soil screening, a practical number of samples chemically analyzed per EA lies below nine, and that screening decisions about soils in each EA should not be based on fewer than four chemical analyses.

For a given CV, there is a theoretical limit to how large the mixing proportion can be. The values of the mixing proportion used in the simulations are shown below as a function of CV. The case MIX = 0 corresponds to an EA characterized by a gamma, lognormal, or Weibull distribution. A value of MIX near 1 indicates an EA where all concentrations are below the QL except those in a small portion of the EA. Neither of these extremes implies an extreme overall mean. If MIX = 0, the contaminating (higher) distribution can have a low mean, resulting in a low overall mean. If MIX is near 1 (i.e., a relatively small contamination area), a high overall mean can be obtained if the mean of the distribution of contaminant concentrations is high enough.

CV	Values of MIX used in the simulations
1.0	0, 0.49
1.5	0, 0.50
2.0	0, 0.50, 0.75
2.5	0, 0.50, 0.85
3.0	0, 0.50, 0.85
3.5	0, 0.50, 0.90
4.0	0, 0.50, 0.90
5.0	0, 0.50, 0.95
6.0	0, 0.50, 0.95

Treatment of Measurement Error. Measurement errors were assumed to be normally distributed with mean 0 (i.e., unbiased measurements) and standard deviation equal to 20 percent of the true value for each chemically analyzed sample. (Earlier simulations included measurement error standard deviations of 10 percent and 25 percent. The difference in results between these two cases was negligible.)

Number of Simulated Samples. Unique combinations of the simulation parameters considered (i.e., 2 values of the EA mean, 10 values for the number of specimens per composite, 8 values for the number of composite samples, 25 combinations of CV and MIX, and 3 contamination models—lognormal, gamma, Weibull), result in a total of 12,000 simulation conditions. One thousand simulated random samples were generated for each of the 12,000 cases obtained by varying the simulation parameters as described above. The average number of physical samples simulated from an EA for a hypothesis test (i.e., the product CN) was 56.

The following 10 hypothesis tests were applied to each of the 12 million random samples:

- Chen test at significance levels of 0.4, 0.3, 0.2, 0.1, 0.05, 0.025, and 0.01
- Original Land test of the null hypothesis H_0: $\mu \geq 2$ SSL at the 5 percent significance level
- Land test of the flipped null hypothesis H_0: $\mu \leq 0.5$ SSL at the 10 percent significance level
- Maximum test.

These simulations involved generation of approximately 650 million random numbers.

Simulation Results. A complete listing of the simulation results, with 150 columns and 59 lines per page, requires 180 pages and is available from EPA on a 3.5-inch diskette.

Representative results for gamma contamination data, with eight composite samples that each consist of six specimens, are shown in Table 32. The gamma contamination model is recommended for determining sample size requirements because it was consistently seen to be least favorable, in the sense that it required higher sample sizes to achieve DQOs than either of the lognormal or Weibull

models. Hence, sample sizes sufficient to protect against a gamma distribution of contaminant concentrations are also protective against a lognormal or Weibull distribution.

Table 32. Comparison of Error Rates for Max Test, Chen Test (at .20 and .10 Significance Levels), and Original Land Test, Using 8 Composites of 6 Samples Each, for Gamma Contamination Data

MU/SSL	MIX	Max test	0.20 Chen test	0.10 Chen test	Land test
C=6 N=8 CV=4					
0.5	.00	.35	.18	.09	.99
0.5	.50	.40	.22	.11	.99
0.5	.90	.40	.19	.09	.98
2.0	.00	.06	.10	.18	.00
2.0	.50	.06	.11	.18	.00
2.0	.90	.04	.16	.29	.01
C=6 N=8 CV=3					
0.5	.00	.24	.18	.10	.93
0.5	.50	.25	.19	.10	.94
0.5	.85	.23	.22	.11	.99
2.0	.00	.04	.03	.06	.00
2.0	.50	.03	.03	.05	.00
2.0	.85	.03	.06	.12	.00
C=6 N=8 CV=2					
0.5	.00	.07	.22	.11	.57
0.5	.50	.06	.19	.09	.68
0.5	.75	.04	.19	.10	.85
2.0	.00	.02	.00	.00	.01
2.0	.50	.02	.00	.01	.00
2.0	.75	.01	.00	.01	.00
C=6 N=8 CV=1					
0.5	.00	.00	.20	.10	.01
0.5	.49	.00	.20	.12	.12
2.0	.00	.01	.00	.00	.02
2.0	.49	.01	.00	.00	.00

MU = True EA Mean - see subsection entitled “Simulation Distributions” in Section 4.3.3.
MIX = Mixing Proportion - see subsection entitled “Simulation Distributions” in Section 4.3.3
C = Number of specimens in a composite.
N = Number of composites analyzed.
CV = EA coefficient of variation $\frac{(\sqrt{C})s}{\bar{x}}$

where s = sample standard deviation and $\bar{x}$ = mean sample concentration

Table 32 shows that the original Land method is unable to control the error rates at 0.5 SSL for gamma distributions. This limitation of the Land method was seen consistently throughout the results for all nonlognormal distributions tested. This limitation led to removal of the Land procedure from the Soil Screening Guidance.

Earlier simulation results for gamma and Weibull distributions did not censor results below the QL and used pure unmixed distributions. In these cases, as the sample size N increased, with all other factors fixed, the Land error rates at 0.5 SSL increased toward 1. Normally, the expectation is that as the sample size increases, information increases, and error rates decrease.

When using data from a Weibull or gamma distribution, the Land confidence interval endpoints converge to a value **that does not equal** the true site mean, μ_x , and results in an increase in error rates. This phenomenon is easily demonstrated, as follows. Let X denote the concentration random variable, let Y = ln(X) denote its logarithm. Let μ_y and σ_y denote the mean and standard deviation of logarithms of the soil concentrations. Then, as the sample size increases, the Land confidence interval endpoints (UL and LL) converge to

$$UL = LL = \exp\left(\mu_y + \frac{\sigma_y^2}{2}\right) \quad . \qquad \textbf{(67)}$$

If X is lognormally distributed, this expression is the mean of X. If X has a Weibull or gamma distribution, this expression is **not** the mean of X. This inconsistency accounts for the increase in error rates with sample size.

Table 32 also shows the fundamental difference between the Max test and the Chen test. For the Max test, the probability of error in deciding to walk away when the EA mean is 2.0 SSL is fairly stable, ranging from 0.01 to 0.06 across the different values of the CV. On the other hand, these error rates vary more across the CV values for the Chen test (e.g., from 0.00 to 0.29 for Chen test at the 0.10 significance level). This occurs because the Chen test is designed to control the other type of error rate (at 0.5 SSL). The Max test is presented in the 1995 Soil Screening Guidance (U.S. EPA, 1995c) because of its simplicity and the stability of its control over the error rate at 2 SSL.

Table 33 shows error rate estimates for four to nine composite samples that each consist of four, six, or eight specimens for EAs with CVs of 2, 2.5, 3, or 3.5, and assuming a gamma distribution. Table 33 should be adequate for most SSL planning purposes. However, more complete simulation results are reported in Appendix I.

Planning for CVs at least as large as 2 is recommended because it is known that CVs greater than 2 occur in practice (e.g., for two of seven EAs in the Piazza Road simulations reported in Section 4.3.6). One conclusion that can be drawn from Table 33 is that composite sample sizes of four are often inadequate. Further support for this conclusion is reported in the Piazza Road simulations discussed in Section 4.3.6.

Conclusions. The primary conclusions from the simulations are:

- For distributions other than lognormal, the Land procedure is prone to decide to investigate further at 0.5 SSL, when the correct decision is to walk away. It is therefore unsuitable for surface soil screening.

- Both the Max test and the Chen test perform acceptably under a variety of distributional assumptions and are potentially suitable for surface soil screening.

Table 33. Error Rates of Max Test and Chen Test at .2 (C20) and .1 (C10) Significance Level for CV = 2, 2.5, 3, 3.5

		CV = 2.0			CV = 2.5			CV = 3.0			CV = 3.5		
N	**MU/SSL**	**Max**	**C20**	**C10**	**Max**	**C20**	**C10**	**Max**	**C20**	**C10**	**Max**	**C20**	**C10**
C = 4													
4	0.5	.09	.20	.11	.14	.18	.09	.19	.18	.08	.24	.20	.10
4	2.0	.13	.08	.16	.19	.17	.28	.20	.21	.33	.26	.29	.42
5	0.5	.11	.21	.10	.15	.18	.09	.26	.20	.08	.26	.20	.09
5	2.0	.10	.05	.11	.10	.09	.18	.17	.19	.30	.18	.23	.36
6	0.5	.11	.21	.12	.21	.20	.10	.28	.21	.11	.31	.19	.09
6	2.0	.06	.03	.08	.08	.08	.14	.11	.13	.23	.11	.18	.28
7	0.5	.12	.20	.10	.25	.22	.11	.31	.20	.09	.36	.18	.10
7	2.0	.04	.03	.05	.05	.04	.09	.08	.11	.18	.08	.14	.23
8	0.5	.16	.19	.09	.25	.20	.09	.36	.20	.10	.42	.20	.09
8	2.0	.02	.02	.03	.04	.03	.07	.05	.08	.14	.07	.13	.21
9	0.5	.16	.21	.11	.28	.20	.09	.36	.18	.09	.44	.22	.12
9	2.0	.01	.01	.02	.03	.03	.06	.04	.07	.13	.07	.12	.20
C = 6													
4	0.5	.03	.20	.12	.08	.21	.12	.15	.20	.10	.16	.17	.08
4	2.0	.14	.03	.08	.16	.08	.17	.17	.14	.24	.20	.19	.33
5	0.5	.04	.20	.10	.11	.17	.09	.17	.20	.10	.22	.20	.10
5	2.0	.09	.02	.05	.09	.04	.10	.13	.10	.18	.15	.13	.24
6	0.5	.06	.20	.11	.14	.21	.10	.19	.20	.10	.25	.20	.10
6	2.0	.04	.01	.02	.06	.03	.07	.09	.07	.14	.09	.10	.19
7	0.5	.06	.20	.09	.12	.19	.10	.23	.22	.10	.29	.21	.10
7	2.0	.02	.00	.01	.05	.02	.04	.06	.06	.10	.08	.09	.14
8	0.5	.06	.19	.09	.15	.20	.10	.25	.19	.10	.30	.19	.10
8	2.0	.02	.00	.01	.02	.01	.03	.03	.03	.05	.04	.06	.11
9	0.5	.06	.20	.10	.18	.22	.11	.28	.20	.11	.34	.19	.09
9	2.0	.01	.00	.01	.02	.01	.02	.03	.02	.04	.03	.05	.09
C = 8													
4	0.5	.02	.21	.13	.06	.19	.10	.10	.21	.10	.14	.18	.08
4	2.0	.12	.02	.05	.15	.04	.09	.17	.09	.17	.19	.14	.25
5	0.5	.03	.22	.11	.05	.20	.11	.11	.20	.10	.17	.19	.09
5	2.0	.07	.01	.02	.09	.02	.06	.09	.04	.10	.12	.08	.17
6	0.5	.02	.18	.09	.08	.21	.11	.13	.19	.10	.20	.20	.10
6	2.0	.04	.00	.01	.06	.01	.02	.07	.04	.07	.08	.07	.13
7	0.5	.03	.20	.11	.09	.20	.11	.18	.21	.11	.22	.20	.11
7	2.0	.03	.00	.00	.04	.01	.01	.04	.02	.04	.05	.05	.09
8	0.5	.04	.20	.10	.11	.21	.11	.17	.21	.10	.26	.19	.10
8	2.0	.02	.00	.00	.02	.01	.01	.04	.01	.03	.03	.03	.06
9	0.5	.04	.21	.11	.11	.21	.10	.20	.19	.10	.30	.23	.12
9	2.0	.01	.00	.00	.02	.00	.01	.01	.00	.01	.02	.02	.04

MU = True EA Mean - see subsection entitled “Simulation Distributions” in Section 4.3.3.
MIX= Mixing Proportion - see subsection entitled “Simulation Distributions” in Section 4.3.3
C = Number of specimens in a composite.
N = Number of composites analyzed.
CV = EA coefficient of variation $\frac{(\sqrt{C})s}{\bar{x}}$

where s = sample standard deviation and $\bar{x}$ = mean sample concentration

4.3.4 Treatment of Observations Below the Limit of Quantitation. Test procedures that are based on estimating a mean contaminant level for an EA, such as the Land and Chen procedures, make use of each measured concentration value. For this reason, the use of all reported concentration measurements in such calculations should be considered regardless of their magnitude—that is, even if the measured levels fall below a quantitation level. One argument for this approach is that the QL is itself an estimate. Another is that some value will have to be substituted for any censored data point (i.e., a point reported as <QL), and the actual measured value is at least as accurate as a substituted value.

The peer review of the Draft Soil Screening Guidance raised the following issue:

> If such censored values do occur in a data set, what values should be used?

There is a substantial amount of literature on this subject and a variety of sophisticated approaches. In the context of SSLs, however, a simple approach is recommended. Consistent with general Superfund guidance, each observation reported as "<QL" shall be replaced with 0.5 QL for computation of the sample mean.

The evidence suggests that the ingestion SSL generally will be 2 orders of magnitude or more greater than the QL for most contaminants. In these cases, the results of soil screening will be insensitive to alternative procedures that could be used to substitute values for observations reported as "<QL." When the SSL is not much greater than the QL (e.g., SSL < 50 QL), the outcome of the soil screening could be affected by the procedure used to substitute for "<QL" values.

The most conservative approach would be to substitute the concentration represented by the QL itself for all observations reported as "<QL." In the context of the SSLs, however, the simple approach of using 0.5 QL is suggested. This will be sufficiently conservative given the conservative factors underlying the SSLs.

4.3.5 Multiple Hypothesis Testing Considerations. The Soil Screening Guidance addresses the following hypothesis testing problem for each EA:

> H_0: mean concentration of a given chemical ≥ 2 SSL

versus

> H_1: mean concentration of a given chemical < 2 SSL.

The default value for the probability of a Type I error is $\alpha = 0.05$, while the default value for the power of the test at 0.5 SSL is $1-\beta = 0.80$. The test is applied separately for each chemical, so that these probabilities apply for each individual chemical. Thus, there is an 80 percent probability of walking away from an EA (i.e., rejecting H_0) when only one chemical is being tested and its true mean level is 0.5 SSL and a 5 percent probability of walking away if its true mean level is 2 SSL.

However, the Soil Screening Guidance does not explicitly address the following issues:

> What is the composite probability of walking away from an EA if there are multiple contaminants?

and

> If such probabilities are unacceptable, how should one compensate when testing for multiple contaminants within a single EA?

The answer to the first question cannot be determined, in general, since the concentrations of the various contaminants will often be dependent on one another (e.g., this would be expected if they originated from the same source of contamination). The joint probability of walking away can be determined, however, if one makes the simplifying assumption that the contaminant concentrations for the different chemicals are independent (uncorrelated). In that case, the probability of walking away is simply the product of the individual rejection probabilities.

For two chemicals (Chemical A and Chemical B, say), this is:

Pr{walking away from EA} = Pr{reject H_0 for Chemical A} $\times$ Pr{reject H_0 for Chemical B}.

While these joint probabilities must be regarded as approximate, they nevertheless serve to illustrate the effect on the error rates when dealing with multiple contaminants.

Assume (for illustrative purposes only) that the probabilities for rejecting the null hypothesis (walking away from the EA) for each single chemical appear as follows:

True concentration	Probability of rejecting H_0
0.2 SSL	0.95
0.5 SSL	0.80 (default 1-ß)
0.7 SSL	0.60
1.0 SSL	0.50
1.5 SSL	0.20
2.0 SSL	0.05 (default α)

Let C(A) denote the concentration of Chemical A divided by the SSL, and let P(A) denote the corresponding probability of rejecting H_0. Define C(B) and P(B) similarly for Chemical B. Assuming independence, the joint probabilities of rejecting the null hypothesis (walking away) are as shown in Table 34.

Table 34. Probability of "Walking Away" from an EA When Comparing Two Chemicals to SSLs

Chemical A		Chemical B					
C(A)	P(A)	C(B) = 0.2 P(B) =.95	C(B) = 0.5 P(B) = .80	C(B) = 0.7 P(B) = .60	C(B) = 1.0 P(B) = .50	C(B) = 1.5 P(B) = .20	C(B) = 2.0 P(B) = .05
0.2	0.95	0.90	0.76	0.57	0.48	0.19	0.05
0.5	0.80	0.76	0.64	0.48	0.40	0.16	0.04
0.7	0.60	0.57	0.48	0.36	0.30	0.12	0.03
1.0	0.50	0.48	0.40	0.30	0.25	0.10	0.03
1.5	0.20	0.19	0.16	0.12	0.10	0.04	0.01
2.0	0.05	0.05	0.04	0.03	0.03	0.01	<0.01

These probabilities demonstrate that the test procedure will tend to be very conservative if multiple chemicals are involved—that is, **all** of the chemical concentrations must be quite low relative to their SSL in order to have a high probability of walking away from the EA. On the other hand, there will be a high probability that further investigation will be called for if the mean concentration for even a single chemical is twice the SSL.

A potential problem occurs when there are several chemicals under consideration and when all or most of them have levels slightly below the SSL (e.g., near 0.5 SSL). For instance, if each of six independent chemicals had levels at 0.5 SSL, the probability of rejecting the null hypothesis would be 80 percent for each such chemical, but the probability of walking away from the EA would be only $(0.80)^6 = 0.26$.

If the same samples are being analyzed for multiple chemicals, then the original choice for the number of such samples ideally should have been based on the worst case (i.e., the chemical expected to have the largest variability). In this case, the probability of correctly rejecting the null hypothesis at 0.5 SSL for the chemicals with less variability will be higher. The overall probability of walking away will be greater than shown above if all or some of the chemicals have less variability than assumed as the basis for determining sample sizes. Here, the sample size will be large enough for the probability of rejecting the null hypothesis at 0.5 SSL to be greater than 0.80 for these chemicals.

The probability values assumed above for deciding that no further investigation is necessary for individual chemicals, which are the basis for these conclusions, are equally applicable for the Land, Chen, and Max tests. They simply represent six hypothetical points of the power curves for these tests (from 0.2 SSL to 2.0 SSL). Therefore, the conclusions are equally applicable for each of the hypothesis testing procedures that have been considered in the current guidance for screening surface soils.

If the surface soil concentrations are positively correlated, as expected when dealing with multiple chemicals, then it is likely that either all the chemicals of concern have relatively high concentrations or they all have relatively low concentrations. In this case, the probability of making the correct decision for an EA would be greater than that suggested by the above calculations that assume independence of the various chemicals.

However, the potential problem of several chemicals having concentrations near 0.5 SSL is not precluded by assuming positive correlations. In fact, it suggests that if the EA average for one chemical is near 0.5 SSL, then the average for others is also likely to be near 0.5 SSL, which is exactly the situation where the probability of **not** walking away from the EA can become large because there is a high probability that H_0 will be rejected for at least one of these chemicals.

An alternative would be to use multiple hypothesis testing procedures to control the overall error rate for the set of chemicals (i.e., the set of hypothesis tests) rather than the separate error rates for the individual chemicals. Guidance for performing multiple hypothesis tests is beyond the scope of the current document. Obtain the advice of a statistician familiar with multiple hypothesis testing procedures if the overall error rates for multiple chemicals is of concern for a particular site. The classical statistical guidance regarding this subject is *Simultaneous Statistical Inference* (Miller, 1991).

4.3.6 Investigation of Compositing Within EA Sectors. If one decides that an EA needs further investigation, then it is natural to inquire which portion(s) of the EA exceed the screening level. This is a different question than simply asking whether or not the EA average soil concentration exceeds the SSL. Conceivably, this question may require additional sampling, chemical

analysis, and statistical analysis. A natural question is whether this additional effort can be avoided by forming composites within sectors (subareas) of the EA. The sector with the highest estimated concentration would then be a natural place to begin a detailed investigation.

The simulations to investigate the performance of rules to decide whether further investigation is required, reported in Section 4.3.3, make specific assumptions about the sampling design. It is assumed that N composite samples are chemically analyzed, each consisting of C specimens selected to be statistically representative of the entire EA. The key point, in addition to random sampling, is that composites must be formed **across** sectors rather than **within** sectors. This assumption is necessary to achieve composite samples that are representative of the EA mean (i.e., have the EA mean as their expected value).

If compositing is limited to sectors, such as quadrants, then each composite represents its sector, rather than the entire EA. The simulations reported in Section 4.3.3, and sample sizes based on them, do not apply to this type of compositing. This does not necessarily preclude compositing within sectors for both purposes, i.e., to test the hypothesis about the EA mean and also to indicate the most contaminated sector. However, little is known about the statistical properties of this approach when applying the Max test, which would depend on specifics of the actual spatial distribution of contaminants for a given EA. Because of the lack of extensive spatial data sets for contaminated soil, there is limited basis for determining what sample sizes would be adequate for achieving desired DQOs for various sites. However, one spatial data set was available and used to investigate the performance of compositing within sectors at one site.

Piazza Road Simulations. Data from the Piazza Road NPL site were used to investigate the properties of tests of the EA mean based on compositing within sectors, as compared to compositing between sectors. The investigation of a single site cannot be used to validate a given procedure, but it may indicate whether further investigation of the procedure is worthwhile.

Seven nonoverlapping 0.4-acre EAs were defined within the Piazza Road site. Each EA is an 8-by-12 grid composed of 14'x14' squares. The data consist of a single dioxin measurement of a composite sample from each small square. These measurements are regarded as true values for the simulations reported in this section. Measurement error was incorporated in the same fashion as for the simulations reported in Section 4.3.3.

Each of the seven EAs was subdivided into four 4-by-6 sectors, six 4-by-4 sectors, eight 4-by-3 sectors, twelve 2-by-4 sectors, and sixteen 2-by-3 sectors. Results are presented here for the cases of four, six, and eight sectors because composites of more than eight specimens are expected to be used rarely, if at all.

Table 35 presents the "true" mean and CV for each EA, computed from all 96 measurements within the 0.4-acre EA. The CVs range from 1.0 to 2.2. Note that two of the seven CVs equal or exceed 2 at this site. This supports EPA's belief that at many sites it is prudent, when planning sample size requirements for screening, to assume a CV of at least 2.5 and to consider the possibility of CVs as large as 3 or 3.5.

As data on variability within EAs for different sites and contaminant conditions accrue over time, it will be possible to base the choice of procedures on a larger, more comprehensive database, rather than just a single site.

Appendix J contains results of simulations from the seven Piazza Road EAs. Sampling with

replacement from each sector was used, because this was felt to be more consistent with the planned compositing. To estimate the error rates at 0.5 SSL and 2 SSL for each EA, the SSL was defined so that the site mean first was regarded as 0.5 SSL and then was regarded as 2 SSL.

Notation for Results from Piazza Road Simulations. The following notation is used in Appendix J. The design variable (DES) indicates whether compositing was within sector (DES=W) or across sectors (DES=X). As in Section 4.3.3, C denotes the number of specimens per composite, and N denotes the number of composite samples chemically analyzed. Results in Appendix J are for the Chen test at the 10 percent significance level and for the Max test. The true mean and CV are shown in the header for each EA.

Table 35. Means and CVs for Dioxin Concentrations for 7 Piazza Road Exposure Areas

EA	Mean of EA	CV of EA	N
1	2.1	1.0	96
2	2.4	1.6	96
3	5.1	1.1	96
4	4.0	1.2	96
5	9.3	2.0	96
6	15.8	2.2	96
7	2.8	1.4	96

Results and Conclusions from Piazza Road Simulations. Although the results from a single site cannot be assumed to apply to all sites, the following observations can be made based on the Piazza Road simulations reported in Appendix J.

- The error rate at 0.5 SSL for the Chen test, using compositing across sectors (DES=X), is generally close to the nominal rate of 0.10. For compositing within sectors (DES=W), the error rate for Chen at 0.5 SSL is generally much lower than the nominal rate.

- Except for plans involving only four analyses (N = 4), the error rate at 2 SSL is always below 0.05 for the Chen test. For the Max test, the error rate at 2 SSL fluctuated between 0 and 16 percent. The error rate at 2 SSL is smaller for the Chen test at the 10 percent significance level than for the Max test in virtually all cases. The only two exceptions to this are for compositing within sector (DES=W) in EA No. 6.

- This observation provides further support for the conclusion drawn from the simulations reported in Section 4.3.3: plans involving only four analyses can result in high error rates in determining the mean contaminant concentration of an EA with the Max test. In most cases the error rates of concern to EPA (at 2 SSL) are 0.10 or larger.

- In general, error rates estimated from Piazza Road simulations for compositing across sectors are at least as small as would be predicted on the basis of the simulation results reported in Section 4.3.3.

- The simulation results show that compositing within sectors using the Max test may be an option for site managers who want to know whether one sector of an EA is more contaminated than the other. However, use of the Max test when compositing within sectors may lead the site manager to draw conclusions about the mean contaminant concentration in that sector only, not across the entire EA.

Part 5: CHEMICAL-SPECIFIC PARAMETERS

Chemical-specific parameters required for calculating soil screening levels include the organic carbon normalized soil-water partition coefficient for organic compounds (K_{oc}), the soil-water partition coefficient for inorganic constituents (K_d), water solubility (S), Henry's law constant (HLC, H′), air diffusivity ($D_{i,a}$), and water diffusivity ($D_{i,w}$). In addition, the octanol-water partition coefficient (K_{ow}) is needed to calculate K_{oc} values. This part of the background document describes the collection and compilation of these parameters for the SSL chemicals.

With the exception of values for air diffusivity ($D_{i,a}$), water diffusivity ($D_{i,w}$), and certain K_{oc} values, all of the values used in the development of SSLs can be found in the Superfund Chemical Data Matrix (SCDM). SCDM is a computer code that includes more than 25 datafiles containing specific chemical parameters used to calculate factor and benchmark values for the Hazard Ranking System (HRS). Because SCDM datafiles are regularly updated, the user should consult the most recent version of SCDM to ensure that the values are up to date.

5.1 Solubility, Henry's Law Constant, and K_{ow}

Chemical-specific values for solubility, Henry's law constant (HLC), and K_{ow} were obtained from SCDM. In the selection of the value for SCDM, measured or analytical values are favored over calculated values. However, in the event that a measured value is not available, calculated values are used. Table 36 presents the solubility, Henry's law constant, and K_{ow} values taken from SCDM and used to calculate SSLs.

Henry's law constant values were available for all but two of the constituents of interest. Henry's law constants could not be obtained from the SCDM datafiles for either carbazole or mercury. As a consequence, this parameter was calculated according to the following equation:

$$HLC = (VP)(M)/(S) \quad \textbf{(68)}$$

where

HLC = Henry's law constant (atm-m^3/mol)
VP = vapor pressure (atm)
M = molecular weight (g/mol)
S = solubility (mg/L or g/m^3).

The SSL equations require the dimensionless form of Henry's law constant, or H', which is calculated from HLC (atm-m^3/mol) by multiplying by 41 (U.S. EPA, 1991b). The values taken from SCDM for HLC and the calculated dimensionless values for H' are both presented in Table 36.

5.2 Air ($D_{i,a}$) and Water ($D_{i,w}$) Diffusivities

Few published diffusivities were available for the subject chemicals for air ($D_{i,a}$) and water ($D_{i,w}$). Water and air diffusivities were obtained from the CHEMDAT8 model chemical properties database (DATATWO.WK1). For chemicals not in CHEMDAT8, diffusivities were estimated using the

WATER8 model correlations for air and water diffusivities. Both CHEMDAT8 and WATER8 can be obtained from EPA's SCRAM bulletin board system, as described in Section 3.1.2. Table 37 presents the values used to calculate SSLs.

Table 36. Chemical-Specific Properties Used in SSL Calculations

CAS No.	Compound	S (mg/L)	HLC (atm-m³/mol)	H′ (dimensionless)	log K_{ow}
83-32-9	Acenaphthene	4.24E+00	1.55E-04	6.36E-03	3.92
67-64-1	Acetone	1.00E+06	3.88E-05	1.59E-03	-0.24
309-00-2	Aldrin	1.80E-01	1.70E-04	6.97E-03	6.50
120-12-7	Anthracene	4.34E-02	6.50E-05	2.67E-03	4.55
56-55-3	Benz(*a*)anthracene	9.40E-03	3.35E-06	1.37E-04	5.70
71-43-2	Benzene	1.75E+03	5.55E-03	2.28E-01	2.13
205-99-2	Benzo(*b*)fluoranthene	1.50E-03	1.11E-04	4.55E-03	6.20
207-08-9	Benzo(*k*)fluoranthene	8.00E-04	8.29E-07	3.40E-05	6.20
65-85-0	Benzoic acid	3.50E+03	1.54E-06	6.31E-05	1.86
50-32-8	Benzo(*a*)pyrene	1.62E-03	1.13E-06	4.63E-05	6.11
111-44-4	Bis(2-chloroethyl)ether	1.72E+04	1.80E-05	7.38E-04	1.21
117-81-7	Bis(2-ethylhexyl)phthalate	3.40E-01	1.02E-07	4.18E-06	7.30
75-27-4	Bromodichloromethane	6.74E+03	1.60E-03	6.56E-02	2.10
75-25-2	Bromoform	3.10E+03	5.35E-04	2.19E-02	2.35
71-36-3	Butanol	7.40E+04	8.81E-06	3.61E-04	0.85
85-68-7	Butyl benzyl phthalate	2.69E+00	1.26E-06	5.17E-05	4.84
86-74-8	Carbazole	7.48E+00	1.53E-08 [a]	6.26E-07	3.59
75-15-0	Carbon disulfide	1.19E+03	3.03E-02	1.24E+00	2.00
56-23-5	Carbon tetrachloride	7.93E+02	3.04E-02	1.25E+00	2.73
57-74-9	Chlordane	5.60E-02	4.86E-05	1.99E-03	6.32
106-47-8	*p*-Chloroaniline	5.30E+03	3.31E-07	1.36E-05	1.85
108-90-7	Chlorobenzene	4.72E+02	3.70E-03	1.52E-01	2.86
124-48-1	Chlorodibromomethane	2.60E+03	7.83E-04	3.21E-02	2.17
67-66-3	Chloroform	7.92E+03	3.67E-03	1.50E-01	1.92
95-57-8	2-Chlorophenol	2.20E+04	3.91E-04	1.60E-02	2.15
218-01-9	Chrysene	1.60E-03	9.46E-05	3.88E-03	5.70
72-54-8	DDD	9.00E-02	4.00E-06	1.64E-04	6.10
72-55-9	DDE	1.20E-01	2.10E-05	8.61E-04	6.76
50-29-3	DDT	2.50E-02	8.10E-06	3.32E-04	6.53
53-70-3	Dibenz(*a,h*)anthracene	2.49E-03	1.47E-08	6.03E-07	6.69
84-74-2	Di-*n*-butyl phthalate	1.12E+01	9.38E-10	3.85E-08	4.61
95-50-1	1,2-Dichlorobenzene	1.56E+02	1.90E-03	7.79E-02	3.43
106-46-7	1,4-Dichlorobenzene	7.38E+01	2.43E-03	9.96E-02	3.42
91-94-1	3,3-Dichlorobenzidine	3.11E+00	4.00E-09	1.64E-07	3.51
75-34-3	1,1-Dichloroethane	5.06E+03	5.62E-03	2.30E-01	1.79

Table 36 (continued)

CAS No.	Compound	S (mg/L)	HLC (atm-m³/mol)	H′ (dimensionless)	log K_{ow}
107-06-2	1,2-Dichloroethane	8.52E+03	9.79E-04	4.01E-02	1.47
75-35-4	1,1-Dichloroethylene	2.25E+03	2.61E-02	1.07E+00	2.13
156-59-2	*cis*-1,2-Dichloroethylene	3.50E+03	4.08E-03	1.67E-01	1.86
156-60-5	*trans*-1,2-Dichloroethylene	6.30E+03	9.38E-03	3.85E-01	2.07
120-83-2	2,4-Dichlorophenol	4.50E+03	3.16E-06	1.30E-04	3.08
78-87-5	1,2-Dichloropropane	2.80E+03	2.80E-03	1.15E-01	1.97
542-75-6	1,3-Dichloropropene	2.80E+03	1.77E-02	7.26E-01	2.00
60-57-1	Dieldrin	1.95E-01	1.51E-05	6.19E-04	5.37
84-66-2	Diethylphthalate	1.08E+03	4.50E-07	1.85E-05	2.50
105-67-9	2,4-Dimethylphenol	7.87E+03	2.00E-06	8.20E-05	2.36
51-28-5	2,4-Dinitrophenol	2.79E+03	4.43E-07	1.82E-05	1.55
121-14-2	2,4-Dinitrotoluene	2.70E+02	9.26E-08	3.80E-06	2.01
606-20-2	2,6-Dinitrotoluene	1.82E+02	7.47E-07	3.06E-05	1.87
117-84-0	Di-*n*-octyl phthalate	2.00E-02	6.68E-05	2.74E-03	8.06
115-29-7	Endosulfan	5.10E-01	1.12E-05	4.59E-04	4.10
72-20-8	Endrin	2.50E-01	7.52E-06	3.08E-04	5.06
100-41-4	Ethylbenzene	1.69E+02	7.88E-03	3.23E-01	3.14
206-44-0	Fluoranthene	2.06E-01	1.61E-05	6.60E-04	5.12
86-73-7	Fluorene	1.98E+00	6.36E-05	2.61E-03	4.21
76-44-8	Heptachlor	1.80E-01	1.09E-03	4.47E-02	6.26
1024-57-3	Heptachlor epoxide	2.00E-01	9.50E-06	3.90E-04	5.00
118-74-1	Hexachlorobenzene	6.20E+00	1.32E-03	5.41E-02	5.89
87-68-3	Hexachloro-1,3-butadiene	3.23E+00	8.15E-03	3.34E-01	4.81
319-84-6	α-HCH (α-BHC)	2.00E+00	1.06E-05	4.35E-04	3.80
319-85-7	β-HCH (β-BHC)	2.40E-01	7.43E-07	3.05E-05	3.81
58-89-9	γ-HCH (Lindane)	6.80E+00	1.40E-05	5.74E-04	3.73
77-47-4	Hexachlorocyclopentadiene	1.80E+00	2.70E-02	1.11E+00	5.39
67-72-1	Hexachloroethane	5.00E+01	3.89E-03	1.59E-01	4.00
193-39-5	Indeno(1,2,3-*cd*)pyrene	2.20E-05	1.60E-06	6.56E-05	6.65
78-59-1	Isophorone	1.20E+04	6.64E-06	2.72E-04	1.70
7439-97-6	Mercury	---	1.14E-02 [b]	4.67E-01	---
72-43-5	Methoxychlor	4.50E-02	1.58E-05	6.48E-04	5.08
74-83-9	Methyl bromide	1.52E+04	6.24E-03	2.56E-01	1.19
75-09-2	Methylene chloride	1.30E+04	2.19E-03	8.98E-02	1.25
95-48-7	2-Methylphenol	2.60E+04	1.20E-06	4.92E-05	1.99
91-20-3	Naphthalene	3.10E+01	4.83E-04	1.98E-02	3.36
98-95-3	Nitrobenzene	2.09E+03	2.40E-05	9.84E-04	1.84
86-30-6	*N*-Nitrosodiphenylamine	3.51E+01	5.00E-06	2.05E-04	3.16
621-64-7	*N*-Nitrosodi-*n*-propylamine	9.89E+03	2.25E-06	9.23E-05	1.40

Table 36 (continued)

CAS No.	Compound	S (mg/L)	HLC (atm-m³/mol)	H′ (dimensionless)	log K_{ow}
87-86-5	Pentachlorophenol	1.95E+03	2.44E-08	1.00E-06	5.09
108-95-2	Phenol	8.28E+04	3.97E-07	1.63E-05	1.48
129-00-0	Pyrene	1.35E-01	1.10E-05	4.51E-04	5.11
100-42-5	Styrene	3.10E+02	2.75E-03	1.13E-01	2.94
79-34-5	1,1,2,2-Tetrachloroethane	2.97E+03	3.45E-04	1.41E-02	2.39
127-18-4	Tetrachloroethylene	2.00E+02	1.84E-02	7.54E-01	2.67
108-88-3	Toluene	5.26E+02	6.64E-03	2.72E-01	2.75
8001-35-2	Toxaphene	7.40E-01	6.00E-06	2.46E-04	5.50
120-82-1	1,2,4-Trichlorobenzene	3.00E+02	1.42E-03	5.82E-02	4.01
71-55-6	1,1,1-Trichloroethane	1.33E+03	1.72E-02	7.05E-01	2.48
79-00-5	1,1,2-Trichloroethane	4.42E+03	9.13E-04	3.74E-02	2.05
79-01-6	Trichloroethylene	1.10E+03	1.03E-02	4.22E-01	2.71
95-95-4	2,4,5-Trichlorophenol	1.20E+03	4.33E-06	1.78E-04	3.90
88-06-2	2,4,6-Trichlorophenol	8.00E+02	7.79E-06	3.19E-04	3.70
108-05-4	Vinyl acetate	2.00E+04	5.11E-04	2.10E-02	0.73
75-01-4	Vinyl chloride	2.76E+03	2.70E-02	1.11E+00	1.50
108-38-3	*m*-Xylene	1.61E+02	7.34E-03	3.01E-01	3.20
95-47-6	*o*-Xylene	1.78E+02	5.19E-03	2.13E-01	3.13
106-42-3	*p*-Xylene	1.85E+02	7.66E-03	3.14E-01	3.17

CAS = Chemical Abstracts Service.
S = Solubility in water (20-25 ˚C).
HLC = Henry's law constant.
H′ = Dimensionless Henry's law constant (HLC [atm-m³/mol] * 41) (25 ˚C).
K_{ow} = Octanol/water partition coefficient.

[a] HLC was calculated using the equation: HLC = vapor pressure * molecular wt. / solubility. Vapor pressure is 6.83E-10 atm and molecular weight is 167.21 g/mol for carbazole.

[b] Value from WATER8 model database.

Table 37. Air Diffusivity ($D_{i,a}$) and Water Diffusivity ($D_{i,w}$) Values for SSL Chemicals (25°C)[a]

CAS No.	Compound	$D_{i,a}$ (cm^2/s)	$D_{i,w}$ (cm^2/s)
83-32-9	Acenaphthene	4.21E-02	7.69E-06
67-64-1	Acetone	1.24E-01	1.14E-05
309-00-2	Aldrin	1.32E-02	4.86E-06
120-12-7	Anthracene	3.24E-02	7.74E-06
56-55-3	Benz(*a*)anthracene	5.10E-02	9.00E-06
71-43-2	Benzene	8.80E-02	9.80E-06
205-99-2	Benzo(*b*)fluoranthene	2.26E-02	5.56E-06
207-08-9	Benzo(*k*)fluoranthene	2.26E-02	5.56E-06
65-85-0	Benzoic acid	5.36E-02	7.97E-06
50-32-8	Benzo(*a*)pyrene	4.30E-02	9.00E-06
111-44-4	Bis(2-chloroethyl)ether	6.92E-02	7.53E-06
117-81-7	Bis(2-ethylhexyl)phthalate	3.51E-02	3.66E-06
75-27-4	Bromodichloromethane	2.98E-02	1.06E-05
75-25-2	Bromoform	1.49E-02	1.03E-05
71-36-3	Butanol	8.00E-02	9.30E-06
85-68-7	Butyl benzyl phthalate	1.74E-02 [b]	4.83E-06 [b]
86-74-8	Carbazole	3.90E-02 [b]	7.03E-06 [b]
75-15-0	Carbon disulfide	1.04E-01	1.00E-05
56-23-5	Carbon tetrachloride	7.80E-02	8.80E-06
57-74-9	Chlordane	1.18E-02	4.37E-06
106-47-8	*p*-Chloroaniline	4.83E-02	1.01E-05
108-90-7	Chlorobenzene	7.30E-02	8.70E-06
124-48-1	Chlorodibromomethane	1.96E-02	1.05E-05
67-66-3	Chloroform	1.04E-01	1.00E-05
95-57-8	2-Chlorophenol	5.01E-02	9.46E-06
218-01-9	Chrysene	2.48E-02	6.21E-06
72-54-8	DDD	1.69E-02 [b]	4.76E-06 [b]
72-55-9	DDE	1.44E-02	5.87E-06
50-29-3	DDT	1.37E-02	4.95E-06
53-70-3	Dibenz(*a,h*)anthracene	2.02E-02 [b]	5.18E-06 [b]
84-74-2	Di-*n*-butyl phthalate	4.38E-02	7.86E-06
95-50-1	1,2-Dichlorobenzene	6.90E-02	7.90E-06
106-46-7	1,4-Dichlorobenzene	6.90E-02	7.90E-06
91-94-1	3,3-Dichlorobenzidine	1.94E-02	6.74E-06
75-34-3	1,1-Dichloroethane	7.42E-02	1.05E-05
107-06-2	1,2-Dichloroethane	1.04E-01	9.90E-06
75-35-4	1,1-Dichloroethylene	9.00E-02	1.04E-05
156-59-2	*cis*-1,2-Dichloroethylene	7.36E-02	1.13E-05
156-60-5	*trans*-1,2-Dichloroethylene	7.07E-02	1.19E-05
120-83-2	2,4-Dichlorophenol	3.46E-02	8.77E-06

Table 37 (continued)

CAS No.	Compound	$D_{i,a}$ (cm^2/s)	$D_{i,w}$ (cm^2/s)
78-87-5	1,2-Dichloropropane	7.82E-02	8.73E-06
542-75-6	1,3-Dichloropropene	6.26E-02	1.00E-05
60-57-1	Dieldrin	1.25E-02	4.74E-06
84-66-2	Diethylphthalate	2.56E-02 [b]	6.35E-06 [b]
105-67-9	2,4-Dimethylphenol	5.84E-02	8.69E-06
51-28-5	2,4-Dinitrophenol	2.73E-02	9.06E-06
121-14-2	2,4-Dinitrotoluene	2.03E-01	7.06E-06
606-20-2	2,6-Dinitrotoluene	3.27E-02	7.26E-06
117-84-0	Di-*n*-octyl phthalate	1.51E-02	3.58E-06
115-29-7	Endosulfan	1.15E-02	4.55E-06
72-20-8	Endrin	1.25E-02	4.74E-06
100-41-4	Ethylbenzene	7.50E-02	7.80E-06
206-44-0	Fluoranthene	3.02E-02	6.35E-06
86-73-7	Fluorene	3.63E-02 [b]	7.88E-06 [b]
76-44-8	Heptachlor	1.12E-02	5.69E-06
1024-57-3	Heptachlor epoxide	1.32E-02 [b]	4.23E-06 [b]
118-74-1	Hexachlorobenzene	5.42E-02	5.91E-06
87-68-3	Hexachloro-1,3-butadiene	5.61E-02	6.16E-06
319-84-6	α-HCH (α-BHC)	1.42E-02	7.34E-06
319-85-7	β-HCH (β-BHC)	1.42E-02	7.34E-06
58-89-9	γ-HCH (Lindane)	1.42E-02	7.34E-06
77-47-4	Hexachlorocyclopentadiene	1.61E-02	7.21E-06
67-72-1	Hexachloroethane	2.50E-03	6.80E-06
193-39-5	Indeno(1,2,3-*cd*)pyrene	1.90E-02	5.66E-06
78-59-1	Isophorone	6.23E-02	6.76E-06
7439-97-6	Mercury	3.07E-02 [b]	6.30E-06 [b]
72-43-5	Methoxychlor	1.56E-02	4.46E-06
74-83-9	Methyl bromide	7.28E-02	1.21E-05
75-09-2	Methylene chloride	1.01E-01	1.17E-05
95-48-7	2-Methylphenol	7.40E-02	8.30E-06
91-20-3	Naphthalene	5.90E-02	7.50E-06
98-95-3	Nitrobenzene	7.60E-02	8.60E-06
86-30-6	*N*-Nitrosodiphenylamine	3.12E-02 [b]	6.35E-06 [b]
621-64-7	*N*-Nitrosodi-*n*-propylamine	5.45E-02 [b]	8.17E-06 [b]
87-86-5	Pentachlorophenol	5.60E-02	6.10E-06
108-95-2	Phenol	8.20E-02	9.10E-06
129-00-0	Pyrene	2.72E-02 [b]	7.24E-06 [b]
100-42-5	Styrene	7.10E-02	8.00E-06
79-34-5	1,1,2,2-Tetrachloroethane	7.10E-02	7.90E-06
127-18-4	Tetrachloroethylene	7.20E-02	8.20E-06

Table 37 (continued)

CAS No.	Compound	$D_{i,a}$ (cm^2/s)	$D_{i,w}$ (cm^2/s)
108-88-3	Toluene	8.70E-02	8.60E-06
8001-35-2	Toxaphene	1.16E-02	4.34E-06
120-82-1	1,2,4-Trichlorobenzene	3.00E-02	8.23E-06
71-55-6	1,1,1-Trichloroethane	7.80E-02	8.80E-06
79-00-5	1,1,2-Trichloroethane	7.80E-02	8.80E-06
79-01-6	Trichloroethylene	7.90E-02	9.10E-06
95-95-4	2,4,5-Trichlorophenol	2.91E-02	7.03E-06
88-06-2	2,4,6-Trichlorophenol	3.18E-02	6.25E-06
108-05-4	Vinyl acetate	8.50E-02	9.20E-06
75-01-4	Vinyl chloride	1.06E-01	1.23E-06
108-38-3	*m*-Xylene	7.00E-02	7.80E-06
95-47-6	*o*-Xylene	8.70E-02	1.00E-05
106-42-3	*p*-Xylene	7.69E-02	8.44E-06

CAS = Chemical Abstracts Service.
[a] Value from CHEMDAT8 model database unless indicated otherwise.
[b] Estimated using correlations in WATER8 model.

5.3 Soil Organic Carbon/Water Partition Coefficients (K_{oc})

Application of SSLs for the inhalation and migration to ground water pathways requires K_{oc} values for each organic chemical of concern. K_{oc} values are also needed for site-specific exposure modeling efforts. An initial review of the literature uncovered significant variability in this parameter, with reported measured values for a compound sometimes varying over several orders of magnitude. This variability can be attributed to several factors, including actual variability due to differences in soil or sediment properties, differences in experimental and analytical approaches used to measure the values, and experimental or measurement error. To resolve this difficulty, an extensive literature review was conducted to uncover all available measured values and to identify approaches and information that might be useful in developing valid K_{oc} values.

The soil-water partitioning behavior of nonionizing and ionizing organic compounds differs because the partitioning of ionizing organics can be significantly influenced by soil pH. For this reason, different approaches were required to estimate K_{oc} values for nonionizing and ionizing organic compounds.

5.3.1 K_{oc} for Nonionizing Organic Compounds. As noted earlier, there is significant variability in reported K_{oc} values and an extensive literature search was conducted to collect all available measured K_{oc} values for the nonionizing hydrophobic organic compounds of interest.

In the literature search, misquotation error was minimized by obtaining the original references whenever possible. Values from compilations and secondary references were used only when the original references could not be obtained. Redundancy of values was avoided, although in rare

instances it was not possible to determine if compilations included such values, especially when data were reported as "selected" values.

In certain references, soil-water partition coefficients (e.g., K_d or K_p) were reported along with the organic carbon content of the soil. In these cases, K_{oc} was computed by dividing K_d by the fractional soil organic carbon content (f_{oc}, g/g). If the partition coefficient was normalized to soil organic matter (i.e., K_{om}), it was converted to K_{oc} as follows (Dragun, 1988):

$$K_{oc} = 1.724\ K_{om} \qquad \textbf{(69)}$$

where

1.724 = conversion factor from organic matter to organic carbon ($f_{om} = 1.724\ f_{oc}$)
K_{om} = partition coefficient normalized to organic matter (L/kg)
f_{om} = fraction organic matter (g/g).

Once collected, K_{oc} values were reviewed. It was not possible to systematically evaluate each source for accuracy or consistency or to analyze sources of variability between references because of wide variations in soil and sediment properties, experimental and analytical methods, and the manner in which these were reported in each reference. This, and the limited number of K_{oc} values for many compounds, prevented any meaningful statistical analysis to eliminate outliers.

Collected values were qualitatively reviewed, however, and some values were excluded. Values measured for low-carbon-content sorbents (i.e., $f_{oc} \leq 0.001$) are generally beyond the range of the linear relationship between soil organic carbon and K_d and were rejected in most cases. Some references produced consistently high or low values and, as a result, were eliminated. Values were also eliminated if they fell outside the range of other measured values. The final values used are presented in Appendix K along with their reference sources.

Summary statistics for the measured K_{oc} values are presented in Table 38. The geometric mean of the K_{oc} for each nonionizing organic compound is used as the the central tendency K_{oc} value because it is a more suitable estimate of the central tendency of a distribution of environmental values with wide variability.

The data contained in Table 38 are summarized in Table 39 for each of the nonionizing organic compounds for which measured K_{oc} values were available. As shown, measured values are available for only a subset of the SSL compounds. As a consequence, an alternative methodology was applied to determine K_{oc} values for the entire set of nonionizing hydrophobic organic compounds of interest.

It has long been noted that a strong linear relationship exists between K_{oc} and K_{ow} (octanol/water partition coefficient) (Lyman et al., 1982) and that this relationship can be used to predict K_{oc} in the absence of measured data. One such relationship was reported by Di Toro (1985). This relationship was selected for use in calculating K_{oc} values for most semivolatile nonionizing organic compounds (Group 1 in Table 39) because it considers particle interaction and was shown to be in conformity with observations for a large set of adsorption-desorption data (Di Toro, 1985). Di Toro's equation is as follows:

$$\log K_{oc} = 0.00028 + (0.983 \times \log K_{ow}) \qquad \textbf{(70)}$$

For volatile organic compounds (VOCs), Equation 70 consistently overpredicted K_{oc} values when compared to measured data. For this reason, a separate regression equation was developed using log K_{ow} and measured log K_{oc} values for VOCs, chlorinated benzenes, and certain chlorinated pesticides:

$$\log K_{oc} = 0.0784 + (0.7919 \times \log K_{ow}) \quad \textbf{(71)}$$

Equation 71 was developed from a linear regression calculated at the 95 percent confidence level. The correlation coefficient (r) was 0.99 with an r^2 of 0.97. The compounds and data used to develop this equation are provided in Appendix K. Equation 71 was used to calculate K_{oc} values for VOCs, chlorobenzenes, and certain chlorinated pesticides (i.e., Group 2 in Table 39). Log K_{oc} values calculated using Equations 70 and 71 were rounded to two decimal places, and the resulting K_{oc} values were rounded to two decimal places in scientific notation (i.e, as they appear in Table 39) prior to calculating SSLs.

Table 38. Summary Statistics for Measured K_{oc} Values: Nonionizing Organics[a]

	K_{oc} (L/kg)				
Compound	**Geometric Mean**	**Average**	**Minimum**	**Maximum**	**Sample Size**
Acenaphthene	4,898	5,028	3,890	6,166	2
Aldrin	48,685	48,686	48,394	48,978	2
Anthracene	23,493	24,362	14,500	33,884	9
Benz(*a*)anthracene	357,537	459,882	150,000	840,000	4
Benzene	62	66	31	100	13
Benzo(*a*)pyrene	968,774	1,166,733	478,947	2,130,000	3
Bis(2-chloroethyl)ether	76	76	76	76	1
Bis(2-ethylhexyl)phthalate	111,123	114,337	87,420	141,254	2
Bromoform	126	126	126	126	1
Butyl benzyl phthalate	13,746	14,055	11,128	16,981	2
Carbon tetrachloride	152	158	123	224	3
Chlordane	51,310	51,798	44,711	58,884	2
Chlorobenzene	224	260	83	500	9
Chloroform	53	57	28	81	5
DDD	45,800	45,800	45,800	45,800	1
DDE	86,405	86,405	86,405	86,405	1
DDT	677,934	792,158	285,467	1,741,516	6
Dibenz(a,h)anthracene	1,789,101	2,029,435	565,014	3,059,425	14
1,2-Dichlorobenzene (*o*)	379	390	267	529	9
1,4-Dichlorobenzene (*p*)	616	687	273	1,375	16
1,1-Dichloroethane	53	54	46	62	2
1,2-Dichloroethane	38	44	22	76	3
1,1-Dichloroethylene	65	65	65	65	1

Table 38 (continued)

Compound	K_{oc} (L/kg) Geometric Mean	Average	Minimum	Maximum	Sample Size
trans-1,2-Dichloroethylene	38	38	38	38	1
1,2-Dichloropropane	47	47	47	47	1
1,3-Dichloropropene	27	27	24	32	3
Dieldrin	25,546	25,604	23,308	27,399	3
Diethylphthalate	82	84	69	98	2
Di-*n*-butylphthalate	1,567	1,580	1,384	1,775	2
Endosulfan	2,040	2,040	2,040	2,040	1
Endrin	10,811	11,422	7,724	15,885	4
Ethylbenzene	204	207	165	255	5
Fluoranthene	49,096	49,433	41,687	54,954	3
Fluorene	7,707	8,906	3,989	16,218	6
Heptachlor	9,528	10,070	6,810	13,330	2
Hexachlorobenzene	80,000	80,000	80,000	80,000	1
α-HCH (α-BHC)	1,762	1,835	1,022	2,891	12
β-HCH (β-BHC)	2,139	2,241	1,156	3,563	14
γ-HCH (Lindane)	1,352	1,477	731	3,249	65
Methoxychlor	80,000	80,000	80,000	80,000	1
Methyl bromide	9	9	9	9	1
Methyl chloride	6	6	6	6	1
Methylene chloride	10	10	10	10	1
Naphthalene	1,191	1,231	830	1,950	20
Nitrobenzene	119	141	31	270	10
Pentachlorobenzene	32,148	36,114	11,381	55,176	5
Pyrene	67,992	70,808	43,807	133,590	27
Styrene	912	912	912	912	1
1,1,2,2-Tetrachloroethane	79	79	79	79	1
Tetrachloroethylene	265	272	177	373	15
Toluene	140	145	94	247	12
Toxaphene	95,816	95,816	95,816	95,816	1
1,2,4-Trichlorobenzene	1,659	1,783	864	3,125	17
1,1,1-Trichloroethane	135	139	106	179	5
1,1,2-Trichloroethane	75	77	60	108	4
Trichloroethylene	94	97	57	150	21
o-Xylene	241	241	222	258	4
m-Xylene	196	204	158	289	3
p-Xylene	311	313	260	347	3

[a] See Appendix K for sources of measured values.

Table 39. Comparison of Measured and Calculated K_{oc} Values

CAS No.	Compound	Chemical Group [a]	Log K_{ow}	Log K_{oc} (L/kg)	Calculated K_{oc} (L/kg)	Measured K_{oc} (L/kg)
83-32-9	Acenaphthene	1	3.92	3.85	7.08E+03	4.90E+03
67-64-1	Acetone	1	-0.24	-0.24	5.75E-01	---
309-00-2	Aldrin	1	6.50	6.39	2.45E+06	4.87E+04
120-12-7	Anthracene	1	4.55	4.47	2.95E+04	2.35E+04
56-55-3	Benz(*a*)anthracene	1	5.70	5.60	3.98E+05	3.58E+05
71-43-2	Benzene	2	2.13	1.77	5.89E+01	6.17E+01
205-99-2	Benzo(*b*)fluoranthene	1	6.20	6.09	1.23E+06	---
207-08-9	Benzo(*k*)fluoranthene	1	6.20	6.09	1.23E+06	---
50-32-8	Benzo(*a*)pyrene	1	6.11	6.01	1.02E+06	9.69E+05
111-44-4	Bis(2-chloroethyl)ether	1	1.21	1.19	1.55E+01	7.59E+01
117-81-7	Bis(2-ethylhexyl)phthalate	1	7.30	7.18	1.51E+07	1.11E+05
75-27-4	Bromodichloromethane	2	2.10	1.74	5.50E+01	---
75-25-2	Bromoform	2	2.35	1.94	8.71E+01	1.26E+02
71-36-3	Butanol	1	0.85	0.84	6.92E+00	---
85-68-7	Butyl benzyl phthalate	1	4.84	4.76	5.75E+04	1.37E+04
86-74-8	Carbazole	1	3.59	3.53	3.39E+03	---
75-15-0	Carbon disulfide	2	2.00	1.66	4.57E+01	---
56-23-5	Carbon tetrachloride	2	2.73	2.24	1.74E+02	1.52E+02
57-74-9	Chlordane	2	6.32	5.08	1.20E+05	5.13E+04
106-47-8	*p*-Chloroaniline	1	1.85	1.82	6.61E+01	---
108-90-7	Chlorobenzene	2	2.86	2.34	2.19E+02	2.24E+02
124-48-1	Chlorodibromomethane	2	2.17	1.80	6.31E+01	---
67-66-3	Chloroform	2	1.92	1.60	3.98E+01	5.25E+01
218-01-9	Chrysene	1	5.70	5.60	3.98E+05	---
72-54-8	DDD	1	6.10	6.00	1.00E+06	4.58E+04
72-55-9	DDE	1	6.76	6.65	4.47E+06	8.64E+04
50-29-3	DDT	1	6.53	6.42	2.63E+06	6.78E+05
53-70-3	Dibenz(*a,h*)anthracene	1	6.69	6.58	3.80E+06	1.79E+06
84-74-2	Di-*n*-butyl phthalate	1	4.61	4.53	3.39E+04	1.57E+03
95-50-1	1,2-Dichlorobenzene	2	3.43	2.79	6.17E+02	3.79E+02
106-46-7	1,4-Dichlorobenzene	2	3.42	2.79	6.17E+02	6.16E+02
91-94-1	3,3-Dichlorobenzidine	2	3.51	2.86	7.24E+02	---
75-34-3	1,1-Dichloroethane	2	1.79	1.50	3.16E+01	5.34E+01
107-06-2	1,2-Dichloroethane	2	1.47	1.24	1.74E+01	3.80E+01
75-35-4	1,1-Dichloroethylene	2	2.13	1.77	5.89E+01	6.50E+01
156-59-2	*cis*-1,2-Dichloroethylene	2	1.86	1.55	3.55E+01	---
156-60-5	*trans*-1,2-Dichloroethylene	2	2.07	1.72	5.25E+01	3.80E+01
78-87-5	1,2-Dichloropropane	2	1.97	1.64	4.37E+01	4.70E+01
542-75-6	1,3-Dichloropropene	2	2.00	1.66	4.57E+01	2.71E+01

Table 39 (continued)

CAS No.	Compound	Chemical Group [a]	Log K_{ow}	Log K_{oc} (L/kg)	Calculated K_{oc} (L/kg)	Measured K_{oc} (L/kg)
60-57-1	Dieldrin	2	5.37	4.33	2.14E+04	2.55E+04
84-66-2	Diethylphthalate	1	2.50	2.46	2.88E+02	8.22E+01
105-67-9	2,4-Dimethylphenol	1	2.36	2.32	2.09E+02	---
121-14-2	2,4-Dinitrotoluene	1	2.01	1.98	9.55E+01	---
606-20-2	2,6-Dinitrotoluene	1	1.87	1.84	6.92E+01	---
117-84-0	Di-*n*-octyl phthalate	1	8.06	7.92	8.32E+07	---
115-29-7	Endosulfan	2	4.10	3.33	2.14E+03	2.04E+03
72-20-8	Endrin	2	5.06	4.09	1.23E+04	1.08E+04
100-41-4	Ethylbenzene	2	3.14	2.56	3.63E+02	2.04E+02
206-44-0	Fluoranthene	1	5.12	5.03	1.07E+05	4.91E+04
86-73-7	Fluorene	1	4.21	4.14	1.38E+04	7.71E+03
76-44-8	Heptachlor	1	6.26	6.15	1.41E+06	9.53E+03
1024-57-3	Heptachlor epoxide	1	5.00	4.92	8.32E+04	---
118-74-1	Hexachlorobenzene	2	5.89	4.74	5.50E+04	8.00E+04
87-68-3	Hexachloro-1,3-butadiene	1	4.81	4.73	5.37E+04	---
319-84-6	α-HCH (α-BHC)	2	3.80	3.09	1.23E+03	1.76E+03
319-85-7	β-HCH (β-BHC)	2	3.81	3.10	1.26E+03	2.14E+03
58-89-9	γ-HCH (Lindane)	2	3.73	3.03	1.07E+03	1.35E+03
77-47-4	Hexachlorocyclopentadiene	1	5.39	5.30	2.00E+05	---
67-72-1	Hexachloroethane	2	4.00	3.25	1.78E+03	---
193-39-5	Indeno(1,2,3-*cd*)pyrene	1	6.65	6.54	3.47E+06	---
78-59-1	Isophorone	1	1.70	1.67	4.68E+01	---
72-43-5	Methoxychlor	1	5.08	4.99	9.77E+04	8.00E+04
74-83-9	Methyl bromide	2	1.19	1.02	1.05E+01	9.00E+00
75-09-2	Methylene chloride	2	1.25	1.07	1.17E+01	1.00E+01
95-48-7	2-Methylphenol	1	1.99	1.96	9.12E+01	---
91-20-3	Naphthalene	1	3.36	3.30	2.00E+03	1.19E+03
98-95-3	Nitrobenzene	1	1.84	1.81	6.46E+01	1.19E+02
86-30-6	*N*-Nitrosodiphenylamine	1	3.16	3.11	1.29E+03	---
621-64-7	*N*-Nitrosodi-*n*-propylamine	1	1.40	1.38	2.40E+01	---
1336-36-3	PCBs	1	5.58	5.49	3.09E+05	---
108-95-2	Phenol	1	1.48	1.46	2.88E+01	---
129-00-0	Pyrene	1	5.11	5.02	1.05E+05	6.80E+04
100-42-5	Styrene	1	2.94	2.89	7.76E+02	9.12E+02
79-34-5	1,1,2,2-Tetrachloroethane	2	2.39	1.97	9.33E+01	7.90E+01
127-18-4	Tetrachloroethylene	2	2.67	2.19	1.55E+02	2.65E+02
108-88-3	Toluene	2	2.75	2.26	1.82E+02	1.40E+02
8001-35-2	Toxaphene	1	5.50	5.41	2.57E+05	9.58E+04
120-82-1	1,2,4-Trichlorobenzene	2	4.01	3.25	1.78E+03	1.66E+03

Table 39 (continued)

CAS No.	Compound	Chemical Group [a]	Log K_{ow}	Log K_{oc} (L/kg)	Calculated K_{oc} (L/kg)	Measured K_{oc} (L/kg)
71-55-6	1,1,1-Trichloroethane	2	2.48	2.04	1.10E+02	1.35E+02
79-00-5	1,1,2-Trichloroethane	2	2.05	1.70	5.01E+01	7.50E+01
79-01-6	Trichloroethylene	2	2.71	2.22	1.66E+02	9.43E+01
108-05-4	Vinyl acetate	1	0.73	0.72	5.25E+00	---
75-01-4	Vinyl chloride	2	1.50	1.27	1.86E+01	---
108-38-3	*m*-Xylene	2	3.20	2.61	4.07E+02	1.96E+02
95-47-6	*o*-Xylene	2	3.13	2.56	3.63E+02	2.41E+02
106-42-3	*p*-Xylene	2	3.17	2.59	3.89E+02	3.11E+02

[a] Group 1: log K_{oc} = 0.983 log K_{ow} + 0.00028.

Group 2: (VOCs, chlorobenzenes, and certain chlorinated pesticides) log K_{oc} = 0.7919 log K_{ow} + 0.0784.

Note: Calculated values rounded as shown for subsequent SSL calculations.

5.3.2 K_{oc} for Ionizing Organic Compounds. Sorption models used to describe the behavior of nonionizing hydrophobic organic compounds in the natural environment are not appropriate for predicting the partitioning of ionizable organic compounds. Certain organic compounds such as amines, carboxylic acids, and phenols contain functional groups that ionize under subsurface pH conditions (Schellenberg et al., 1984). Because the ionized and the neutral species of such compounds have different sorption coefficients, sorption models based solely on the partitioning of the neutral species may not accurately predict soil sorption under different pH conditions.

To address this problem, a technique was employed to predict K_{oc} values for the 15 ionizing SSL organic compounds over the pH range of the subsurface environment. These compounds include:

Organic Acids

- Benzoic acid
- 2-Chlorophenol
- 2,4-Dichlorophenol
- 2,4-Dimethylphenol
- 2,4-Dinitrophenol
- 2-Methylphenol
- Pentachlorophenol
- Phenol
- 2,3,4,5-Tetrachlorophenol
- 2,3,4,6-Tetrachlorophenol
- 2,4,5-Trichlorophenol
- 2,4,6-Trichlorophenol

Organic Bases

- *p*-Chloroaniline
- *N*-Nitrosodiphenylamine
- *N*-Nitrosodi-*n*-propylamine

Estimation of K_{oc} values for these chemicals involves two analyses. First, the extent to which the compound ionizes under subsurface conditions must be determined to estimate the relative proportion of neutral and ionized species under the conditions of concern. Second, the K_{oc} values for the neutral and ionized forms ($K_{oc,n}$ and $K_{oc,i}$) must be determined and weighted according to the extent of ionization at a particular pH to estimate a pH-specific K_{oc} value. For organic acids, the ionized species is an anion (A^-) with a lower tendency to sorb to subsurface materials than the neutral species. Therefore, $K_{oc,i}$ for organic acids is likely to be less than $K_{oc,n}$. In the case of organic bases, the ionized species is positively charged (HB^+) so that $K_{oc,i}$ is likely to be greater than $K_{oc,n}$.

It should be noted that this approach is based on the assumption that the sorption of ionizing organic compounds to soil is similar to hydrophobic organic sorption in that the dominant sorbent is soil organic carbon. Shimizu et al. (1993) demonstrated that, for several "natural solids," pentachlorophenol sorption correlates more strongly with cation exchange capacity and clay content than with organic carbon content. This suggests that this organic acid interacts more strongly with soil mineral constituents than organic carbon. The estimates of K_{oc} developed here may overpredict contaminant mobility because they ignore potential sorption to soil components other than organic carbon.

Extent of Ionization. The sorption potential of ionized and neutral species differs because most subsurface solids (i.e., soil and aquifer materials) have a negative net surface charge. Therefore, positively charged chemicals have a greater tendency to sorb than neutral forms, and neutral species sorb more readily than negatively charged forms. Thus, predictions for the total sorption of any ionizable organic compound must consider the extent to which it ionizes over the range of subsurface pH conditions of interest. Consistent with the EPA/Office of Solid Waste (EPA/OSW) Hazardous Waste Identification Rule (HWIR) proposal (U.S. EPA, 1992a), the 7.5th, 50th, and 92.5th percentiles (i.e., pH values of 4.9, 6.8, and 8.0) for 24,921 field-measured ground water pH values in the U.S. EPA STORET database are defined as the pH conditions of interest for SSL development.

The extent of ionization can be viewed as the fraction of neutral species present that, for organic acids, can be determined from the following pH-dependent relationship (Lee et al., 1990):

$$\Phi_{n,acid} = \frac{[HA]}{[HA] + [A^-]} = \left(1 + 10^{pH - pKa}\right)^{-1} \qquad \textbf{(72)}$$

where

$\Phi_{n,acid}$ = fraction of neutral species present for organic acids (unitless)
$[HA]$ = equilibrium concentration of organic acid (mol/L)
$[A^-]$ = equilibrium concentration of anion (mol/L)
pKa = acid dissociation constant (unitless).

Using Equation 68, one can show that, in ground water systems with pH values exceeding the pKa by 1.5 pH units, the ionizing species predominates, and, in ground water systems with pH values that are 1.5 pH units less than the pKa, the neutral species predominates. At pH values approximately equal to the pKa, a mixed system of both neutral and ionizing components occurs.

The fraction of neutral species for organic bases is defined by:

$$\Phi_{n,base} = \frac{[B^\circ]}{[B^\circ] + [HB^+]} = \left(1 + 10^{pKa - pH}\right)^{-1} \qquad \textbf{(73)}$$

where

$\Phi_{n,base}$ = fraction of neutral species present for organic bases (unitless)
$[B^\circ]$ = equilibrium concentration of neutral organic base (mol/L)
$[HB^+]$ = equilibrium concentration of ionized species (mol/L).

As with organic acids, pH conditions determine the relative concentrations of neutral and ionized species in the system. However, unlike organic acids, the neutral species predominates at pH values

that exceed the pKa, and the ionized species predominates at pH values less than the pKa. For the SSL organic bases, *N*-nitrosodi-*n*-propylamine and *N*-nitrosodiphenylamine have very low pKa values and the neutral species are expected to prevail under environmental pH conditions. The pKa for *p*-chloroaniline, however, is 4.0 and, at low subsurface pH conditions (i.e., pH = 4.9), roughly 10 percent of the compound will be present as the less mobile ionized species.

Table 40 presents pKa values and fraction neutral species present over the ground water pH range for the SSL ionizing organic compounds. This table shows that ionized species are significant for only some of the constituents under normal subsurface pH conditions. The pKa values for phenol, 2-methylphenol, and 2,4-dimethylphenol are 9.8 or greater. Hence, the neutral species of these compounds predominates under typical subsurface conditions (i.e., pH = 4.9 to 8), and these compounds will be treated as nonionizing organic compounds (see Section 5.3.1). The pKa value for 2,4-dinitrophenol is less than 4 and the ionized species of this compound predominates under subsurface conditions. However, the pKas for 2-chlorophenol, 2,4-dichlorophenol, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, 2,3,4,5-tetrachlorophenol, 2,3,4,6-tetrachlorophenol, pentachlorophenol, and benzoic acid fall within the range of environmentally significant pH conditions. Mixed systems consisting of both the neutral and the ionized species will prevail under such conditions with both species contributing to total sorption.

Table 40. Degree of Ionization (Fraction of Neutral Species, Φ) as a Function of pH

Compound	pKa[a]	pH = 4.9	pH = 6.8	pH = 8.0
Benzoic acid	4.18	0.1600	0.0024	0.0002
p-Chloroaniline[b]	4.0	0.8882	0.9984	0.9999
2-Chlorophenol	8.40	0.9997	0.9755	0.7153
2,4-Dichlorophenol	7.90	0.9990	0.9264	0.4427
2,4-Dimethylphenol	10.10	1.0000	0.9995	0.9921
2,4-Dinitrophenol	3.30	0.0245	0.0003	0.00002
2-Methylphenol	9.80	1.0000	0.9990	0.9844
N-Nitrosodiphenylamine[b]	< 0	1.0000	1.0000	1.0000
N-Nitrosodi-*n*-propylamine[b]	< 1	0.9999	1.0000	1.0000
Pentachlorophenol	4.80	0.4427	0.0099	0.0006
Phenol	10.0	1.0000	0.9994	0.9901
2,3,4,5-Tetrachlorophenol	6.35[c]	0.9657	0.2619	0.0219
2,3,4,6-Tetrachlorophenol	5.30	0.7153	0.0307	0.0020
2,4,5-Trichlorophenol	7.10	0.9937	0.6661	0.1118
2,4,6-Trichlorophenol	6.40	0.9693	0.2847	0.0245

[a] Kollig et al. (1993).
[b] Denotes that the compound is an organic base.
[c] Lee et al. (1991).

Prediction of Soil-Water Partition Coefficients. Lee et al. (1990) developed a relationship from thermodynamic equilibrium considerations to predict the total sorption of an ionizable organic compound from the partitioning of its ionized and neutral forms:

$$K_{oc} = K_{oc,n}\Phi_n + K_{oc,i}\,(1 - \Phi_n) \qquad \textbf{(74)}$$

where

K_{oc}	=	soil organic carbon/water partition coefficient (L/kg)
$K_{oc,n}$	=	partition coefficient for the neutral species (L/kg)
Φ_n	=	fraction of neutral species present for acids or bases
$K_{oc,i}$	=	partition coefficient for the ionized species (L/kg).

This relationship defines the total sorption coefficient for any ionizing compound as the sum of the weighted individual sorption coefficients for the ionized and neutral species at a given pH. Lee et al. (1990) verified that this relationship adequately predicts laboratory-measured K_{oc} values for pentachlorophenol.

A literature review was conducted to compile the pKa and the laboratory-measured values of $K_{oc,n}$ and $K_{oc,i}$ shown in Table 41. Data collected during this review are presented in RTI (1994), along with the references reviewed. Sorption coefficients for both neutral and ionized species were reported for only four of the nine ionizable organic compounds of interest. Sorption coefficients reported for the remaining compounds were generally $K_{oc,n}$, and estimates of $K_{oc,i}$ were necessary to predict the compound's total sorption. The methods for estimating $K_{oc,i}$ for organic acids and organic bases are discussed separately in the following subsections.

Organic Acids. Sorption coefficients for both the neutral and ionized species have been reported for two chlorophenolic compounds: 2,4,6-trichlorophenol and pentachlorophenol. For 2,4,5-trichlorophenol and 2,3,4,5-tetrachlorophenol, soil-water partitioning coefficient (K_p) data in the literature were adequate to allow calculation of $K_{oc,i}$ from K_p and soil f_{oc} (Lee et al., 1991). From these measured values, the ratios of $K_{oc,i}$ to $K_{oc,n}$ are: 0.1 (2,4,6-trichlorophenol), 0.02 (pentachlorophenol), 0.015 (2,4,5-trichlorophenol), and 0.051 (2,3,4,5-tetrachlorophenol). A ratio of 0.015 (1.5 percent) was selected as a conservative value to estimate $K_{oc,i}$ for the remaining phenolic compounds, benzoic acid, and vinyl acetate.

Organic Bases. No measured sorption coefficients for either the neutral or the ionized species were found for the three organic bases of interest (*N*-nitrosodi-*n*-propylamine, *N*-nitrosodiphenylamine, and *p*-chloroaniline). Generally, the sorption of ionizable organic bases has not been as well investigated as that of the organic acids, and there has been no relationship developed between the sorption coefficients of the neutral and ionized species. EPA is currently initiating research on models for predicting the sorption of organic bases in the subsurface.

As noted earlier, the neutral species of the organic base predominates at pH values exceeding the pKa. For *N*-nitrosodi-*n*-propylamine (pKa < 1) and *N*-nitrosodiphenylamine (pKa < 0), the neutral species is present under environmentally significant conditions. The neutral species constitutes approximately 90 percent of the system for *p*-chloroaniline (Table 40).

Table 41. Soil Organic Carbon/Water Partition Coefficients and pKa Values for Ionizing Organic Compounds

Compound	$K_{oc,n}$ (L/kg)	$K_{oc,i}$ (L/kg)	pKa[a]
Benzoic acid	32[b]	0.5[c]	4.18
2-Chlorophenol	398[b]	6.0[c]	8.40
2,4-Dichlorophenol	159[d]	2.4[c]	7.90
2,4-Dinitrophenol	0.8[a]	0.01[c]	3.30
Pentachlorophenol	19,953[e]	398[e]	4.80
2,3,4,5-Tetrachlorophenol	17,916[f]	67[g]	6.35[h]
2,3,4,6-Tetrachlorophenol	6,190[i]	93[c]	5.30
2,4,5-Trichlorophenol	2,380[i]	36[j]	7.10
2,4,6-Trichlorophenol	1,070[i]	107[k]	6.40

[a] Kollig et al. (1993).
[b] Meylan et al. (1992).
[c] Estimate based on the ratio of $K_{oc,i}/K_{oc,n}$ for compounds for which data exist; $K_{oc,i}$ was estimated to be $0.015 \times K_{oc,n}$.
[d] Calculated using data (K_p = 0.62, f_{oc} = 0.0039) contained in Lee et al. (1991); agrees well with Boyd (1982) reporting measured K_{oc} = 126 L/kg.
[e] Lee et al. (1990).
[f] Average of values reported for two aquifer materials from Schellenberg et al. (1984).
[g] Calculated using data (K_p = 0.26, f_{oc} = 0.0039) contained in Lee et al. (1991).
[h] Lee et al. (1991).
[i] Schellenberg et al. (1984).
[j] Calculated using data (K_p = 0.14, f_{oc} = 0.0039) contained in Lee et al. (1991).
[k] Kukowski (1989).

The neutral species has a lower tendency to sorb to subsurface materials than the positively charged ionized species. As a consequence, the determination of overall sorption potential based solely on the neutral species for *N*-nitrosodi-*n*-propylamine, *N*-nitrosodiphenylamine, and *p*-chloroaniline is conservative, and these three organic bases will be treated as nonionizing organic compounds (see Section 5.3.1).

Soil-Water Partition Coefficients for Ionizing Organic Compounds. Partition coefficients for the neutral and ionized species ($K_{oc,n}$ and $K_{oc,i}$, respectively) and pKa values for nine ionizable organic compounds are provided in Table 41. These parameters can be used in Equation 74 to compute K_{oc} values for organic acids at any given pH. K_{oc} values for each of the ionizable compounds of interest are presented in Table 42 for pHs of 4.9, 6.8, and 8.0. Appendix L contains pH-specific K_{oc} values for ionizable organics over this entire range.

5.4 Soil-Water Distribution Coefficients (K_d) for Inorganic Constituents

As with organic chemicals, development of SSLs for inorganic chemicals (i.e., toxic metals) requires a soil-water partition coefficient (K_d) for each constituent. However, the simple relationship between soil organic carbon content and sorption observed for organic chemicals does not apply to inorganic constituents. The soil-water distribution coefficient (K_d) for metals and other inorganic compounds is affected by numerous geochemical parameters and processes, including pH; sorption to clays, organic

matter, iron oxides, and other soil constituents; oxidation/reduction conditions; major ion chemistry; and the chemical form of the metal. The number of significant influencing parameters, their variability in the field, and differences in experimental methods result in as much as seven orders of magnitude variability in measured metal K_d values reported in the literature (Table 43). This variability makes it much more difficult to derive generic K_d values for metals than for organics.

Table 42. Predicted Soil Organic Carbon/Water Partition Coefficients (K_{oc},L/kg) as a Function of pH: Ionizing Organics

Compound	pH = 4.9	pH = 6.8	pH = 8.0
Benzoic acid	5.5	0.6	0.5
2-Chlorophenol	398	388	286
2,4-Dichlorophenol	159	147	72
2,4-Dinitrophenol	0.03	0.01	0.01
Pentachlorophenol	9,055	592	410
2,3,4,5-Tetrachlorophenol	17,304	4,742	458
2,3,4,6-Tetrachlorophenol	4,454	280	105
2,4,5-Trichlorophenol	2,365	1,597	298
2,4,6-Trichlorophenol	1,040	381	131

Because of their great variability and a limited number of data points, no meaningful estimate of central tendency K_d values for metals could be derived from available measured values. For this reason, an equilibrium geochemical speciation model (MINTEQ) was selected as the best approach for estimating K_d values for the variety of environmental conditions expected to be present at Superfund sites.

This approach and model were also used by OSW to estimate generic K_d values for metals proposed for use in the HWIR proposal (U.S. EPA, 1992a). The HWIR MINTEQA2 analyses were conducted under a variety of geochemical conditions and metal concentrations representative of solid waste landfills across the Nation. The metal K_d values developed for this effort were reviewed for SSL application and were used as preliminary values to develop the September 1993 draft SSLs.

Upon further review of the HWIR MINTEQ modeling effort, EPA decided it was necessary to conduct a separate MINTEQ modeling effort to develop metal K_d values for SSL application. Reasons for this decision include the following:

- It was necessary to expand the modeling effort to include other metal contaminants likely to be encountered at Superfund sites (i.e., beryllium, copper, and zinc).

- HWIR work incorporated low, medium, and high concentrations of dissolved organic acids that are present in municipal solid waste (MSW) leachate. These organic acids are not expected to exist in high concentrations in pore waters underlying Superfund sites; therefore, their inclusion in the Superfund contaminated soil scenario is not warranted.

- The HWIR modeling simulations for chromium (+3) were found to be in error. This error has been corrected in subsequent HWIR modeling work but corrected results were not available at the time of preliminary SSL development.

Table 43. Summary of Collected K_d Values Reported in Literature

	AECL (1990)[a]	Baes and Sharp (1983) or Baes et al. (1984)[b]			Coughtrey et al. (1985)[c]	Battelle (1989)[d]
Metal	**Range**	**Geometric Mean[e]**	**Range**	**No. Values**	**Range**	**Range**
Antimony	45-550	45[f]	--	--	--	2.0-15.9
Arsenic[e]	--	200[f]	--	--	--	5.86-19.4
Arsenic (+3)	--	3.3[g]	1.0-8.3	19	--	--
Arsenic (+5)	--	6.7[g]	1.9-18	37	--	--
Barium	--	60[f]	--	--	--	530-16,000
Beryllium	250-3,000	650[f]	--	--	--	70-8,000
Cadmium	2.7-17,000	6.4[h]	1.26-26.8	28	32-50	14.9-567
Chromium	1.7-2,517	850[f]	--	--	--	--
Chromium (+2)	--	2,200[g]	470-150,000	15	--	--
Chromium (+3)	--	--	--	--	--	168-3,600
Chromium (+6)	--	37[g]	1.2-1,800	18	--	16.8-360
Mercury[e]	--	10[f]	--	--	--	322-5,280
Nickel	60-4,700	150[f]	--	--	~20	12.2-650
Selenium	150-1,800	300[f]	--	--	< 9	5.9-14.9
Silver	2.7-33,000	46[h]	10-1,000	16	50	0.4-40.0
Thallium	--	1,500[f]	--	--	--	0.0-0.8
Vanadium	--	1,000[f]	--	--	--	50-100.0
Zinc	0.1-100,000	38[h]	0.1-8,000	146	≥ 20	--

[a] The Atomic Energy of Canada, Limited (AECL, 1990) presents the distribution of K_d values according to four major soil types—sand, silt, clay, and organic material. Their data were obtained from available literature.

[b] Baes et al. (1984) present K_d values for approximately 220 agricultural soils in the pH range of 4.5 to 9. Their data were derived from available literature and represent a diverse mixture of soils, extracting solutions, and laboratory techniques.

[c] Coughtrey et al. (1985) report best estimates and ranges of measured soil K_d values for a limited number of metals.

[d] Battelle Memorial Institute (Battelle, 1989) reports a range in K_d values as a function of pH (5 to 9) and sorbent content (a combination of clay, aluminum and iron oxyhydroxides, and organic matter content). The sorbent content ranges were <10 percent, 10 to 30 percent, and >30 percent sorbent. Their data were based on available literature.

[e] The valence of these metals is not reported in the documents.

[f] Estimated based on the correlation between K_d and soil-to-plant concentration factor (B_v).

[g] Average value reported by Baes and Sharp (1983).

[h] Represents the median of the logarithms of the observed values.

For these reasons, a MINTEQ modeling effort was expanded to develop a series of metal-specific isotherms for several of the metals expected to be present in soils underlying Superfund sites. The model used was an updated version of MINTEQA2 obtained from Allison Geoscience Consultants, Inc. Model results are reported in the December 1994 draft Technical Background Document (U.S. EPA, 1994i) and were used to calculate the SSLs presented in the December 1994 draft Soil Screening Guidance (U.S. EPA, 1994h).

The MINTEQA2 model was further updated by Allison Geoscience Consultants, Inc., in 1995 to include thermodynamic data for silver, an improved estimate of water saturation in the vadose zone (i.e., water saturation is assumed to be 77.7 percent saturated as opposed to 100 percent), and revised estimates of sorbent mass (i.e., organic matter content, iron oxide content).

This updated model, which is expected to be made public through EPA's Environmental Research Laboratory in Athens, Georgia, was used to revise the generic K_d values for the EPA/OSW HWIR modeling effort. The metal K_d values for SSL application were also revised. Model results are contained in this document. The following section describes the important assumptions and limitations of this modeling effort.

5.4.1 Modeling Scope and Approach. New MINTEQA2 modeling runs were conducted to develop sorption isotherms for barium, beryllium, cadmium, chromium (+3), copper, mercury (+2), nickel, silver, and zinc. The general approach and input values used for pH, iron oxide (FeOx) concentration, and background chemistry were unchanged from the HWIR modeling effort.

The HWIR MINTEQA2 analyses were conducted under a variety of geochemical conditions and metal concentrations. Three types of parameters were identified as part of the chemical speciation modeling effort: (1) parameters that have a direct first-order impact on metal speciation and are characterized by a wide range in environmental variability; (2) parameters that have an indirect, generally less pronounced effect on metal speciation and are characterized by a relatively small or insignificant environmental variability; and (3) parameters that may have a direct first-order impact on metal speciation but neither the natural variability nor its significance is known.

In the HWIR modeling effort, parameters of the first type ("master variables") were limited to those having a significant effect on model results, including pH, concentration of available amorphous iron oxide adsorption sites (i.e., FeOx content), concentration of solid organic matter adsorption sites (with a dependent concentration of dissolved natural organic matter), and concentration of leachate organic acids expected to be present in MSW leachate. High, medium, and low values were assigned to each of the master variables to account for their natural environmental variability. The SSL modeling effort used this same approach and inputs except that anthropogenic organic acids were not included in the model simulations. Furthermore, the SSL modeling effort incorporated a medium fraction of organic carbon (f_{oc}) that correlated to the HWIR high concentration.

Parameters of the second type constitute the background pore-water chemistry, which consists of chemical constituents commonly occurring in ground water at concentrations great enough to affect metal speciation. These constituents were treated as constants in both the SSL and HWIR effort. The third type of parameter was entirely omitted from consideration in both modeling efforts due to poorly understood geochemistry and the lack of reliable thermodynamic data. The most important of these parameters is the oxidation-reduction (redox) potential. To compensate, both modeling efforts incorporated an approach that was most protective of the environment with respect to the impact of redox potential on the partitioning of redox-sensitive metals (i.e., each metal was modeled in the oxidation state that most enhances metal mobility).

For the HWIR modeling effort, metal concentrations were varied from the maximum contaminant level (MCL) to 1,000 times the MCL for each individual metal. This same approach was taken for SSL modeling, although for certain metals the concentration range was extended to determine the metal concentration at which the sorption isotherm departed from linearity.

Sorption isotherms for arsenic (+3), chromium (+6), selenium, and thallium are unchanged from the previous efforts and are based on laboratory-derived pH-dependent sorption relationships developed

for HWIR. Using these relationships, the K_d distribution as a function of pH is presented for each of these four metals in Figure 10.

Sorption isotherms for antimony and vanadium could not be estimated using MINTEQA2 because the thermodynamic databases do not contain the required reactions and associated equilibrium constants. Sufficient experimental research has not been conducted to develop pH-dependent relationships for these two metals. As a consequence, K_d values for antimony and vanadium were obtained from Baes et al. (1984) (Table 43). These K_d values are not pH-dependent.

5.4.2 Input Parameters. Table 44 lists high, medium, and low values for pH and iron oxide used for both the HWIR and SSL MINTEQ modeling efforts. Sources for these values are as follows (U.S. EPA, 1992a):

- Values for pH were obtained from analysis of 24,921 field-measured pH values contained in the EPA STORET database. The pH values of 4.9, 6.8, and 8.0 correspond to the 7.5th, 50th, and 92.5th percentiles of the distribution.

- Iron oxide contents were based on analysis of six aquifer samples collected over a wide geographic area, including Florida, New Jersey, Oregon, Texas, Utah, and Wisconsin. The lowest of the six analyses was taken to be the low value, the average of the six was used as the medium value, and the highest was taken as the high value.

The development of the values presented in Table 44 is described in more detail in U.S. EPA (1992a).

Thirteen chemical constituents commonly occurring in ground water were used to define the background pore-water chemistry for HWIR and SSL modeling efforts (Table 45). Because these constituents were treated as constants, a single total ion concentration, corresponding to the median total metal concentration from a probability distribution obtained from the STORET database, was assigned to each of the background pore-water constituents (U.S. EPA, 1992a).

Although the HWIR and the SSL MINTEQ modeling efforts were consistent in the majority of the assumptions and input parameters used, the fraction of organic carbon (f_{oc}) used for the SSL modeling effort was slightly different than that used for the HWIR modeling effort. The f_{oc} used for the SSL effort was equal to 0.002 g/g, which better reflected average subsurface conditions at Superfund sites. This value is approximately equal to the high value of organic carbon used in the HWIR modeling effort.

Table 44. Summary of Geochemical Parameters Used in SSL MINTEQ Modeling Effort

Value	pH	Iron oxide content (weight percent)
Low	4.9	0.01
Medium	6.8	0.31
High	8.0	1.11

Source: U.S. EPA (1992a)

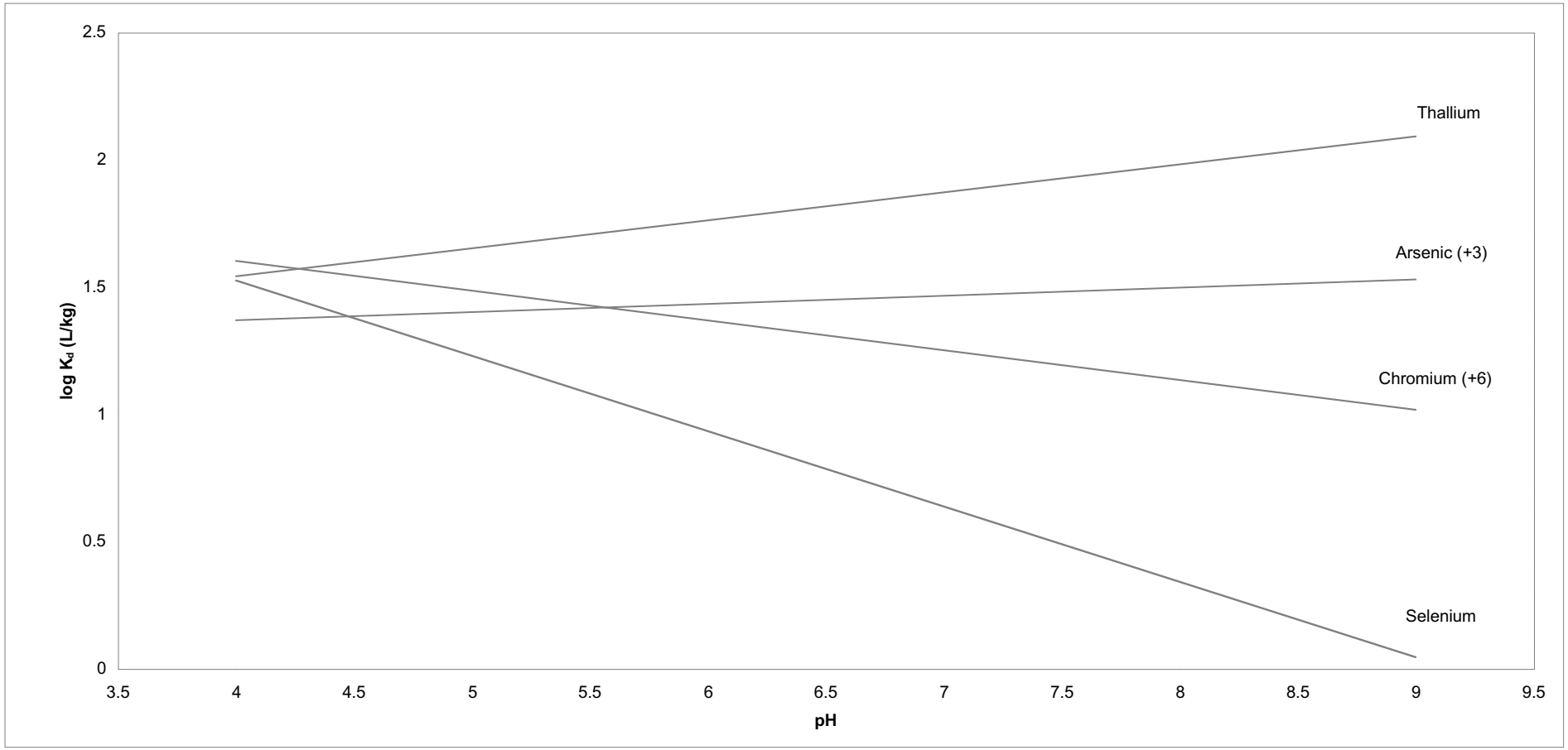


Figure 10. Empirical pH-dependent adsorption relationship: arsenic (+3), chromium

Table 45. Background Pore-Water Chemistry Assumed for SSL MINTEQ Modeling Effort[a]

Parameter	Concentration (mg/L)
Aluminum	0.2
Bromine	0.3
Calcium	48
Carbonate	187
Chlorine	15
Iron (+3)	0.2
Magnesium	14
Manganese (+2)	0.04
Nitrate	1
Phosphate	0.09
Potassium	2.9[b]
Sodium	22
Sulfate	25

[a] Median values from STORET database as reported in U.S. EPA (1992a).
[b] Median values from STORET database; personal communication from J. Allison, Allison Geosciences.

5.4.3. Assumptions and Limitations. The SSL MINTEQ modeling effort incorporates several basic simplifying assumptions. In addition, the applicability and accuracy of the model results are subject to limitations. Some of the more significant assumptions and limitations are described below.

- **The system is assumed to be at equilibrium.** This assumption is inherent in geochemical aqueous speciation models because the fundamental equations of mass action and mass balance are equilibrium based. Therefore, any possible influence of adsorption (or desorption) rate limits is not considered.

  This assumption is **conservative**. Because the model is being used to simulate metal desorption from the solid substrate, if equilibrium conditions are not met, the desorption reaction will be incomplete and the metal concentration in pore water will be less than predicted by the model.

- **Redox potential is not considered.** The redox potential of the system is not considered due to the difficulty in obtaining reliable field measurements of oxidation reduction potential (Eh), which are needed to determine a realistic frequency distribution of this parameter. Furthermore, the geochemistry of redox-sensitive species is poorly understood. Reactions involving redox species are often biologically mediated and the concentrations of redox species are not as likely to reflect thermodynamic equilibrium as other inorganic constituents.

  To provide a **conservative** estimate of metal mobility, all environmentally viable oxidation states are modeled separately for the redox-sensitive metals; the most conservative was selected for defining SSL metal K_d values. The redox-sensitive

constituents that make up the background chemistry are represented only by the oxidation state that most enhances metal mobility (U.S. EPA, 1992a).

- **Potential sorbent surfaces are limited.** Only metal adsorption to FeOx and solid organic matter is considered in the system. It is recognized that numerous other natural sorbents exist (e.g., clay and carbonate minerals); however, thermodynamic databases describing metal adsorption to these surfaces are not available and the potential for adsorption to such surfaces is not considered. This assumption is **conservative** and will underpredict sorption for soils with significant amounts of such sorption sites.

- **The available thermodynamic database is limiting.** As metal behavior increases in complexity, thermodynamic data become more rare. The lack of complete thermodynamic data requires simplification to the defined system. This simplification may be **conservative** or **nonconservative** in terms of metal mobility.

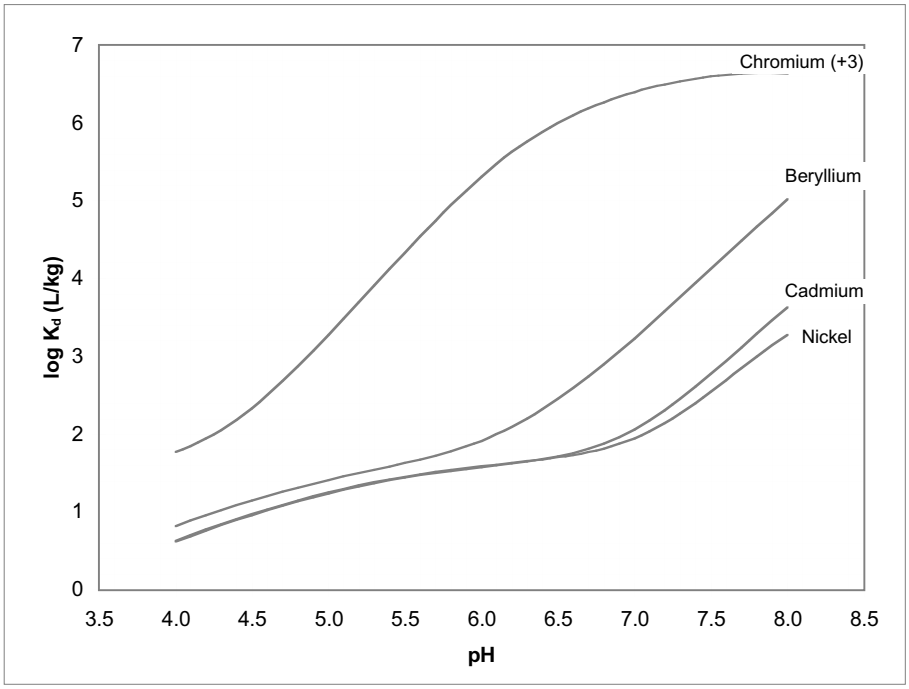
- **Metal competition is not considered.** Model simulations were performed for systems comprised of only one metal (i.e., the potential for competition between multiple metals for available sorbent surface sites was not considered). Generally, the competition of multiple metals for available sorption sites results in higher dissolved metal concentrations than would exist in the absence of competition. Consequently, this assumption is **nonconservative** but is significant only at metal concentrations much higher than the SSLs.

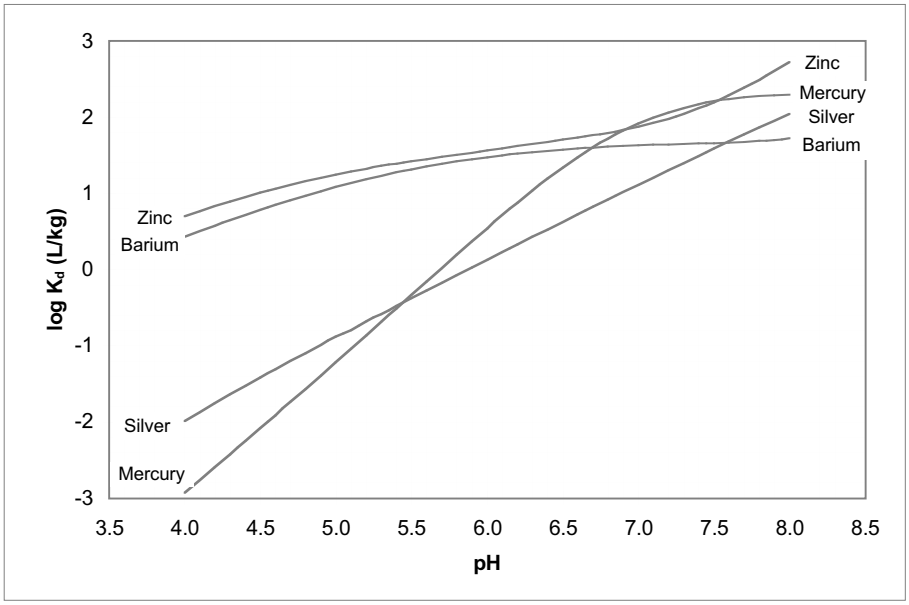
Other assumptions and limitations associated with this modeling effort are discussed in RTI (1994).

5.4.4 Results and Discussion. MINTEQ model results indicate that metal mobility is most affected by changes in pH. Based on this observation and because iron oxide content is not routinely measured in site characterization efforts, pH-dependent K_ds for metals were developed for SSL application by fixing iron oxide at its medium value and fraction organic carbon at 0.002. For arsenic (+3), chromium (+6), selenium, and thallium, the empirical pH-dependent K_ds were used.

Table 46 shows the SSL K_d values at high, medium, and low subsurface pH conditions. Figure 11 plots MINTEQ-derived metal K_d values over this pH range. Figure 10 shows the same for the empirically derived metal K_ds. These results are discussed below by metal and compared with measured values. See RTI (1994) for more information. pH-dependent values are not available for antimony, cyanide, and vanadium. The estimated K_d values shown in Table 46 for antimony and vanadium are reported by Baes et al. (1984) and the K_d value for cyanide is obtained from SCDM.

Arsenic. K_d values developed using the empirical equation for arsenic (+3) range from 25 to 31 L/kg for pH values of 4.9 to 8.0, respectively. These values correlate fairly well with the range of measured values reported by Battelle (1989)—5.86 to 19.4 L/kg. They are slightly above the range reported by Baes and Sharp (1983) for arsenic (+3) (1.0-8.3). The estimated K_d values for arsenic (+3) do not correlate well with the value of 200 L/kg presented by Baes et al. (1984). Oxidation state is not specified in Baes et al. (1984), and the difference between the empirical-derived K_d values presented here and the value presented by Baes et al. (1984) may reflect differences in oxidation states (arsenic (+3) is the most mobile species).





Note: Conditions depicted are medium iron oxide content (0.31 wt %) and organic matter of 0.2 wt %.

Figure 11. Metal Kd as a function of pH.

Table 46. Estimated Inorganic K_d Values for SSL Application

Metal	Estimated K_d (L/kg) pH = 4.9	pH = 6.8	pH = 8.0
Antimony[a]		4.5E+01	
Arsenic (+3)[b]	2.5E+01	2.9E+01	3.1E+01
Barium	1.1E+01	4.1E+01	5.2E+01
Beryllium	2.3E+01	7.9E+02	1.0E+05
Cadmium	1.5E+01	7.5E+01	4.3E+03
Chromium (+3)	1.2E+03	1.8E+06	4.3E+06
Chromium (+6)[b]	3.1E+01	1.9E+01	1.4E+01
Cyanide[c]		9.9E+00	
Mercury (+2)	4.0E-02	5.2E+01	2.0E+02
Nickel	1.6E+01	6.5E+01	1.9E+03
Selenium[b]	1.8E+01	5.0E+00	2.2E+00
Silver	1.0E-01	8.3E+00	1.1E+02
Thallium[b]	4.4E+01	7.1E+01	9.6E+01
Vanadium[a]		1.0E+03	
Zinc	1.6E+01	6.2E+01	5.3E+02

[a] Geometric mean measured value from Baes et al., 1984 (pH-dependent values not available).
[b] Determined using an empirical pH-dependent relationship (Figure 10).
[c] SCDM = Superfund Chemical Data Matrix (pH-dependent values not available).

Barium. For ground water pH conditions, MINTEQ-estimated K_d values for barium range from 11 to 52 L/kg. This range correlates well with the value of 60 L/kg reported by Baes et al. (1984). Battelle (1989) reports a range in K_d values from 530 to 16,000 L/kg for a pH range of 5 to 9. The model-predicted K_d values for barium are several orders of magnitude less than the measured values, possibly due to the lower sorptive potential of iron oxide, used as the modeled sorbent, relative to clay, a sorbent present in the experimental systems reported by Battelle (1989).

Beryllium. The K_d values estimated for beryllium range from 23 to 100,000 L/kg for the conditions studied. AECL (1990) reports medians of observed values for K_d ranging from 250 L/kg for sand to 3,000 L/kg for organic matter. Baes et al. (1984) report a value of 650 L/kg. Battelle (1989) reports a range of K_d values from 70 L/kg for sand to 8,000 L/kg for clay. MINTEQ results for medium ground water pH (i.e., a value of 6.8) yields a K_d value of 790 L/kg. Hence, there is reasonable agreement between the MINTEQ-predicted K_d values and values reported in the literature.

Cadmium. For the three pH conditions, MINTEQ K_d values for cadmium range from 15 to 4,300 L/kg, with a value of 75 at a pH of 6.8. The range in experimentally determined K_d values for cadmium is as follows: 1.26 to 26.8 L/kg (Baes et al., 1983), 32 to 50 L/kg (Coughtrey et al., 1985), 14.9 to 567 L/kg (Battelle, 1989), and 2.7 to 17,000 L/kg (AECL, 1990). Thus the MINTEQ estimates are generally within the range of measured values.

Chromium (+3). MINTEQ-estimated K_d values for chromium (+3) range from 1,200 to 4,300,000 L/kg. Battelle (1989) reports a range of K_d values of 168 to 3,600 L/kg, orders of

magnitude lower than the MINTEQ values. This difference may reflect the measurements of mixed systems comprised of both chromium (+3) and (+6). The incorporation of chromium (+6) would tend to lower the K_d. Because the model-predicted values may overpredict sorption, the user should exercise care in the use of these values. Values for chromium (+6) should be used where speciation is mixed or uncertain.

Chromium (+6). Chromium (+6) K_d values estimated using the empirical pH-dependent adsorption relationship range from 31 to 14 L/kg for pH values of 4.9 to 8.0. Battelle (1989) reports a range of 16.8 to 360 L/kg for chromium (+6) and Baes and Sharp (1983) report a range of 1.2 to 1,800. The predicted chromium (+6) K_d values thus generally agree with the lower end of the range of measured values and the average measured values (37) reported by Baes and Sharp (1983). These values represent conservative estimates of mobility the more toxic of the chromium species.

Mercury (+2). MINTEQ-estimated K_d values for mercury (+2) range from 0.04 to 200 L/kg. These model-predicted estimates are less than the measured range of 322 to 5,280 L/kg reported by Battelle (1989). This difference may reflect the limited thermodynamic database with respect to mercury and/or that only the divalent oxidation state is considered in the simulation. Allison (1993) reviewed the model results in comparison to the measured values reported by Battelle (1989) and found reasonable agreement between the two sets of data, given the uncertainty associated with laboratory measurements and model precision.

Nickel. MINTEQ-estimated K_d values for nickel range from 16 to 1,900 L/kg. These values agree well with measured values of approximately 20 L/kg (mean) and 12.2 to 650 L/kg, reported by Coughtrey et al. (1985) and Battelle (1989), respectively. These values also agree well with the value of 150 L/kg reported by Baes et al. (1984). However, the predicted values are at the low end of the range reported by the AECL (1990)—60 to 4,700 L/kg.

Selenium. Empirically derived K_d values for selenium range from 2.2 to 18 L/kg for pH values of 8.0 to 4.9. The range in experimentally determined K_d values for selenium is as follows: less than 9 L/kg (Coughtrey et al., 1985), 5.9 to 14.9 L/kg (Battelle, 1989), and 150 to 1,800 L/kg (AECL, 1990). Baes et al. (1984) reported a value of 300 L/kg. Although they are significantly below the values presented by the AECL (1990) and Baes et al. (1984), the MINTEQ-predicted K_d values correlate well with the values reported by Coughtrey et al. (1985) and Battelle (1989).

Silver. The K_d values estimated for silver range from 0.10 to 110 L/kg for the conditions studied. The range in experimentally determined K_d values for silver is as follows: 2.7 to 33,000 L/kg (AECL, 1990), 10 to 1,000 L/kg (Baes et al., 1984), 50 L/kg (Coughtrey et al., 1985), and 0.4 to 40 L/kg (Battelle, 1989). The model-predicted K_d values agree well with the values reported by Coughtrey et al. (1985) and Battelle (1989) but are at the lower end of the ranges reported by AECL (1990) and Baes et al. (1984).

Thallium. Empirically derived K_d values for thallium range from 44 to 96 L/kg for pH values of 4.9 to 8.0. Generally, these values are about an order of magnitude greater than those reported by Battelle (1989)—0.0 to 0.8 L/kg - but are well below the value predicted by Baes et al. (1984).

Zinc. MINTEQ-estimated K_d values for zinc range from 16 to 530 L/kg. These estimated K_d values are within the range of measured K_d values reported by the AECL (1990) (0.1 to 100,000 L/kg) and Baes et al. (1984) (0.1 to 8,000 L/kg). Coughtrey et al. (1985) reported a K_d value for zinc of greater than or equal to 20 L/kg.

5.4.5 Analysis of Peer-Review Comments. A peer review was conducted of the model assumptions and inputs used to estimate K_d values for SSL application. This review identified several issues of concern, including:

- The charge balance exceeds an acceptable margin of difference (5 percent) in most of the simulations. A variance in excess of 5 percent may indicate that the model problem is not correctly chemically poised and therefore the results may not be chemically meaningful.

- The model should not allow sulfate to adsorb to the iron oxide. Sulfate is a weakly outer-sphere adsorbing species and, by including the adsorption reaction, sulfate is removed from the aqueous phase at pH values less than 7 and is prevented from participating in precipitation reaction at these pH values.

- Modeled K_d values for barium and zinc could not be reproduced for all studied conditions.

A technical analysis of these concerns indicated that, although these comments were based on true observations about the model results, these factors do not compromise the validity of the MINTEQ results in this application. This technical analysis is provided in Appendix M.

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APPENDIX A

Generic SSLs

APPENDIX A

Generic SSLs

Table A-1 provides generic SSLs for 110 chemicals. Generic SSLs are derived using default values in the standardized equations presented in Part 2 of this document. The default values (listed in Table A-2) are conservative and are likely to be protective for the majority of site conditions across the nation.

However, the generic SSLs are not necessarily protective of all known human exposure pathways, reasonable land uses, or ecological threats. Thus, before applying generic SSLs at a site, it is extremely important to compare the conceptual site model (see the *User's Guide)* with the assumptions behind the SSLs to ensure that the site conditions and exposure pathways match those used to develop generic SSLs (see Parts 1 and 2 and Table A-2). If this comparison indicates that the site is more complex than the SSL scenario, or that there are significant exposure pathways **not** accounted for by the SSLs, then generic SSLs are not sufficient for a full evaluation of the site. A more detailed site-specific approach will be necessary to evaluate the additional pathways or site conditions.

Generic SSLs are presented separately for major pathways of concern in both surface and subsurface soils. The first column to the right of the chemical name presents levels based on direct ingestion of soil and the second column presents levels based on inhalation. As discussed in the *User's Guide*, the fugitive dust pathway may be of concern for certain metals but does not appear to be of concern for organic compounds. Therefore, SSLs for the fugitive dust pathway are only presented for inorganic compounds. Except for mercury, no SSLs for the inhalation of volatiles pathway are provided for inorganic compounds because these chemicals are not volatile.

The user should note that several of the generic SSLs for the inhalation of volatiles pathway are determined by the soil saturation concentration (C_{sat}), which is used to address and screen the potential presence of nonaqueous phase liquids (NAPLs). As explained in Section 2.4.4, for compounds that are liquid at ambient soil temperature, concentrations above C_{sat} indicate a potential for free-phase liquid contamination to be present and the need for additional investigation.

The third column presents generic SSL values for the migration to ground water pathway developed using a default DAF (dilution-attenuation factor) of 20 to account for natural processes that reduce contaminant concentrations in the subsurface (see Section 2.5.6). SSLs in Table A-1 are rounded to two significant figures except for values less than 10, which are rounded to one significant figure. Note that the 20 DAF values in Table A-1 are not exactly 20 times the 1 DAF values because each SSL is calculated independently in both the 20 DAF and 1 DAF columns, with the final value presented according to the aforementioned rounding conventions.

The fourth column contains the generic SSLs for the migration to ground water pathway developed assuming no dilution or attenuation between the source and the receptor well (i.e., a DAF of 1). These values can be used at sites where little or no dilution or attenuation of soil leachate concentrations is expected at a site (e.g., sites with shallow water tables, fractured media, karst topography, or source size greater than 30 acres).

Generally, if an SSL is not exceeded for a pathway of concern, the user may eliminate the pathway or areas of the site from further investigation. If more than one exposure pathway is of concern, the lowest SSL should be used.

Table A-1. Generic SSLs [a]

Organics				Migration to ground water	
CAS No.	**Compound**	**Ingestion (mg/kg)**	**Inhalation volatiles (mg/kg)**	**20 DAF (mg/kg)**	**1 DAF (mg/kg)**
83-32-9	Acenaphthene	4,700 [b]	--- [c]	570 [b]	29 [b]
67-64-1	Acetone	7,800 [b]	1.0E+05 [d]	16 [b]	0.8 [b]
309-00-2	Aldrin	0.04 [e]	3 [e]	0.5 [e]	0.02 [e]
120-12-7	Anthracene	23,000 [b]	--- [c]	12,000 [b]	590 [b]
56-55-3	Benz(*a*)anthracene	0.9 [e]	--- [c]	2 [e]	0.08 [e,f]
71-43-2	Benzene	22 [e]	0.8 [e]	0.03	0.002 [f]
205-99-2	Benzo(*b*)fluoranthene	0.9 [e]	--- [c]	5 [e]	0.2 [e,f]
207-08-9	Benzo(*k*)fluoranthene	9 [e]	--- [c]	49 [e]	2 [e]
65-85-0	Benzoic acid	3.1E+05 [b]	--- [c]	400 [b,i]	20 [b,i]
50-32-8	Benzo(*a*)pyrene	0.09 [e,f]	--- [c]	8	0.4
111-44-4	Bis(2-chloroethyl)ether	0.6 [e]	0.2 [e,f]	0.0004 [e,f]	2E-05 [e,f]
117-81-7	Bis(2-ethylhexyl)phthalate	46 [e]	31,000 [d]	3,600	180
75-27-4	Bromodichloromethane	10 [e]	3,000 [d]	0.6	0.03
75-25-2	Bromoform	81 [e]	53 [e]	0.8	0.04
71-36-3	Butanol	7,800 [b]	10,000 [d]	17 [b]	0.9 [b]
85-68-7	Butyl benzyl phthalate	16,000 [b]	930 [d]	930 [d]	810 [b]
86-74-8	Carbazole	32 [e]	--- [c]	0.6 [e]	0.03 [e,f]
75-15-0	Carbon disulfide	7,800 [b]	720 [d]	32 [b]	2 [b]
56-23-5	Carbon tetrachloride	5 [e]	0.3 [e]	0.07	0.003 [f]
57-74-9	Chlordane	0.5 [e]	20 [e]	10	0.5
106-47-8	*p*-Chloroaniline	310 [b]	--- [c]	0.7 [b]	0.03 [b,f]
108-90-7	Chlorobenzene	1,600 [b]	130 [b]	1	0.07
124-48-1	Chlorodibromomethane	8 [e]	1,300 [d]	0.4	0.02
67-66-3	Chloroform	100 [e]	0.3 [e]	0.6	0.03
95-57-8	2-Chlorophenol	390 [b]	53,000 [d]	4 [b,i]	0.2 [b,f,i]
218-01-9	Chrysene	88 [e]	--- [c]	160 [e]	8 [e]
72-54-8	DDD	3 [e]	--- [c]	16 [e]	0.8 [e]
72-55-9	DDE	2 [e]	--- [c]	54 [e]	3 [e]
50-29-3	DDT	2 [e]	--- [g]	32 [e]	2 [e]
53-70-3	Dibenz(*a,h*)anthracene	0.09 [e,f]	--- [c]	2 [e]	0.08 [e,f]
84-74-2	Di-*n*-butyl phthalate	7,800 [b]	2,300 [d]	2,300 [d]	270 [b]
95-50-1	1,2-Dichlorobenzene	7,000 [b]	560 [d]	17	0.9
106-46-7	1,4-Dichlorobenzene	27 [e]	--- [g]	2	0.1 [f]
91-94-1	3,3-Dichlorobenzidine	1 [e]	--- [c]	0.007 [e,f]	0.0003 [e,f]
75-34-3	1,1-Dichloroethane	7,800 [b]	1,300 [b]	23 [b]	1 [b]
107-06-2	1,2-Dichloroethane	7 [e]	0.4 [e]	0.02	0.001 [f]
75-35-4	1,1-Dichloroethylene	1 [e]	0.07 [e]	0.06	0.003 [f]
156-59-2	*cis*-1,2-Dichloroethylene	780 [b]	1,200 [d]	0.4	0.02
156-60-5	*trans*-1,2-Dichloroethylene	1,600 [b]	3,100 [d]	0.7	0.03
120-83-2	2,4-Dichlorophenol	230 [b]	--- [c]	1 [b,i]	0.05 [b,f,i]

Table A-1 (continued)

Organics				**Migration to ground water**	
CAS No.	**Compound**	**Ingestion (mg/kg)**	**Inhalation volatiles (mg/kg)**	**20 DAF (mg/kg)**	**1 DAF (mg/kg)**
78-87-5	1,2-Dichloropropane	9 [e]	15 [b]	0.03	0.001 [f]
542-75-6	1,3-Dichloropropene	4 [e]	0.1 [e]	0.004 [e]	0.0002 [e]
60-57-1	Dieldrin	0.04 [e]	1 [e]	0.004 [e]	0.0002 [e,f]
84-66-2	Diethylphthalate	63,000 [b]	2,000 [d]	470 [b]	23 [b]
105-67-9	2,4-Dimethylphenol	1,600 [b]	--- [c]	9 [b]	0.4 [b]
51-28-5	2,4-Dinitrophenol	160 [b]	--- [c]	0.3 [b,f,i]	0.01 [b,f,i]
121-14-2	2,4-Dinitrotoluene	0.9 [e]	--- [c]	0.0008 [e,f]	4E-05 [e,f]
606-20-2	2,6-Dinitrotoluene	0.9 [e]	--- [c]	0.0007 [e,f]	3E-05 [e,f]
117-84-0	Di-*n*-octyl phthalate	1,600 [b]	10,000 [d]	10,000 [d]	10,000 [d]
115-29-7	Endosulfan	470 [b]	--- [c]	18 [b]	0.9 [b]
72-20-8	Endrin	23 [b]	--- [c]	1	0.05
100-41-4	Ethylbenzene	7,800 [b]	400 [d]	13	0.7
206-44-0	Fluoranthene	3,100 [b]	--- [c]	4,300 [b]	210 [b]
86-73-7	Fluorene	3,100 [b]	--- [c]	560 [b]	28 [b]
76-44-8	Heptachlor	0.1 [e]	4 [e]	23	1
1024-57-3	Heptachlor epoxide	0.07 [e]	5 [e]	0.7	0.03
118-74-1	Hexachlorobenzene	0.4 [e]	1 [e]	2	0.1 [f]
87-68-3	Hexachloro-1,3-butadiene	8 [e]	8 [e]	2	0.1 [f]
319-84-6	α-HCH (α-BHC)	0.1 [e]	0.8 [e]	0.0005 [e,f]	3E-05 [e,f]
319-85-7	β-HCH (β-BHC)	0.4 [e]	--- [g]	0.003 [e]	0.0001 [e,f]
58-89-9	γ-HCH (Lindane)	0.5 [e]	--- [c]	0.009	0.0005 [f]
77-47-4	Hexachlorocyclopentadiene	550 [b]	10 [b]	400	20
67-72-1	Hexachloroethane	46 [e]	55 [e]	0.5 [e]	0.02 [e,f]
193-39-5	Indeno(1,2,3-*cd*)pyrene	0.9 [e]	--- [c]	14 [e]	0.7 [e]
78-59-1	Isophorone	670 [e]	4,600 [d]	0.5 [e]	0.03 [e,f]
7439-97-6	Mercury	23 [b,l]	10 [b,i]	2 [i]	0.1 [i]
72-43-5	Methoxychlor	390 [b]	--- [c]	160	8
74-83-9	Methyl bromide	110 [b]	10 [b]	0.2 [b]	0.01 [b,f]
75-09-2	Methylene chloride	85 [e]	13 [e]	0.02 [e]	0.001 [e,f]
95-48-7	2-Methylphenol	3,900 [b]	--- [c]	15 [b]	0.8 [b]
91-20-3	Naphthalene	3,100 [b]	--- [c]	84 [b]	4 [b]
98-95-3	Nitrobenzene	39 [b]	92 [b]	0.1 [b,f]	0.007 [b,f]
86-30-6	*N*-Nitrosodiphenylamine	130 [e]	--- [c]	1 [e]	0.06 [e,f]
621-64-7	*N*-Nitrosodi-*n*-propylamine	0.09 [e,f]	--- [c]	5E-05 [e,f]	2E-06 [e,f]
1336-36-3	PCBs	1 [h]	--- [h]	--- [h]	--- [h]
87-86-5	Pentachlorophenol	3 [e,j]	--- [c]	0.03 [f,i]	0.001 [f,i]
108-95-2	Phenol	47,000 [b]	--- [c]	100 [b]	5 [b]
129-00-0	Pyrene	2,300 [b]	--- [c]	4,200 [b]	210 [b]
100-42-5	Styrene	16,000 [b]	1,500 [d]	4	0.2
79-34-5	1,1,2,2-Tetrachloroethane	3 [e]	0.6 [e]	0.003 [e,f]	0.0002 [e,f]

Table A-1 (continued)

Organics				Migration to ground water	
CAS No.	Compound	Ingestion (mg/kg)	Inhalation volatiles (mg/kg)	20 DAF (mg/kg)	1 DAF (mg/kg)
127-18-4	Tetrachloroethylene	12 [e]	11 [e]	0.06	0.003 [f]
108-88-3	Toluene	16,000 [b]	650 [d]	12	0.6
8001-35-2	Toxaphene	0.6 [e]	89 [e]	31	2
120-82-1	1,2,4-Trichlorobenzene	780 [b]	3,200 [d]	5	0.3 [f]
71-55-6	1,1,1-Trichloroethane	--- [c]	1,200 [d]	2	0.1
79-00-5	1,1,2-Trichloroethane	11 [e]	1 [e]	0.02	0.0009 [f]
79-01-6	Trichloroethylene	58 [e]	5 [e]	0.06	0.003 [f]
95-95-4	2,4,5-Trichlorophenol	7,800 [b]	--- [c]	270 [b,i]	14 [b,i]
88-06-2	2,4,6-Trichlorophenol	58 [e]	200 [e]	0.2 [e.f.i]	0.008 [e,f,i]
108-05-4	Vinyl acetate	78,000 [b]	1,000 [b]	170 [b]	8 [b]
75-01-4	Vinyl chloride	0.3 [e]	0.03 [e]	0.01 [f]	0.0007 [f]
108-38-3	*m*-Xylene	1.6E+05 [b]	420 [d]	210	10
95-47-6	*o*-Xylene	1.6E+05 [b]	410 [d]	190	9
106-42-3	*p*-Xylene	1.6E+05 [b]	460 [d]	200	10

Table A-1 (continued)

Inorganics				Migration to ground water	
CAS No.	Compound	Ingestion (mg/kg)	Inhalation fugitive particulate (mg/kg)	20 DAF (mg/kg)	1 DAF (mg/kg)
7440-36-0	Antimony	31 [b]	--- [c]	5	0.3
7440-38-2	Arsenic	0.4 [e]	750 [e]	29 [i]	1 [i]
7440-39-3	Barium	5,500 [b]	6.9E+05 [b]	1,600 [i]	82 [i]
7440-41-7	Beryllium	0.1 [e]	1,300 [e]	63 [i]	3 [i]
7440-43-9	Cadmium	78 [b,m]	1,800 [e]	8 [i]	0.4 [i]
7440-47-3	Chromium (total)	390 [b]	270 [e]	38 [i]	2 [i]
16065-83-1	Chromium (III)	78,000 [b]	--- [c]	--- [g]	--- [g]
18540-29-9	Chromium (VI)	390 [b]	270 [e]	38 [i]	2 [i]
57-12-5	Cyanide (amenable)	1,600 [b]	--- [c]	40	2
7439-92-1	Lead	400 [k]	--- [k]	--- [k]	--- [k]
7440-02-0	Nickel	1,600 [b]	13,000 [e]	130 [i]	7 [i]
7782-49-2	Selenium	390 [b]	--- [c]	5 [i]	0.3 [i]
7440-22-4	Silver	390 [b]	--- [c]	34 [b,i]	2 [b,i]
7440-28-0	Thallium	--- [c]	--- [c]	0.7 [i]	0.04 [i]
7440-62-2	Vanadium	550 [b]	--- [c]	6,000 [b]	300 [b]
7440-66-6	Zinc	23,000 [b]	--- [c]	12,000 [b,i]	620 [b,i]

DAF = Dilution and attenuation factor.

[a] Screening levels based on human health criteria only.

[b] Calculated values correspond to a noncancer hazard quotient of 1.

[c] No toxicity criteria available for that route of exposure.

[d] Soil saturation concentration (C_{sat}).

[e] Calculated values correspond to a cancer risk level of 1 in 1,000,000.

[f] Level is at or below Contract Laboratory Program required quantitation limit for Regular Analytical Services (RAS).

[g] Chemical-specific properties are such that this pathway is not of concern at any soil contaminant concentration.

[h] A preliminary remediation goal of 1 mg/kg has been set for PCBs based on *Guidance on Remedial Actions for Superfund Sites with PCB Contamination* (U.S. EPA, 1990) and on EPA efforts to manage PCB contamination.

[i] SSL for pH of 6.8.

[j] Ingestion SSL adjusted by a factor of 0.5 to account for dermal exposure.

[k] A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA, 1994).

[l] SSL is based on RfD for mercuric chloride (CAS No. 007487-94-7).

[m] SSL is based on dietary RfD.

Table A-2. Generic SSLs: Default Parameters and Assumptions

Parameter	SSL pathway: Inhalation	SSL pathway: Migration to ground water	Default
Source Characteristics			
Continuous vegetative cover	●		50 percent
Roughness height	❍		0.5 cm for open terrain; used to derive $U_{t,7}$
Source area (A)	●	❍	0.5 acres (2,024 m^2); used to derive L for MTG
Source length (L)		●	45 m (assumes square source)
Source depth		❍	Extends to water table (i.e., no attenuation in unsaturated zone)
Soil Characteristics			
Soil texture	❍	❍	Loam; defines soil characteristics/ parameters
Dry soil bulk density (ρ_b)	●	●	1.5 kg/L
Soil porosity (n)	●	❍	0.43
Vol. soil water content (θ_w)	●	●	0.15 (INH); 0.30 (MTG)
Vol. soil air content (θ_a)	●	●	0.28 (INH); 0.13 (MTG)
Soil organic carbon (f_{oc})	●	●	0.006 (0.6%, INH); 0.002 (0.2 %, MTG)
Soil pH	❍	❍	6.8; used to determine pH-specific K_d (metals) and K_{oc} (ionizable organics)
Mode soil aggregate size	❍		0.5 mm; used to derive $U_{t,7}$
Threshold windspeed @ 7 m ($U_{t,7}$)	●		11.32 m/s
Meteorological Data			
Mean annual windspeed (U_m)	●		4.69 m/s (Minneapolis, MN)
Air dispersion factor (Q/C)	●		90th percentile conterminous U.S.
Volatilization Q/C	●		68.81; Los Angeles, CA; 0.5-acre source
Fugitive particulate Q/C	●		90.80; Minneapolis, MN; 0.5-acre source
Hydrogeologic Characteristics			
Hydrogeologic setting		❍	Generic (national); surficial aquifer
Dilution/attenuation factor (DAF)		●	20

● Indicates input parameters directly used in SSL equations.
❍ Indicates parameters/assumptions used to develop SSL input parameters.
INH = Inhalation pathway.
MTG = Migration to ground water pathway.

Analysis of Effects of Source Size on Generic SSLs

A large number of commenters on the December 1994 Soil Screening Guidance suggested that most contaminated soil sources were 0.5 acre or less. Before changing this default assumption from 30 acres to 0.5 acre, the Office of Emergency and Remedial Response (OERR) conducted an analysis of the effects of changing the area of a contaminated soil source on generic SSLs calculated for the inhalation and migration to ground water exposure pathways. This analysis includes:

- An analysis of the sensitivity of SSLs to a change in source area from 30 acres to 0.5 acre
- Mass-limit modeling results showing the depth of contamination for a 30-acre source that corresponds to a 0.5-acre SSL.

All equations, assumptions, and model input parameters used in this analysis are consistent with those described in Part 2 of this document unless otherwise indicated. Chemical properties used in the analysis are described in Part 5 of this document.

In summary, the results of this analysis indicate that:

- The SSLs are not particularly sensitive to varying the source area from 30 acres to 0.5 acre. This reduction in source area lowers SSLs for the inhalation pathway by about a factor of 2 and lowers SSLs for the migration to ground water pathway by a factor of 2.9 under typical hydrogeologic conditions.
- Half-acre SSLs calculated for 43 volatile and semivolatile contaminants using the infinite source models correspond to mass-limit SSLs for a 30-acre source uniformly contaminated to a depth of about 1 to 21 meters (depending on contaminant and pathway); the average depth is 8 meters for the inhalation pathway (21 contaminants) and 11 meters for the migration to ground water pathway (43 contaminants).

Sensitivity Analysis. For the inhalation pathway, source area affects the Q/C value (a measure of dispersion), which directly affects the final SSL and is not chemical-specific. Higher Q/C values result in higher SSLs. As shown in Table 3 (Section 2.4.3), the effect of area on the Q/C value is not sensitive to meteorological conditions, with the ratio of a 0.5-acre Q/C to a 30-acre Q/C ranging from 1.93 to 1.96 over the 29 conditions analyzed. Decreasing the source area from 30 acres to 0.5 acre will therefore increase inhalation SSLs by about a factor of 2.

For the migration to ground water pathway, source area affects the DAF, which also directly affects the final SSLs and is not chemical-specific. The sensitivity analysis for the dilution factor is more complicated than for Q/C because increasing source area (expressed as the length of source parallel to ground water flow) not only increases infiltration to the aquifer, which decreases the dilution factor, but also increases the mixing zone depth, which tends to increase the dilution factor. The first effect generally overrides the second (i.e., longer sources have lower dilution factors) except for very thick aquifers (see Section 2.5.7).

The sensitivity analysis described in Section 2.5.7 shows that the dilution model is most sensitive to the aquifer's Darcy velocity (i.e., hydraulic conductivity $\times$ hydraulic gradient). For a less conservative Darcy velocity (90th percentile), decreasing the source area from 30 acres to 0.5 acre increased the dilution factor by a factor of 3.1 (see Table 9, Section 2.5.7). For the conditions analyzed, decreasing the source area from 30 acres to 0.5 acre affected dilution factor from no increase to a factor of 4.3 increase. No increase in dilution factor for a 0.5-acre source was observed for the less conservative

(higher) aquifer thickness (46 m). In this case the decrease in mixing zone depth balances the decrease in infiltration rate for the smaller source.

Mass-Limit Analysis. The infinite source assumption is one of the more conservative assumptions inherent in the SSL models, especially for small sources. This assumption should provide adequate protection for sources with larger areas than those used to calculate SSLs. To test this hypothesis the SSL mass-limit models (Section 2.6) were used to calculate, for 43 volatile and semivolatile chemicals, the depth at which a mass-limit SSL for a 30-acre source is equal to a 0.5-acre infinite-source SSL.

The mass-limit models are simple mass-balance models that calculate SSLs based on the conservative assumption that the entire mass of contamination in a source either volatilizes (inhalation model) or leaches (migration to ground water model) over the exposure period of interest. These models were developed to correct the mass-balance violation in the infinite source models for highly volatile or soluble contaminants.

Table A-3 presents the results of this analysis. These results demonstrate that 0.5-acre infinite source SSLs are protective of uniformly contaminated 30-acre source areas of significant depth. For the 21 chemicals analyzed for the inhalation pathway, these source depths range up to 21 meters, with an average depth of 8 meters and a standard deviation of 5.7. For the migration to ground water pathway, source depths for 43 contaminants range to 21 meters, with an average of 11 meters and a standard deviation of 5.4.

References

U.S. EPA (Environmental Protection Agency). 1990. *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*. Office of Solid Waste and Emergency Response, Washington, DC. NTIS PB91-921206CDH.

U.S. EPA (Environmental Protection Agency). 1994. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*. Office of Solid Waste and Emergency Response, Washington, DC. Directive 9355.4-12.

Table A-3.Source Depth where 30-acre[a] Mass-Limit SSLs = 0.5-acre[b] Infinite-Source SSLs[c]

Chemical	Source depth (m)	
	Inhalation	Migration to ground water[c]
Acetone	NA	21
Benzene	8.1	12
Benzoic acid	NA	21
Bis(2-chloroethyl)ether	0.7	18
Bromodichloromethane	NA	13
Bromoform	0.9	11
Butanol	NA	20
Carbon disulfide	19	11
Carbon tetrachloride	11	6
Chlorobenzene	3.5	6
Chlorodibromomethane	NA	13
Chloroform	8.3	14
2-Chlorophenol	NA	4
1,2-Dichlorobenzene	NA	3
1,4-Dichlorobenzene	NA	3
1,1-Dichloroethane	9.1	15
1,2-Dichloroethane	5.6	18
1,1-Dichloroethylene	15	10
cis-1,2-Dichloroethylene	NA	15
trans-1,2-Dichloroethylene	NA	12
2,4-Dichlorophenol	NA	8
1,2-Dichloropropane	6.2	14
1,3-Dichloropropene	12	12
2,4-Dimethylphenol	NA	7
2,4-Dinitrophenol	NA	21
2,4-Dinitrotoluene	NA	11
2,6-Dinitrotoluene	NA	12
Ethylbenzene	NA	4
Methyl bromide	12	17
Methylene chloride	8.9	18
2-Methylphenol	NA	11
Nitrobenzene	0.5	13
1,1,2,2-Tetrachloroethane	1.6	11
Tetrachloroethylene	8.7	7
Toluene	NA	7
1,1,1-Trichloroethane	NA	9
1,1,2-Trichloroethane	3.4	14
Trichloroethylene	6.8	7
Vinyl acetate	4.6	20

Table A-3. (continued)

Chemical	Source depth (m)	
	Inhalation	Migration to ground water[c]
Vinyl chloride	21	13
m-Xylene	NA	4
o-Xylene	NA	4
p-Xylene	NA	4

NA = Risk-based SSL not available.

[a] Q/C = 35.15; DAF = 10.

[b] Q/C = 68.81; DAF = 20.

[c] Migration to ground water mass-limit analysis based on 70-yr exposure duration and 0.18 m/yr infiltration rate.

APPENDIX B

Route-to-Route Extrapolation of Inhalation Benchmarks

APPENDIX B

Route-to-Route Extrapolation of Inhalation Benchmarks

Introduction

For a number of the contaminants commonly found at Superfund sites, inhalation benchmarks for toxicity are not available from IRIS or HEAST. As pointed out by commenters to the December 1994 *Soil Screening Guidance*, ingestion SSLs tend to be higher than inhalation SSLs for most volatile chemicals with both inhalation and ingestion benchmarks. This suggests that ingestion SSLs may not be adequately protective for inhalation exposure to chemicals that lack inhalation benchmarks.

To address this concern, the Office of Emergency and Remedial Response (OERR) evaluated potential approaches for deriving inhalation benchmarks using route-to-route extrapolation from oral benchmarks (e.g., inhalation reference concentrations [RfCs] from oral reference doses [RfDs]). OERR evaluated Agency initiatives concerning route-to-route extrapolation, including: the potential reactivity of airborne toxicants (e.g., portal-of-entry effects), the pharmacokinetic behavior of toxicants for different routes of exposure (e.g., absorption by the gut versus absorption by the lung), and the significance of physicochemical properties in determining dose (e.g., volatility, speciation). During this process, OERR consulted with staff in the EPA Office of Research and Development (ORD) to identify appropriate techniques and key technical aspects in performing route-to-route extrapolation. The following sections describe OERR's analysis of route-to-route extrapolation and the conclusions reached regarding the use of extrapolated inhalation benchmarks to support inhalation SSLs.

B.1 Extrapolation of Inhalation Benchmarks

The first step taken in considering route-to-route extrapolation of inhalation benchmarks was to compare existing inhalation benchmarks to inhalation benchmarks extrapolated from oral studies. This comparison was important to determine whether a simple route-to-route extrapolation could provide a defensible inhalation benchmark for chemicals lacking appropriate inhalation studies. OERR identified nine chemicals found in IRIS (Integrated Risk Information System) that have verified RfDs and RfCs for noncancer effects, including three chemicals found in the SSL guidance (ethylbenzene, styrene, and toluene). Reference concentrations for inhalation exposure were extrapolated from oral reference doses for adults using the following formula:

$$\text{extrapolated RfC}\ \left(\text{mg/m}^3\right) = \text{RfD}\ \left(\text{mg/kg-d}\right) \times \frac{70\ \text{kg}}{20\ \text{m}^3/\text{d}}\ . \qquad \textbf{(B-1)}$$

It is important to note that dosimetric adjustments were not made to account for respiratory tract deposition efficiency and distribution; physical, biological, and chemical factors; and other aspects of exposure (e.g., discontinuous exposure) that affect uptake and clearance. Consequently, this simple extrapolation method relies on the implicit assumption that the route of administration is irrelevant to the dose delivered to a target organ, an assumption not supported by the principles of dosimetry or pharmacokinetics.

The limited data on noncarcinogens suggest that more volatile constituents tend to have extrapolated RfCs closer to the RfCs developed by EPA (i.e., extrapolated RfC within a factor of 3 of the RfC in IRIS). The less volatile chemicals (e.g., dichlorvos) tend to be below the RfCs developed by EPA workgroups by 1 to 3 orders of magnitude. Although this data set is insufficient to discern trends in extrapolated versus IRIS RfCs, two points are reasonably clear: (1) for some volatile chemicals, route-to-route extrapolation results in inhalation benchmarks reasonably close to the RfC, and (2) as volatility decreases and/or chemical speciation becomes important (e.g., hydrogen sulfide) with respect to environmental chemistry and toxicology, the uncertainty in extrapolated inhalation benchmarks is likely to increase.

For carcinogens, OERR identified 41 chemicals in IRIS for which oral cancer slope factors (CSF_{oral}) and inhalation unit risk factors (URFs) are available, including 23 chemicals covered under the SSL guidance. Unit risk factors for inhalation exposure were extrapolated from oral carcinogenic slope factors for adults using the following formula:

$$\text{URF}\ (\mu g/m^3)^{-1} = \frac{\text{CSF}_{\text{oral}}\ (\text{mg/kg-d})^{-1}}{70\ \text{kg}} \times 20\ m^3/d \times 10^{-3}\ \text{mg}/\mu g\ . \qquad \textbf{(B-2)}$$

Using the extrapolated URF, risk-specific air concentrations were calculated as a lifetime average exposure concentration as shown in equation B-3:

$$\text{extrapolated air concentration}\ \mu g/m^3 = \frac{\text{target risk}\ 10^{-6}}{\text{URF}\ (\mu g/m^3)^{-1}}\ . \qquad \textbf{(B-3)}$$

Not surprisingly, the risk-based (i.e., 10^{-6}) air concentrations in IRIS are the same as the air concentrations extrapolated from the CSF_{oral} for 30 of the 41 carcinogenic chemicals evaluated (at one significant figure). Historically, oral and inhalation slope factors have been based on oral studies for chemicals for which pharmacokinetic or portal-of-entry effects were considered insignificant. As a result, route of exposure extrapolations were often included in the development of the carcinogenic slope factors. However, the divergence of extrapolated air concentrations with risk-based (i.e., 10^{-6}) air concentrations in IRIS reflects newer methods in use at EPA that address portal-of-entry effects, dosimetry, and pharmacokinetic behavior. For example, 1,2-dibromomethane has an extrapolated 10^{-6} air concentration that is 2 orders of magnitude below the value in IRIS. This difference is probably attributable to differences in: (1) the endpoint for inhalation exposure (nasal cavity carcinoma) versus oral exposure (squamous cell carcinoma), and/or (2) portal-of-entry effects directly related to deposition physiology and absorption of 1,2-dibromomethane.

B.2 Comparison of Extrapolated Inhalation SSLs with Generic SSLs

Having performed a simple extrapolation of inhalation benchmarks, the next step was to compare the inhalation SSLs (SSL_{inh}) based on extrapolated data to the soil saturation concentrations* (C_{sat}) and generic SSLs for soil ingestion (SSL_{ing}) and ground water ingestion (SSL_{gw}). Table B-1 presents the 50 organic chemicals in the SSL guidance that lack inhalation benchmarks. The table presents oral benchmarks found in IRIS (columns 2 and 3) and extrapolated inhalation benchmarks as

* The derivation of C_{sat} and its significance is discussed in Section 2.4.4 of this Technical Background Document.

described in Equations B-1 and B-2 (columns 4 and 5). In addition, the table presents volatilization-based SSLs and SSLs based on particulate emissions derived from the extrapolated toxicity values. For each column of extrapolated inhalation SSLs in this table, values are truncated at 1,000,000 mg/kg because the soil concentration cannot be greater than 100 percent (i.e., 1,000,000 ppm).

B.2.1 Comparison of Extrapolated SSLs Based on Volatilization

The extrapolated SSL_{inh} for volatilization (SSL_{inh-v}) was calculated with Equation 4 in Section 2.4 using a chemical-specific volatilization factor (VF). In Table B-1, the SSL_{inh-v} values based on extrapolated inhalation benchmarks (column 6) are compared with the soil saturation concentration (C_{sat}, column 7) and generic migration to ground water SSLs assuming a dilution attenuation factor (DAF) of 20 (SSL_{gw}).

As described in Section 2.4.4, C_{sat} represents the concentration at which soil pore air is saturated with a chemical and maximum volatile emissions are reached. A comparison of the C_{sat} with the extrapolated SSL_{inh-v} values indicates that, for 36 of the 50 contaminants, SSL_{inh-v} exceeds the soil saturation concentration, often by several orders of magnitude. Because maximum volatile emissions occur at C_{sat}, these 36 contaminants are not likely to pose significant risks through the inhalation pathway, and therefore the lack of inhalation benchmarks is not likely to underestimate risk through the volatilization pathway.

For the remaining 14 contaminants with extrapolated SSL_{inh-v} values below C_{sat}, all are above the generic SSL_{gw} values. This analysis suggests that SSLs based on the migration-to-groundwater pathway are likely to be protective of the inhalation pathway as well. However, for sites where groundwater is not of concern, the SSLs based on ingestion may not necessarily be protective of the inhalation pathway. The analysis indicates that the extrapolated inhalation SSLs are below SSLs based on direct ingestion for the following chemicals: acetone, bromodichloromethane, chlorodibromomethane, cis-1,2-dichloroethylene, and *trans*-1,2-dichloroethylene. This analysis supports the **possibility** that the SSLs based on direct ingestion for the listed chemicals may not be adequately protective of inhalation exposures. However, a more rigorous evaluation of the route-to-route extrapolation methods used to derive the toxicity criteria for this analysis is warranted (refer to section B.3).

B.2.2 Comparison of Extrapolated SSLs Based on Particulate Emissions

The extrapolated particulate inhalation SSLs (SSL_{inh-p}) were calculated with Equation 4 in Section 2.4 using the particulate emission factor (PEF) of 1.32×10^9 m^3/kg. Table B-1 compares the SSL_{inh-p} values based on extrapolated benchmarks (column 10) and generic SSLs based on direct ingestion (SSL_{ing}, Column 9). This comparison indicates that the extrapolated SSL_{inh-p} values that are based on the PEF are well above the SSLs for soil ingestion. Thus, ingestion SSLs are likely to be protective of inhalation risks from fugitive dusts from surface soils.

B.3 Conclusions and Recommendations

Based on the results presented in this appendix, OERR reached several conclusions regarding route-to-route extrapolation of inhalation benchmarks for the development of generic inhalation SSLs. First, it is reasonable to assume that, for some contaminants, the lack of inhalation benchmarks may underestimate risks due to inhalation exposure. Of the 17 volatile organics for which both the ingestion and inhalation SSLs are based on IRIS benchmarks, all had inhalation SSLs that were below the ingestion SSLs. Nevertheless, generic SSLs for ground water ingestion (DAF of 20) are lower,

often significantly lower, than both extrapolated and IRIS-based inhalation SSLs with the exception of vinyl chloride, which is gaseous at ambient temperatures. Thus, at sites where ground water is of concern, migration to ground water SSLs generally will be protective from the standpoint of inhalation risk. However, if the ground water is not of concern at a site (e.g., if ground water below the site is not potable), the use of SSLs for soil ingestion may not be adequately protective of the inhalation pathway.

Second, the **extrapolated** SSL_{inh} values are not intended to be used as generic SSLs for site investigations; the **extrapolated** inhalation SSLs are useful in determining the potential for inhalation risks but should not be misused as SSLs. Route-to-route extrapolation methods must account for the relationship between physicochemical properties and absorption and distribution of toxicants, the significance of portal-of-entry effects, and the potential differences in metabolic pathways associated with the intensity and duration of inhalation exposure. However, methods required to generate sufficiently rigorous inhalation benchmarks have recently been developed by the ORD. A final guidance document was made available by ORD in November of 1995 that addresses many of the issues critical to the development of inhalation benchmarks described above. The document, entitled *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (U.S. EPA, 1994), describes the application of inhalation dosimetry to derive inhalation reference concentrations and represents the current state-of-the-science at EPA with respect to inhalation benchmark development. The fundamentals of inhalation dosimetry are presented with respect to toxicokinetics and the physicochemical properties of chemical contaminants.

Thus, at sites where the migration to ground water pathway is not of concern and a site manager determines that the inhalation pathway may be significant for contaminants lacking inhalation benchmarks, route-to-route extrapolation may be performed using EPA-approved methods on a case-by-case basis. Chemical-specific route-to-route extrapolations should be accompanied by a complete discussion of the data, underlying assumptions, and uncertainties identified in the extrapolation process. Extrapolation methods should be consistent with the EPA guidance presented in *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry*. If a route-to-route extrapolation is found not to be appropriate based on the ORD guidance, the information on extrapolated SSLs may be included as part of the uncertainty analysis of the baseline risk assessment for the site.

Reference

U.S. EPA (Environmental Protection Agency). 1994. *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry.* EPA/600/8-90/066F. Office of Research and Development, Washington, DC.

Table B-1. Comparison of Extrapolated Inhalation SSLs (SSL_{inh}) with Soil Concentrations (C_{sat}), and Migration to Ground Water (SSL_{gw})

	IRIS oral benchmarks		Extrapolated inhalation benchmarks		VF-based SSLs (mg/kg)				PEF-based SSLs (mg/kg)
Compound	**RfD (mg/kg-d)**	**CSF $(mg/kg\text{-}d)^{-1}$**	**RfC (mg/m^3)**	**URF $(mg/m^3)^{-1}$**	**Extrapolated volatilization $SSL_{inh\text{-}v}$**	**C_{sat}**	**Generic SSL_{gw} (DAF 20)**	**Generic SSL_{ing}**	**Extrapolated particulate $SSL_{inh\text{-}p}$**
Acenaphthene	6E-02		2.1E-01		48,000	181	570	4,700	>1,000,000
Acetone	1E-01		3.5E-01		**4,600**	**103,747**	**16**	**7,800**	>1,000,000
Anthracene	3E-01		1.1E+00		860,000	8	12,000	23,000	>1,000,000
Benz*(a)* anthracene		7.3 E-01		2.1E-04	110	22	2	0.9	15,000
Benzo*(b)* fluoranthene		7.3 E-01		2.1E-04	54	11	5	0.9	15,000
Benzo*(k)* fluoranthene		7.3 E-02		2.1E-05	4,600	6	49	9	150,000
Benzo*(a)* pyrene		7.3 E+00		2.1E-03	28	10	8	0.09	1,500
Benzoic acid	4E+00		1.4E+01		>1,000,000	363	400	310,000	>1,000,000
Bis(2-ethylhexyl)phthalate		1.4 E-02		4.0E-06	130,000	30,804	3,600	46	800,000
Bromodichloromethane		6.2 E-02		1.8E-05	**1.14**	**2,981**	**0.6**	**10**	180,000
Butanol	1E-01		3.5E-01		14,000	10,477	17	7,800	>1,000,000
Butyl benzyl phthalate	2E-01		7.0E-01		>1,000,000	928	930	16,000	>1,000,000
Carbazole		2.0 E-02		5.7E-06	1,100	153	0.6	32	560,000
p -Chloroaniline	4E-03		1.4E-02		4,100	2,632	0.7	310	>1,000,000
Chlorodibromomethane		8.4 E-02		2.4E-05	**1.5**	**1,260**	**0.4**	**8**	130,000
2-Chlorophenol	5E-03		1.8E-02		550	53,482	4	390	>1,000,000
Chrysene		7.3 E-03		2.1E-06	3,200	4	160	88	>1,000,000
DDD		2.4 E-01		6.9E-05	820	540	16	3	47,000
DDE		3.4 E-01		9.7E-05	620	3,218	54	2	33,000
Dibenz*(a,h)* anthracene		7.3 E+00		2.1E-03	120	57	2	0.09	1,500
Di-*n* -butyl phthalate	1E-01		3.5E-01		>1,000,000	2,279	2,300	7,800	>1,000,000
3,3'-Dichlorobenzidine,		4.5 E-01		1.3E-04	24	14	0	1	25,000
***cis* -1,2-Dichloroethylene**	1E-02		3.5E-02		**110**	**1,205**	**0.4**	**780**	>1,000,000
***trans* -1,2-Dichloroethylene**	2E-02		7.0E-02		**170**	**3,067**	**0.7**	**1,600**	>1,000,000
2,4-Dichlorophenol	3E-03		1.1E-02		2,500	4,419	1	240	>1,000,000
Diethylphthalate	8E-01		2.8E+00		>1,000,000	1,974	470	63,000	>1,000,000
2,4-Dimethylphenol	2E-02		7.0E-02		19,000	10,656	9	1,600	>1,000,000
2,4-Dinitrophenol	2E-03		7.0E-03		1,000	279	0.3	160	>1,000,000
2,4-Dinitrotoluene		6.8E-01		1.9E-04	4	182	0.0008	0.9	17,000
2,6-Dinitrotoluene		6.8E-01		1.9E-04	4	94	0.0007	0.9	17,000
Di-*n* -octyl phthalate	2E-02		7.0E-02		>1,000,000	9,984	10,000	1,600	>1,000,000
Endosulfan	6E-03		2.1E-02		18,000	7	18	470	>1,000,000
Endrin	3E-04		1.1E-03		2,500	18	1	23	>1,000,000
Fluoranthene	4E-02		1.4E-01		450,000	132	4300	3,100	>1,000,000

Table B-1. Comparison of Extrapolated Inhalation SSLs (SSL_{inh}) with Soil Concentrations (C_{sat}), and Migration to Ground Water (SSL_{gw})

Compound	IRIS oral benchmarks		Extrapolated inhalation benchmarks		VF-based SSLs (mg/kg)				PEF-based SSLs (mg/kg)
	RfD (mg/kg-d)	CSF $(mg/kg\text{-}d)^{-1}$	RfC (mg/m^3)	URF $(mg/m^3)^{-1}$	Extrapolated volatilization $SSL_{inh\text{-}v}$	C_{sat}	Generic SSL_{gw} (DAF 20)	Generic SSL_{ing}	Extrapolated particulate $SSL_{inh\text{-}p}$
Fluorene	4E-02		1.4E-01		75,000	164	560	3,100	>1,000,000
γ-Hexachlorocyclohexane		1.3 E+00		3.7E-04	3.1	44	0.009	0.5	8,600
Indeno*(* 1,2,3-*cd)* pyrene		7.3 E-01		2.1E-04	660	0.5	14	0.9	15,000
Isophorone		9.5 E-04		2.7E-07	720	4,570	0.5	670	>1,000,000
Methoxychlor	5E-03		1.8E-02		74,000	26	160	390	>1,000,000
2-Methylphenol	5E-02		1.8E-01		37,000	16,827	15	3,900	>1,000,000
Naphthalene	4E-02		1.4E-01		8,200	375	84	3,100	>1,000,000
N -Nitrosodiphenylamine		4.9 E-03		1.4E-06	1,000	275	1	130	>1,000,000
N-Nitrosodi-*n* -propylamine		7.0 E+00		2.0E-03	0.1	2,413	0.00005	0.09	1,600
Pentachlorophenol		1.2 E-01		3.4E-05	83	7,121	0.03	3	94,000
Phenol	6E-01		2.1E+00		400,000	22,588	100	47,000	>1,000,000
Pyrene	3E-02		1.1E-01		420,000	85	4,200	2,300	>1,000,000
2,4,5-Trichlorophenol	1E-01		3.5E-01		250,000	11,618	270	7,800	>1,000,000
m -Xylene	2E+00		7.0E+00		45,000	418	210	160,000	>1,000,000
o -Xylene	2E+00		7.0E+00		45,000	413	190	160,000	>1,000,000
p -Xylene	2E+00		7.0E+00		41,000	461	200	160,000	>1,000,000

NR = $SSL_{inh\text{-}v}$ is greater than 1,000,000 ppm (= no volatile inhalation risk at any soil concentration)

Bold indicates where extrapolated SSL_{inh} values are less than SSL values based on direct ingestion.

APPENDIX C

Limited Validation of the Jury Infinite Source and Jury Finite Source Models (EQ, 1995)

LIMITED VALIDATION OF THE JURY INFINITE SOURCE AND JURY REDUCED SOLUTION FINITE SOURCE MODELS FOR EMISSIONS OF SOIL-INCORPORATED VOLATILE ORGANIC COMPOUNDS

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OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE
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SECTION 1

INTRODUCTION

In December 1995, the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response published the Draft Technical Background Document (TBD) for Soil Screening Guidance (U.S. EPA, 1994). This document provides the technical background behind the development of the Soil Screening Guidance for Superfund, and defines the Soil Screening Framework. The framework consists of a suite of methodologies for developing Soil Screening Levels (SSLs) for 107 chemicals commonly found at Superfund sites. An SSL is defined as "a chemical concentration in soil below which there is no concern under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) for ingestion, inhalation, and migration to ground water exposure pathways...." (U.S. EPA, 1994).

The SSL inhalation pathway considers exposure to vapor-phase contaminants emitted from soils. Inhalation pathway SSLs are calculated using air pathway fate and transport models. Currently, the models and assumptions used to calculate SSLs for inhalation of volatiles are updates of risk assessment methods presented in the Risk Assessment Guidance for Superfund (RAGS) Part B (U.S. EPA, 1991). The RAGS Part B methodology employs a reverse calculation of the concentration in soil of a given contaminant that would result in an acceptable risk-level in ambient air at the point of maximum long-term air concentration.

Integral to the calculation of the inhalation pathway SSLs for volatiles, is the soil-to-air volatilization factor (VF) which defines the relationship between the concentration of contaminants in soil and the volatilized contaminants in air. The VF (m^3/kg) is calculated as the inverse of the ambient air concentration at the center of a ground-level, nonbouyant area source of volatile emissions from soil. The equation for calculating the VF consists of two parts: 1) a volatilization model, and 2) an air dispersion model.

The volatilization model mathematically predicts volatilization of contaminants fully incorporated in soils as a diffusion-controlled process. The basic assumption in the mathematical treatment of the movement of volatile contaminants in soils under a concentration gradient is the applicability of the diffusion laws. The changes in contaminant concentration within the soil as well as the loss of contaminant at the soil surface by volatilization can then be predicted by solving the diffusion equation for different boundary conditions.

As noted in the TBD, Environmental Quality Management, Inc. (EQ) under a subcontract to E. H. Pechan conducted a preliminary evaluation of several soil volatilization models for the U.S. EPA Office of Emergency and Remedial Response (OERR) that might be suitable for addressing both infinite and finite sources of emissions (EQ, 1994). The results of this study indicated that simplified analytical solutions are presented in Jury et al. (1984 and 1990) for both infinite and finite emission sources. These analytical solutions are mathematically consistent and use a common theoretical approximation of the effective diffusion coefficient in soil. Under a subcontract with E. H. Pechan for OERR, EQ performed a limited validation of the Jury Infinite Source emission model (Jury et al., 1984, Equation 8) and the Jury Reduced Solution finite source emission model (Jury et al., 1990, Equation B1), hereinafter known as the Jury volatilization models.

This document reports on several studies in which volatilization of contaminants from soils was directly measured and data were obtained necessary to calculate emissions of contaminants using the Jury Infinite Source model and the Jury Reduced Solution finite source model. These data are then compared and analyzed by statistical methods to determine the relative accuracy of each model.

1.1 PROJECT OBJECTIVES

The primary objective of this project was to assess the relative accuracy of the Jury volatilization models using experimental emission flux data from previous studies as a reference data base.

1.2 TECHNICAL APPROACH

The following series of tasks comprised the technical approach for achieving the project objectives:

1. Review the theoretical basis and development of the Jury volatilization models to verify the applicable model boundary conditions and variables, and to document model assumptions and limitations.

2. Perform a literature search and survey (not to exceed nine contacts) for the purpose of determining the availability of acceptable emission flux data from experimental and field-scale measurement studies of volatile organic compound (VOC) emissions from soils. Acceptable data must have undergone proper quality assurance/quality control (QA/QC) procedures.

3. Determine if the emission flux measurement studies referred to in Task No. 2 also provided sufficient site data as input variables to the volatilization models. Again, acceptable variable input data must have undergone proper QA/QC procedures.

4. Review, collate, and normalize emission flux measurement data and volatilization model variable data, and compute chemical-specific emission rates for comparison to respective measured emission rates.

5. Perform statistical analysis of the results of Task No. 4 to establish the extent of correlation between measured and modeled values and perform parametric analysis of key model variables.

SECTION 2

REVIEW OF THE JURY VOLATILIZATION MODELS

The Jury Reduced Solution finite source volatilization model calculates the instantaneous emission flux from soil at time, t, as:

$$J_s = C_o\ e^{-m}\ (D_E/p\ t)^{1/2}\ \left[1\ - \exp\ (-L^2/4\ D_E\ t)\right] \qquad (1)$$

where J_s = Instantaneous emission flux, μg/cm^2 -day

C_o = Initial soil concentration (total volume), μg/cm^3-soil

μ = Degradation rate constant, 1 /day

t = Time, days

D_E = Effective diffusion coefficient, cm^2 /day

L = Depth from the soil surface to the bottom of contamination, cm

and,

$$DE\ =\ \left[(a^{10/3}\ D_g^a\ K_H\ +\ Q1^{10/3}\ D_i^w)/f^2\right]/(\rho_b\ f_{oc}\ K_{oc}\ +\ Q\ +\ a\ K_H) \qquad (2)$$

where D_E = Effective diffusion coefficient, cm^2 /day

a = Soil volumetric air content, cm^3/cm^3

D_g^a = Gaseous diffusion coefficient in air, cm^2/day

K_H = Henry's law constant, unitless

Θ = Soil volumetric water content, cm^3/cm^3

D_i^w = Liquid diffusion coefficient in pure water, cm^2/day

ϕ = Total soil porosity, unitless

ρ_b = Soil dry bulk density, g/cm^3

f_{oc} = Soil organic carbon fraction

K_{oc} = Organic carbon partition coefficient, cm^3/g.

The model assumes no boundary layer at the soil-air interface, no water flux through the soil, and an isotropic soil column contaminated uniformly to some depth L. The initial and boundary conditions for which Equation 1 is solved are:

$$c\ =\ C_0 \text{ at } t = 0,\ 0\ \leq\ x\ \leq\ L$$

$$c\ =\ 0 \text{ at } t = 0,\ x\ \succ\ L$$

$$c = 0 \text{ at } t \succ 0,\ x = 0$$

where c and C_o are, respectively, the soil concentration and initial soil concentration (g/cm^3-total volume), x is the distance measured normal to the soil surface (cm), and t is the time (days).

The average flux over time (J_s^{avg}) is computed by integrating the time-dependent flux over the exposure interval.

The Jury Infinite Source volatilization model calculates the instantaneous emission flux from soil at time, t, as:

$$J_s = C_0 (D_E/\pi t)^{1/2} \tag{3}$$

where J_s = Instantaneous emission flux, μg/cm^2-day

C_o = Initial soil concentration (total volume), μg/cm^3-soil

t = Time, days

D_E = Effective diffusion coefficient, cm^2/day (Equation 2).

The model assumes no boundary layer at the soil-air interface, no water flux through the soil, and an isotropic soil column contaminated uniformly to an infinite depth. The boundary conditions for which Equation 3 is solved are:

$$c = C_0 \text{ at } t \geq 0,\ x = \infty$$

$$c = O \text{ at } t > 0,\ x = 0$$

The average flux over time (J_s^{avg}) is calculated as:

$$J_s^{avg} = C_0 (4 D_E / \pi t)^{1/2} \tag{4}$$

2.1 FINITE SOURCE MODEL DERIVATION

The Jury Reduced Solution finite source model is derived from the methods presented by Mayer et al. (1974), and Carslaw and Jaeger (1959). Mayer et al. (1974) considered a system where pesticide is uniformly mixed with a layer of soil and volatilization occurs at the soil surface. If diffusion is the only mechanism supplying pesticide to the surface of an isotropic soil column, and if the diffusion coefficient, D_E, is assumed to be constant, the general diffusion equation is:

$$\frac{\partial^2 c}{\partial x^2} - \frac{1}{D_E} \frac{\partial c}{\partial t} = O \tag{5}$$

where c = Soil concentration, g/cm^3 - total volume

x = Distance measured normal to soil surface, cm

D_E = Effective diffusion coefficient in soil, cm^2/d

t = Time, days.

If the pesticide is rapidly removed by volatilization from the soil surface and is maintained at a zero concentration, the initial and boundary conditions which also allow for diffusion across the lower boundary at x = L are identical to those of Equation 1.

Recognizing the analogy between the heat transfer equation (Fourier's Law) and the transfer of matter under a concentration gradient (Fick's Law), Mayer et al. (1974) employed the heat transfer equation of Carslaw and Jaeger (1959, page 62, Equation 14) to solve the diffusion equation given these initial and boundary conditions as:

$$C = C_o/2)\{2 \text{ erf}\left[x/2(D_E t)^{1/2}\right] - \text{ erf}\left[(x - L)/2(D_E t)^{1/2}\right] - \text{ erf}\left[(x + L)/2(D_E t)^{1/2}\right]\} \quad (6)$$

The flux is obtained by differentiating Equation 6 with respect to x, determining $\partial c / \partial x$ at x = O. and multiplying by D_E. The result is:

$$J_s = D_E \left[\partial c/\partial x\right]_{x=o} = \left[D_E \; C_o / (\pi D_E t)^{1/2}\right]\left[1 - \exp(-L^2/4 D_E t)\right] \quad (7)$$

Note that Equation 7 is equivalent to the Jury Reduced Solution given in Equation 1 with the exception of the first-order degradation expression ($e^{-\mu t}$).

Jury et al. (1983 and 1990) expanded upon the work of Carslaw and Jaeger (1959) and Mayer et al. (1974) by developing an analytical solution for Equation 5 which includes water flux through the soil column and a soil-air boundary layer. In addition, the Jury et al. solution also includes a theoretical approximation of the effective diffusion coefficient (Equation 2) which was not included in Mayer et al. (1974). Given these conditions, the flux equation from Jury et aI (1983) is given as:

$$J_s = - D_E (\partial c_T/\partial x) + V_E C_T \quad (8)$$

where C_T = Soil total concentration

x = Depth normal to soil surface

V_E = Effective solute convection velocity.

The minus sign is used because the x direction is positive downward.

Given the initial and boundary conditions:

$c = C_o$ at t=0, $0 \leq x \leq L$

c = O at t=0, x > L

c = O at t>0, x = 0

$J_s = - hC_G$ at t>0, x = 0

where h = Transport coefficient across the soil-air boundary layer of thickness d ($h = D_g^a/d$)

C_G = Vapor-phase concentration ($C_G = K_H C_I$),

The Jury et al. (1983) analytical solution for the volatilization flux is:

$$J_s(t,L) = + \frac{1}{2} C_o V_E \left[\text{erfc}\left(\frac{V_E t}{2(D_E t)^{1/2}} \right) - \text{erfc}\left(\frac{L + V_E t}{2(D_E t)^{1/2}} \right) \right]$$

$$+ \frac{1}{2} C_o (2H_E + V_E) \exp\left(\frac{H_E (H_E + V_E)t}{D_E} \right) \tag{9}$$

$$x \left[\exp\left(\frac{H_E L}{D_E} \right) \text{erfc}\left(\frac{L + (2H_E + V_E)t}{2(D_E t)^{1/2}} \right) - \text{erfc}\left(\frac{(2H_E + V_E)t}{2(D_E t)^{1/2}} \right) \right]$$

where H_E Is the transport coefficient across the boundary layer divided by the gasphase partition coefficient, $H_E = h/(\rho_b f_{oc} K_{oc}/K_H + \Theta/K_H + a)$.

Jury et al. (1990) explains that compounds with large values of K_H are insensitive to the thickness of the soil-air boundary layer (i.e., as $H_E \rightarrow \infty$). Therefore, for the case where $H_E \rightarrow \infty$ and in the absence of water flux ($V_E = 0$) Equation 9 is reduced to Equation 1 where the approximation

$$\text{erfc}\,[x] = \frac{1}{(\pi)^{1/2}} \frac{e^{-x^2}}{x} \tag{10}$$

is used to expand the error function for large values of x (Carslaw and Jaeger, 1959).

The Jury Reduced Solution given in Equation 1 is therefore a reduced form of the analytical solution given in Equation 9 for the conditions of zero water flux and no soil-air boundary layer. As such, the Jury Reduced Solution (discounting degradation) is equivalent to the Mayer et al. (1974) solution for diffusion across both the upper and lower boundaries (Equation 7).

2.2 INFINITE SOURCE MODEL DERIVATION

The Jury Infinite Source volatilization model (Equation 3) is derived from Mayer et al. (1974) Equations 3 and 4. Mayer et al. (1974) employed the heat transfer equation of Carslaw and Jaeger (19SS, page 97, Equation 8) to solve the diffusion equation given the boundary conditions:

$$c = C_o \text{ at } t = 0,\ 0 \le x \le L$$

$$c = 0 \text{ at } t \succ 0,\ x = 0$$

$$\partial c / \partial x = 0 \text{ at } x = L$$

The Mayer et al. (1974) solution for the volatilization flux is:

$$J_s = D_E \left[\partial c / \partial x \right]_{x=0} = D_E C_o / (\pi D_E t)^{1/2} \left[1 + 2 \sum_{n=1}^{\infty} (-1)^n \exp(-n^2 L^2 / D_E t) \right] \tag{11}$$

Therefore, Equation 11 is the analytical solution for a finite emission source, but accounts only for diffusion across the upper boundary.

The summation expression in Equation 11 decreases with increasing L and decreasing D_E and t. If this term is small enough to be negligible, Equation 11 reduces to:

$$J_s = D_E C_o/(\pi D_E t)^{1/2} \quad (12)$$

Use of Equation 12 will result in less than 1 percent error if $t < L^2/18.4\ D_E$ (Mayer et al., 1974) .

Jury et al. (1984 and 1990) gave the solution for the semi-infinite case in Equation 3 where

$C = C_o$ at $t \geq 0$, $x = \infty$ as:

$$J_s = C_o(D_E/\pi t)^{1/2}$$

Equation 3 is equivalent to the semi-infinite solution of Mayer et al. (1974) as given in Equation 12 and provides a bounding estimate of the maximum volatilization flux but does not account for source depletion. As with Equation 12, use of Equation 3 on a finite system will result in less than 1 percent error if $t < L^2/18.4\ D_E$. For the purposes of calculating SSLs based on volatilization from soils, let t be set equal to the exposure interval. If $t < L^2/18.4\ D_E$, Equation 1 should be used to calculate the volatilization factor. As an alternative, an estimate of the average emission flux over the exposure interval, $\langle J_s \rangle$, can be obtained from a simple mass balance:

$$\langle J_s \rangle = C_o L/t \quad (13)$$

where C_o = Initial soil concentration (total volume), $\mu g/cm^3$-soil

L = Depth from soil surface to the bottom of contamination, cm

t = Exposure interval, days.

2.3 SUMMARY OF MODEL ASSUMPTIONS AND LIMITATIONS

The Jury Reduced Solution finite source volatilization model is analogous to the mathematical solution for heat flow in a solid such that the region $0 < x < L$ is initially at constant temperature, the region $x > L$ is at zero, and the surface $x = 0$ is maintained at zero for $t > 0$ (Carslaw and Jaeger, 1959). As such, the model's applicability to diffusion processes is limited to the initial and boundary conditions upon which the model is derived. The following represents the major model assumptions for these conditions:

1. Contamination is uniformly incorporated from the soil surface to depth L.
2. The soil column is isotropic to an infinite depth (i.e., uniform bulk density, soil moisture content, porosity and organic carbon fraction).
3. Liquid water flux is zero through the soil column (i.e., no leaching or evaporation).
4. No soil-air boundary layer exists.
5. The soil equilibrium liquid-vapor partitioning (Henry's law) is instantaneous.
6. The soil equilibrium adsorption isotherm is instantaneous, linear, and reversible.

7. Initial soil concentration is in dissolved form (i.e., no residual-phase contamination).

8. Diffusion occurs simultaneously across the upper boundary at $x = 0$ and the lower boundary at $x = L$.

The model is therefore limited to surface contamination extending to a known depth and cannot account for subsurface contamination covered by a layer of clean soil. Also, the model does not consider mass flow of contaminants due to water movement in the soil nor the volatilization rate of nonaqueous-phase liquids (residuals). Finally, the model does not account for the resistance of a soil-air boundary layer for contaminants with low Henry's law constants.

The Jury Infinite Source volatilization model is analogous to the mathematical solution for heat flow in a semi-infinite solid. The major model assumptions are the same as those of the Jury Reduced Solution finite source model except that the contamination is assumed to be uniformly incorporated from the soil surface to an infinite depth, and that diffusion occurs only across the upper boundary.

In general, both models describe the vapor-phase diffusion of the contaminants to the soil surface to replace that lost by volatilization to the atmosphere. Each model predicts an exponential decay curve over time once equilibrium is achieved. In actuality, there is a high initial flux rate from the soil as surface concentrations are depleted. The lower flux rate characteristics of the latter portion of the decay curve are thus determined by the rate at which contaminants diffuse upward. This type of desorption curve has been well documented in the literature. It is important to note that both models do not account for the high initial rate of volatilization before equilibrium is attained and will tend to underpredict emissions during this period. Finally, each model is most applicable to single chemical compounds fully incorporated into isotropic soils. Effective solubilities and activity coefficients in multicomponent systems are not addressed in the determination of the effective diffusion coefficient nor is the effect of nonlinear soil adsorption and desorption isotherms. However, because of the complexities involved with theoretical solutions to these effects, their contribution to model accuracy is difficult to predict, especially in multicomponent systems.

SECTION 3

MODEL VALIDATION

To achieve the project objective, EQ executed a literature search and a survey of professional environmental investigation/research firms as well as regulatory agencies to obtain experimental and field data suitable for comparing modeled emissions with actual emissions. The literature search uncovered several papers and bench-scale experimental studies concerned with the volatilization and vapor density of pesticides and chlorinated organics incorporated in soils (Farmer et al., 1972, 1974, and 1980; Spencer and Cliath, 1969 and 1970; Spencer, 1970; and Jury et al., 1980).

3.1 VALIDATION OF THE JURY INFINITE SOURCE MODEL

From the literature search, one bench-scale study was found that approximated the boundary conditions of the Jury Infinite Source model and met the data requirements for this project, Farmer et al., (1972). The Farmer et al. (1972) study reports the experimental emissions of lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer) and dieldrin (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, exo-5, 8-dimethanonapthalene) incorporated in Gila silt loam.

The objective of the survey of professional firms and regulatory agencies was to find pilot-scale or field-scale studies of volatilization of organic compounds using the U.S. EPA emission isolation flux chamber. The candidate flux chamber studies must also have provided adequate data for input to the volatilization models.

Flux chamber studies were chosen to provide pilot-scale or field-scale measurement data needed for model validation. Flux chambers have been widely used to measure flux rates of VOCs and inorganic gaseous pollutants from a wide variety of sources. The flux chamber was originally developed by soil scientists to measure biogenic emissions of inorganic gases and their use dates back at least two decades (Hill et al., 1978). In the early 1980's, EPA became interested in this technique for estimating emission rates from hazardous wastes and funded a series of projects to develop and evaluate the flux chamber method. The initial work involved the development of a design and approach for measuring flux rates from land surfaces. A test cell was constructed and parametric tests performed to assess chamber design and operation (Kienbusch and Ranum, 1986 and Kienbusch et al., 1986). A series of field tests were performed to evaluate the method under field conditions (Radian Corporation, 1984 and Balfour, et al., 1984). A user's guide was subsequently prepared summarizing guidance on the design, construction, and operation of the EPA recommended flux chamber (Keinbusch, 1985). The emission isolation flux chamber is presently considered the preferred in-depth direct measurement technique for emissions of VOCs from land surfaces (EPA, 1990).

EQ contacted several environmental consulting firms as well as State and local agencies. In addition, the EPA data base of emission flux measurement data was reviewed (EPA, 1991a). Although several flux measurement studies were found, only one applicable study was identified with adequate QA/QC documentation and the necessary input data for the Jury Infinite Source model (Radian Corporation, 1989).

From Farmer et al. (1972) the influence of pesticide vapor pressure on volatilization was measured by comparing the volatilization from Gila silt loam of dieldrin with that of lindane. Volatilization of dieldrin and lindane was measured in a closed airflow system by collecting the volatilized insecticides in ethylene glycol traps. Ten grams of soil were treated with either 5 or 10 μg/g of C-14 tagged insecticide in hexane. The hexane was evaporated by placing the soils in a

fume hood overnight. Sufficient water was then added to bring the initial soil water content to 10 percent. For the volatilization studies, the treated soil was placed in an aluminum pan 5 mm deep, 29 mm wide, and 95 mm long. This produced a bulk density of 0.75 g/cm^3. The aluminum pan was then introduced into a 250 mL bottle which served as the volatilization chamber. A relative humidity of 100 percent was maintained in the incoming air stream to prevent water evaporation from the soil surface. Air flow was maintained at 8 mL/s equivalent to approximately 0.018 miles per hour. The temperature was maintained at 30°C. The soil was a Gila silt loam, which contained 0.58 percent organic carbon.

The volatilized insecticides were trapped in 25 mL of ethylene glycol. Insecticides were extracted into hexane and anhydrous sodium sulfate was added to the hexane extract to remove water. Aliquots of the dried hexane were analyzed for lindane and dieldrin using liquid scintillation. The extraction efficiencies for lindane and dieldrin were 100 and 95 percent, respectively. The concentrations of volatilized compounds were checked using gas-liquid chromatography. All experiments were run in duplicate.

To ensure that the initial soil concentrations of lindane and dieldrin were in dissolved form, the saturation concentration (mg/kg) of both compounds under experimental conditions was calculated using the procedures given in U.S. EPA (1994):

$$C_{sat} = \frac{S}{\rho_b} (f_{oc} K_{oc} \rho_b + \Theta + K_H a) \qquad (14)$$

where S is the pure component solubility in water. C_{sat} for lindane and dieldrin were calculated to be 34 mg/kg and 12 mg/kg, respectively. Therefore, the initial soil concentrations of 10 and 5 mg/kg were below saturation for both compounds.

Table 1 gives the values of each variable employed to calculate the emissions of lindane and dieldrin using the Jury Infinite Source volatilization model (Equation 3). The potential for loss of contaminant at the lower boundary at each time-step was checked to see if $t > L^2/18.4\ D_E$. If this condition was true at any time-step, the boundary conditions of the infinite source model were violated. In such a case, emissions were also calculated using the finite source model of Mayer et al. (1974) as presented in Equation 11. The difference between the predictions of both models were compared at each time-step and a percent error was calculated for the infinite source model. The instantaneous emission flux values predicted by Equation 3 and Equation 11 (where applicable) were plotted against the measured flux values for dieldrin and lindane at both 5 and 10 ppmw.

Figure 1 shows the comparison of the predicted and measured values of dieldrin at an initial soil concentration of 5 ppmw. For dieldrin, the boundary conditions of the infinite source model were not violated until the last time-step. A best curve was fit to both the measured and predicted values. As expected, both curves indicate an exponential decrease in emissions with time.

The ratio of the modeled emission flux to the measured emission flux was determined as a measure of the relative difference between the modeled and measured values. The natural log of this ratio was then analyzed by using a standard paired Student's t-test. This analysis is equivalent to assuming a lognormal distribution for the emission flux and analyzing the logtransformed data for differences between modeled and measured values.

TABLE 1.
VOLATILIZATION MODEL INPUT VALUES FOR LINDANE AND DIELDRIN

Variable	Symbol	Units	Value	Reference/Equation
Initial soil concentration	C_o	mg/kg	5 and 10	Farmer et al. (1972)
Soil depth	L	cm	0.5	Farmer et al. (1972)
Soil dry bulk density	ρ_b	g/cm^3	0.75	Farmer et al. (1972)
Soil particle density	ρ_s	g/cm^3	2.65	U.S. EPA (1988)
Gravimetric soil moisture content	w	percent	10	Farmer et al. (1972)
Water-filled soil porosoty	Θ	cm^3/cm^3	0.075	$w\rho_s$
Total soil porosity	ϕ	cm^3/cm^3	0.717	$1-(\rho_b/\rho_s)$
Air-filled soil porosity	a	cm^3/cm^3	0.642	ϕ - Θ
Soil organic carbon	f_{oc}	fraction	0.0058	Farmer et al. (1972)
Organic carbon partition coefficient	K_{oc}	cm^3/g	1380	U.S. EPA (1994)
Diffusivity in air (Lindane)	D_g^a	cm^2/d	1521	U.S. EPA (1994)
Diffusivity in air (Dieldin)	D_g^a	cm^2/d	1080	U.S. EPA (1994)
Diffusivity in water (Lindane)	D_i^w	cm^2/d	0.480	U.S. EPA (1994a)
Diffusivity in water (Dieldrin)	D_i^w	cm^2/d	0.410	U.S. EPA (1994a)
Henry's law constant (Lindane)	K_H	unitless	1.40 E-04	U.S. EPA (1994)
Henry's law constant (Dieldrin)	K_H	unitless	2.75 E-06	U.S. EPA (1994)
Degradation rate constant (Lindane and Dieldrin)	μ	1/day	0	Default to eliminate effects of degradation

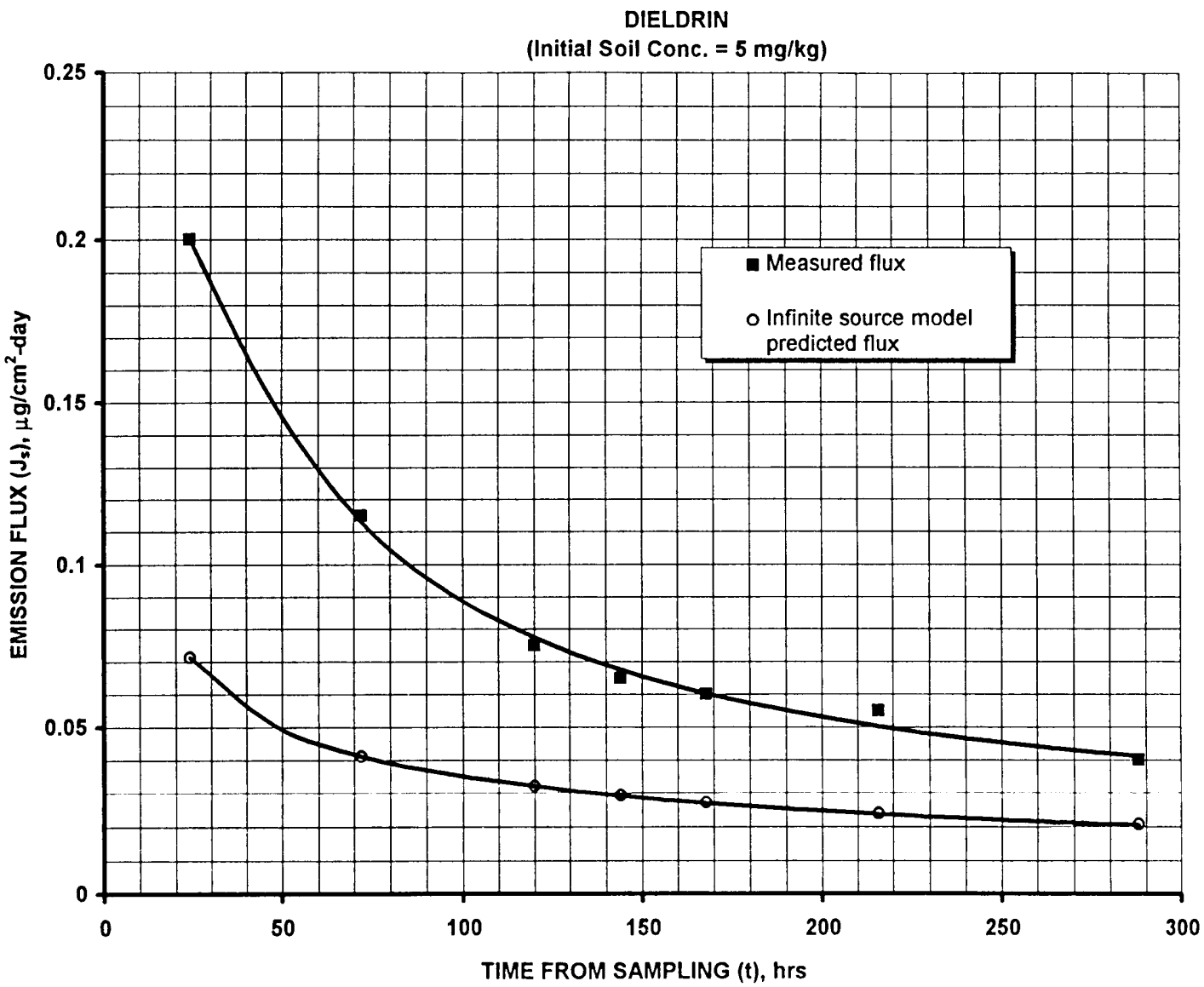

Figure 1
Predicted And Measured Emission Flux Of Dieldrin Versus Time (C_o = 5 ppmw)

The data were also analyzed by using standard linear regression techniques (Figure 2). Again, the data were assumed to follow a lognormal distribution. A simple linear regression model was fit to the log-transformed data and the Pearson correlation coefficient was determined. The Pearson correlation coefficient is a measure of the strength of the linear association between the two variables.

From a limited population of four observations, the correlation coefficient was calculated to be 0.994 with a mean ratio of modeled-to-measured values of 0.42. The actual significance (p-value) of the paired Student's t-test was $p = 0.0001$. The lower and upper confidence limits were calculated to be 0.38 and 0.48, respectively. On average, this indicates that at the 95 percent confidence limit, the modeled emission flux is between 0.38 and 0.48 times the measured emission flux.

Figure 3 shows the modeled and measured flux values of dieldrin at an initial soil concentration of 10 ppmw, while Figure 4 shows the relationship of the log-transformed data and the upper and lower confidence limits. At 10 ppmw, the correlation coefficient was 0.974 with a mean ratio of 0.45, p-value of 0.0001, and a 95 percent confidence interval of 0.37 to 0.54.

As can be seen from Figures 1 and 3, the model underpredicts the emissions during the initial stages of the experiment. This is to be expected in that during this phase, contaminant is evaporating from the soil surface. The apparent discrepancy between measured and predicted values decreases with time as equilibrium is achieved and diffusion becomes the rate-limiting factor.

For lindane, the boundary conditions of the infinite source model were violated after the first time-step (i.e., $t > L^2/18.4\ D_E$ at 24 hours). Therefore, the Mayer et al. (1974) finite source model was used to derive a percent error at each succeeding timestep. At an initial soil concentration of 5 ppmw, the infinite source model predicted 114 percent total mass loss of the finite source model over the entire time span of the experiment. At a concentration of 10 ppmw, the infinite source model predicted 107 percent total mass loss of the finite source model.

Figures 5 and 6 show the comparison of modeled to measured values of lindane at initial soil concentrations of 5 and 10 ppmw, respectively. Likewise, Figures 7 and 8 show the comparisons of the log-transformed data. At an initial soil concentration of 5 ppmw, the correlation coefficient between modeled and measured values was 0.997 with a mean modeled-to-measured ratio of 0.81, a p-value of 0.3281, and a 95 percent confidence interval of 0.46 to 1.44. At an initial soil concentration of 10 ppmw, the correlation coefficient was calculated to be 0.998, the mean ratio 0.73, the p-value 0.1774, and the confidence interval 0.41 to 1.28.

The p-values for dieldrin are considerably lower than those of lindane. This is due to the very narrow confidence interval around the modeled values. In the case of dieldrin, Equation 3 did not predict a loss of contaminant at the lower boundary until the last time-step (i.e., $t > L^2/18.4\ D_E$ at 12 days). This results in a nearly perfect straight line when the log-transformed data are plotted. For dieldrin, therefore, Equations 3 and 11 predict identical values until the last timestep.

Table 2 summarizes statistical analysis for the bench-scale comparative validation of the Jury Infinite Source volatilization model. In general, the data support good agreement between modeled and measured values and show relatively narrow confidence intervals and high correlation coefficients.

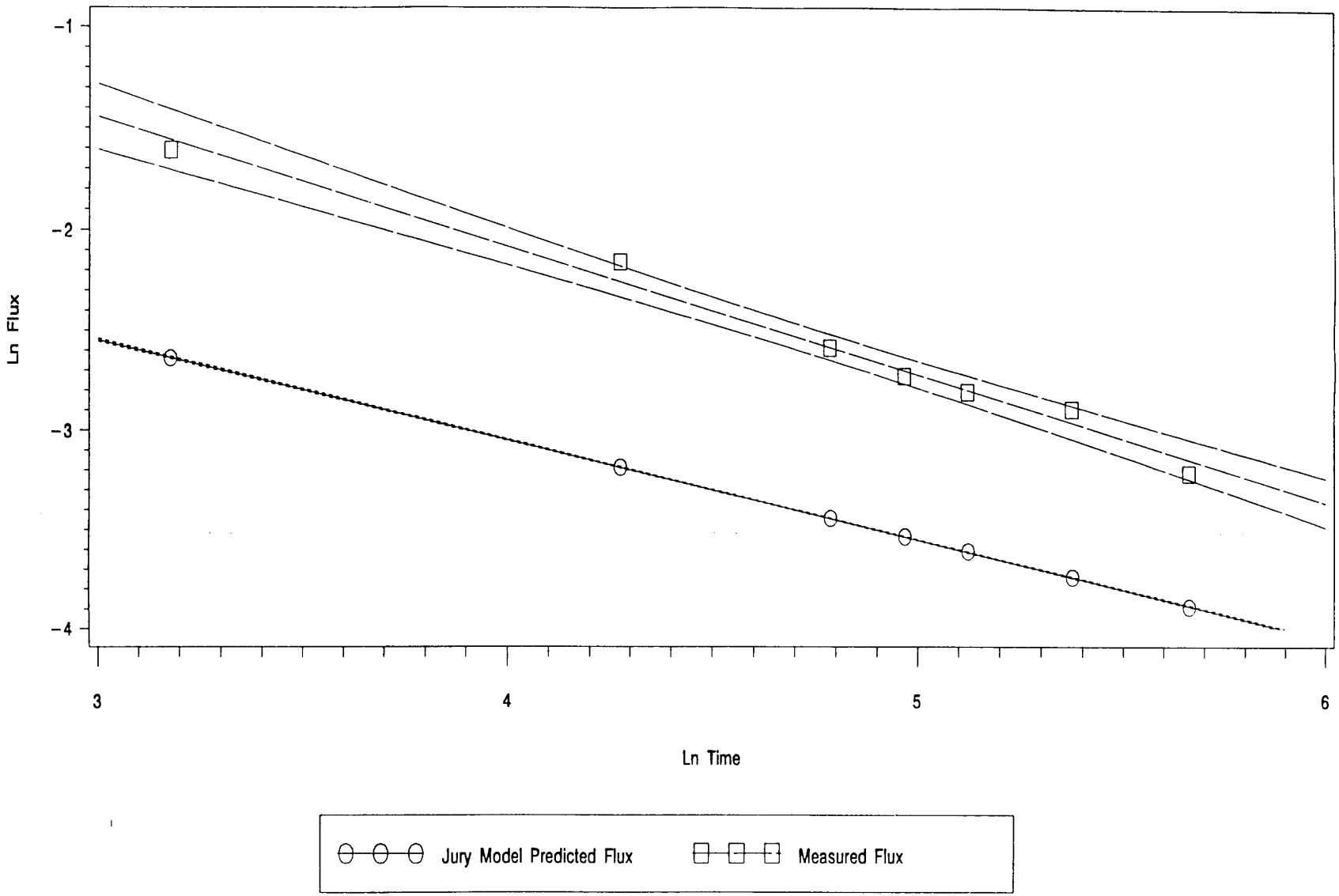

Figure 2
Predicted And Measured Emission Flux Of Dieldrin Versus Time (C_o = 10 ppmw)

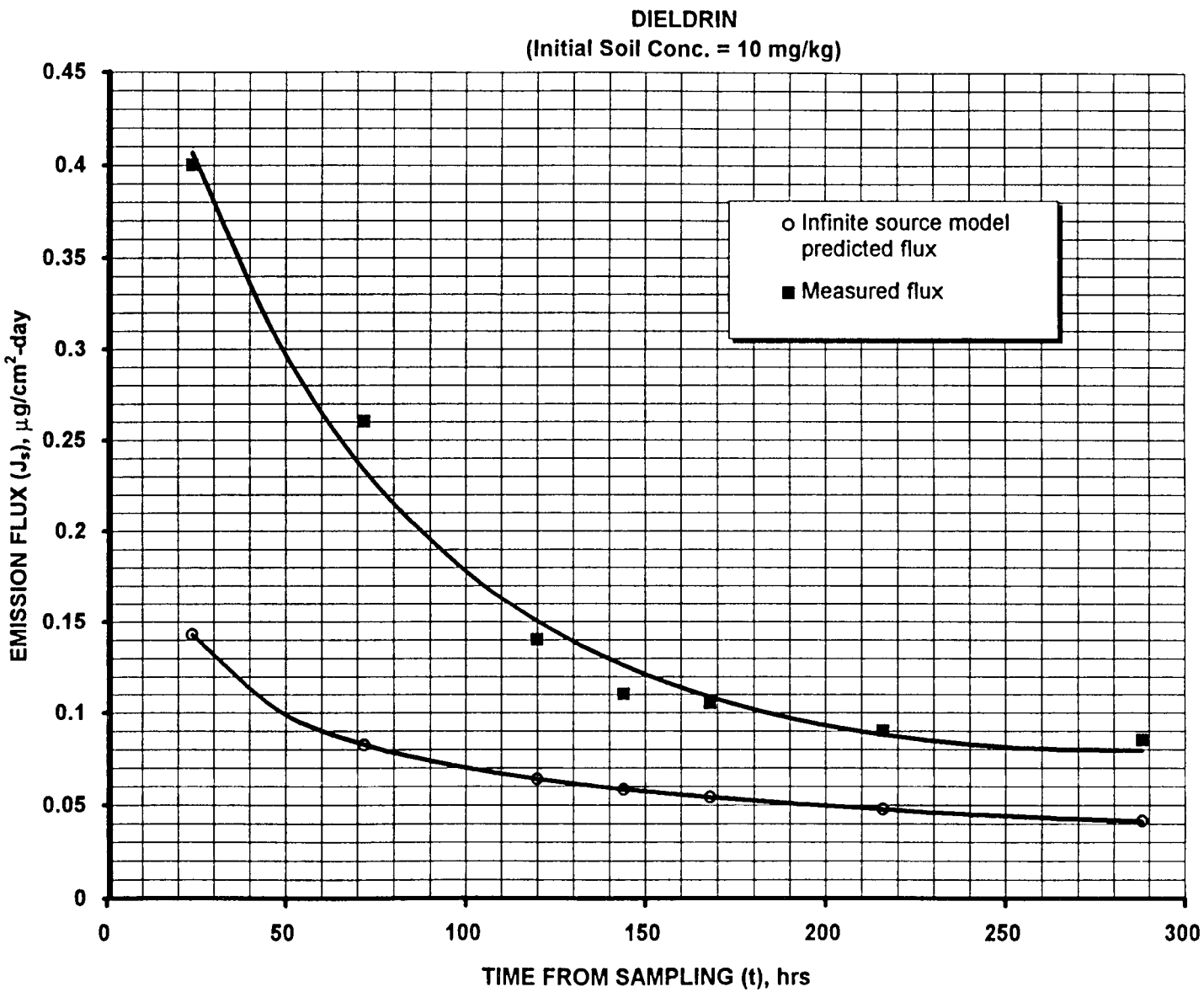

Figure 3
Predicted And Measured Emission Flux Of Dieldrin Versus Time (C_o = 10 ppmw)

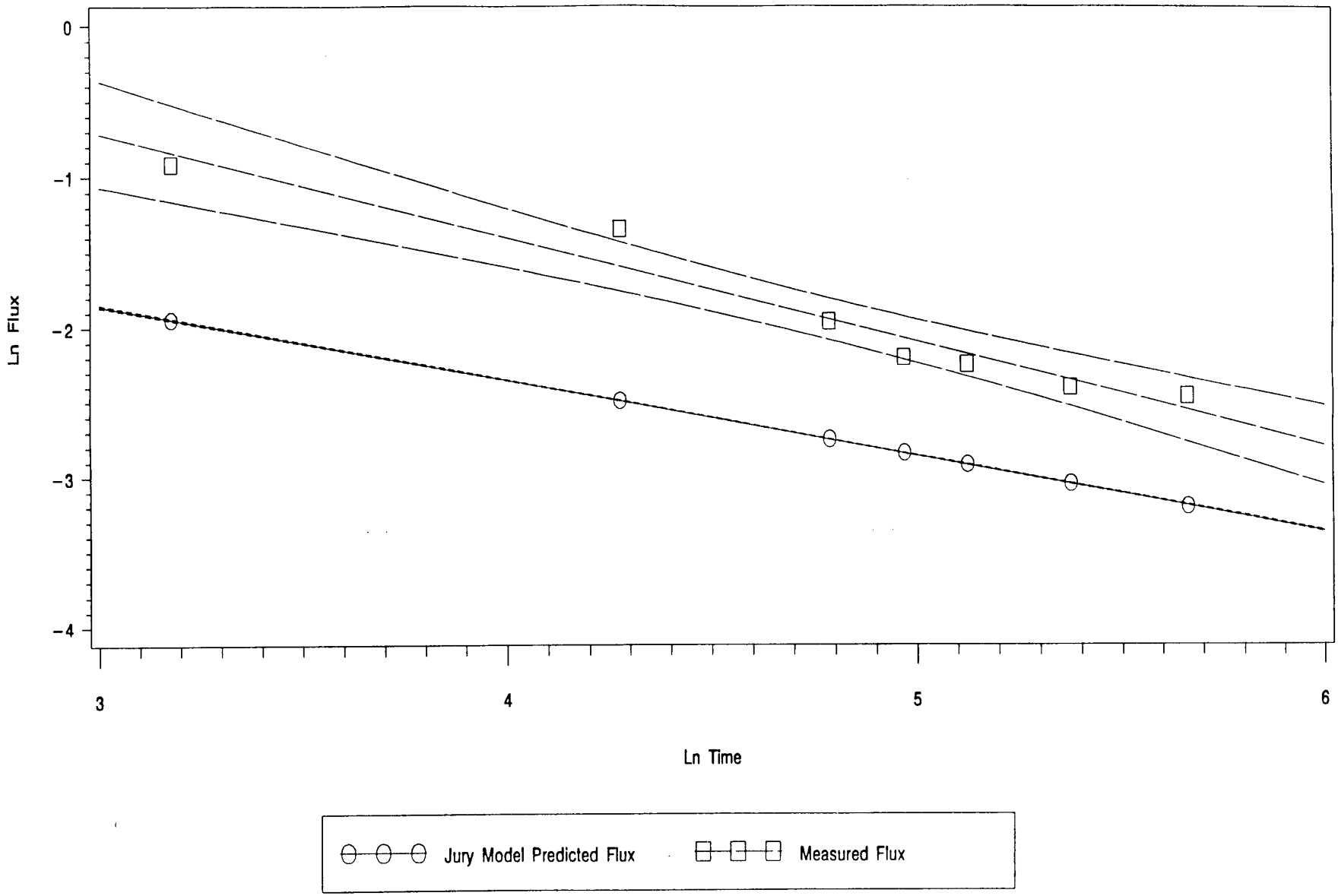

Figure 4
Comparison Of Log-Transformed Modeled And Measured Emission Flux Of Dieldrin (C_o = 10 ppmw)

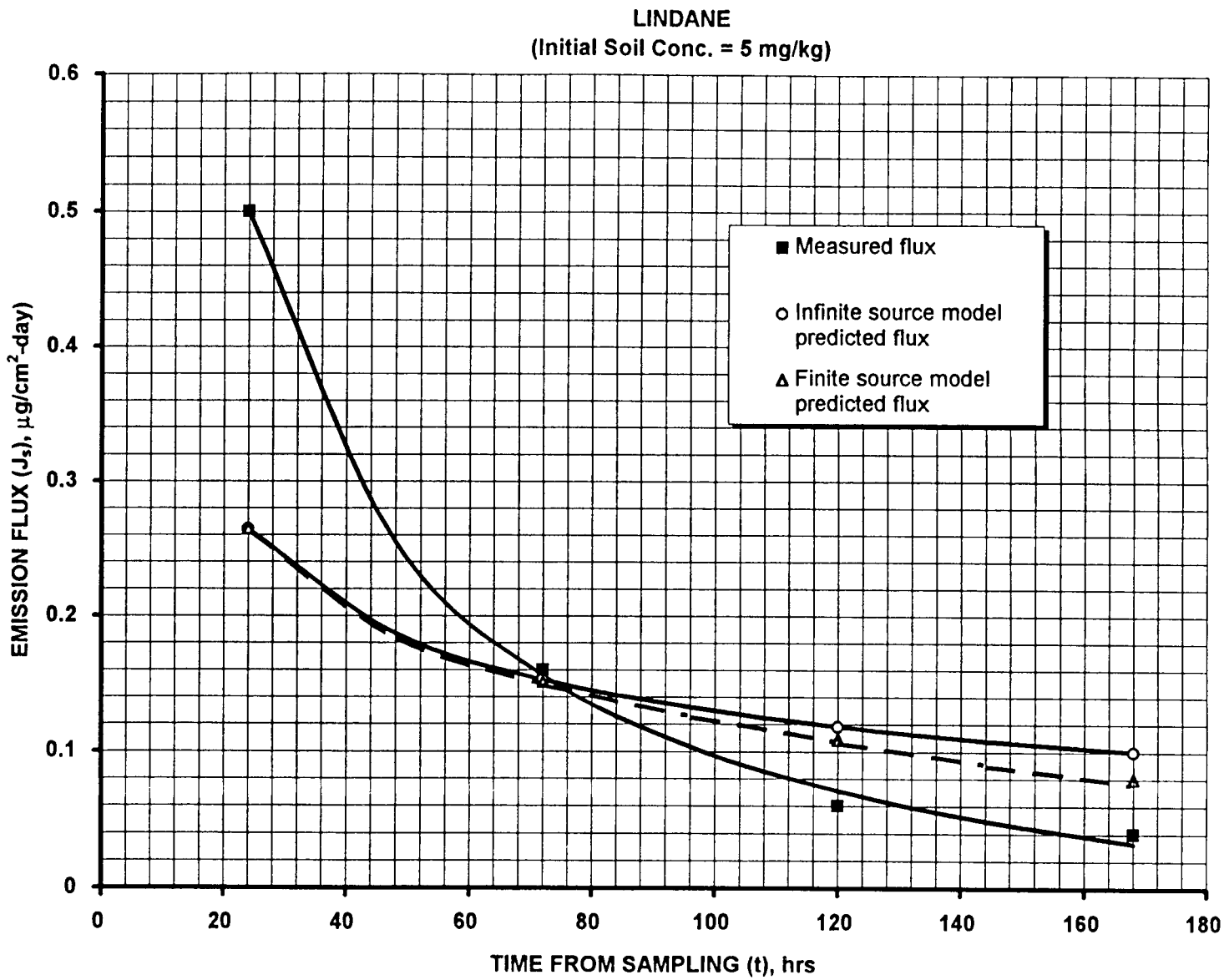

Figure 5
Predicted And Measured Emission Flux Of Lindane Versus Time (Co = 5 ppmw)

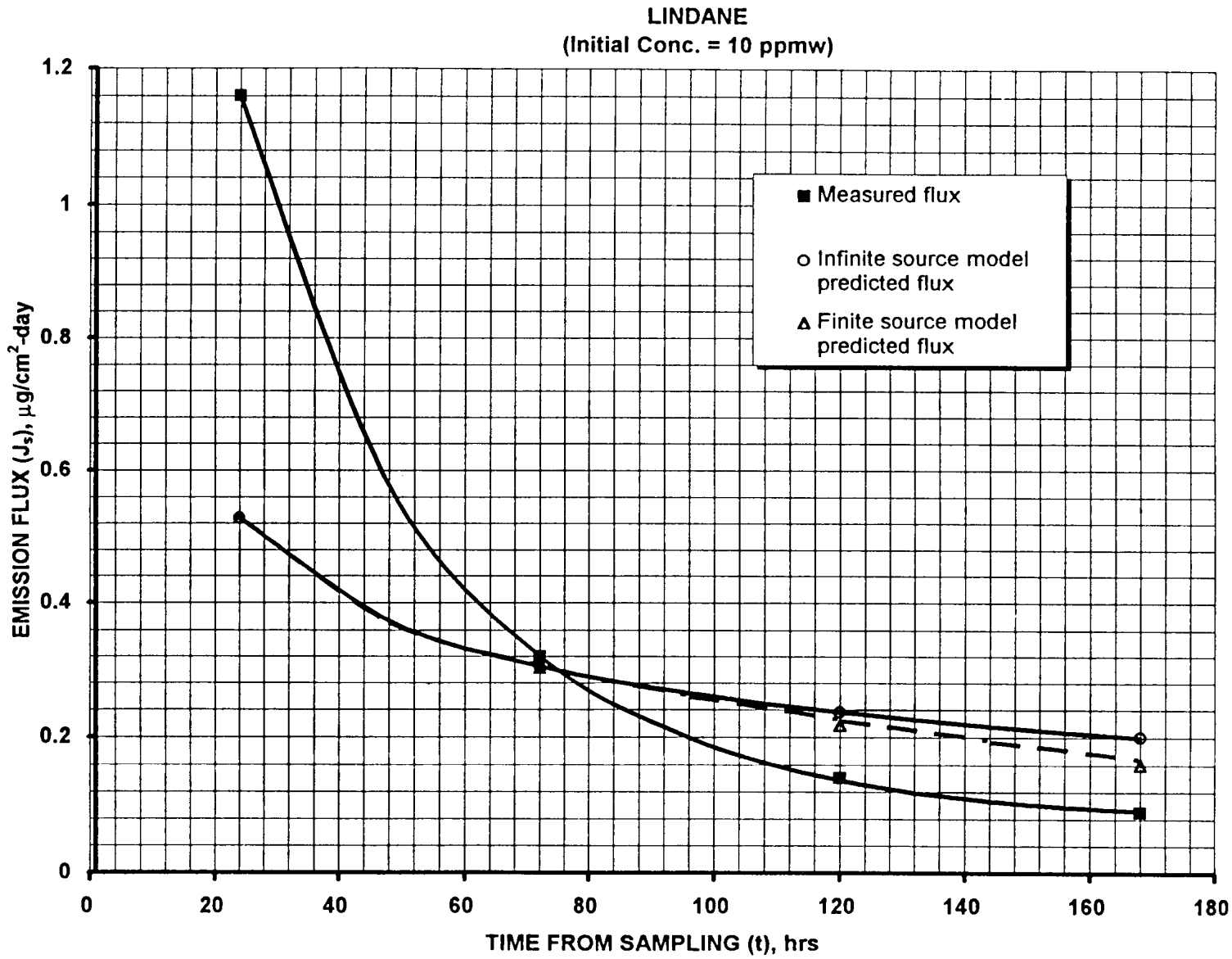

Figure 6
Predicted And Measured Emission Flux Of Lindane Versus Time (C_o = 10 ppmw)

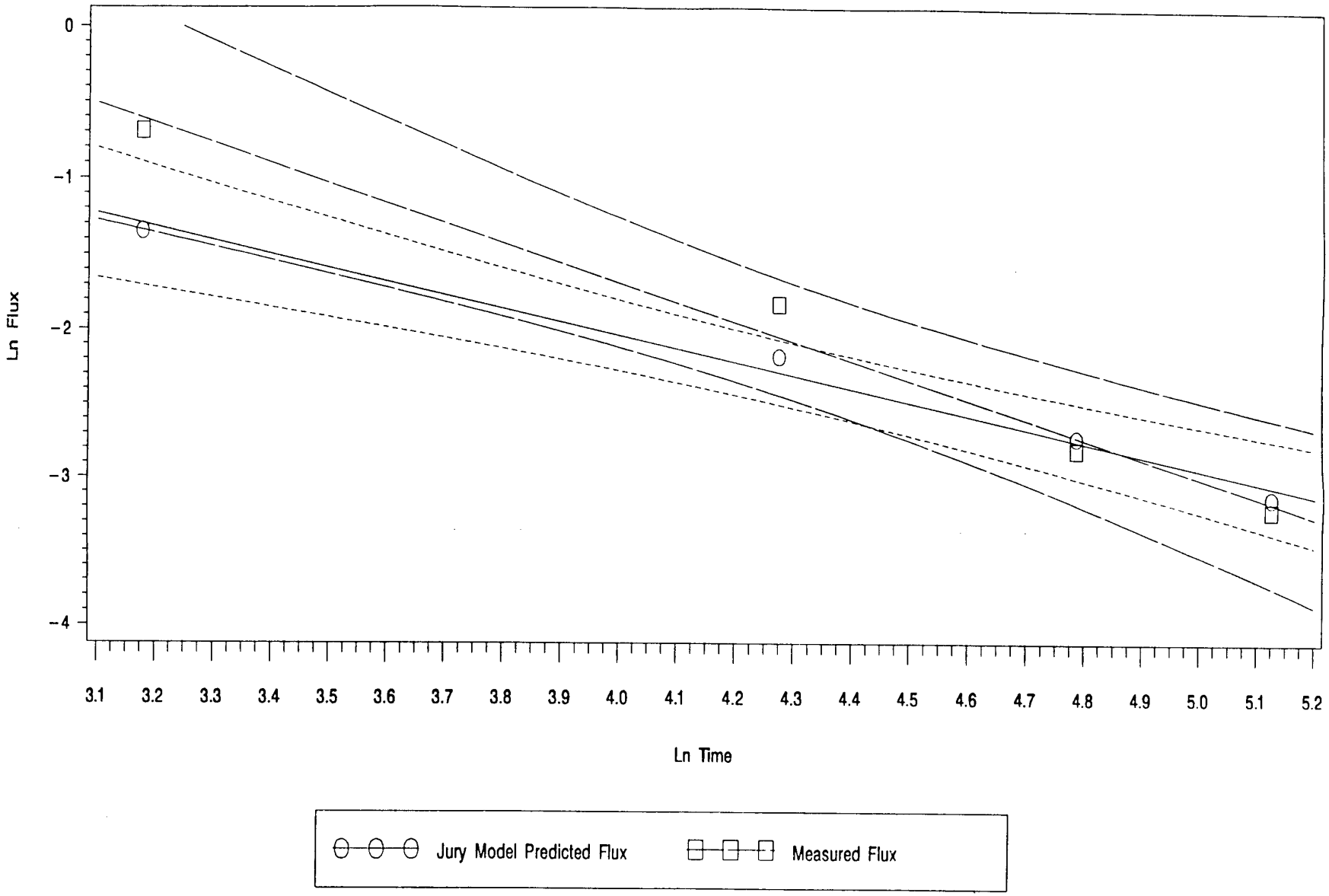

Figure 7
Comparison Of Log-Transformed Modeled And Measured Emission Flux Of Lindane (C_o = 5 ppmw)

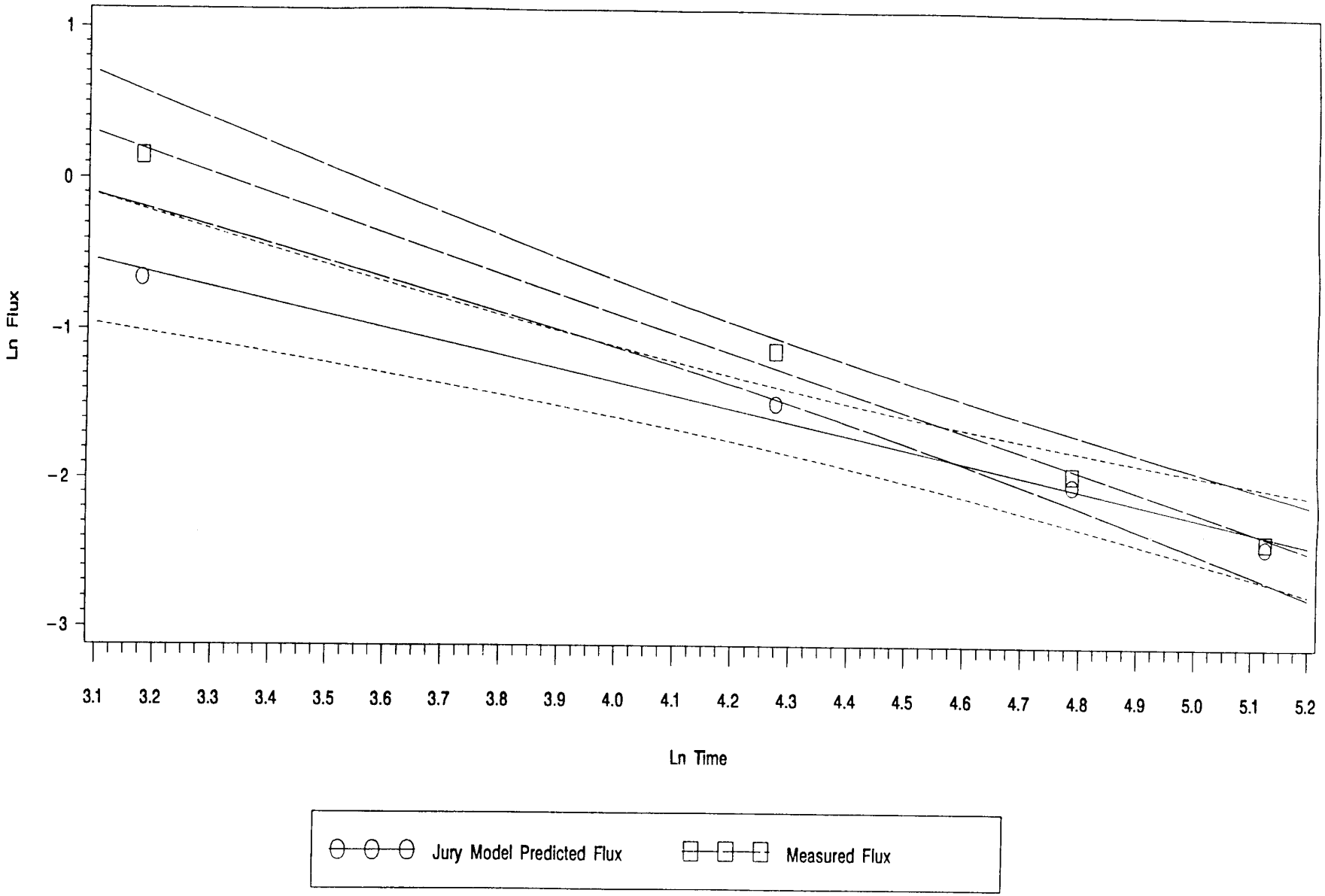

Figure 8
Comparison Of Log-Transformed Modeled And Measured Emission Flux Of Lindane (C_o = 10 ppmw)

TABLE 2.
SUMMARY OF THE BENCH-SCALE VALIDATION OF THE JURY INFINITE SOURCE MODEL

Chemical	N	Correlation coefficient	Mean ratio: Modeled-to-measured	p-value	95% confidence interval
Lindane (5 ppmw)	4	0.997	0.81	0.3281	(0.46, 1.44)
Lindane (10 ppmw)	4	0.998	0.73	0.1774	(0.41, 1.28)
Dieldrin (5 ppmw)	7	0.994	0.42	0.0001	(0.38, 0.48)
Dieldrin (10 ppmw)	7	0.974	0.45	0.0001	(0.37, 0.54)

Appendix A contains the spreadsheet calculations for the bench-scale validation of the Jury Infinite Source volatilization model.

From Radian Corporation (1989), a pilot-scale study was designed to determine how different treatment practices affect the rate of loss of benzene, toluene, xylenes, and ethylbenzene (BTEX) from soils. The experiment called for construction of four piles of loamy sand soil, each with a volume of approximately 4 cubic yards (7900 pounds), a surface area of 8 square meters, and a depth of 0.91 meters. Each test cell was lined with an impermeable membrane and the soil in each cell was sifted to remove particles larger than three-eighth inch in diameter. The contaminated soil for each pile was prepared in batches using 55-gallon drums. In the "high level" study, each soil batch was brought to 5 percent moisture content and 6 liters of gasoline added. Additional water was then added to bring the soil to 10 percent moisture by weight. The drums were capped and sat undisturbed overnight. The drums were then opened the next day and shoveled into the test cell platform. Twenty-two soil batches were prepared for each soil pile. Each batch consisted of 360 pounds of soil and 6.0 liters of fuel. Therefore, each soil pile contained 7900 pounds of soil and 132 liters of gasoline. Each soil pile was then subjected to one of the following management practices:

- A control pile that was not moved or treated
- An "aerated" or "mechanically mixed" pile
- A soil pile simulating soil venting or vacuum extraction
- A soil pile heated to 38°C.

Losses due to volatilization during the mixing and transfer process and during a 28 hour holding time in the test bed before initial sampling reduced the residual BTEX in soil. For the purpose of this validation study, however, these losses caused initial soil concentrations of benzene, toluene, and ethylbenzene to be below or within a factor of two of their respective single component saturation concentrations. Because the mixed pile, vented pile, and heated pile were subject to mechanical disturbances or thermal treatment, only the control pile data were used in this study.

In general, the test schedule called for collection of soil samples and air emission loss measurements during the first, sixth, and seventh weeks Soil samples were collected randomly within specified grid areas by composite core collection to the maximum depth of the pile. Emission losses were measured similarly using an emission isolation flux chamber as specified in Kienbusch (1985). Only data for which soil samples and flux chamber measurements were taken on the same day were used for this study.

Analysis of BTEX in soil samples was accomplished by employing the EPA 5030 extraction method and the EPA 8020 analytical method. The BTEX method was modified to reduce the sample hold time to one day in an effort to improve the accuracy of the method. Five soil samples were submitted in duplicate. The relative percent differences (RPD) ranged from 8.0 to 48.9 percent. The average RPD for the five samples was 26.8 percent. In addition, EPA QC sample analysis indicated average percent recoveries ranging from 89 percent for m-xylene to 119 percent for toluene. The pooled coefficient of variation (CV) for all the BTEX analysis was 10.5 percent. Spiked sample recoveries (eight samples) ranged from 75 percent for m-xylene to 168 percent for toluene. The average spike recoveries ranged from 108 percent for benzene to 146 percent for toluene. Finally, both system blanks and reagent blanks indicated no contamination was found in the analytical system.

It should be noted that the standard method used for BTEX analysis was observed to have contributed to the variabilities in soil concentrations. The EPA acceptance criteria based on 95 percent confidence intervals from laboratory studies are roughly 30 to 160 percent for the BTEX compounds during analysis of water samples. The necessary extraction step for soil samples would increase this already large variability.

Analysis of vapor-phase organic compounds via the emission isolation flux chamber was accomplished using a gas chromatograph (GC). Gas samples were collected from the flux chamber in 100 mL, gas-tight syringes and analyzed by the GC in laboratory facilities adjacent to the test site. During the study, a multicomponent standard was analyzed daily to assess the precision and daily replication of the analytical system. The results of the analysis indicated a good degree of reproducibility with coefficients of variation ranging from 5.1 to 16.3 percent.

From these data, instantaneous emission fluxes were calculated for benzene, toluene, and ethylbenzene corresponding to each time period at which flux chamber measurements were made. Table 3 gives the values of each variable employed to calculate emissions of each compound using the Jury Infinite Source model and the Mayer et al. (1974) finite source model. Appendix A contains the spreadsheet data for benzene, toluene, and ethylbenzene at initial soil concentrations of 110 ppm, 880 ppm, and 310 ppm, respectively.

It should be noted that the fraction of soil organic carbon (f_{oc}) was not available from Radian (1989). For this reason, the default value for f_{oc} of 0.006 from U.S. EPA (1994) was used for all calculations.

Figures 9, 10, and 11 show the comparison of modeled and measured emission fluxes of benzene, toluene, and ethylbenzene, respectively. The Radian Corporation study noted that the second measured value in each figure represented a data outlier, possibly due to the formation of a soil fissure, reducing the soil path resistance and increasing the emission flux.

Table 4 presents the results of the statistical analysis of the comparison of modeled and measured values. For both benzene and ethylbenzene, measured values were below the detection limits after the fifth observation; measured values for toluene were below the detection limit after the seventh observation.

TABLE 3.
VOLATILIZATION MODEL INPUT VARIABLES FOR BENZENE, TOLUENE, AND ETHYLBENZENE

Variable	Symbol	Units	Value	Reference/Equation
Initial soil concentration - benzene - toluene - ethylbenzene	C_o	mg/kg	 110 880 310	Radian (1989)
Soil Depth	L	cm	91	Radian (1989)
Soil dry bulk density	ρ_b	g/cm^3	1.5	Radian (1989)
Soil particle density	ρ_s	g/cm^3	2.65	U.S. EPA (1988)
Gravimetric soil moisture content	w	percent	10	Radian (1989)
Water-filled soil porosoty	Θ	cm^3/cm^3	0.150	$w\rho_b$
Total soil porosity	ϕ	cm^3/cm^3	0.434	$1-(\rho_b/\rho_s)$
Air-filled soil porosity	a	cm^3/cm^3	0.284	ϕ - Θ
Soil organic carbon	f_{oc}	Fraction	0.006	U.S. EPA (1994) default value
Organic carbon partition coefficient - benzene - toluene - ethylbenzene	K_{oc}	cm^3/g	 57 131 221	 U.S. EPA (1994) U.S. EPA (1994) U.S. EPA (1994)
Diffusivity in air - benzene - toluene - ethylbenzene	D_g^a	cm^2/s	 0.0870 0.0870 0.0750	 U.S. EPA (1994) U.S. EPA (1994) U.S. EPA (1994)
Diffusivity in water - benzene - toluene - ethylbenzene	D_i^w	cm^2/s	 9.80 E-06 8.60 E-06 8.64 E-06	 U.S. EPA (1994a) U.S. EPA (1994a) U.S. EPA (1994a)
Henry's law constant - benzene - toluene - ethylbenzene	K_H	Unitless	 0.22 0.26 0.32	 U.S. EPA (1994) U.S. EPA (1994) U.S. EPA (1994)
Degradation rate constant	μ	1/day	0	Default to eliminate effects of degradation

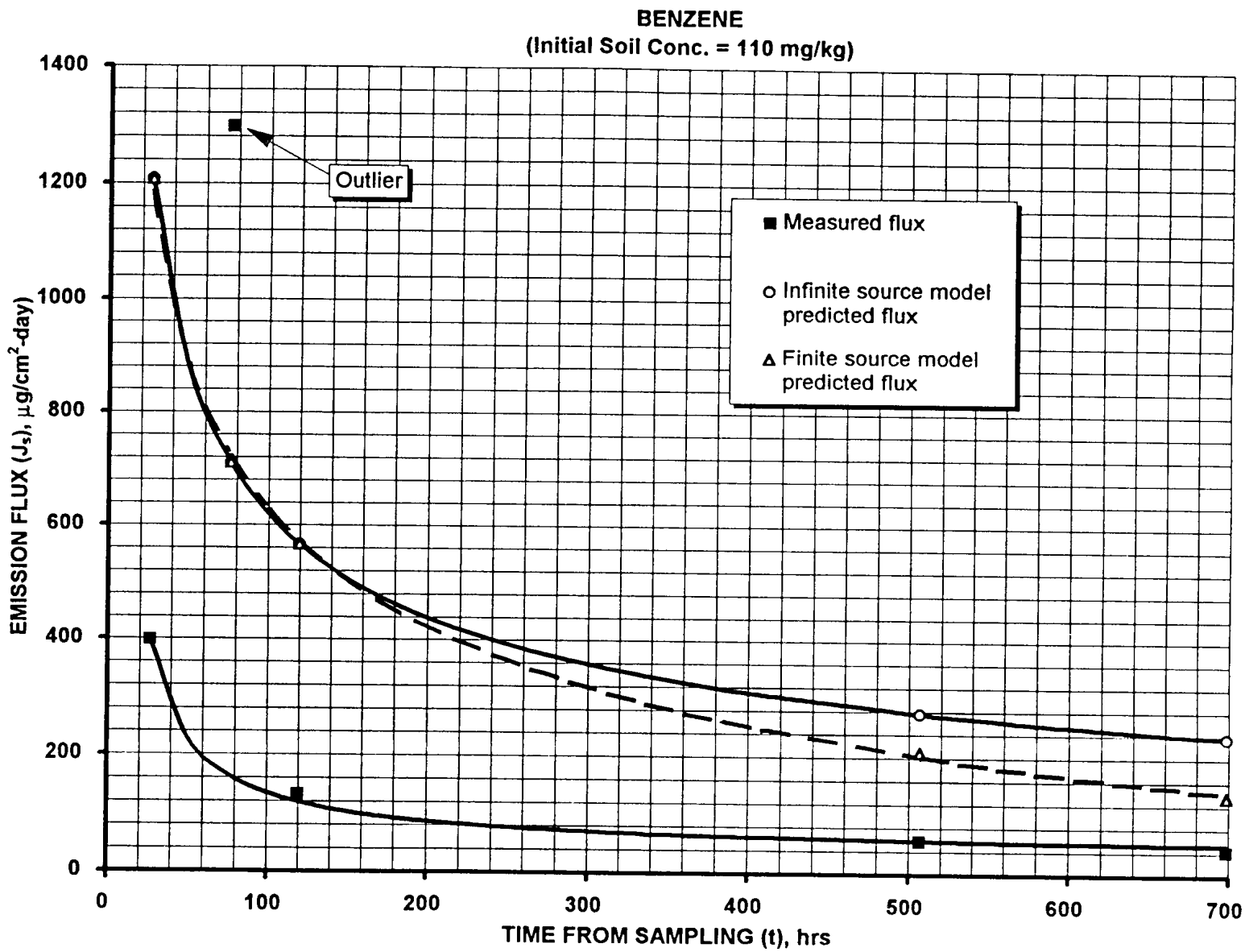

Figure 9
Predicted And Measured Emission Flux Of Benzene (C_o = 110 ppmw)

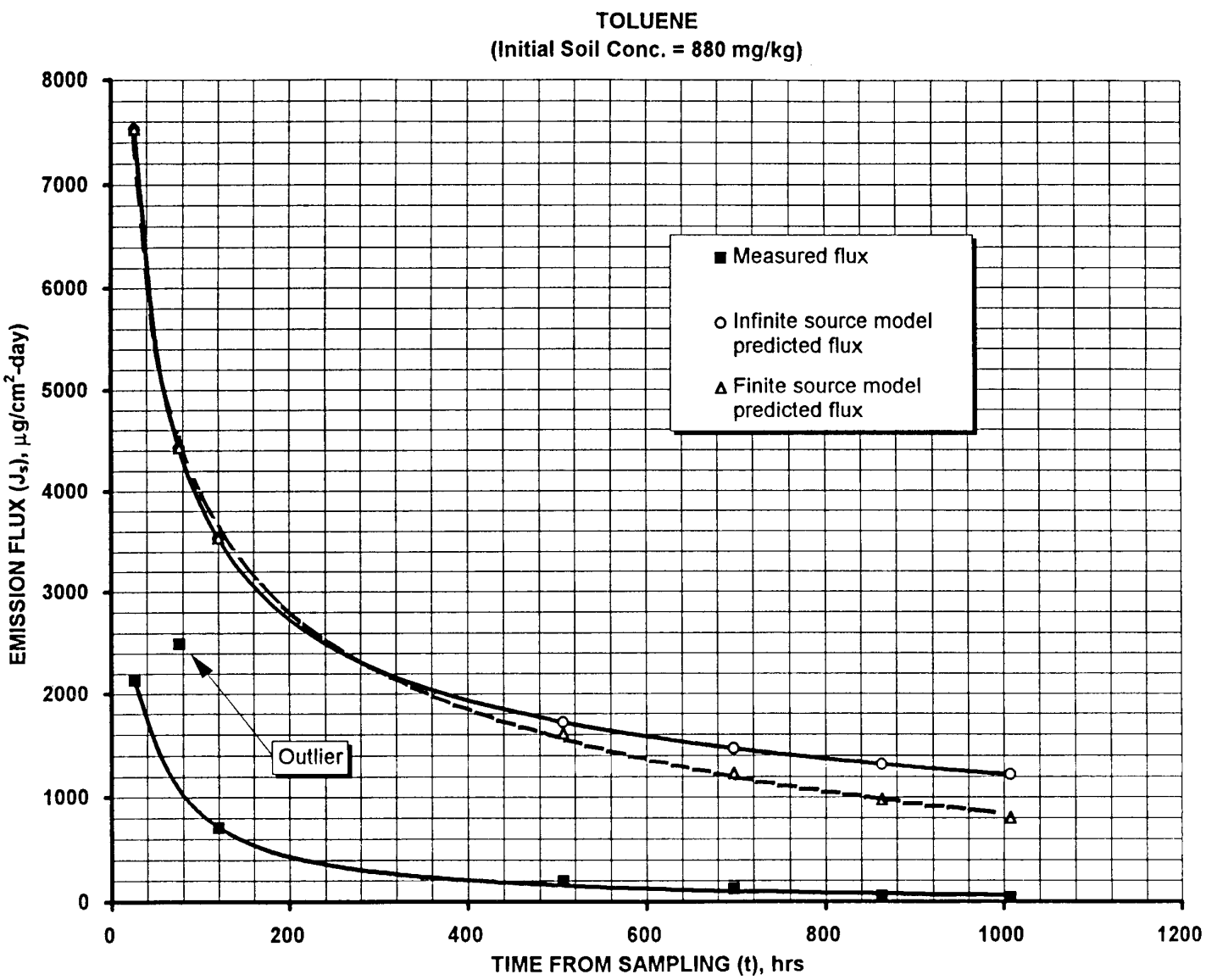

Figure 10
Predicted And Measured Emission Flux Of Toluene (C_o = 880 ppmw)

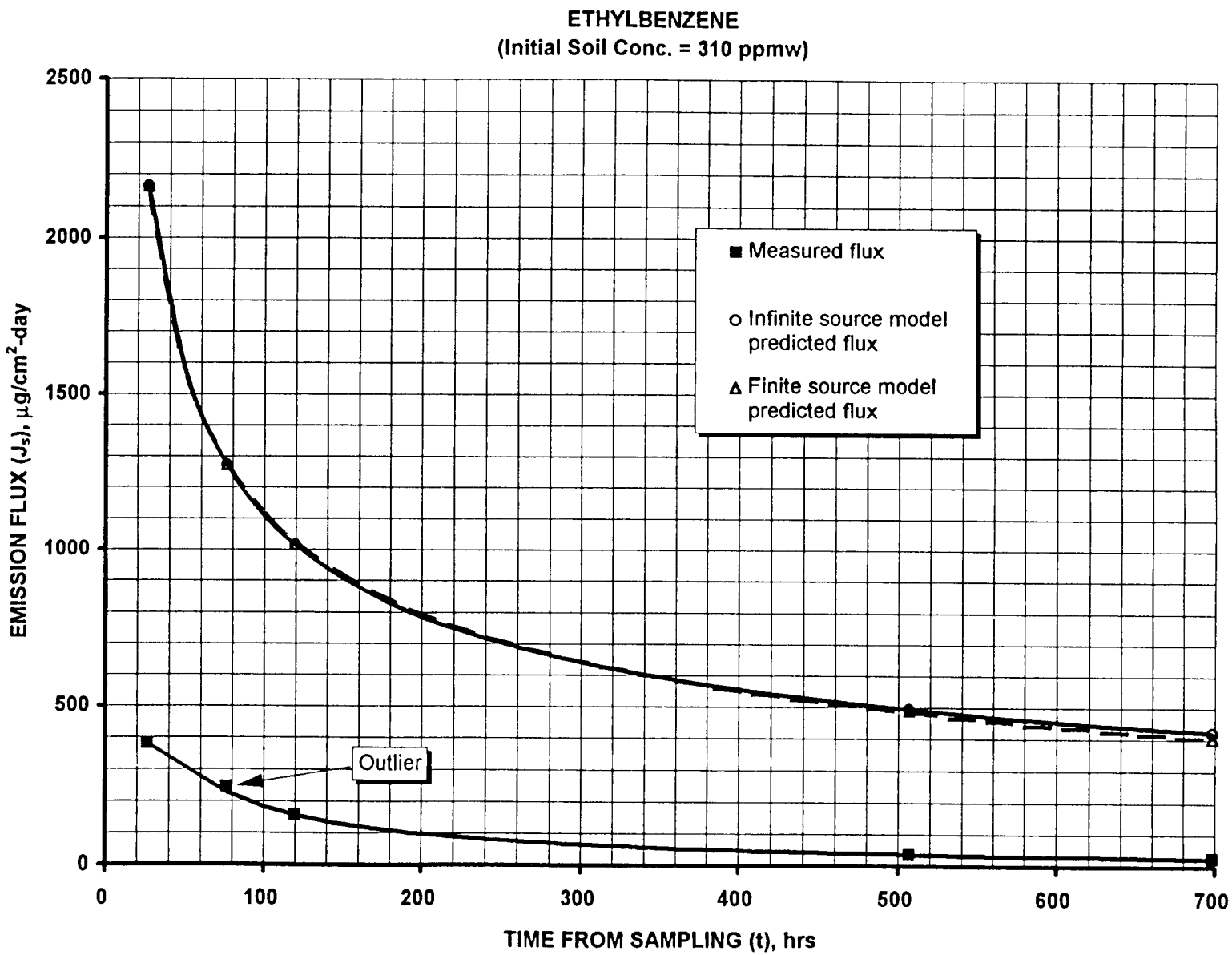

Figure 11
Predicted And Measured Emission Flux Of Ethylbenzene (C_o = 310 ppmw)

TABLE 4.
SUMMARY OF STATISTICAL ANALYSIS OF PILOT-SCALE VALIDATION

Chemical	N	Correlation coefficient	Mean ratio: Modeled-to-measured	p-value	95% confidence interval
Benzene (110 ppm)	5	0.982	2.5	0.0149	(1.4, 4.5)
Toluene (880 ppm)	7	0.988	6.3	0.0002	(3.9, 10.4)
Ethylbenzene (310 ppm)	5	0.999	7.8	0.0008	(4.9, 12.4)

Figures 12, 13, and 14 show the comparison of the log-transformed data for the modeled and measured emission fluxes of benzene, toluene, and ethylbenzene, respectively. As can be seen from Table 4, correlation coefficients ranged from 0.982 for benzene to 0.999 for ethylbenzene, while p-values and 95 percent confidence intervals indicate a significant statistical difference between modeled and measured values.

The boundary conditions of the infinite source model were violated after the first timestep for benzene, and after the third time-step for both toluene and ethylbenzene. The infinite source model predicted 134 percent, 117 percent, and 103 percent of the total mass loss of the finite source model for benzene, toluene, and ethylbenzene, respectively.

In general, the predicted values were higher than the measured values throughout the time-span of the experiment for all three compounds. It is also interesting to note that during the initial stage of the experiment the predicted values were considerably higher than measured values even when contaminant loss at the soil surface due to evaporation was expected. Although the relative differences between predicted and measured values are not excessive (i.e., the highest modeled-to-omeasured mean ratio is within a factor of approximately 10), they are considerably higher than those of the bench-scale studies.

Any one or a combination of the following could account for the larger discrepancies between measured and predicted values in the pilot-scale study:

1. Although the initial soil concentrations of the three compounds were below or within a factor of two of their respective single component saturation concentrations, they may have been greater than the component concentrations for which a residual-phase of gasoline existed. If this were the case, measured emissions may have been in part due to the presence of nonaqueous-phase liquids (NAPL) which would have violated the model's assumptions of equilibrium partitioning.

2. Soil mixing processes and transfer to the test bed may have resulted in heterogenous incorporation of the contaminants. If surface concentrations were reduced due to incomplete mixing, measured emissions would have been reduced during the initial stages of the experiment.

3. Sampling and/or analytical variability may have resulted in under reporting of emission fluxes and/or over reporting of initial soil concentrations.

4. Contaminants sorbed to the test bed liner may have acted to reduce emissions.

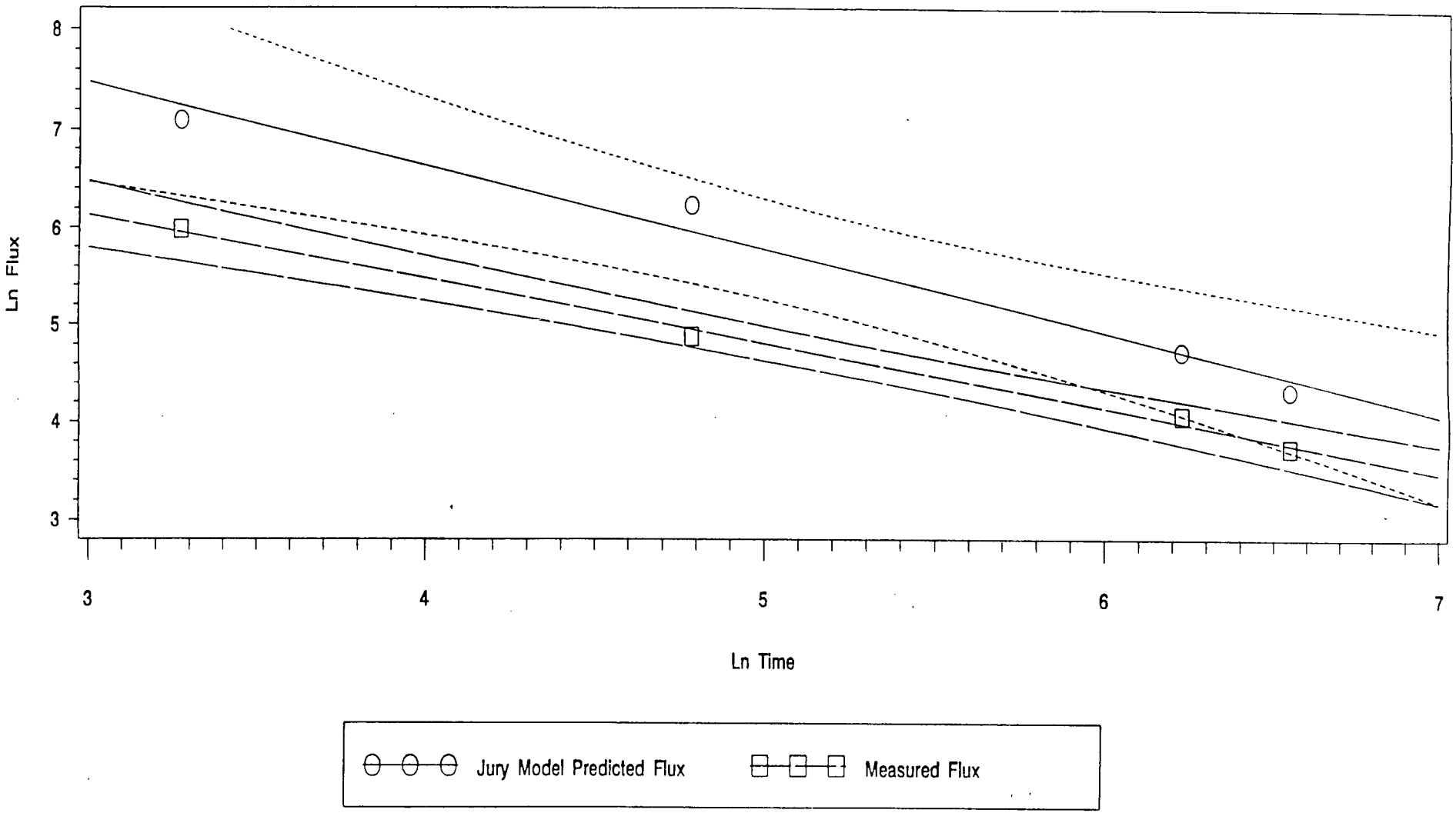

Figure 12
Comparison Of Log-Transformed Modeled And Measured Emission Flux Of Benzene (C_o = 110 ppmw)

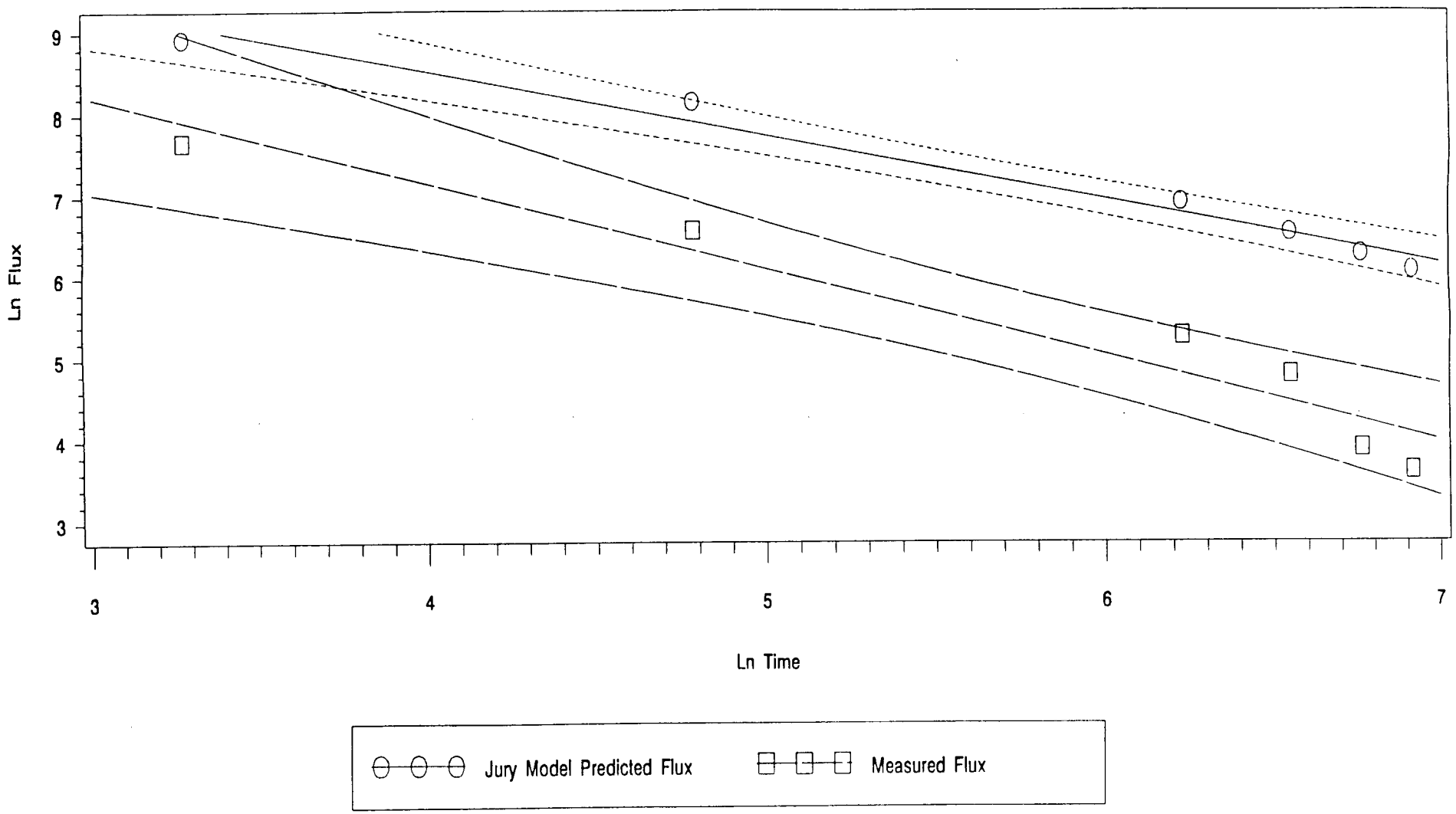

Figure 13
Comparison Of Log-Transformed Modeled And Measured Emission Flux Of Toluene (C_o = 880 ppmw)

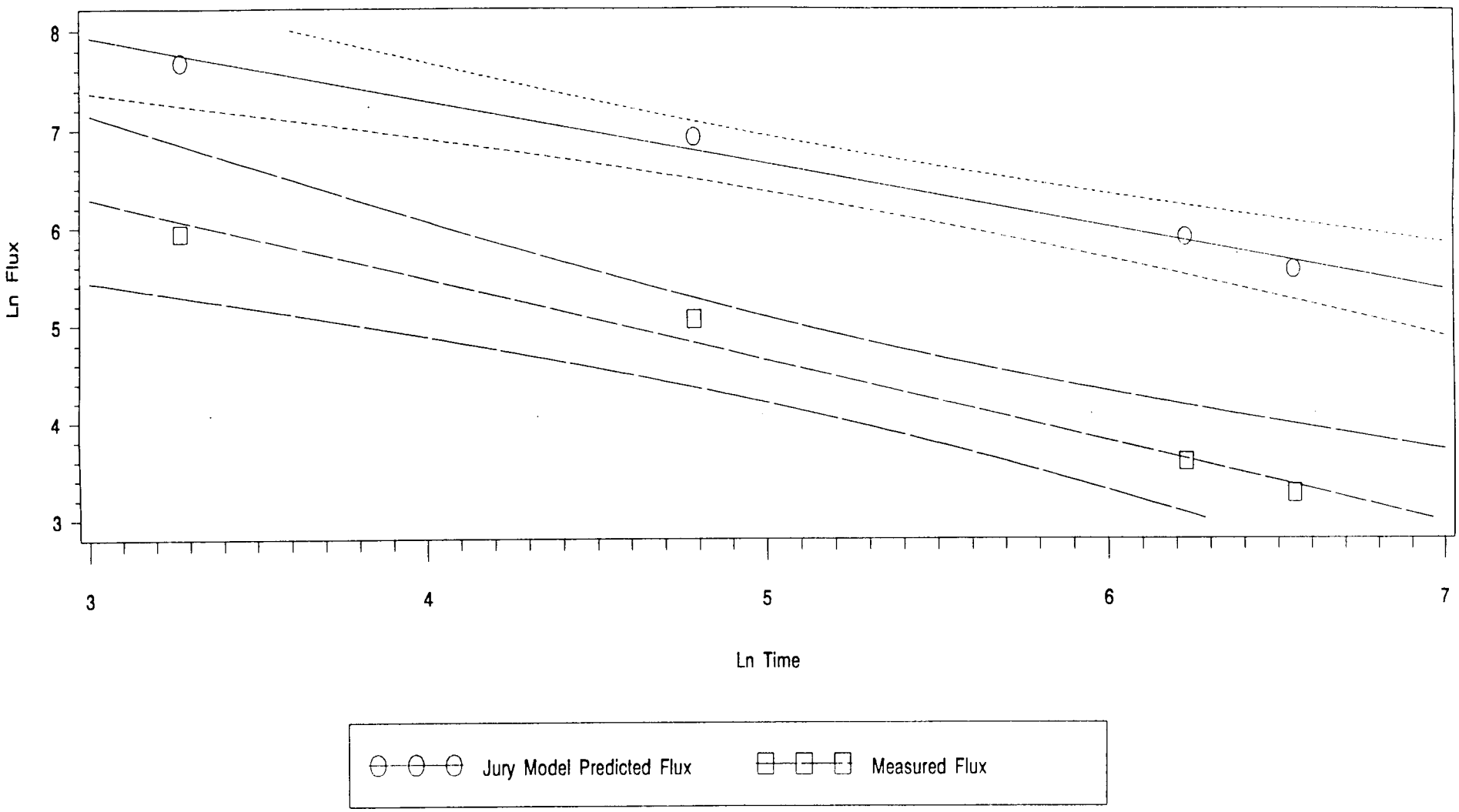

Figure 14
Comparison Of Log-Transformed Modeled And Measured Emission Flux Of Ethylbenzene (C_o = 310 ppmw)

5. Variability in the relative humidity of the air above the test bed may have induced surface water evaporation in between flux chamber samples. Water evaporation would have moved contaminants to the surface by convection and depleted soil concentrations in between sampling events.

6. The model is not as accurate for compounds with relatively high Henry's law constants.

From these observations, it appears more likely that the larger discrepancies between modeled and measured emissions in the pilot-scale study are due to experimental conditions. Sufficient uncertainty exists as to whether all model boundary conditions were maintained during the experiment. For this reason, the results of the pilot-scale validation should be considered less reliable than those of the bench-scale validation. This conclusion suggests that controlled studies should be considered for validation of model predictions for compounds with relatively high Henry's law constants.

3.2 VALIDATION OF THE JURY REDUCED SOLUTION FINITE SOURCE MODEL

From the literature search, one bench-scale study was found that replicated the boundary conditions of the Jury Reduced Solution model (Equation 1). Jury et al. (1980) reports the emissions of the herbicide triallate [S-(2,3,3-trichloroallyl) diisopropyithiocarbamate] incorporated in San Joaquin sandy loam. This study replicated the model boundary conditions in that a clean layer of soil underlayed the contaminated soil allowing diffusion across the lower boundary as well as the upper boundary.

Volatilization of triallate was measured in a closed volatilization chamber (Spencer et al., 1979). The air chamber above the soil was 2 mm deep and 3 cm wide, matching the width of the evaporating surface. An average air flow rate of 1 liter per minute was maintained across the surface equivalent to a windspeed of 1 km/h. Triallate was applied by atomizing the material in hexane onto the air-dry autoclaved soil. The soil was mixed and allowed to equilibrate in a vented fume hood. The soil was then transferred to the chamber and wetted from the bottom. To prevent water evaporation at the soil surface, the chamber was maintained at 100 percent relative humidity and a temperature of 25°C.

The volatilized triallate was trapped daily on polyurethane plugs and extracted and analyzed as described in Grover et al. (1978). The volatilization of triallate at an initial soil concentration of 10 ppmw was measured over a 29 day period in the absence of water evaporation. Calculation of the saturation concentration (C_{sat}) confirmed that the initial concentration of 10 ppmw was in dissolved form. Table 5 gives the values of each variable employed to calculate emissions of triallate using the Jury Reduced Solution volatilization model.

Figure 15 shows the comparison of the predicted and measured values for triallate at an initial soil concentration of 10 ppmw. The data plots indicate very good agreement between modeled and measured values. Figure 16 shows the comparison of the log-transformed data and confidence intervals. From the population of 32 observations, the correlation coefficient was calculated to be 0.998 with a mean modeled-to-measured ratio of 1.11. The p-value was calculated at 0.0001, and the confidence interval was 1.07 to 1.16.

TABLE 5.
VOLATILIZATION MODEL INPUT VALUES FOR TRIALLATE

Variable	Symbol	Units	Value	Reference/Equation
Initial soil concentration	C_o	mg/kg	10	Jury et at. (1980)
Soil depth	L	cm	10	Jury et at. (1980)
Soil dry bulk density	ρ_b	g/cm^3	1.34	Jury et at. (1980)
Soil particle density	ρ_s	g/cm^3	2.65	U.S. EPA (1988)
Gravimetric soil moisture content	w	percent	21	Calculated from Jury et al. (1980)
Water-filled soil porosoty	Θ	cm^3/cm^3	0.279	Jury et at. (1980)
Total soil porosity	ϕ	cm^3/cm^3	0.494	Jury et at. (1980)
Air-filled soil porosity	a	cm^3/cm^3	0.215	Jury et at. (1980)
Soil organic carbon	f_{oc}	fraction	0.0072	Calculated from Jury et al. (1980)
Organic carbon partition coefficient	K_{oc}	cm^3/g	3600	Jury et at. (1980)
Diffusivity in air	D_g^a	cm^2/d	3888	Jury et at. (1980)
Diffusivity in water	D_i^w	cm^2/d	0.432	Jury et at. (1980)
Henry's law constant	K_H	unitless	1.04 E-03	Jury et at. (1980)
Degradation rate constant	μ	1/day	0	Default to eliminate effects of degradation

The degree of agreement between modeled and measured emission flux values for triallate may be due to soil adsorption studies conducted to experimentally derive the organic carbon partition coefficient specific to the San Joaquin sandy loam used in the experiment. With experimentally derived values of K_{oc}, more accurate phase partitioning was possible resulting in an experimental-specific value of the effective diffusion coefficient (Equation 2). Appendix B contains the spreadsheet calculations for the bench-scale validation of the Jury Reduced Solution finite source volatilization model.

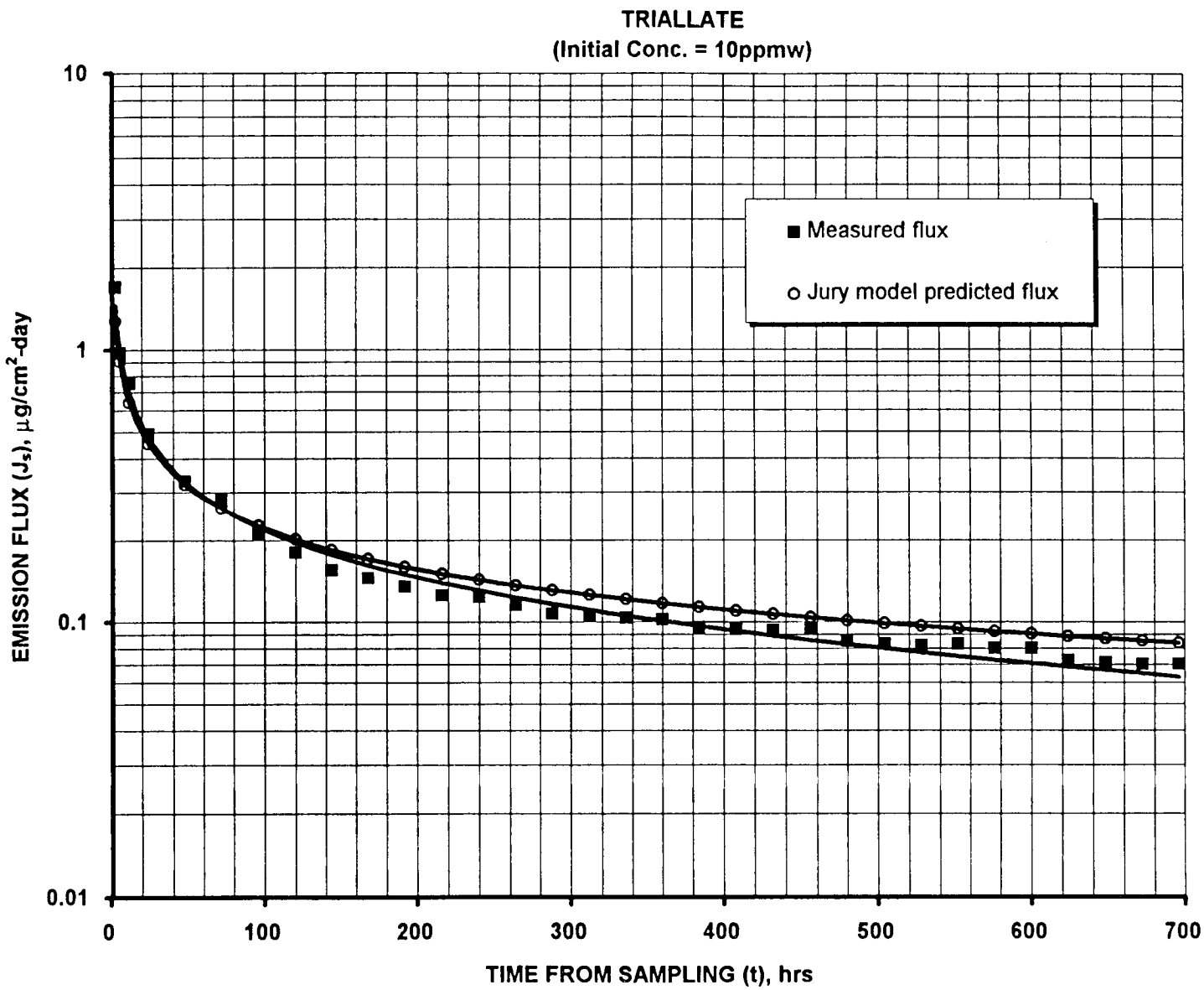

Figure 15
Predicted And Measured Emission Flux Of Triallate Versus Time

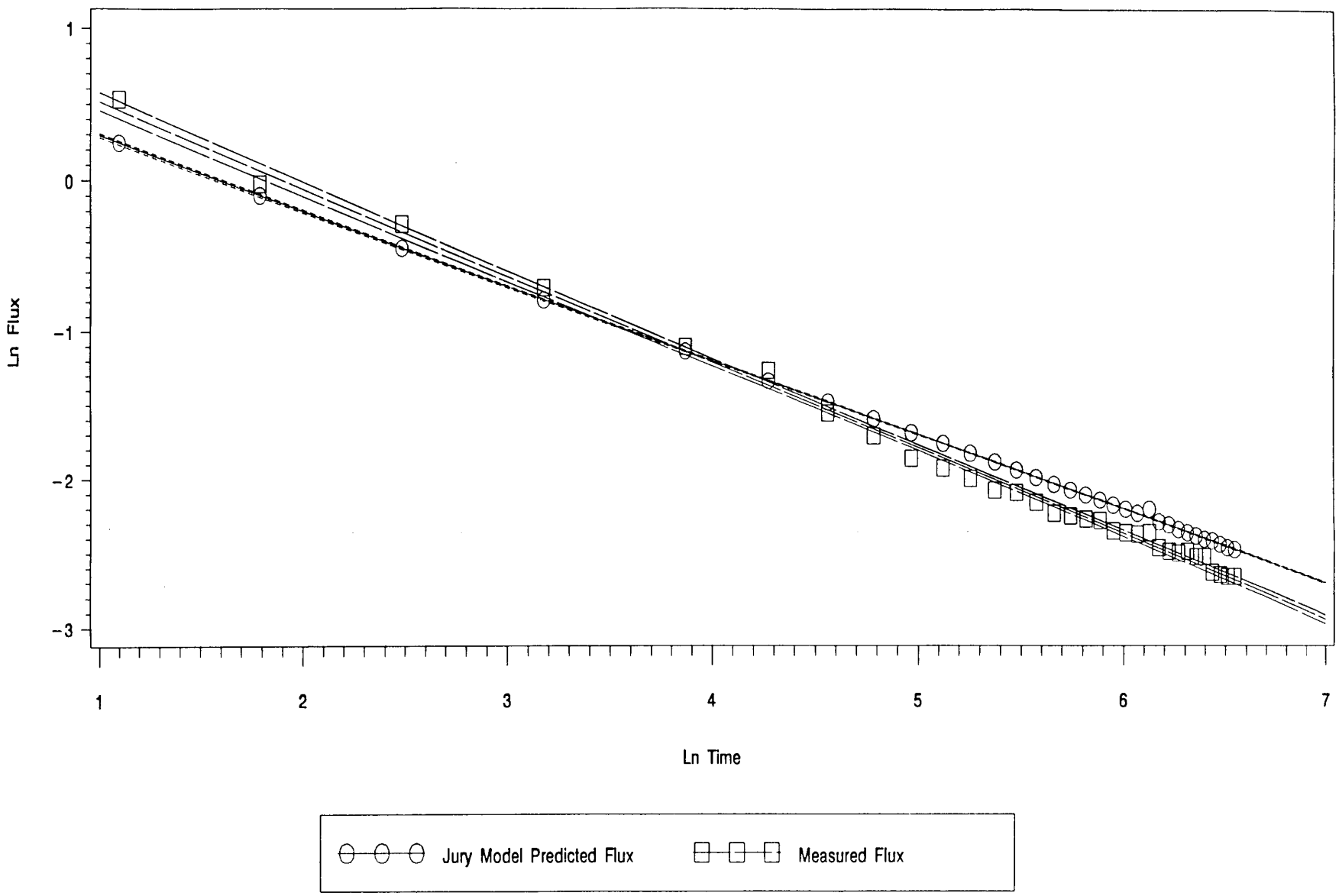

Figure 16
Comparison Of Log-Transformed Modeled And Measured Emission Flux Of Triallate

SECTION 4

PARAMETRIC ANALYSIS OF THE JURY VOLATILIZATION MODELS

This section presents the results of parametric analysis of the key variables of the Jury volatilization models (Equations 1 and 3). The Jury volatilization models are applicable for the case of no boundary layer resistance at the soil-air interface and no water flux through the soil column. Because the models are equivalent to the Mayer et al. (1974) solutions to the general diffusion equation (Equation 5), the parametric observations of Mayer et al. (1974) and Farmer, et al. (1980) are also directly applicable.

Jury et al. (1983) established the relationship between vapor and solute diffusion and adsorption by defining total phase concentration partitioning as it relates to the effective diffusion coefficient. The effective diffusion coefficient is a theoretical expression of the combination of soil parameters and chemical properties which govern the rate at which soil contaminants move to the surface to replace those lost by evaporation. As such, the effective diffusion coefficient is the rate-limiting factor governing the general diffusion equation in soils given the initial and boundary conditions for which the models are applicable. The remainder of this section discusses the key soil and nonsoil parameters used in the expression of the effective diffusion coefficient and the general diffusion equation.

4.1 AFFECTS OF SOIL PARAMETERS

In this section, the experimental results of Farmer, et al. (1980) are discussed as they relate to the effect of soil water content, soil bulk density, air-filled soil porosity, and temperature on diffusion in soil.

Soil Moisture Content

Farmer, et al. (1980) indicates that the effect of soil moisture content on the volatilization flux of contaminants through soils is exponential. Increasing soil water content decreases the pore spaces available for vapor diffusion and will decrease volatilization flux. In contrast, increasing soil water content has also been shown to increase the volatility of pesticides in soil under certain conditions (Gray, et al., 1965; and Spencer and Cliath, 1969 and 1970). In essence, the soil water content affects the contaminant adsorption capacity by competing for soil adsorption sites. Under these conditions, an increase in soil moisture above a certain point will tend to desorb contaminants, increasing the flux dependent on the relative water and contaminant adsorption isotherms.

Bulk Density

Soil compaction or bulk density also determines the porosity of soil and thus affects the diffusion through the soil. Experimental results from Farmer et al. (1980) indicate that soil bulk density also has an exponential effect on volatilization flux through the soil. From previous considerations of the effect of soil water content, a higher bulk density will have similar effects to that of an increased soil moisture content.

Soil Air-Filled Porosity

The effects of soil water content and soil bulk density on volatilization can be contributed to their effect on the air-filled porosity, which in turn is the major soil factor controlling volatilization. The effect of air-filled porosity is manifested in the expression of the effective diffusion coefficient. The effective diffusion coefficient, however, does not depend only on the amount of air-filled pore

space. The presence of liquid film on the solid surfaces not only reduces porosity, but also modifies the pore geometry increasing tortuosity and the length of the gas passage. The Jury et al. (1983) expression of the effective diffusion coefficient uses the model of Millington and Quirk (1961) to account for the porosity and the tortuosity of soil as a porous medium.

Soil Temperature

The effect of soil temperature on the volatilization flux is multifunctional. The diffusion in air, D_g^a, is theoretically related to temperature, T, and the collision integral, Ω, in the following manner (Lyman, et al., 1990):

$$D_g^a \text{ (proportional to) } \frac{T^{0.5}}{\Omega(T)} \tag{15}$$

The exponential coefficient for temperature varies from 1.5 to 2 over a wide range of temperatures. Barr and Watts (1972) found that 1.75 gave the best values for gaseous diffusion. Farmer, et al. (1980) estimates the effective diffusion coefficient at temperature T_2 as:

$$D_2 = D_1 (T_2 / T_1)^{0.5} \tag{16}$$

where D_2 = Diffusion coefficient at T_2

D_1 = Diffusion coefficient at T_1

T = Absolute temperature.

A temperature increase will effect the vapor pressure function of the Henry's Law constant, which causes an increase in the vapor concentration gradient across the soil layer. In actual fact, temperature gradients will exist across the soil due primarily to seasonal variations. Vapor diffusion is influenced by such gradients; however, these effects of fluctuating soil temperatures will tend to cancel one another over time.

4.2 AFFECTS OF NONSOIL PARAMETERS

The nonsoil variables in the Jury volatilization models include the initial soil concentration, C_o, the Henry's law constant (K_H), the soil/water partition coefficient, (K_D) and the depth of contaminant incorporation (L).

Initial Soil Concentration

The effect of change in the initial soil concentration is linear; i.e., an increase in C_o of 100 percent causes an increase in the emission rate of 100 percent. Probably the greatest degree of uncertainty in the value of C_o is likely to be either insufficient soil sampling to adequately characterize site soil concentrations, or the variability in percent recovery of contaminants as it applies to existing sampling and analysis methods for organic compounds in soils. Typically, present extraction and analysis method recovery variability increases the likelihood of underprediction of the emission rate (i.e., more contaminant is present in the soil than is reported by sampling and analysis methods).

Henry's Law Constant and Soil/Water Partition Coefficient

Jury et al. (1984) showed that a given chemical can be grouped into three main categories depending on the ratio K_D/K_H. These categories are defined as a function of which phase dominates diffusion. A Category I chemical is dominated by the vapor-phase, a Category III chemical by the liquid-phase, and Category II chemicals by vapor-phase diffusion at low soil water content and liquid-dominated at high water content. Desorption from the solid-phase to the liquid-phase is a function of the soil/water partition coefficient, while volatilization from the liquid to the vapor-phase is a function of the Henry's law constant. Therefore, the interstitial vapor density, and thus emission flux, is directly proportional to K_H and inversely proportional to K_D. Because the Jury volatilization models do not account for a soil-air boundary layer, the effects of K_H and K_D are exponential for all three categories of chemicals.

Depth of Contaminant Incorporation

The Jury Reduced Solution finite source model accounts for diffusion across both the upper and lower boundaries. Therefore for chemicals with high effective diffusion coefficients, the residual soil concentration will decrease rapidly. In this regard, the emission flux curve will become asymptotic more rapidly than for the semi-infinite case (Equation 3). The exponential term $[1 - \exp(-L^2/4\ D_E t)]$ in Equation 1 accounts for diffusion across the lower boundary such that the term decreases rapidly with time for small values of L and large values of D_E.

SECTION 5

CONCLUSIONS

From the results of this study, it can be concluded that for the compounds included in the experimental data, both models showed good agreement with measured data given the conditions of each test. Each model demonstrated superior agreement with bench-scale measured values and to a lesser extent the infinite source model with pilot-scale data. The results indicate high correlation coefficients across all experimental data with mean modeled-to-measured ratios as low as 0.37 and as high as 7.8.

From a review of test conditions, it was concluded that the bench-scale studies better approximated the initial and boundary conditions of the infinite source model. This is evident in the lower modeled-to-measured mean ratios and narrow 95 percent confidence intervals. Although the pilot-scale study data showed reasonable agreement with predicted values, questions remain as to whether the test conditions were in agreement with model assumptions and accurately replicated all model boundary conditions. Overall, each model provided reasonably accurate predictions.

Clearly, this validation study is limited by the range of conditions simulated, the assumptions under which the models operate, and the initial and boundary conditions of each model. Important limitations include:

1. The duration of the experiments examined range from 7 to 36 days. Model performance for longer periods could not be validated.

2. Both models assume no mass flow of contaminants due to water movement in the soil. Mass flow due to capillary action or redistribution of contaminates due to rain events may be significant if applicable to site-specific condition.

3. The models are valid only if the effective diffusion coefficient in soil is constant. This assumes isotropic soils and completely homogeneous incorporation of contaminants. In reality, soils are usually heterogeneous, with properties that change with depth (e.g., fraction of organic carbon, water content, porosity, etc.). The user will need to carefully consider the characterization of soil properties before assigning model input parameters.

4. The equilibrium partitioning relationships used in the models are no longer valid for pure-phase chemicals or when high dissolved concentrations are present. Therefore, the models should not be used when these conditions exist.

5. The models do not consider the effects of a soil-air boundary layer on the volatilization rate. For chemicals with Henry's law constants less than approximately 2.5×10^{-5}, volatilization is highly dependent on the thickness of the boundary layer (Jury et al., 1984). A boundary layer will restrict volatilization if the maximum flux through the boundary layer is small compared to the rate at which the contaminant moves to the surface. In this case, the volatilization rate is inversely proportional to the boundary layer thickness.

6. In the case of the infinite source model, validation for chemicals with relatively high Henry's law constants requires that the depth of contamination be sufficient to prevent loss at the lower boundary over the duration of the experiment, i.e., $L > (18.4\ D_E\ t)^{1/2}$. Although this study indicates that the Jury Infinite Source model exhibited a relatively small maximum error (i.e., 134% of the Mayer et al. finite source model total mass loss for benzene), any future validation studies should

maintain a sufficient depth of incorporation to prevent violation of the model boundary conditions.

7. No experimental data could be found in the literature for validation of the Jury Reduced solution finite source model for compounds with high Henry's law constants.

Emission rates predicted by the Jury Infinite Source volatilization model and the Jury Reduced Solution finite source volatilization model indicate good correlation to measured emission rates under controlled conditions, but predicted values for field conditions would be subject to error because the boundary conditions and environmental conditions are not as well defined as they are in the laboratory. Nonetheless, results of this study indicate that both models should make reasonable estimates of loss through volatilization at the soil surface given the boundary conditions of each model.

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APPENDIX A

VALIDATION DATA FOR THE JURY INFINITE SOURCE MODEL

DIELDRIN 5 PPM
(1 of 2)

Chemical	Sample Point	Initial soil conc.,	Initial soil conc.,	Emitting area	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravimetric soil moisture,	Water-filled soil porosity,	Solubility	Soil organic carbon,	Saturation conc.,	$C_o > C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o		(L)		ρ_b	ρ_s	w	Θ	S	f_{oc}	C_{sat}		($\mu g/m^2$ -	K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		Kg/L	Kg/L	(wt. fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	min)	(cm^3/g)
Dieldrin	1	5	5.00E-06	27.55	0.5	GilaSlit Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	200	10900
Dieldrin	2	5	5.00E-06	27.55	0.5	Gila Slit Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	115	10900
Dieldrin	3	5	5.00E-06	27.55	0.5	Gila Slit Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	75	10900
Dieldrin	4	5	5.00E-06	27.55	0.5	Gila Slit Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	65	10900
Dieldrin	5	5	5.00E-06	27.55	0.5	Gila Slit Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	60	10900
Dieldrin	6	5	5.00E-06	27.55	0.5	Gila Slit Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	55	10900
Dieldrin	7	5	5.00E-06	27.55	0.5	Gila Slit Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	40	10900

DIELDRIN 5 PPM
(2 of 2)

Chemical	Soil/water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux emission flux	Time, t	$t > L^2/14.4\ D_E$	Infinite source model emission flux
	K_D	D_g^a	D_i^w	D_E	K_H	ϕ	a		Cumulative		
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	(unitless)	(unitless)	(unitless)	($\mu g/cm^2$-day)	(hours)	(Yes/No)	($\mu g/cm^2$-day)
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.2000	24	No	0.0714
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.1150	72	No	0.0412
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.0750	120	No	0.0319
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.0650	144	No	0.0292
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.0600	168	No	0.0270
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.0550	216	No	0.0238
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.0400	288	No	0.0206

DIELDRIN 10 PPM
(1 of 2)

Chemical	Sample Point	Initial soil conc.,	Initial soil conc.,	Emitting area	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravimetric soil moisture,	Water-filled soil porosity,	Solubility,	Soil organic carbon,	Saturation conc.,	$C_o > C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o		(L)		ρ_b	ρ_s	w	Θ	S	f_{oc}	C_{sat}		(ng/cm^2	K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		(g/cm^3)	(g/cm^3)	(wt. fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	-day)	(cm^3/g)
Dieldrin	1	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	0 1870	0.0058	12	No	400	10900
Dieldrin	2	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	260	10900
Dieldrin	3	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	140	10900
Dieldrin	4	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	110	10900
Dieldrin	5	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	105	10900
Dieldrin	6	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	0 1870	0.0058	12	No	90	10900
Dieldrin	7	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	0.1870	0.0058	12	No	85	10900

DIELDRIN 10 PPM
(2 of 2)

Chemical	Soil/ water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux	Time, t	$t > L^2/14.4\ D_E$	Infinite source model emission flux
	K_D	D_g^a	D_l^w	D_E	K_H	ϕ	a		Cumulative		
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	(unitless)	(unitless)	(unitless)	($\mu g/cm^2$-day)	(hrs)	(Yes/No)	($\mu g/cm^2$-day)
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.4000	24	No	0.1428
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.2600	72	No	0.0825
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.1400	120	No	0.0639
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.1100	144	No	0.0583
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.1050	168	No	0.0540
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.0900	216	No	0.0476
Dieldrin	63.22	0.0125	4.74E-06	1.32E-08	0.00011	0.7170	0.6420	0.0850	288	No	0.0412

LINDANE 5 PPM
(1 of 2)

Chemical	Sample Point	Initial soil conc.	Initial soil conc.	Emitting area	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravimetric soil moisture,	Water-filled soil porosity,	Solubility,	Soil organic carbon,	Saturation conc.,	$C_o>C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o		(L)		ρ_b	ρ_s	w	Θ	S	f_{oc}	C_{sat}			K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		(g/cm^3)	(g/cm^3)	(wt. fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	(ng/cm^2-day)	(cm^3/g)
Lindane	1	5	5.00E-06	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	500	1380
Lindane	2	5	5.00E-06	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	160	1380
Lindane	3	5	5.00E-06	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	60	1380
Lindane	4	5	5.00E-06	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	40	1380

LINDANE 5 PPM
(2 of 2)

Chemical	Soil/water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux	Time, t	$t > L^2/14.4\ D_E$	Infinite source model emission flux	Finite source model emmision flux	Infinite source model error
	K_D	D_g^a	D_i^w	D_E	K_H	ϕ	a		Cumulative				
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	(unitless)	(unitless)	(unitless)	($\mu g/cm^{2-}$day)	(hours)	(Yes/No)	($\mu g/cm^{2-}$day)	($\mu g/cm^{2-}$day)	(percent)
Lindane	8.00	0.0176	5.57E-06	1.80E-07	0.00014	0.7170	0.6420	0.5000	24	No	0.2641	0.2641	0.0000
Lindane	8.00	0.0176	5.57E-06	1.80E-07	0.00014	0.7170	0.6420	0.1600	72	Yes	0.1525	0.1510	0.9604
Lindane	8.00	0.0176	5.57E-06	1.80E-07	0.00014	0.7170	0.6420	0.0600	120	Yes	0.1181	0.1086	8.7891
Lindane	8.00	0.0176	5.57E-06	1.80E-07	0.00014	0.7170	0.6420	0.0400	168	Yes	0.0998	0.0797	25.2965

LINDANE 10 PPM
(1 OF 2)

Chemical	Sample Point	Initial soil conc.,	Initial soil conc.,	Emitting area	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravimetric soil moisture,	Water-filled soil porosity,	Solubility,	Soil organic carbon,	Saturation conc.,	$C_o > C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o		(L)		ρ_b	ρ_s	w	Θ	S	f_{oc}	C_{sat}		(ng/cm^2	K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		(g/cm^3)	(g/cm^3)	(wt. fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	-day)	(cm^3/g)
Lindane	1	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	1160	1380
Lindane	2	10	1.00E-05	27.55	0.5	Gila Silt Loarn	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	320	1380
Lindane	3	10	1.00E-05	27.55	0.5	Gila Silt Loam	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	140	1380
Lindane	4	10	1.00E-05	27.55	0.5	Gila Silt Loarn	0.75	2.65	0.10	0.0750	4.2000	0.0058	34	No	90	1380

LINDANE 10 PPM
(2 of 2)

Chemical	Soil/water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux	Time, t	$t > L^2/14.4\ D_E$	Infinite source model emission flux	Finite source model emmision	Infinite source model error
	K_D	D_g^a	D_l^w	D_E	K_H	ϕ	a	($\mu g/cm^2$	Cumulative		($\mu g/cm^2$	($\mu g/cm^2$	
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	(unitless)	(unitless)	(unitless)	-day)	(hours)	(Yes/No)	-day)	-day)	(percent)
Lindane	8.00	0.0176	5.57E-.06	1.80E-07	0.00014	0.7170	0.6420	1.1600	24	No	0.5282	0.5282	0.0000
Lindane	8.00	0.0176	5.57E-.06	1.80E-07	0.00014	0.7170	0.6420	0.3200	72	Yes	0.3049	0.3020	0.9604
Lindane	8.00	0.0176	5.57E-.06	1.80E-07	0.00014	0.7170	0.6420	0.1400	120	Yes	0.2362	0.2171	8.7891
Lindane	8.00	0.0176	5.57E-.06	1.80E-07	0.00014	0.7170	0.6420	0.0900	168	Yes	0.1996	0.1593	25.296

BENZENE 110 PPMW
(1 of 2)

Chemical	Sample Point	Initial soil conc.,	Initial soil conc.,	Flux chamber surface area	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravimetric soil moisture,	Water-filled soil porosity,	Solubility,	Soil organic carbon,	Saturation conc.,	$C_o > C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o		(L)		ρ_b	ρ_s	w	Θ	S	f_{oc}	C_{sat}		(μg/cm^2	K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		(Kg/L)	(Kg/L)	(wt. fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	-day)	(cm^3/g)
Benzene	3	110	1.10E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	1780	0.006	862	No	2760	57
Benzene	4	110	1.10E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	1780	0.006	862	No	9000	57
Benzene	5	110	1.10E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	1780	0.006	862	No	910	57
Benzene	6	110	1.10E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	1780	0.006	862	No	400	57
Benzene	7	110	1.10E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	1780	0.006	862	No	290	57
Benzene	8	110	1.10E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	1780	0.006	862	No	0	57

BENZENE 110 PPMW
(2 of 2)

Chemical	Soil/water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	H	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux	Time, t	$t > L^2/14.4\ D_E$	Infinite source model emission flux	Finite source model emmision flux	Infinite source model error
	K_D	D_g^a	D_l^w	D_E		K_H	ϕ	a	(μg/cm^2	Cumulative		(μg/cm^2	(μg/cm^2	
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	(atm-m^3/mol)	(unitless)	(unitless)	(unitless)	-day)	(hours)	(Yes/No)	-day)	-day)	(percent)
Benzene	0.34	0.0870	9.80E-06	2.14E-03	0.00543	0.22263	0.4340	0.2840	397	26.40	No	1207	1207	0.0000
Benzene	0.34	0.0870	9.80E-06	2.14E-03	0.00543	0.22263	0.4340	0.2840	1296	76.25	Yes	710	710	0.0002
Benzene	0.34	0.0870	9.80E-06	2.14E-03	0.00543	0.22263	0.4340	0.2840	131	119.73	Yes	567	567	0.0253
Benzene	0.34	0.0870	9.80E-06	2.14E-03	0.00543	0.22263	0.4340	0.2840	58	506.83	Yes	275	209	31.5053
Benzene	0.34	0.0870	9.80E-06	2.14E-03	0.00543	0.22263	0.4340	0.2840	42	698.55	Yes	235	135	73.9743
Benzene	0.34	0.0870	9.80E-06	2.14E-03	0.00543	0.22263	0.4340	0.2840	0	863.17	Yes	211	92	128.3941

TOLUENE 880 PPMW
(1 OF 2)

Chemical	Sample Point	Initial soil conc.	Initial soil conc.	Flux chamber surface area	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravimetric soil moisture,	Water-filled soil porosity,	Solubility	Soil organic carbon,	Saturation conc.,	$C_o > C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o		(L)		ρ_b	ρ_s	w	Θ	S	f_{oc}	C_{sat}		($\mu g/m^2$	K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		(kg/L)	(kg/L)	(wt. fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	-min)	(cm^3/g)
Toluene	3	880	8.80E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	558	0.006	522	Yes	14800	131
Toluene	4	880	8.80E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	558	0.006	522	Yes	17300	131
Toluene	5	880	8.80E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	558	0.006	522	Yes	4910	131
Toluene	6	880	8.80E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	558	0.006	522	Yes	1340	131
Toluene	7	880	8.80E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	558	0.006	522	Yes	830	131
Toluene	8	880	8.80E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	558	0.006	522	Yes	340	131
Toluene	9	880	8.80E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	558	0.006	522	Yes	260	131

TOLUENE 880 PPMW
(2 OF 2)

Chemical	Soil/water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	H	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux	Time, t	$t > L^2/14.4\ D_E$	Infinite source model emission flux	Finite source model emmision flux	Infinite source model error
	K_D	D_g^a	D_l^w	D_E	(atm-	K_H	ϕ	a	($\mu g/cm^{2-}$	Cumulative				
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	m^3/mol)	(unitless)	(unitless)	(unitless)	day)	(hours)	(Yes/No)	($\mu g/cm^{2-}$ day)	($\mu g/cm^{2-}$ day)	(percent)
Toluene	0.79	0.0870	8.60E-06	1.30E-03	0.00637	0.26117	0.4340	0.2840	2131	26.40	No	7524	7524	0.0000
Toluene	0.79	0.0870	8.60E-06	1.30E-03	0.00637	0.26117	0.4340	0.2840	2491	76.25	No	4427	4427	0.0000
Toluene	0.79	0.0870	8.60E-06	1.30E-03	0.00637	0.26117	0.4340	0.2840	707	119.73	No	3533	3533	0.0001
Toluene	0.79	0.0870	8.60E-06	1.30E-03	0 00637	0.26117	0.4340	0.2840	193	506.83	Yes	1717	1613	6.4806
Toluene	0.79	0.0870	8.60E-06	1.30E-03	0.00637	0.26117	0.4340	0.2840	120	698.55	Yes	1463	1231	18.8541
Toluene	0.79	0.0870	8.60E-06	1.30E-03	0.00637	0.26117	0.4340	0.2840	49	863. 17	Yes	1316	978	34.5481
Toluene	0.79	0.0870	8.60E-06	1.30E-03	0.00637	0.26117	0.4340	0.2840	37	1007.17	Yes	1218	800	52.2568

ETHYLBENZENE 310 PPMW
(1 of 2)

Chemical	Sample Point	Initial soil conc.	Initial soil conc.	Flux chamber surface	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravimetric soil moisture,	Water-filled soil porosity,	Solubility	Soil organic carbon,	Satura-tion conc.,	$C_o > C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o	area	(L)		ρ_b	ρ_s	w	Θ	S	f_{oc}	C_{sat}		($\mu g/cm^2$	K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		($g/cm^{3)}$	($g/cm^{3)}$	(wt. fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	-min)	(cm^3/g)
Ethylbenzene	3	310	3.1 0E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	173	0.006	257	Yes	2640	221
Ethylbenzene	4	310	3.1 0E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	173	0.006	257	Yes	1700	221
Ethylbenzene	5	310	3.1 0E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	173	0.006	257	Yes	1080	221
Ethylbenzene	6	310	3.1 0E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	173	0.006	257	Yes	250	221
Ethylbenzene	7	310	3.1 0E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	173	0.006	257	Yes	180	221
Ethyibenzene	8	310	3.1 0E-04	1300	91	Loamy Sand	1.5	2.65	0.10	0.1500	173	0.006	257	Yes	0	221

ETHYLBENZENE 310 PPMW
(2 of 2)

Chemical	Soil/ water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux	Time, t	$t > L^2/14.4\ D_E$	Infinite source model emission flux	Finite source model emmision flux	Infinite source model error
	K_D	D_g^a	D_l^w	D_E	K_H	ϕ	a	($\mu g/cm^{2-}$	Cumulative		($\mu g/cm^{2-}$	($\mu g/cm^{2-}$	
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	(unitless)	(unitless)	(unitless)	day)	(hours)	(Yes/No)	day)	day)	(percent)
Ethylbenzene	1.33	0.0750	7.80E-06	8.64E-04	0.32021	0.4340	0.2840	380	26.40	No	2162	2162	0.0000
Ethylbenzene	1.33	0.0750	7.80E-06	8.64E-04	0.32021	0.4340	0.2840	245	76.25	No	1272	1272	0.0000
Ethylbenzene	1.33	0.0750	7.80E-06	8.64E-04	0.32021	0.4340	0.2840	156	119.73	No	1015	1015	0.0000
Ethylbenzene	1.33	0.0750	7.80E-06	8.64E-04	0.32021	0.4340	0.2840	36	506.83	Yes	493	488	1.0596
Ethylbenzene	1.33	0.0750	7.80E-06	8.64E-04	0.32021	0.4340	0.2840	26	698.55	Yes	420	402	4.6357
Ethyibenzene	1.33	0.0750	7.80E-06	8.64E-04	0.32021	0.4340	0.2840	0	863.17	Yes	373	343	10.0850

APPENDIX B

VALIDATION DATA FOR THE JURY REDUCED SOLUTION FINITE SOURCE MODEL

TRIALLATE 10 PPM
(1 OF 2)

Chemical	Sample Point	Initial soil conc.	Initial soil conc.	Emitting	Soil Depth	Soil Type	Soil bulk density,	Soil particle density,	Gravi-metric soil moisture, w	Water-filled soil porosity,	Solubility	Soil organic carbon,	Saturation conc.,	$C_o > C_{sat}$	Measured emission flux	Organic carbon part. coeff.,
		C_o	C_o	area	(L)		ρ_b	ρ_s	(wt.	Θ	S	f_{oc}	C_{sat}		(μg/cm^2	K_{oc}
		(mg/kg)	(g/g)	(cm^2)	(cm)		(Kg/L)	(Kg/L)	fraction)	(unitless)	(mg/L)	(fraction)	(mg/kg)	(Yes/No)	-day)	(cm^3/g)
Triallate	1	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	1.700	3600
Triallate	2	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.975	3600
Triallate	3	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.750	3600
Triallate	4	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.490	3600
Triallate	5	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.330	3600
Triallate	6	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.280	3600
Triallate	7	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.210	3600
Triallate	8	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.180	3600
Triallate	9	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.155	3600
Triallate	10	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.145	3600
Triallate	11	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.135	3600
Triallate	12	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.125	3600
Triallate	13	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.123	3600
Triallate	14	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.115	3600
Triallate	15	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.107	3600
Triallate	16	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.105	3600
Triallate	17	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.103	3600
Triallate	18	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.102	3600
Triallate	19	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.095	3600
Triallate	20	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.094	3600
Triallate	21	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.093	3600
Triallate	22	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.094	3600
Triallate	23	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.085	3600
Triallate	24	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.083	3600
Triallate	25	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.082	3600
Triallate	26	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.083	3600
Triallate	27	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.00.72	105	No	0.080	3600
Triallate	28	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.00.72	105	No	0.080	3600
Trlallate	29	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.00.72	105	No	0.072	3600
Triallate	30	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0 071	3600
Triallate	31	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0 070	3600
Triallate	32	10	1.00E-05	30	10	San Joaquin Sandy Loam	1.34	2.65	0.21	0.2787	4.00	0.0072	105	No	0.070	3600

TRIALLATE 10 PPM
(2 OF 2)

Chemical	Soil/ water part. coeff.,	Diffusivity in air,	Diffusivity in water,	Effective diffusion coefficient,	Henry's law constant,	Total soil porosity,	Air-filled soil porosity,	Measured emission flux	Time, t	Jury finite source model emission flux
	K_D	D_g^a	D_l^w	D_E	K_H	ϕ			Cumulative	
	(cm^3/g)	(cm^2/s)	(cm^2/s)	(cm^2/s)	(unitless)	(unitless)	(unitless)	($\mu g/cm^{2-}$ day)	(hours)	($\mu g/cm^{2-}$ day)
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	1.700	3	1.278
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.975	6	0.904
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.750	12	0.639
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.490	24	0.452
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.330	48	0.320
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.280	72	0.261
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.210	96	0.226
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.180	120	0.202
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.155	144	0.184
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.145	168	0.171
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.135	192	0.160
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.125	216	0.151
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.123	240	0.143
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.115	264	0.136
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.107	288	0.130
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.105	312	0.125
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.103	336	0.121
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.102	360	0.117
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.095	384	0.113
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.094	408	0.110
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.093	432	0.107
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.094	456	0.104
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.085	480	0.101
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.083	504	0.099
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.082	528	0.096
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.083	552	0.094
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.080	576	0.092
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.080	600	0.090
Triailate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.072	624	0.085
Triaiiate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.071	648	0.087
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0.070	672	0.085
Triallate	25.92	0.0450	5.00E-06	4.14E-08	0.00104	0.4943	0.2156	0 070	696	0.084

APPENDIX D

Revisions to VF and PEF Equations (EQ, 1994b)

ENVIRONMENTAL QUALITY MANAGEMENT, INC.

MEMORANDUM

TO:	Ms. Janine Dinan	**DATE:**	July 11, 1994
SUBJECT:	Revisions to VF and PEF Equations	**FROM:**	Craig Mann
FILE:	5099-3	**cc:**	

Subsequent to the evaluation of the dispersion equations in the RAGS - Part B performed by Environmental Quality Management, Inc. (EQ,1993), questions have arisen as to the accuracy of the modeling protocol used to derive the dispersion coefficient (Q/C) used in the volatilization factor (VF) and the particulate emission factor (PEF) presently employed to calculate the air pathway Soil Screening Levels (SSLs).

EQ, 1993 used the Industrial Source Complex model (ISC2-ST) to derive a normalized concentration (kg/m^3 per g/m^2-s) for a series of square and rectangular area sources of differing size. This modeling protocol employed a source subdivision scheme similar to that recommended in the ISC2-ST Model User's Manual (EPA, 1992) whereby the source was subdivided into smaller sources closest to the center of the area. The center of the area was found to represent the point of maximum annual average concentration for all source shapes analyzed. Consecutive model runs were performed whereby source subdivision was increased between runs. Final source subdivision was reached when the model results converged within a factor of three percent or less.

From these data, a simple linear regression was used to evaluate the nature of the relationship between the normalized concentration and the size of the area. Preliminary plots of the data indicated that the relationship was exponential. Therefore, the relationship was linearized by taking the natural logarithms (ln) of each variable. The resulting linear regression for a square area of 0.5 acres resulted in a normalized concentration (C/Q) of 0.0098 kg/m^3 per g/m^2-s; the inverse of the normalized concentration resulted in a dispersion coefficient (Q/C) of 101.8 g/m^2-s per kg/m^3.

On May 5, 1994 a teleconference was held between representatives of the Toxics Integration Branch of the Office of Emergency and Remedial Response (OERR) and the Source Receptor Analysis Branch of the Office of Air Quality Planning Standards (OAQPS) to discuss the relative merits of the available area source algorithms as applied to nearfield and on-site receptors exposed to ground-level nonbuoyant emissions. The conclusions drawn from this teleconference were that a new algorithm recently developed by OAQPS would yield more accurate results for the exposure scenario in question.

The new algorithm is incorporated into the ISC2 model platform in both short-term mode (AREA-ST) and long-term mode (AREA-LT). Both models employ a double numerical integration over the area source in the upwind and crosswind directions as follows:

$$\chi = \frac{Q_A K}{2\pi u_s} \int_x \frac{VD}{\sigma_y \sigma_z} \left(\int_y \exp\left[-0.5 \left(\frac{Y}{\sigma_y} \right)^2 \right] dy \right) dx \qquad (1)$$

where Q_A = Area source emission rate (g/m^2-s)

K = Units scaling coefficient

V = Vertical term

D = Decay term.

The integral in the lateral (i.e., crosswind or y) direction is solved analytically as:

$$\int_y \exp\left[-0.5\left(\frac{Y}{\sigma_y}\right)^2\right]dy = \operatorname{erfc}\left(\frac{Y}{\sigma_y}\right) \qquad (2)$$

where erfc is the complementary error function.

The integral in the longitudinal (i.e., upwind or x) direction is solved by using a weighted average of successive estimates of the integral using a trapezoidal approximation. The model uses three separate criteria to determine convergence of the upwind integral. The result of these numerical methods is an estimate of the full integral that is essentially equivalent to, but much more efficient than, the method of estimating the integral as a series of line sources, such as the method used by the Point, Area, Line (PAL 2.0) model. Wind tunnel tests have also shown that the new algorithm performs well with on-site and near-field receptors.

Because the new algorithm provides better concentration estimates and does not require source subdivision, a revised dispersion analysis was performed for both volatile and particulate matter contaminants using the new algorithm.

The first part of the analysis involved a determination of the relationship between concentration and source size. In addition, this part of the analysis included a determination of the point of maximum annual average concentration for a square area source. This assessment employed the AREA-ST model as acquired from the OAQPS Technology Transfer Network, Support Center for Regulatory Air Models (SCRAM) Bulletin Board.

Meteorological data used for this analysis were 1989 hourly data for the Los Angeles National Weather Service (NWS) surface station, upper air data were from the Oakland NWS station for the same year. Rural dispersion coefficients were employed and all regulatory default options used. Modeling assumed flat terrain with no flagpole receptors; source rotation angle was set equal to zero.

Five source sizes were included in the assessment: 0.5, 5, 30, 200, and 600 acres. A coarse Cartesian receptor grid was employed within and extending beyond the source perimeter; a discrete receptor was also placed at the center of each source (x,y = 0,0). Emissions from each source were set equal to 1.0 g/m^2-s; concentrations were calculated in units of kg/m^3.

Figure 1 shows the relationship between source size (acres) and annual average concentration (kg/m3) for the five source sizes modeled. In each case, the point of maximum concentration was located at the center of the source. As an example, Attachment A is the model run sheets for the 0.5 acre source. As can be seen from Figure 1, the relationship between concentration and source size is exponential. Results also show that the maximum concentration representing the 600 acre source is 2.9 times higher than that of the 0.5 acre source.

Having established that when using the AREA-ST model the point of maximum concentration for a square area source is the center receptor, the second part of the analysis was to determine which of the 29 meteorological sites from EQ, 1993 best represents the average exposure and the high end exposure to volatile and particulate matter emissions. It was determined that the average exposure case should be represented by the 50th percentile site concentration, while the high end exposure is best represented by the 90th percentile site concentration.

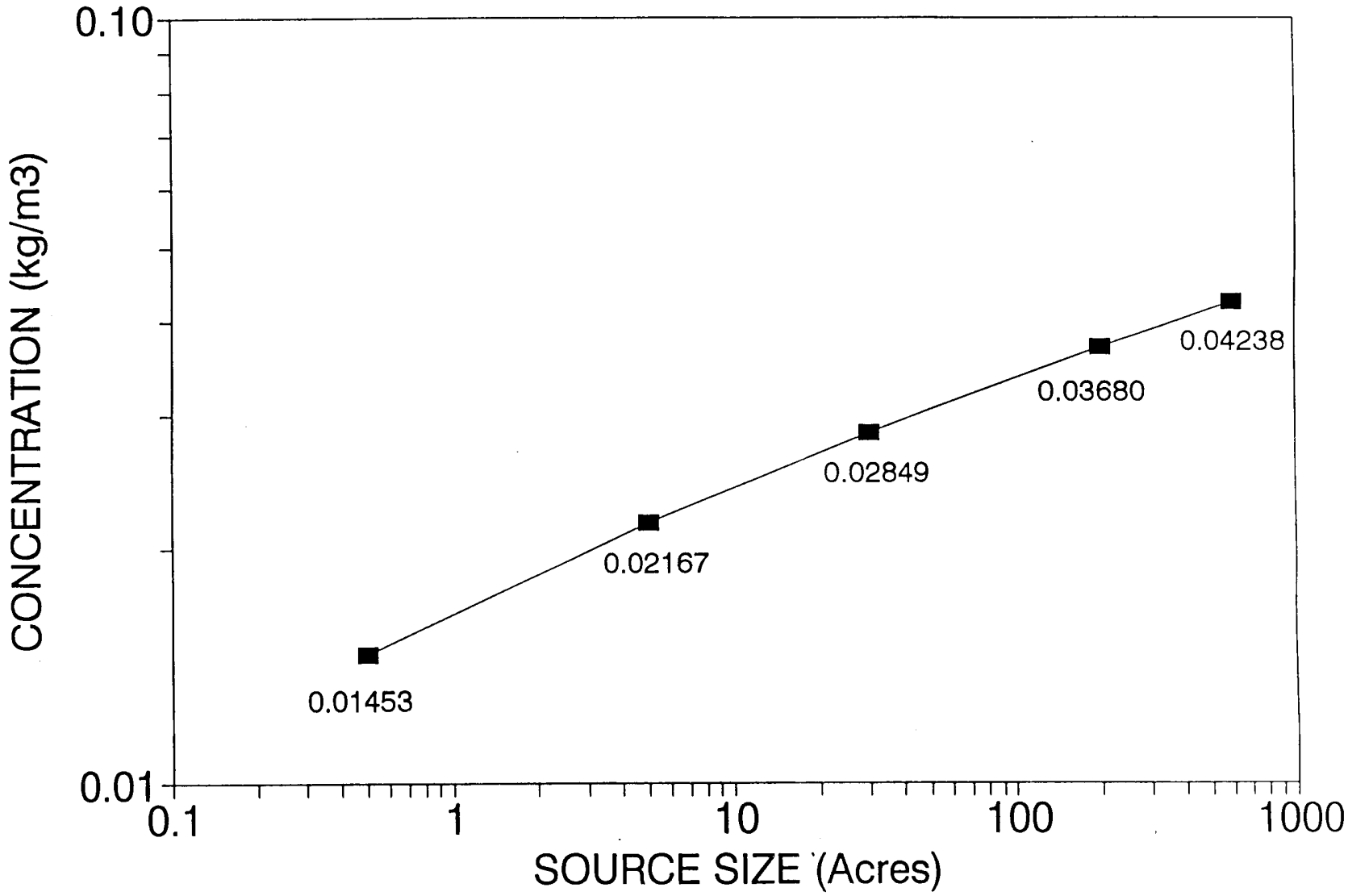

Figure 1
Normalized Annual Average Concentration Versus Source Size

Each of the 29 sites from EQ, 1993 were subsequently modeled at an emission rate of 1.0 g/m^2-s with a single discrete receptor at the center of the square area source. Source sizes modeled were 0.5 acres and 30 acres. Hourly meteorological data for each site were from EQ, 1993. From the set of SS normalized annual average concentrations, the 50th percentile site was determined to be Salt Lake City, Utah; Los Angeles, California (89th percentile site) was determined to be the closest approximation of the 90th percentile site. Table 1 shows the resulting dispersion coefficients for the two source sizes and the percentile ranking of each site.

In order to determine the average and high end sites for particulate matter exposures resulting from wind erosion, a normalized concentration could not be used because meteorological conditions other than simple dispersion (i.e., wind velocity and frequency) influence emissions and therefore actual concentrations. For this reason, actual concentrations were calculated for each site using the existing PEF equation as follows:

$$C = (C/Q)\left[\frac{0.036\,(1-V)\times(U_m/U_{t-7})^3 \times F(x)}{3600\ s/h}\right] \qquad (3)$$

where C = Annual average PM_{10} concentration, kg/m^3

(C/Q) = Normalized annual average concentration (kg/m^3 per g/m^2 -s)

V = Fraction of continuous vegetative cover

U_m = Mean annual windspeed, m/s

U_{t-7} = Equivalent threshold value of windspeed at 7 m, m/s

F(x) = Windspeed distribution function from Cowherd, 1985.

The value of (C/Q) for each site was the normalized concentration previously estimated for volatile emissions (i.e., the inverse of each dispersion coefficient in Table 1). The value of V was set equal to 0.5. The mean annual windspeed (U_m) for each site was taken from Weather of U.S. Cities, Second Edition, Volume 2 by J. A. Ruffner and F. E. Bair, Gale Research Co., Detroit, Michigan. The value of F(x) was estimated for each site from Figure 4-3 or calculated from Appendix B of Cowherd 1985, as appropriate.

The value of U_{t-7} was calculated as follows:

$$U_{t-7} = \frac{U_t}{0.4}\ \ln\left(\frac{700}{z_0}\right) \qquad (4)$$

where U_{t-7} = Equivalent threshold value of windspeed at 7 m, m/s

Z_o = Surface roughness height, cm (z_o = 0.5 cm for open terrain)

U_t = Threshold friction velocity, m/s (U_t = 0.625 m/s).

Table 2 gives the results of this analysis and shows the relative PM_{10} concentrations for each site by source size and the percentile rankings. As can be seen from Table 2, the 50th percentile site was Salt Lake City, Utah, while the 89th percentile site was Minneapolis, Minnesota.

TABLE 1.
VOLATILE DISPERSION SITE RANKINGS

City	NWS Surface Station Number	0.5 Acre (Q/C) (g/m^2-s per kg/m^3)	30 Acre (Q/C) (g/m^2-s per kg/m^3)	Site Ranking Percentile (%)
Huntington	13860	52.77	27.08	100
Fresno	93193	62.00	31.85	96
Phoenix	23183	64.06	32.63	93
Los Angeles	**24174**	**68.82**	**35.10**	**89**
Winnemucca	24128	69.25	35.49	86
Boise	24131	69.40	35.69	82
Hartford	14740	71.33	36.64	79
Little Rock	13963	73.37	37.68	75
Portland	14764	74.24	37.86	71
Salem	24232	73.42	37.88	68
Charleston	13880	74.91	38.42	64
Denver	23062	75.59	38.80	61
Atlanta	13874	77.16	39.68	57
Raleigh-Durham	13722	77.46	39.87	54
Salt Lake City	**24127**	**78.06**	**40.14**	**50**
Houston	12960	79.24	40.70	46
Lincoln	14939	81.63	41.56	43
Harrisburg	14751	81.90	42.34	39
Bismarck	24011	83.40	42.72	36
Seattle	24233	82.71	42.81	32
Cleveland	14820	83.19	43.03	29
Albuquerque	23050	84.18	43.31	25
Miami	12839	85.40	43.57	21
San Francisco	23234	89.53	46.06	18
Philadelphia	13739	90.09	46.38	14
Minneapolis	14922	90.74	46.84	11
Las Vegas	23169	95.51	49.48	7
Chicago	94846	97.75	50.45	4
Casper	24089	100.00	51.68	0

TABLE 2. PEF.CALCULATIONS AND SITE RANKINGS

	NWS surface station	Mean annual wind-speed	Mean annual wind-speed	Roughness height, Zo t	Threshold friction velocity at surface	Threshold friction velocity at 7m		F(x),	F(x),	Vegetative cover	PM10 emission flux	0.5 Acre (Q/C) (g/m2-s per	0.5 Acre annual average conc.	30 Acre (Q/C) (g/m2-s per	30 Acre annual average conc.	Site ranking percentile
City	number	(mph)	(m/s)	(cm)	(m/s)	(m/s)	x	x<=2	x>2	(fraction)	(g/m2-s)	kg/m3)	(ug/m3)	kg/ m3)	(ug/ m3)	(%)
Casper	24089	12.9	5.77	0.5	0.625	11.32	1.74	0.57	NA	0.50	3.77E-07	100.00	3.77	51.68	7.29	100
Cleveland	14820	10.8	4.83	0.5	0.625	11.32	2.08	NA	2.32E-01	0.50	9.01E-08	83.19	1.08	43.03	2.09	96
Lincoln	14939	10.4	4.65	0.5.	0.625	11.32	2.16	NA	1.82E-01	0.50	6.30E-08	81.63	077	41.56	1.52	93
Minneapolis	**14922**	**10.5**	**4.69**	**0.5**	**0.625**	**11.32**	**2.14**	**NA**	**1.94E-01**	**0.50**	**6.92E-08**	**90.74**	**0.76**	**46.84**	**1.48**	**89**
Bismarck	24011	10.3	4.60	0.5	0.625	11.3Z	2.18	NA	1.70E-01	0.50	5.73E-08	83.40	0.69	42.72	1.34	86
Chicago	94846	10.4	4.65	0.5	0.625	11.32	2.16	NA	1.82E-01	0.50	6.30E-08	97.75	0.64	50.45	1.25	82
Philadelphia	13739	9.6	4.29	0.5	0.625	11.32	2.34	NA	9.93E-02	0.50	2.71E-08	90.09	0.30	46.38	0.58	79
Miami	12835	9.2	4.11	0.5	0.625	11.32	2.44	NA	6.82E-02	0.50	1.64E-08	85.40	0.19	43.57	0.38	75
Altanta	13874	9.1	4.07	0.5	0.625	11.32	2.47	NA	6.16E-02	0.50	1.43E-08	77.16	0.19	39.68	0.36	71
Seattle	24233	9.1	4.07	0.5	0.625	11.32	2.47	NA	6.16E-02	0.50	1.43E-08	82.71	0.17	42.81	0.33	68
Boise	24131	8.9	3.98	0.5	0.625	11.32	2.52	NA	4.95E-02	0.50	1.07E-08	69.40	0.15	35.69	0.30	64
Las Vegas	23165	9.1	4.07	0.5	0.625	11.32	2.47	NA	6.16E-02	0.50	1.43E-08	95.51	0.15	49.48	0.29	61
Albuquerque	23050	9.0	4.02	0.5	0.625	11.32	2.49	NA	5.53E-02	0.50	1.24E-08	84.18	0.15	43.31	0.29	57
Denver	23062	8.8	3.93	0.5	0.625	11.32	2.55	NA	4.41E-02	0.50	9.25E-09	75.59	0.12	38.80	0.24	54
Salt Lake City	**24127**	**8.8**	**3.93**	**0.5**	**0.625**	**11.32**	**2.55**	**NA**	**4.41E-02**	**0.50**	**9.25E-09**	**78.06**	**0.12**	**40.14**	**0.23**	**50**
Portland	14762	8.7	3.89	0.5	0.625	11.32	2.58	NA	3.91E-02	0.50	7.93E-09	74.24	0.11	37.86	0.21	46
Charleston	13880	8.7	3.89	0.5	0.625	11.32	2.58	NA	3.91E-02	0.50	7.93E-09	74.91	0.11	38.42	0.21	43
Hartford	14764	8.6	3.84	0.5	0.625	11.32	2.61	NA	3.45E-02	0.50	6.76E-09	71.33	0.095	36.64	0.18	39
San Francisco	23234	8.7	3.89	0.5	0.625	11.32	2.58	NA	3.91E-02	0.50	7.93E-09	89.53	0.089	46.06	0.17	36
Little Rock	13963	8.0	3.58	0.5	0.625	11.32	2.80	NA	1.45E-02	0.50	2.29E-09	73.37	0.031	37.68	0.061	32
Winnemucca	24128	7.9	3.53	0.5	0.625	11.32	2.84	NA	1.23E-02	0.50	1.86E-09	69.25	0.027	35.49	0.052	29
Houston	12960	7.8	3.49	0.5	0.625	11.32	2.88	NA	1.03E-02	0.50	1.51E-09	79.24	0.019	40.70	0.037	25
Raleigh-Durham	13722	7.7	3.44	0.5	0.625	11.32	2.91	NA	8.60E-03	0.50	1.21E-09	77.461	0.016	39.87	0.030	21
Harrisburg	14751	7.7	3.44	0.5	0.625	11.32	2.91	NA	8.60E-03	0.50	1.21E-09	81.90	0.015	42.34	0.029	18
LosAngeles	24174	7.4	3.31	0.5	0.625	11.32	3.03	NA	4.74E-03	0.50	5.92E-10	68.82	8.60E-03	35.10	0.017	14
Salem	2423 2	7.0	3.13	0.5	0.625	11.32	3.21	NA	1.87E-03	0.50	1.98E-10	73.42	2.69E-03	37.88	5.22E-03	11
Huntington	13860	6.5	2.91	0.5	0.625	11.32	3.45	NA	4.45E-04	0.50	3.76E-11	52.77	7.13E-04	27.08	1.39E-03	7
Fresno	93193	6.4	2.86	0.5	0.625	11.32	3.51	NA	3.19E-04	0.50	2.58E-11	62.00	4.16E-04	31.85	8.09E-04	4
Phoenix	23183	6.3	2.82	0.5	0.625	11.32	3.56	NA	2.25E-04	0.50	1.73E-11	64.06	2.71E-04	32.63	5.31E-04	0

F(x) <= 2 from Cowherd (1985), Figure 4-3.
F(x) > 2 from Cowherd (1985), Appendix B.
NA = Not Appilcable.

Table 3 summarizes the results of the dispersion coefficient analysis for both the VF and PEF equations. In addition, Table 3 also gives the default values of the PEF variables for both average and high end exposures.

TABLE 3.
VF AND PEF VALUES OF (Q/C) FOR AVERAGE AND HIGH END EXPOSURES

Site size	Average annual conc., PM10 (ug/m^3)	High End annual conc., PM10 (ug/m^3)	PEF Average (Q/C), (g/m^2-s per kg/m^3)	PEF High End (Q/C), (g/m^2-s per kg/m^3)	VF Average (Q/C), (g/m^2-s per kg/m^3)	VF High End (Q/C), (g/m^2-s per kg/m^3)
0.5 Acres	0.12	0.76	78.06	90.74	78.06	68.82
30 Acres	0.23	1.48	40.14	46.84	40.14	35.10

Average Site for PM10= Salt Lake City
Average Site for Volatiles = Salt Lake City
High End Site for PM10 = Minneapolis
High End Site for Volatiles = Los Angeles

Average Site for PM10: Mean annual windspeed (U_m) = 3.93 m/s; F(x) = 0.044, at x = 2.55.
High End Site for PM10: U_m = 4.69 m/s; F(x) = 0.194, at x = 2.14.
Where:
Vegetative cover (V) = 0.5.
Surface roughness height (Z_o) = 0.5 cm.
Threshold friction velocity (U_t) = 0.625 m/s at surface.
Threshold windspeed at 7 meters (U_t-7) = U_t/0.4 x In(700/Z_o) = 11.32 m/s.

ATTACHMENT A

AREA-ST MODEL RUN SHEETS FOR A 0.5 ACRE SQUARE AREA SOURCE

```
CO      STARTING
CO      TITLEONE       AREA    SOURCES--- 1/2 acre    run
CO      MODELOPT       DFAULT  CONC     RURAL
CO      AVERTIME       PERIOD
CO      POLLUTID       PM10
CO      RUNORNOT       RUN
CO      ERRORFIL       AREA1.ERR
CO      FINISHED


SO STARTING
                 SRCID       SRCTYP      XS          YS          ZS
SO LOCATION      A1/2        AREA        -22.5       -22.5       .0000
                 SRCID       QS          HS          XINIT       YINIT
SO SRCPARAH      A1/2        1.0         0.0         45.         45.

SO      EHISUNIT       .100000E-02    (GRAMS/(SEC-M**2))    KILOGRAMS/CUBIC-METER

SO      SRCGROUP       AREA1   A1/2

SO      FINISHED

RE      STARTING
RE      DISCCART       0.             o.
RE      DISCCART       25.            0.
RE      DISCCART       -25.           o.
RE      DISCCART       25.            25.
RE      DISCCART       25.            -25.
RE      DISCCART       -25.           -25.
RE      DISCCART       -25.           25.
RE      DISCCART       50.            0.
RE      DISCCART       -50.           0.
RE      DISCCART       50.            50.
RE      DISCCART       50.            -50.
RE      DISCCART       -50.           -50.
RE      DISCCART       -50.           50.
RE      DSSCCART       75.            0.
RE      DISCCART       -75.           0.
RE      DISCCART       75.            75.
RE      DISCCART       75.            -75.
RE      DISCCART       -75.           -75.
RE      DISCCART       -75.           75.
RE      DISCCART       100.           0.
RE      DISCCART       -100.          0.
RE      DISCCART       100.           100.
RE      DISCCART       100.           -100.
RE      DISCCART       -100.          -100.
RE      DISCCART       -100.          100.

RE      FINISHED

ME      STARTING
ME      INPUTFIL       C:\CRAIG\23174-89.ASC
ME      ANEHHGHT       10.0 METERS
ME      SURFDATA       23174   1989    LOS ANGELES
ME      UAIRDATA       23230   1989    OAKLAND
```

```
ME      WINDCATS       1.54    3.09    5.14    8.23    10.80
ME      FINISHED

OU      STARTING
OU      RECTABLE       ALLAVE  FIRST
OU      FINISHED

**************************************************
*** SETUP Finishes Successfully ***
**************************************************
```

```
*** AREAST - VERSION TESTA ***   *** AREA SOURCES---1/2 acre run***
TEST OF ST AREA SOURCE ALGORITHM ***                              ***

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

                          *** MODEL SETUP OPTIONS SUMMARY     ***
```

```
**Model Is Setup For Calculation of Average CONCentration Values.

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
       1. Final Plume Rise.
       2. Stack-tip Downwash.
       3. Buoyancy-induced Dispersion.
       4. Use Calms Processing Routine.
       5. Not Use Missing Data Processing Routine.
       6. Default Wind Profile Exponents.
       7. Default Vertical Potential Temperature Gradients.
       8. "Upper Bound" Values for Supersquat Buildings.
       9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates PERIOD Averages Only

**This Run Includes: 1 Source(s); 1 Source Group(s); and 25 Receptore(s)

**The Model Assumes A Pollutant Type of: PM10

**Model Set To Continue RUNning After the Setup Testing.ff

**Output Options Selected:
Model Outputs Tables of PERIOD Averages by Receptor
Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)

**NOTE: The Following Flags May Appear Following CONC Values:
       c for Calm Hours
       m for Hissing Hours
       b for Both Calm and Missing Hours

**Misc. Inputs:
       Anem. Hgt. (m) = 10.00 ; Decay Coef. =.0000 ; Rot. Angle = .0
       Emission Units = (GRAMS/(SEC-M**2)); Emission Rate Unit Factor = .lOOOOE-02
       Output Units = KILOGRAMS/CUBIC-METER

**input Runstream File: area1.dat,                  **Output Print File: area1.out
**Detailed Error/Message File: AREA1.ERR
```

```
*** AREAST - VERSION TESTA ***   *** AREA SOURCES--- 1/2 acre run                    ***
TEST OF ST AREA SOURCE ALGORITHM ***                                                  ***

*** MODELING OPTIONS USED: CONC RURAL FLAT          DFAULT
```

*** AREA SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (USER UNITS /METERS**2)	COORD X (METERS)	(SW CORNER) Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	X-DIM OF AREA (METERS)	Y-DIM OF AREA (METERS)	ORIENT. OF AREA (DEG.)	EMISSION RATE SCALAR VARY BY
A1/2	0	.10000E+01	-22.5	-22.5	.0	.00	45.00	45.00	.00	

```
*** AREAST - VERSION TESTA ***    *** AREA SOURCES--- 1/2 acre run                    ***
TEST OF ST AREA SOURCE ALGORITHM  ***                                                 ***

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT
```

*** SOURCE IDs DEFINING SOURCE GROUPS ***

```
GROUP ID                                  SOURCE IDs

AREA1 A1/2
```

```
*** AREAST - VERSION TESTA *** *** AREA SOURCES--- 1/2 acre run
TEST OF ST AREA SOURCE ALGORITHM ***       ***

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT


                    *** DISCRETE CARTESIAN RECEPTORS ***
                (X-COORD, Y-C00RD, ZELEV, ZFLAG) (METERS)

(       .0,       .0,   .0,     .0);   (     25.0,       .0,   .0,     .0);
(    -25.0,       .0,   .0,     .0);   (     25.0,     25.0,   .0,     .0);
(     25.0    -25.0,   .0,     .0);   (    -25.0,    -25.0,   .0,     .0);
(    -25.0     25.0,   .0,     .0);   (     50.0,       .0,   .0,     .0);
(    -50.0,       .0,   .0,     .0);   (     50.0,     50.0,   .0,     .0);
(     50.0    -50.0,   .0,     .0);   (    -50.0,    -50.0,   .0,     .0);
(    -50.0     50.0,   .0,     .0);   (     75.0,       .0,   .0,     .0);
(    -75.0,       .0,   .0,     .0);   (     75.0,     75.0,   .0,     .0);
(     75.0,    -75.0,   .0,     .0);   (    -75.0,    -75.0,   .0,     .0);
(    -75.0,     75.0,   .0,     .0);   (    100.0,       .0,   .0,     .0);
(   -100.0,       .0,   .0,     .0);   (    100.0,    100.0,   .0,     .0);
(    100.0,    100.0,   .0,     .0);   (   -100.0,   -100.0,   .0,     .0);
(   -100.0,    100.0,   .0,     .0);
```

*** AREAST - VERSION TESTA *** *** AREA SOURCES--- 1/2 acre run
TEST OF ST AREA SOURCE ALGORITHM *** ***

*** MODELING OPTIONS USED CONC RURAL FLAT DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1111111111	1111111111	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	1111111111	1111111111
1111111111	111111			

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WlLL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(HETERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY	WlND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.00000E+00	.O0000E+00	.00000E+00	.00000E+00	.00000E+00	.O0000E+00
B	.00000E+00	.00000E+00	.00000t+00	.00000E+00	.00000E+OO	.00000E+OO
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.OO000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

*** AREAST - VERSION TESTA *** *** AREA SOURCES--- 1/2 acre run ***
TEST OF ST AREA SOURCE ALGORITHM *** ***

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: C:\CRAIG\23174-89.ASC FORMAT: (412,2F9.4,F6.1,I2,2F7.1)
SURFACE STATION NO : 23174 UPPER AIR STATION NO.: 23230
NAME: LOS NAME: OAKLAND
YEAR: 1989 YEAR: 1989

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	URBAN
89	1	1	1	251.0	3.09	282.6	4	533.0	533.0
89	1	1	2	228.0	3.09	282.0	4	568.6	568.6
89	1	1	3	194.0	2.57	282.0	4	604.1	604.1
89	1	1	4	143.0	4.63	282.0	4	639.6	639.6
89	1	1	5	173.0	2.06	282.0	5	675.2	151.0
89	1	1	6	272.0	3.09	280.4	6	710.7	151.0
89	1	1	7	265.0	2.06	280.4	6	746.3	151.0
89	1	1	8	233.0	2.06	282.0	5	134.9	265.4
89	1	1	9	257.0	2.06	283.7	4	278.2	387.0
89	1	1	10	261.0	.00	285.9	3	421.6	508.6
89	1	1	11	44.0	2.06	288.2	3	564.9	630.2
89	1	1	12	56.0	3.60	289.3	3	708.3	751.8
89	1	1	13	83.0	4.12	289.3	3	851.6	873.4
89	1	1	14	59.0	4.12	290.4	3	995.0	995.0
89	1	1	15	82.0	4.12	287.6	3	995.0	995.0
89	1	1	16	74.0	3.60	287.6	4	995.0	995.0
89	1	1	17	81.0	3.60	285.9	5	992.3	979.1
89	1	1	18	87.0	3.09	284.3	6	975.8	880.6
89	1	1	19	154.0	4.12	286.5	5	959.2	782.2
89	1	1	20	167.0	2.06	285.4	6	942.7	683.8
89	1	1	21	280.0	2.57	285.4	6	926.2	585.3
89	1	1	22	252.0	2.06	284.3	6	909.6	486.9
89	1	1	23	220.0	3.09	283.2	6	893.1	388.4
89	1	1	24	260.0	1.54	283.7	7	876.5	290.0

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** AREAST - VERSION TESTA ***   *** AREA SOURCES--- 1/2 acre run                 ***
TEST OF ST AREA SOURCE ALGORITHM ***                                               ***

*** MODELING OPTIONS USED: CONC RURAL FLAT      DFAULT

 *** THE PERIOD ( 8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: AREA1 ***
 INCLUDING SOURCE(S): A1/2,

                         *** DISCRETE CARTESIAN RECEPTOR POINTS ***

 ** CONC OF PM10                  IN KILOGRAMS/CUBIC-METER                          **
```

X-COORD (M)	Y-COORD (M)	CONE	X-COORD (M))	Y-COORD (M	CONC
.00	.00	.01453	25.00	.00	.00679
-25.00	.00	.00594	25.00	25.00	.00414
25.00	-25.00	.00104	-25.00	-25.00	.00220
-25.00	25.00	.00223	50.00	.00	.00175
-50.00	.00	.00158	50.00	50.00	.00060
50.00	-50.00	.00018	-50.00	-50.00	.00034
-50.00	50.00	.00037	75.00	.00	.00076
-75.00	.00	.00078	75.00	75 .00	.00024
75.00	-75.00	.00008	-75.00	-75.00	.00015
-75.00	75.00	.00016	100.00	.00	.00041
-100.00	.00	.00047	100.00	100.00	.00013
100.00	-100.00	.00005	-100.00	-100.00	.00009
-100.00	100.00	.00009			

```
*** AREAST - VERSION TESTA ***   *** AREA SOURCES--- 1/2 acre run
TEST OF ST AREA SOURCE ALGORITHM ***

*** MODELING OPTIONS USED: CONC RURAL FLAT           DFAULT

                  *** THE SUMMARY OF MAXIMUM PERIOD ( 8760 HRS) RESULTS ***

                    ** CONC OF PM10IN    KILOGRAMS/CUBIC-METER          **

                                                                                NETWORK
GROUP ID             AVERAGE CONC           RECEPTOR (XR, YR, ZELEV, ZFLAG) OF TYPE GRID-ID

AREA1   1ST HIGHEST VALUE IS   .01453 AT (       .00,        .00,   .00,       .00)      DC
        2ND HIGHEST VALUE IS   .00679 AT (     25.00,        .00,   .00,       .00)      DC
        3RD HIGHEST VALUE IS   .00594 AT (    -25.00,        .00,   .00,       .00)      DC
        4TH HIGHEST VALUE IS   .00414 AT (     25.00,      25.00,   .00,       .00)      DC
        5TH HIGHEST VALUE IS   .00223 AT (    -25.00,      25.00,   .00,       .00)      DC
        6TH HIGHEST VALUE IS   .00220 AT (    -25.00,     -25.00,   .00,       .00)      DC

*** RECEPTOR TYPES:
GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY
```

```
*** AREAST - VERSION TESTA ***   *** AREA SOURCES--- 1/2 acre run                    ***
TEST OF ST AREA SOURCE ALGORITHM ***                                                  ***

*** MODELING OPTIONS USED: CONC RURAL FLAT       DFAULT

*** Message Summary For ISC2 Model Execution ***

 -------- Summary of Total Messages --------

A Total of       0 Fatal Error Message(s)
A Total of       0 Warning Message(s)
A Totat of     653 Informational Message(s)

A Total of     653 Calm Hours Identified


                    ******** FATAL ERROR MESSAGES ********
                                 *** NONE ***

                      ******** WARNING MESSAGES ********
                                 *** NONE ***

                 ******************************************
                  *** ISCST2 Finishes Successfully ***
                 ******************************************
```

APPENDIX E

Determination of Ground Water Dilution Attenuation Factors

DETERMINATION OF GROUNDWATER DILUTION ATTENUATION FACTORS FOR FIXED WASTE SITE AREAS USING EPACMTP

BACKGROUND DOCUMENT

EPA OFFICE OF SOLID WASTE

May 11, 1994

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PREFACE

The work documented in this report was conducted by HydroGeoLogic, Inc. for the EPA Office of Solid Waste. The work was performed partially under Contract No. 68-W0-0029 and partially under Contract No. 68-W3-0008, subcontracted through ICF Inc. This documentation was prepared under Contract No. 68-W4-0017. Technical direction on behalf of the Office of Solid Waste was provided by Dr. Z.A. Saleem.

ABSTRACT

The EPA Composite Model for Leachate Migration with Transformation Products (EPACMTP) was applied to generate Dilution Attenuation Factors (DAF) for the groundwater pathway in support of the development of Soil Screening Level Guidance. The model was applied on a nationwide basis, using Monte Carlo simulation, to determine DAFs as a function of the area of the contaminated site at various probability levels. The analysis was conducted in two stages: First, the number of Monte Carlo iterations required to achieve converged results was determined. Convergence was defined as a change of less than 5 % in the 85th percentile DAF value. A number of 15,000 Monte Carlo iterations was determined to yield convergence; subsequent analyses were performed using this number of iterations. Second, Monte Carlo analyses were performed to determine DAF values as a function of the contaminated area. The effects of different placements of the receptor well were evaluated.

1.0 INTRODUCTION

The Agency is developing estimates for threshold values of chemical concentrations in soils at contaminated sites that represent a level of concentration above which there is sufficient concern to warrant further site-specific study. These concentration levels are called Soil Screening Levels (SSLs). The primary purpose of the SSLs is to accelerate decision making concerning contaminated soils. Generally, if contaminant concentrations in soil fall below the screening level and the site meets specific residential use conditions, no further study or action is warranted for that area under CERCLA (EPA, 1993b).

The Soil Screening Levels have been developed using residential land use human exposure assumptions and considering multiple pathways of exposure to the contaminants, including migration of contaminants through soil to an underlying potable aquifer. Contaminant migration through the unsaturated zone to the water table generally reduces the soil leachate concentration by attenuation processes such as adsorption and degradation. Groundwater transport in the saturated zone further reduces concentrations through attenuation and dilution. The contaminant concentration arriving at a receptor point in the saturated zone, e.g., a domestic drinking water well, is therefore generally lower than the original contaminant concentration in the soil leachate.

The reduction in concentration can be expressed succinctly in a Dilution-Attenuation Factor (DAF) defined as the ratio of original soil leachate concentration to the receptor point concentration. The lowest possible value of DAF is therefore one; a value of DAF=1 means that there is no dilution or attenuation at all; the concentration at the receptor point is the same as that in the soil leachate. High values of DAF on the other hand correspond to a high degree of dilution and attenuation.

For any specific site, the DAF depends on the interaction of a multitude of site-specific factors and physical and bio-chemical processes. The DAF also depends on the nature of the contaminant itself; i.e., whether or not the chemical degrades or sorbs. As a result, it is impossible to predict DAF values without the aid of a suitable computer fate and transport simulation model that simulates the migration of a contaminant through the subsurface, and accounts for the relevant mechanisms and processes that affect the receptor concentration.

The Agency has developed the EPA Composite Model for Leachate Migration with Transformation Products (EPACMTP; EPA, l993a, 1994) to assess the groundwater quality impacts due to migration of wastes from surface waste sites. This model simulates the fate and transport of contaminants after their release from the land disposal unit into the soil, downwards to the water table and subsequently through the saturated zone. The fate and transport model has been coupled to a Monte Carlo driver to permit determination of DAFs on a generic, nationwide basis. The EPACMTP model has been applied to determine DAFs for the subsurface pathway for fixed waste site areas, as part of the development of Soil Screening Levels. This report describes the application of EPACMTP for this purpose.

2.0 GROUNDWATER MODEL

2.1 Description of EPACMTP Model

The EPA Composite Model for Leachate Migration with Transformation Products (EPACMTP, EPA, 1993a, 1994) is a computer model for simulating the subsurface fate and transport of contaminants that are released at or near the soil surface. A schematic view of the conceptual subsurface system as simulated by EPACMTP, is shown in Figure 1. The contaminants are initially released over a rectangular source area representing the waste site. The modeled subsurface system consists of an unsaturated zone underneath the source area, and an underlying water table aquifer. Contaminants move vertically downward through the unsaturated zone to the water table. The contaminant is assumed to be dissolved in the aqueous phase; it migrates through the soil under the influence of downward infiltration. The rate of infiltration may reflect the combined effect of precipitation and releases from the source area. Once the contaminant enters the saturated zone, a three-dimensional plume develops under the combined influence of advection with the ambient groundwater flow and dispersive mixing.

The EPACMTP accounts for the following processes affecting contaminant fate and transport: advection, dispersion, equilibrium sorption, first-order decay reactions, and recharge dilution in the saturated zone. For contaminants that transform into one or more daughter products, the model can account for the fate and transport of those transformation products also.

The EPACMTP model consists of three main modules:

- An unsaturated zone flow and transport module
- A saturated zone flow and transport module
- A Monte Carlo driver module, which generates model input parameter values from specified probability distributions

The assumptions of the unsaturated zone and saturated zone flow and transport modules are described in Section 2.2. The Monte Carlo modeling procedure is described in Section 2.3.

2.2 Fate and Transport Simulation Modules

2.2.1 Unsaturated zone flow and transport module

Details on the mathematical formulation and solution techniques of the unsaturated zone flow and transport module are provided in the EPACMTP background document (EPA, 1993a). For completeness, the major features and assumptions are summarized below:

- The source area is a rectangular area.
- Contaminants are distributed uniformly over the source area.
- The soil is a uniform, isotropic porous medium.
- Flow and transport in the unsaturated zone are one-dimensional, downward.
- Flow is steady state, and driven by a prescribed rate of infiltration.
- Flow is isothermal and governed by Darcy's Law.

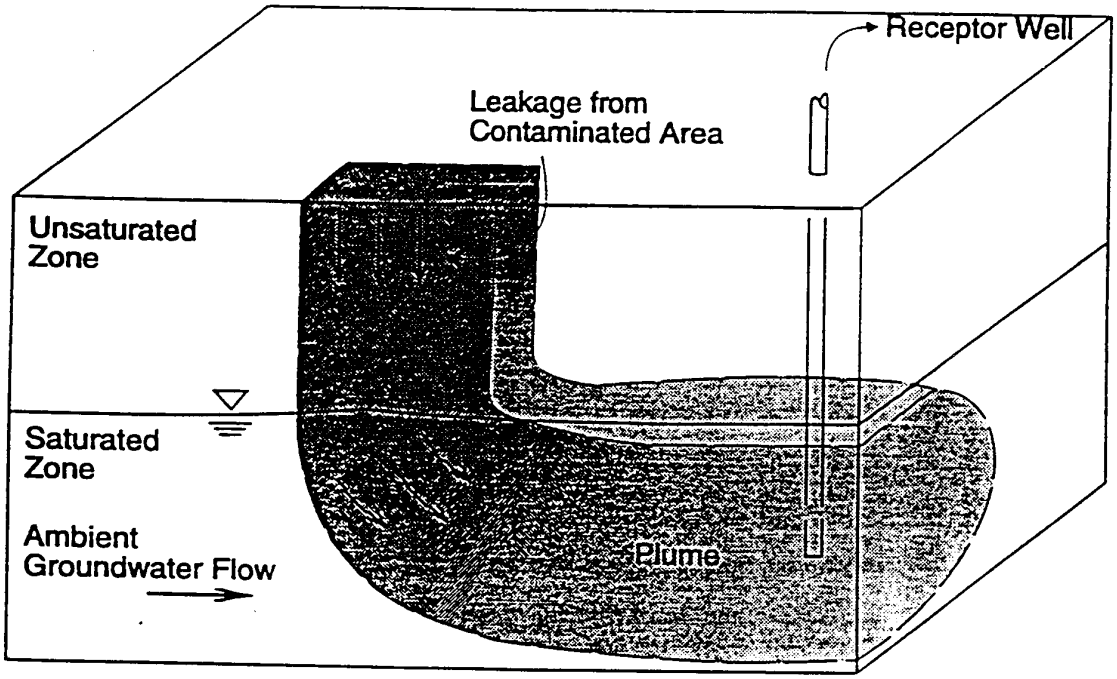


Figure 1
Conceptual View Of The Unsaturated Zone-Saturated Zone System Simulated By EPACMTP

- The leachate concentration entering the soil is either constant (with a finite or infinite duration), or decreasing with time following a first-order decay process.

- The chemical is dilute and present in solution or soil solid phase only.

- Sorption of chemicals onto the soil solid phase is described by a linear or nonlinear (Freundlich) equilibrium isotherm.

- Chemical and biological transformation process can be represented by an effective, first-order decay coefficient.

2.2.2 Saturated zone flow and transport module

The unsaturated zone module computes the contaminant concentration arriving at the water table, as a function of time. Multiplying this concentration by the rate of infiltration through the unsaturated zone yields the contaminant mass flux entering the saturated zone. This mass flux is specified as the source boundary condition for the saturated zone flow and transport module.

Groundwater flow in the saturated zone is simulated using a (quasi-) three-dimensional steady state solution for predicting hydraulic head and Darcy velocities in a constant thickness groundwater system subject to infiltration and recharge along the top of the aquifer and a regional hydraulic gradient defined by upstream and downstream head boundary conditions.

In addition to modeling fully three-dimensional groundwater flow and contaminant fate and transport, EPACMTP offers the option to perform quasi-3D modeling. When this option is selected, the model ignores either the flow component in the horizontal transverse (-y) direction, or the vertical (-z) direction. The appropriate 2D approximation is selected automatically in the code, based on the relative significance of plume movement in the horizontal transverse versus vertical directions. Details of this procedure are provided in the saturated zone background document (EPA, 1993a). The switching criterion that is implemented in the code will select the 2D areal solution for situations with a relatively thin saturated zone in which the contaminant plume would occupy the entire saturated thickness; conversely, the solution in which advection in the horizontal transverse direction is ignored is used in situations with a large saturated thickness, in which the effect of vertical plume movement is more important.

The saturated zone transport module describes the advective-dispersive transport of dissolved contaminants in a three-dimensional, constant thickness aquifer. The initial boundary is zero, and the lower aquifer boundary is taken to be impermeable. No-flux conditions are set for the upstream aquifer boundary. Contaminants enter the saturated zone through a patch source of either constant concentration or constant mass flux on the upper aquifer boundary, representing the area directly underneath the waste site at the soil surface. The source may be of a finite or infinite duration. Recharge of contaminant-free infiltration water occurs along the upper aquifer boundary outside the patch source. Transport mechanisms considered are advection, longitudinal, vertical and transverse hydrodynamic dispersion, linear or nonlinear equilibrium adsorption, first-order decay and daughter product formation. As in the unsaturated zone, the saturated zone transport module can simulate multi-species transport involving chained decay reactions. The saturated zone transport module of EPACMTP can perform either a fully three-dimensional transport simulation, or provide a quasi-3D approximation. The latter ignores advection in either the horizontal transverse (-y) direction, on the vertical (-z) direction, consistent with the quasi-3D flow solution. In the course of a Monte Carlo simulation, the appropriate 2D approximations are selected automatically for each individual Monte Carlo iteration, thus yielding an overall quasi-3D simulation.

The saturated zone and transport module is based on the following assumptions:

- The aquifer is uniform and initially contaminant-free.
- The flow field is at steady state; seasonal fluctuations in groundwater flow are neglected.
- The saturated thickness of the aquifer remains constant; mounding is represented by the head distribution along the top boundary of the modeled saturated zone system.
- Flow is isothermal and governed by Darcy's Law.
- The chemical is dilute and present in the solution or aquifer solid phase only.
- Adsorption onto the solid phase is described by a linear or nonlinear equilibrium isotherm.
- Chemical and/or biochemical transformation of the contaminant can be described as a first-order process.

2.2.3 Model capabilities and limitations

EPACMTP is based on a number of simplifying assumptions which make the code easier to use and ensure its computational efficiency. These assumptions, however, may cause application of the model to be inappropriate in certain situations.

The main assumptions embedded in the fate and transport model are summarized in the previous sections and are discussed in more detail here. The user should verify that the assumptions are reasonable for a given application.

Uniform Porous Soil and Aquifer Medium. EPACMTP assumes that the soil and aquifer behave as uniform porous media and that flow and transport are described by Darcy's law and the advection-dispersion equation, respectively. The model does not account for the presence of cracks, macro-pores, and fractures. Where these features are present, EPACMTP may underpredict the rate of contaminant movement.

Single Phase Flow and Transport. The model assumes that the water phase is the only mobile phase and disregards interphase transfer processes other than reversible adsorption onto the solid phase. For example, the model does not account for volatilization in the unsaturated zone, which will tend to give conservative predictions for volatile chemicals. The model also does not account for the presence of a second liquid phase (e.g., oil). When a mobile oil phase is present, the movement of hydrophobic chemicals may be underpredicted by the model, since significant migration may occur in the oil phase rather than in the water phase.

Equilibrium Adsorption. The model assumes that adsorption of contaminants onto the soil or aquifer solid phase occurs instantaneously, or at least rapidly relative to the rate of contaminant movement. In addition, the adsorption process is taken to be entirely reversible.

Geochemistry. The EPACMTP model does not account for complex geochemical processes, such as ion exchange, precipitation and complexation, which may affect the migration of chemicals in the subsurface environment. EPACMTP can only approximate such processes as an effective equilibrium retardation process. The effect of geochemical interactions may be especially important in the fate and transport analyses of metals. Enhancement of the model for handling a wide variety of geochemical conditions is currently underway.

First-Order Decay. It is assumed that the rate of contaminant loss due to decay reactions is proportional to the dissolved contaminant concentration. The model is based on one overall decay constant and does not explicitly account for multiple degradation processes, such as oxidation, hydrolysis, and biodegradation. When multiple decay processes do occur, the user must determine the overall, effective decay rate. In order to increase flexibility of the model, the user may instruct the model to determine the overall decay coefficient from chemical specific hydrolysis constants plus soil and aquifer temperature and pH.

Prescribed Decay Reaction Stoichiometry. For scenarios involving chained decay reactions, EPACMTP assumes that the reaction stoichiometry is always prescribed, and the speciation factors are specified by the user as constants (see *EPACMTP Background Document*, EPA, 1993a). In reality, these coefficients may change as functions of aquifer conditions (temperature, pH, etc.) and/ or concentration levels of other chemical components.

Uniform Soil. EPACMTP assumes that the unsaturated zone profile is homogeneous. The model does not account for the presence of cracks and/or macropores in the soil, nor does it account for lateral soil variability. The latter condition may significantly affect the average transport behavior when the waste source covers a large area.

Steady-State Flow in the Unsaturated-Zone. Flow in the unsaturated zone is always treated as steady state, with the flow rate determined by the long term, average infiltration rate through a disposal unit, or by the average depth of ponding in a surface impoundment. Considering the time scale of most practical problems, assuming steady-state flow conditions in the unsaturated zone is reasonable.

Groundwater Mounding. The saturated zone module of EPACMTP is designed to simulate flow and transport in an unconfined aquifer. Groundwater mounding beneath the source is represented only by increased head values on top of the aquifer. The saturated thickness of the aquifer remains constant in the model, and therefore the model treats the aquifer as a confined system. This approach is reasonable as long as the mound height is small relative to the saturated thickness of the aquifer and the thickness of the unsaturated zone. For composite modeling, the effect of mounding is partly accounted for in the unsaturated zone module, since the soil is allowed to become saturated. The aquifer porous material is assumed to be uniform, although the model does account for anisotropy in the hydraulic conductivity. The lower aquifer boundary is assumed to be impermeable.

Flow in the Saturated Zone. Flow in the saturated zone is taken to be at steady state. Thc concept is that of regional flow in the horizontal longitudinal direction, with vertical disturbance due to recharge and infiltration from the overlying unsaturated zone and waste site (source area). EPACMTP accounts for variable recharge rates underneath and outside the source area. It is, however, assumed that the saturated zone has a constant thickness, which may cause inaccuracies in the predicted groundwater flow and contaminant transport in cases where the infiltration rate from the waste disposal facility is high.

Transport in the Saturated Zone. Contaminant transport in the saturated zone is by advection and dispersion. The aquifer is assumed to be initially contaminant free and contaminants enter the aquifer only from the unsaturated zone immediately underneath the waste site, which is modeled as a rectangular horizontal plane source. EPACMTP can simulate both steady state and transient transport in the saturated zone. In the former case, the contaminant mass flux entering at the water table must be constant with time. In the latter case, the flux at the water table can be constant or vary as a function of time. The transport module accounts for equilibrium adsorption and decay reactions, both of which are modeled in the same manner as in the unsaturated zone. The adsorption and decay coefficients are assumed to be uniform throughout saturated zone.

2.3 Monte Carlo Module

EPACMTP was designed to perform simulations on a nationwide basis, and to account for variations of model input parameters reflecting variations in site and hydrogeological conditions. The fate and transport model is therefore linked to a Monte Carlo driver which generates model input parameter values from the probability distribution of each parameter. The Monte Carlo modeling procedure is described in more detail in this section.

The Monte Carlo method requires that for each input parameter, except constant parameters, a probability distribution is provided. The method involves the repeated generation of pseudo-random values of the uncertain input variable(s) (drawn from the known distribution and within the range of any imposed bounds) and the application of the model using these values to generate a series of model responses (receptor well concentration). These responses are then statistically analyzed to yield the cumulative probability distribution of the model output. Thus, the various steps involved in the application of the Monte Carlo simulation technique are:

(1) Selection of representative cumulative probability distribution functions for the relevant input variables.

(2) Generation of a pseudo-random number from the distributions selected in (1). These values represent a possible set of values (a realization) for the input variables.

(3) Application of the fate and transport simulation modules to compute the output(s), i.e., downstream well concentration.

(4) Repeated application of steps (2) and (3) for a specified number of iterations.

(5) Presentation of the series of output (random) values generated in step (3).

(6) Analysis of the Monte Carlo output to derive regulatory DAF values.

The Monte Carlo module designed for implementation with the EPACMTP composite model performs steps 2-5 above. This process is shown conceptually in Figure 2. Step 6 is performed as a post-processing step. This last step simply involves converting the normalized receptor well concentrations to DAF values, and ranking then for high to low values. Each Monte Carlo iteration yields one DAF value for the constituent of concern (plus one DAF value for each of the transformation products, if the constituent is a degrader). Since each Monte Carlo iteration has equal probability, ordering the DAF values from high to low, directly yields their cumulative probability distribution (CDF). If appropriate, CDF curves representing different regional distributions may be combined into a single CDF curve, which is a weighted average of the regional curves.

A simplified flow chart that illustrated the linking of the Monte Carlo module to the simulation modules of the EPACMTP composite model is presented in Figure 3. The modeling input data is read first, and subsequently the desired random numbers are generated. The generated random and/ or derived parameter values are then assigned to the model variables. Following this, the contaminant transport fate and transport simulation is performed. The result is given in terms of the predicted contaminant concentration(s) in a down-stream receptor well. The generation of random parameter values and fate and transport simulation is repeated as many times as desired to determine the probability distribution of down-stream well concentrations.

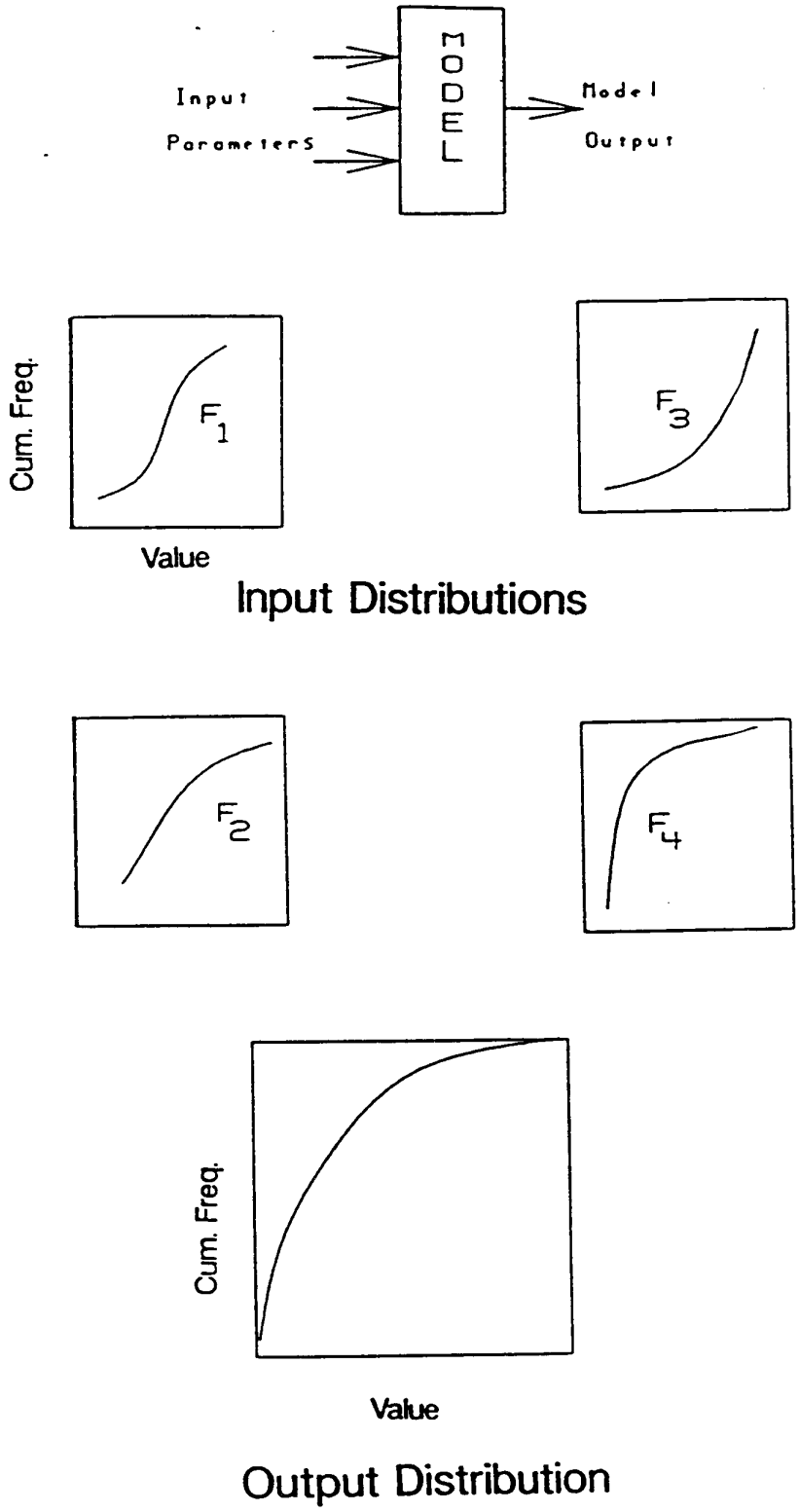


Figure 2
Conceptual Monte Carlo Framework For Deriving Probability Distribution Of Model Output From Probability Distributions Of Input Parameters

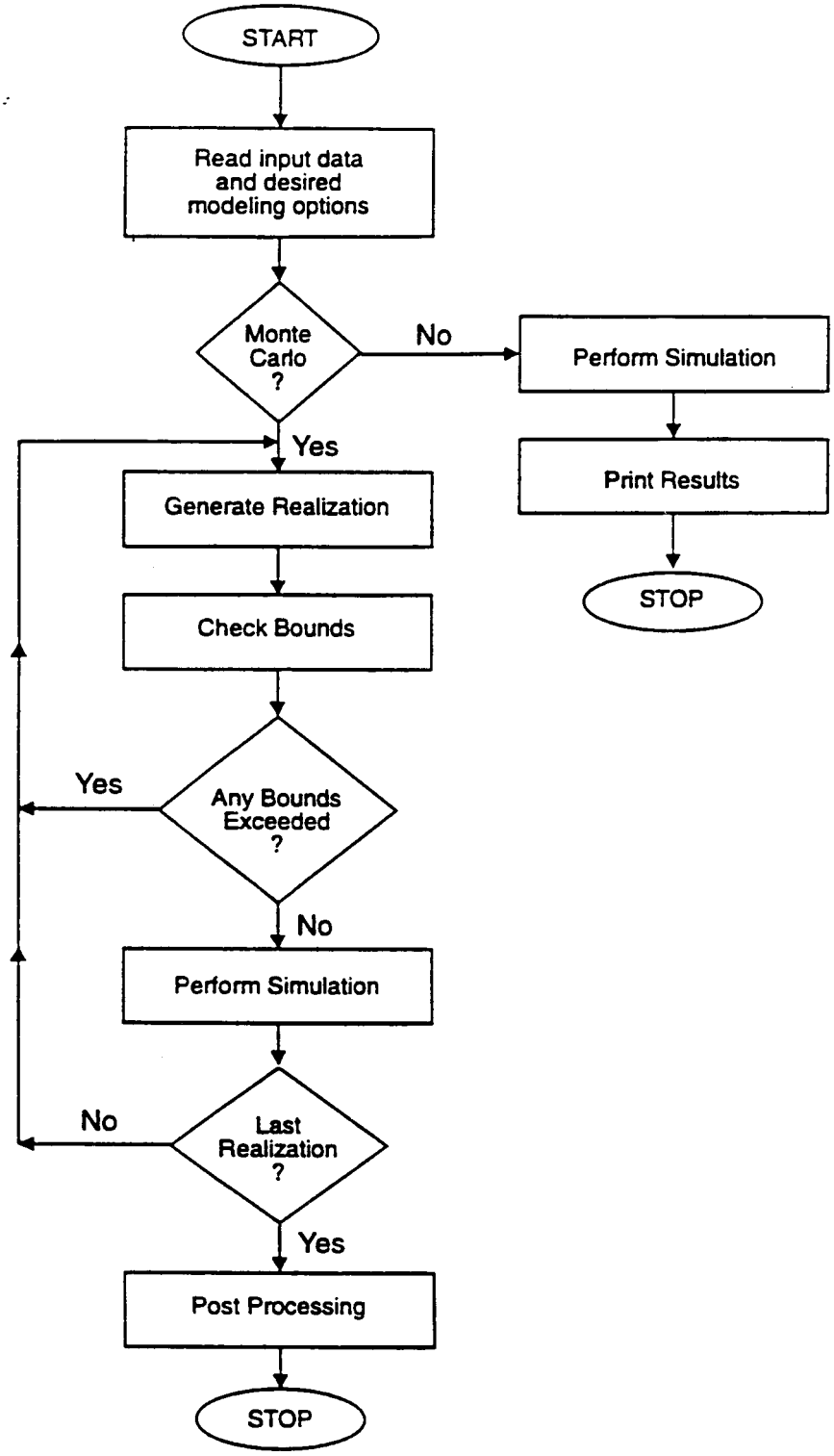


Figure 3
Flow Chart Of EPACMTP For Monte Carlo Simulation

2.3.1 Capabilities and Limitations of Monte Carlo Module

The Monte Carlo module in EPACMTP is implemented as a flexible module that can accommodate a wide variety of input distributions. These include: constant, normal, lognormal, exponential, uniform, $\log_{10}$ uniform, Johnson SB, empirical, or derived. In addition, specific upper and/or lower bounds can be provided for each parameter. The empirical distribution is used when the data does not fit any of the other probability distributions. When the empirical distribution is used, the probability distribution is specified in tabular form as a list of parameter values versus cumulative probability, from zero to one.

It is important to realize that the Monte Carlo method accounts for parameter variability and uncertainty; it does, however, not provide a way to account or compensate for process uncertainty. If the actual flow and transport processes that may occur at different sites, are different from those simulated in the fate and transport module, the result of a Monte Carlo analysis may not accurately reflect the actual variation in groundwater concentrations.

EPACMTP does not directly account for potential statistical dependencies, i.e., correlations between parameters. The probability distributions of individual parameters are considered to be statistically independent. At the same time, EPACMTP does incorporate a number of safeguards against generating impossible combinations of model parameters. Lower and upper bounds on the parameters prevent unrealistically low or high values from being generated at all.

In the case of model parameters that have a direct physical dependence on other parameters, these parameters can be specified as derived parameters. For instance, the ambient groundwater flow rate is determined by the regional hydraulic gradient and the aquifer hydraulic conductivity. In the Monte Carlo analyses, the ambient groundwater flow rate is therefore calculated as the product of conductivity and gradient, rather than generated independently. A detailed discussion of the derived parameters used in the model is provided in the *EPACMTP User's Guide* (EPA, 1994).

3.0 MODELING PROCEDURE

This section documents the modeling procedure followed in determining the groundwater pathway DAF values for the Soil Screening Levels. Section 3.1 describes the overall approach for the modeling analysis; section 3.2 describes the model options used and summarizes the input parameter values.

3.1 Modeling Approach

The overall modeling approach consisted of two stages. First, a sensitivity analysis was performed to determine the optimal number of Monte Carlo repetitions required to achieve a stable and converged result, and to determine which site-related parameters have the greatest impact on the DAFs. Secondly, Monte Carlo analyses were performed to determined DAF values as a function of the size of the source area, for various scenarios of receptor well placement.

3.1.1 Determination of Monte Carlo Repetition Number and Sensitivity Analysis

The criterion for determining the optimal number of Monte Carlo repetitions was set to a change in DAF value of no more than 5 percent when the number of repetitions is varied. A Monte Carlo simulation comprising 20,000 repetitions was first made. The results from this simulation were analyzed by calculating the 85th percentile DAP value obtained by sampling model output sequences of different length, from 2,000 to the full 20,000 repetitions. The modeling scenario considered in this analysis was the same as that in the base case scenario discussed in the next section, with the size of the source area set to 10,000 m^2.

The sensitivity analysis on site-related model parameters was performed by fixing one parameter at a time, while remaining model parameters were varied according to their default, nationwide probability distributions as discussed in the *EPACMTP User's Guide* (EPA, 1993b).

For each parameter, the low, medium, and high values were selected, corresponding to the 15th, 50th, and 85th percentile, respectively, of that parameter's probability distribution. As a result, the sensitivity analysis reflects, in part, the width of each parameter's probability distribution. Parameters with a narrow range of variation will tend to be among the less sensitive parameters, and vice versa for parameters that have a wide range of variation. By conducting the sensitivity analysis as a series of Monte Carlo simulations, any parameter interactions on the model output are automatically accounted for. Each of the Monte Carlo simulations yields a probability distribution of predicted receptor well concentrations. Evaluating the distributions obtained with different fixed values of the same parameter provides a measure of the overall sensitivity and impact of that parameter. In each case the model was run for 2,000 Monte Carlo iterations. Steady-state conditions (continuous source) were simulated in all cases.

In a complete Monte Carlo analysis, over 20 different model parameters are involved. These parameters may be divided into two broad categories. The first includes parameters that are independent of contaminant-specific chemical properties, e.g., depth to water table, aquifer thickness, receptor well distance, etc. The second category encompasses those parameters that are related to contaminant-specific sorption and biochemical transformation characteristics. This category includes the organic carbon partition coefficient, but also parameters such as aquifer pH, temperature and fraction organic carbon. The sensitivity of the model to the first category of parameters has examined, by considering a non-degrading, non-sorbing contaminant. Under these conditions, any parameters in the second category will have zero sensitivity. In addition, all unsaturated zone parameters can be left out of the analysis, since the predicted steady state contaminant concentration at the water table will always be the same as that entering the unsaturated

zone. The only exception to this is the soil type parameter. In the nationwide Monte Carlo modeling approach, different soil types are distinguished. Each of the three different soil types (sandy loam, silt loam or silty clay loam) has a different distribution of infiltration rate, with the sandy loam soil type having the highest infiltration rates, silty clay loam having the lowest, and silty loam having intermediate rates. The effect of the soil type parameter is thus intermixed with that of infiltration rate. Table 1 lists the input 'low', 'medium' and 'high' values for all the parameters examined.

Table 1
Parameter input values for model sensitivity analysis.

Parameter	Low	Median	High
Source Parameters			
Source Area (m^2)	4.8×10^4	2.8×10^5	1.1×10^6
Infiltration Rate (m/yr)	6.0×10^{-4}	6.4×10^{-3}	1.7×10^{-1}
Recharge Rate (m/yr)	6.0×10^{-4}	8.0×10^{-3}	1.5×10^{-1}
Saturated Zone Parameters			
Saturated Thickness (m)	15.55	60.8	159.3
Hydraulic conductivity (m/yr)	1.9×10^3	1.5×10^4	5.5×10^4
Regional gradient	4.3×10^{-3}	1.8×10^{-2}	5.0×10^{-2}
Ambient groundwater velocity (m/yr)	53.2	404.0	2883.0
Porosity	0.374	0.415	0.455
Longitudinal Dispersivity (m)	4.2	12.7	98.5
Transverse Dispersivity (m)	0.53	1.59	12.31
Vertical Dispersivity (m)	0.026	0.079	0.62

3.1.2 Analysis of DAF Values for Different Source Areas

Following completion of the sensitivity analysis discussed above, an analysis was performed of the variation of DAF values with size of the contaminated area. The sensitivity analysis, results of which are presented in Section 4.1, showed that the size of the contaminated source area is one of the most sensitive parameters in the model. For the purpose of deriving DAF values for the groundwater pathway in determining soil screening levels, it would therefore be appropriate to correlate the DAF value to the size of the contaminated area.

The EPACMTP modeling analysis was designed to determine the size of the contaminated area that would result in DAF values of 10 and 100 at the upper 85th, 90th, and 95th percentile of probability, respectively. Since it is not possible to directly determine the source area that results in a specific DAF value, the model was executed for a range of different source areas, using a different but fixed source area value in each Monte Carlo simulation. The 85th, 90th, and 95th percentile DAF values were then plotted against source area, in order to determine the value of source area corresponding to a specific DAF value.

3.1.2.1 *Model Options and Input Parameters*

Table 2 summarizes the EPACMTP model options used in performing the simulations. Model input parameters used are summarized in Table 3. The selected options and input parameter distributions and values are consistent with those used in the default nationwide modeling, and are discussed individually in the *EPACMTP User's Guide (EPA,* 1994). Exceptions to this default modeling scenario are discussed below.

Table 2
Summary of EPACMTP modeling options.

Option	Value Selected
Simulation Type	Monte Carlo
Number of Repetitions	15,000
Nationwide Aggregation	Yes
Source Type	Continuous
Unsat. Zone Present	Yes
Sat. Zone Model	Quasi-3D
Contaminant Degradation	No
Contaminant Sorption	No

Source Area

In the default, nationwide modeling scenario, the waste site area, or source area, is treated as a Monte Carlo variable, with a distribution of values equal to that of the type of waste unit, e.g. landfills, considered. In the present modeling analyses, the source area was set to a different but constant value in each simulation run.

Receptor Well Location

In the default nationwide modeling scenario, the position of the nearest downgradient receptor well in the saturated zone is treated as a Monte Carlo variable. The position of the well is defined by its x-, y-, and z-coordinates. The x-coordinate represents the distance along the ambient groundwater flow direction from the downgradient edge of the contaminated area. The y-coordinate represents the horizontal transverse distance of the well from the plume centerline. The x-, and y-coordinate in turn can be defined in terms of an overall downgradient distance, and an angle off-center (EPA, 1994). The z-coordinate represents the depth of the well intake point below the water table. This is illustrated schematically in Figure 4, which shows the receptor well location in both plan view and cross-sectional view.

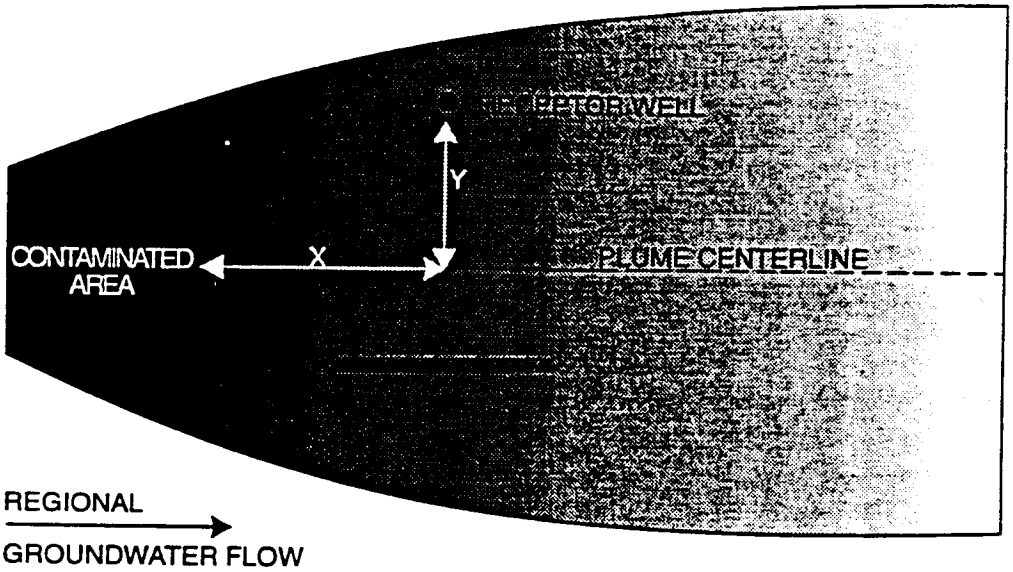
In the default nationwide modeling scenario, the x-, and z-coordinates of the well are determined from Agency surveys on the distance of residential wells from municipal landfills, and data on the depth of residential drinking water wells, respectively. The y-coordinate value is determined so that the well location falls within the approximate areal extent of the contaminant plume (see Figure 4).

For the present modeling analysis, a number of different receptor well placement scenarios were considered. These scenarios are summarized in Table 4.

Table 3
Summary of EPACMTP input parameters.

Parameter	Value or Distribution Type	Comment
Source-Specific		
Area	Constant	Varied in each run
Infiltration Rate	Soil-type dependent	default
Recharge Rate	Soil-type dependent	default
Leachate Concentration	= 1.0	default
Chemical-Specific		
Hydrolysis Rate Constants	= 0.0	Contaminant does not degrade
Organic Carbon Partition Coeff.	= 0.0	Contaminant does not sorb
Unsaturated Zone Specific		
Depth to Water Table	Empirical	default
Dispersivity	Soil-depth dependent	default
Soil Hydraulic Properties	Soil-type dependent	default
Soil Chemical Properties	Soil-type dependent	default
Saturated Zone Specific		
Sat. Zone Thickness	Exponential	default
Hydraulic Conductivity	Derived from Part. Diam.	default
Hydraulic Gradient	Exponential	default
Seepage Velocity	Derived from Conductivity and Gradient	default
Particle Diameter	Empirical	default
Porosity	Derived from Part. Diam	default
Bulk Density	Derived from Porosity	default
Longitudinal Dispersivity	Distance-dependent	default
Transverse Dispersivity	Derived from Long. Dispersivity	default
Vertical Dispersivity	Derived from Long. Dispersivity	default
Receptor Well x-coordinate	= 25 feet	Set to fixed value
Receptor Well y-coordinate	Within plume	default
Receptor Well z-coordinate	Empirical	default

Note: 'Default' represents default nationwide Monte Carlo scenario as presented in *EPACMTP User's Guide* (EPA, 1994).



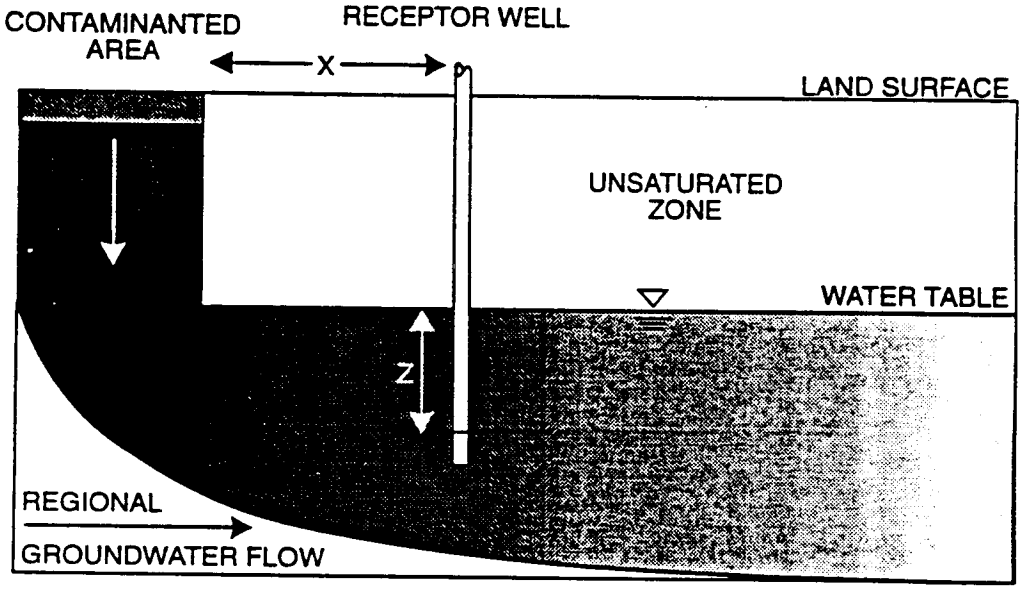


Figure 4
Plain View And Cross-Section View Showing Location Of Receptor Well

Table 4
Receptor Well Location Scenarios

Scenario	Xwell	Ywell	Zwell
1 (Base Case)	25 ft from edge of source area	Monte Carlo within plume	Nationwide Distribution
2	Nationwide Distribution	Monte Carlo within plume	Nationwide Distribution
3	0 ft from edge of source area	Monte Carlo within half-width of source area	Nationwide Distribution
4	25 ft from edge of source area	Monte Carlo within half-width of source area	Nationwide Distribution
5	100 ft from edge of source area	Monte Carlo within half-width of source area	Nationwide Distribution
6	25 ft from edge of source area	Width of source area + 25 ft	25 ft below water table

Xwell = Downgradient distance of receptor well from edge of source area.
Ywell = Horizontal transverse distance from plume centerline.
Zwell = Depth of well intake point below water tablet

The base case scenario (scenario 1) involved setting the x-distance of the receptor well to 25 feet from the edge of the source area. Nationwide default options were used for the receptor well y- and z-coordinates. The y-coordinate of the well was assigned a uniform probability distribution within the boundary of the plume. The depth of the well intake point (z-coordinate) was assumed to vary within upper and lower bounds of 15 and 300 feet below the water table, reflecting a national sample distribution of depths of residential drinking water wells (EPA, 1994).

In addition to this base case scenario, a number of other well placement scenarios were investigated also. These are numbered in Table 4 as scenarios 2 through 6. Scenario 2 corresponds to the default, nationwide Monte Carlo modeling scenario in which the x, y, and z locations of the well are all variable. In scenarios 3, 4 and 5, the distance between the receptor well and the source area is varied from zero to 100 feet. In these scenarios, the ycoordinate of the well was constrained to the central portion of the plume. In scenario number 6, the x-, y-, and z-coordinates of the receptor well were all set to constant values. These additional scenarios were included in the analysis in order to assess the sensitivity of the model results to the location of the receptor well.

Aquifer Particle Size Distribution

In the default Monte Carlo modeling scenario, the aquifer hydraulic conductivity, porosity, and bulk density are determined from the mean particle diameter. The particle diameter distribution used is based on data compiled by Shea (1974). In the present modeling analyses for fixed waste site areas, the same approach and data were used, but the distribution was shifted somewhat to assign more weight to the smallest particle diameter interval. The result is that lower values of the hydraulic conductivity values generated, and also of the ambient groundwater seepage velocities, received more emphasis. Lower ambient groundwater velocities reduce the degree of dilution of the incoming contaminant plume and therefore result in lower, i.e. more conservative, DAF values. Table 5 summarizes the distribution of particle size diameters used in both the default nationwide modeling scenario and in the present analyses.

Table 5
Distribution of aquifer particle diameter.

Nationwide Default		Present Analyses	
Particle Diameter (cm)	Cumulative Probability	Particle Diameter (cm)	Cumulative Probability
$3.9\ 10^{-4}$	0.000	$4.0\ 10^{-4}$	0.100
$7.8\ 10^{-4}$	0.038	$8.0\ 10^{-4}$	0.150
$1.6\ 10^{-3}$	0.104	$1.6\ 10^{-3}$	0.200
$3.1\ 10^{-3}$	0.171	$3.1\ 10^{-3}$	0.270
$6.3\ 10^{-3}$	0.262	$6.3\ 10^{-3}$	0.330
$1.25\ 10^{-2}$	0.371	$1.25\ 10^{-2}$	0.440
$2.5\ 10^{-2}$	0.560	$2.5\ 10^{-2}$	0.590
$5.0\ 10^{-2}$	0.792	$5.0\ 10^{-2}$	0.790
$1.0\ 10^{-1}$	0.904	$1.0\ 10^{-1}$	0.880
$2.0\ 10^{-1}$	0.944	$2.0\ 10^{-1}$	0.910
$4.0\ 10^{-1}$	0.946	$4.0\ 10^{-1}$	0.940
$8.0\ 10^{-1}$	1.000	$7.5\ 10^{-1}$	1.000

4.0 RESULTS

This section presents the results of the modeling analyses performed. The analysis of the convergence of the Monte Carlo simulation is presented first, followed by the parameter sensitivity analysis, and thirdly the analysis of DAF values as a function of source area for various well placement scenarios.

4.1 Convergence of Monte Carlo Simulation

Table 6 summarizes the results of this convergence analysis. It shows the variation of the 85th percentile DAF value with the number of Monte Carlo repetitions, from 2,000 to 20,000. The variations in DAF values are shown both as absolute and relative differences. The table shows that for this example, the DAF generally increases with the number of Monte Carlo repetitions. It should be kept in mind that the results from different repetition numbers as presented in the table, are not independent of one another. For instance, the first 2,000 repetitions are also incorporated in the 5000 repetition results, which in turn is in the 10,000 repetition result, etc. The rightmost column of Table 6 shows the percentage difference in DAF value between different repetition numbers. At repetition numbers of 14,000 or less, the percentage difference varies in a somewhat irregular manner. However, for repetition numbers of 15,000 or greater, the DAF remained relatively constant, with incremental changes of DAF remaining at 1 % or less. Based upon these results, a repetition number of 15,000 was selected for use in the subsequent runs with fixed source area.

4.2 Parameter Sensitivity Analysis

Results of the parameter sensitivity analysis are summarized in Table 7. The parameters are ranked in this table in order of relative sensitivity. Relative sensitivity is defined for this purpose as the absolute difference between the "high" and "low" DAF at the 85th percentile level, divided by the 85th percentile DAF for the "median" case.

The table shows that the most sensitive parameters included the rate of infiltration, which is a function of soil type, the saturated thickness of the aquifer, the size of source area, the groundwater seepage velocity, and the vertical position of the receptor well below the water table. The least sensitive parameters included porosity, downstream distance of the receptor well in both the x- and y-directions, the horizontal transverse dispersivity, and the areal recharge rate. To interpret these results, it should be kept in mind that the rankings reflect in part the range of variation of each parameter in the data set used for the sensitivity analysis. The infiltration rate was a highly sensitive parameter since, for a given leachate concentration, it directly affects the mass flux of contaminant entering the subsurface. The size of the source would be expected to be equally sensitive, were it not for the fact that in the sensitivity analysis, the source area had a much narrower range of variation than the infiltration rate. The "high" and "low" values of the source area, which were taken from a nationwide distribution of landfill waste units, varied by a factor of 23, while the ratio of "high" to "low" infiltration rate was almost 300.

In the simulations performed for the sensitivity analysis, no constraint was imposed on the vertical position of the well. The well was modeled as having a uniform distribution with the well intake point located anywhere between the water table and the base of the aquifer. The aquifer saturated thickness and vertical position of the well were both among the sensitive parameters, with similar effects on DAF values. Increasing either the saturated thickness, or the fractional depth of the receptor well below the water table, increases the likelihood that the receptor well will be located underneath the contaminant plume and sample uncontaminated groundwater, leading to a

Table 6
Variation of DAF with number of Monte Carlo repetitions

No. of Repetitions	85-th Percentile DAF	Difference	Relative Difference (%)
2,000	347.8		
		-10.9	-3.1
5,000	336.9		
		+17.3	+5.1
10,000	354.2		
		+5.0	+ 1.4
11,000	359.2		
		+28.2	+7.9
12,000	387.4		
		-18.1	-4.7
13,000	369.3		
		-0.2	-0.05
14,000	369.1		
		+ 18.2	+4.9
15,000	387.3		
		+0.1	+0.03
16,000	387.4		
		+0.6	+0.15
17,000	388.0		
		-0.7	-0.18
18,000	387.3		
		+2.9	+0.75
19,000	390.2		
		+2.6	+0.67
20,000	392.8		

Table 7
Sensitivity of model parameters.

Parameter	85% DAF Value			Relative Sensitivity*	Rank
	Low	Median	High		
Infiltration Rate	4805.4	418.8	11.6	11.4	1
Saturated Thickness	25.3	198.5	2096.9	10.4	2
G.W. Velocity	7.6	97.7	816.3	8.3	3
Source Area	357.1	85.2	35.6	3.8	4
Hydr. Conductivity	19.8	180.4	660.1	3.5	5
Vertical Well Position	49.1	206.1	491.4	2.1	6
G.W. Gradient	32.4	168.3	383.0	2.1	7
Long. Dispersivity	182.6	104.2	78.8	1.0	8
Vert. Dispersivity	179.6	114.9	66.6	1.0	9
Porosity	41.3	49.9	79.7	0.8	10
Receptor Well Distance	163.9	117.9	84.5	0.7	11
Transv. Dispersivity	156.7	156.3	173.5	0.1	12
Receptor Well Angle	127.3	130.8	113.6	0.1	13
Ambient Recharge	108.3	100.0	114.4	0.06	14

* Relative Sensitivity = l High-Low l /Median

high DAF value. The dilution-attenuation factors were also sensitive to the groundwater velocity, and the parameters that determine the groundwater velocity, i.e., hydraulic conductivity and ambient gradient. Table 7 shows that a higher groundwater velocity results in an increase of the dilution-attenuation factor. Since a conservative contaminant was simulated under steady-state conditions, variations in travel time do not affect the DAF. The increase of DAF with increasing flow velocity reflects the greater mixing and dilution of the contaminant as it enters the saturated zone in systems with high groundwater flow rate. Porosity also directly affects the groundwater velocity, but was not among the sensitive parameters. This is a reflection of the narrow range of variation assigned to this parameter.

The off-center angle which determines the y position of the well relative to the plume center line would be expected to have a similar effect as the well depth, but is seen to have a much smaller sensitivity. This was a result of constraining the y-location of the receptor well to be always inside the approximate areal extent of the contaminant plume. The effect is that the relative sensitivity of the off-center angle was much less than that of the vertical coordinate of the well. The low relative sensitivity of recharge rate reflects the fact that this parameter has an only indirect effect on plume concentrations.

Overall, the Monte Carlo results were not very sensitive to dispersivity and downstream distance of the receptor well. The probable explanation for these parameters is that variations of the parameters produce opposing effects which tended to cancel one another. Low dispersivity values will produce a compact plume which increases the probability that a randomly located receptor well will lie outside (underneath) the plume. Higher dispersivities will increase the chance that the well will intercept the plume. At the same time, however, mass balance considerations dictate that in

this case average concentrations inside the plume will be lower than in the low dispersivity case. Similar reasoning applies to the effect of receptor well distance. If the well is located near the source, concentrations in the plume will be relatively high, but so is the chance that the well does not intercept the plume at all. At greater distances from the source, the likelihood that the well is located inside the plume is greater, but the plume will also be more diluted. In the course of a full Monte Carlo simulation these opposing effects would tend to average out. The much lower sensitivity of transverse dispersivity, α_T, compared to α_L and α_V can be contributed to the imposed constraint that the well must always be within the areal extent of the plume.

The results of the sensitivity analysis show that the site characteristic which lends itself best for a classification system for correlating sites to DAF values is the size of the contaminated (or source) area. In the subsequent analyses, the DAF values were therefore determined as a function of the source area size. These results are presented in the following section.

4.3 DAF Values as a Function of Source Area

This section presents the DAF value as a function of source area for various well location scenarios. The results for each of the scenarios examined are presented in tabular and graphical form. Figure 5 shows the variation of the 85th, 90th, and 95th percentile DAF with source area for the base case scenario. The source area is expressed in square feet. The figure displays DAF against source area in a log-log graph. The graph shows an approximately linear relationship except that at very large values of the source area, the DAF starts to level off. Eventually the DAF approaches a value of 1.0. As expected, the curve for the 95th percentile DAF always shows the lowest DAF values, while the 85th percentile shows the highest DAFs. The DAF versus source area relationship for the other well placement scenarios are shown in Figures 6 through 10. The numerical results for each scenario are summarized in Tables Al through A6 in the appendix.

Inspection and comparison of the results for each scenario indicate that the relationship follows the same general shape in each case, but the magnitude of DAF values at a given source area can be quite different for different well placement scenarios. In order to allow a direct comparison between the various scenarios analyzed, the DAF values obtained for a source area of 150,000 ft^2 (3.4 acres) are shown in Table 8 as a function of the receptor well location scenario.

Inspection of the DAF values shows that the default nationwide scenario for locating the receptor well results in the highest DAF values, as compared to the base case scenario and the other scenarios, in which the receptor well location was fixed at a relatively close distance from the waste source. In the default nationwide modeling scenario, the well location is assigned from nationwide data on both the distance from the waste source and depth of the well intake point below the water table. In the default nationwide modeling scenario, the receptor well is allowed to be located up to 1 mile from the waste source. In the base case (Scenario 1) the well is allowed to be located anywhere within the areal extent of the contaminant plume for a fixed x-distance of 25 feet. This allows the well to be located near the fringes of the contaminant plume where concentrations are relatively low and DAF values are correspondingly high. In contrast, in Scenarios 3, 4, and 5, the well location was constrained to be within the half-width of the waste source. In other words, the well was always placed in the central portion of the contaminant plume where concentrations are highest. As a result, these scenarios show lower DAF values then the base case scenario. The results for Scenarios 3, 4, and 5, which differ only in the x-distance of the receptor well, show that placement of the well at either 25 or 100 feet away from the waste source results in 85% and 90% DAF values that are actually lower, i.e. more conservative, than placement of the well directly at the edge of the waste source. This is a counter-intuitive result, but may be explained from the interaction between distance from the waste source and vertical extent of the contaminant plume below the water table. Close to the waste source, the contaminant concentrations within the plume are highest, but the plume may not have penetrated very deeply into the saturated zone (Figure 2).

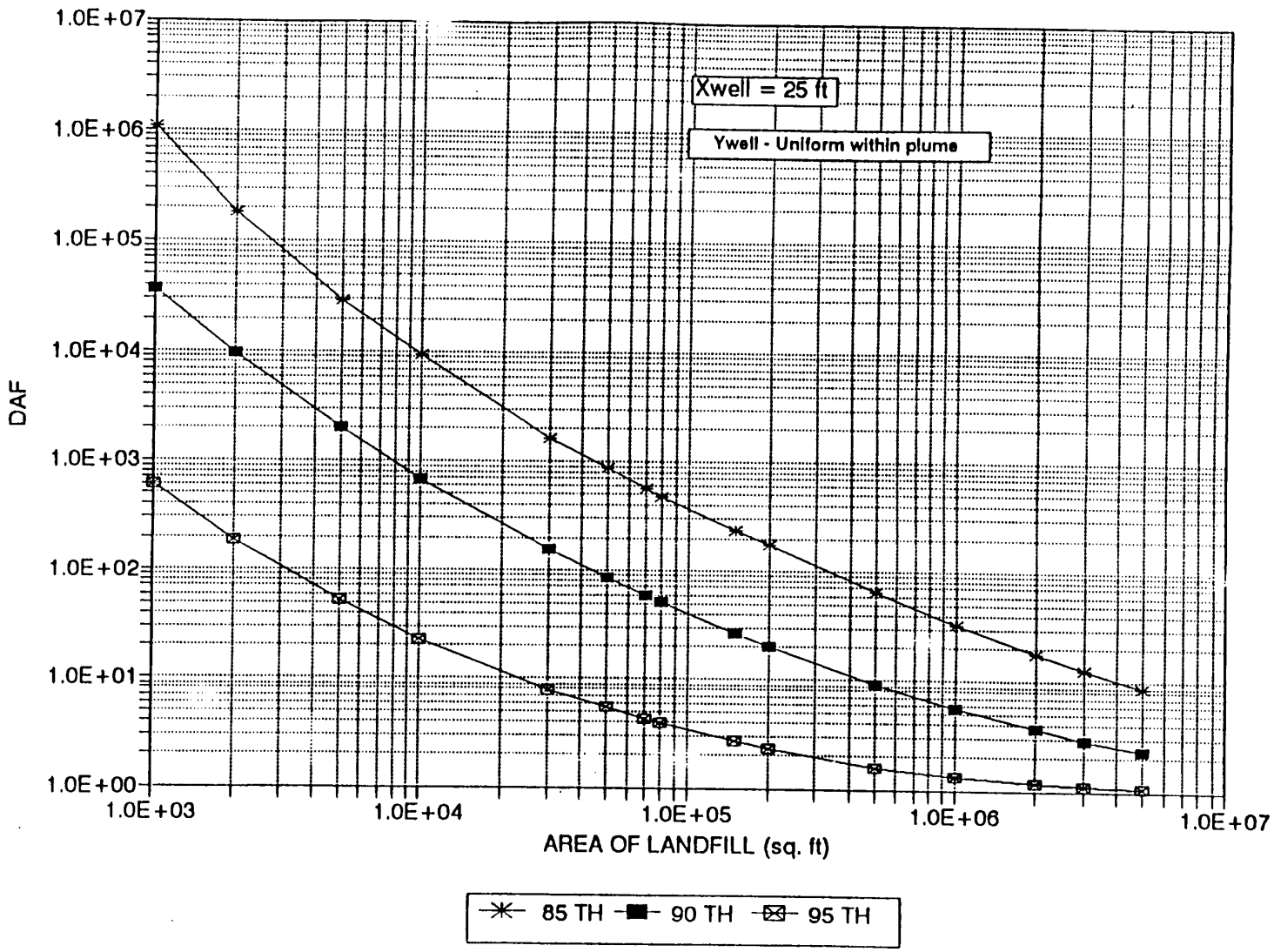


Figure 5
Variation Of DAF With Size Of Source For The Base Case Scenario
(x=25 ft, y=uniform in plume, z=nationwide distribution)

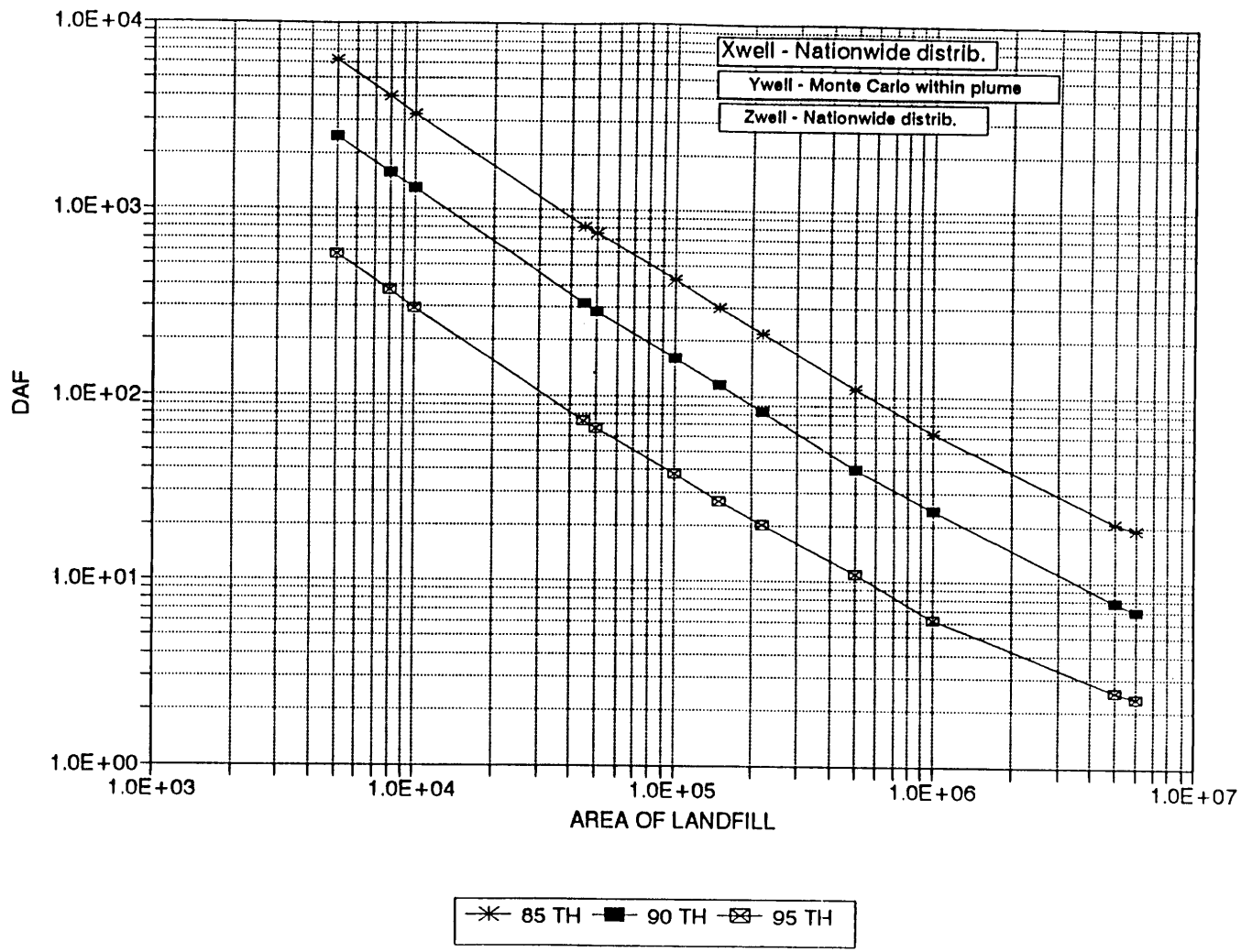


Figure 6
Variation Of DAF With Size Of Source Area For The Default Nationwided Scenario (Scenario 2: x=nationwide distribution, y=uniform in plume, z=nationwide distribution)

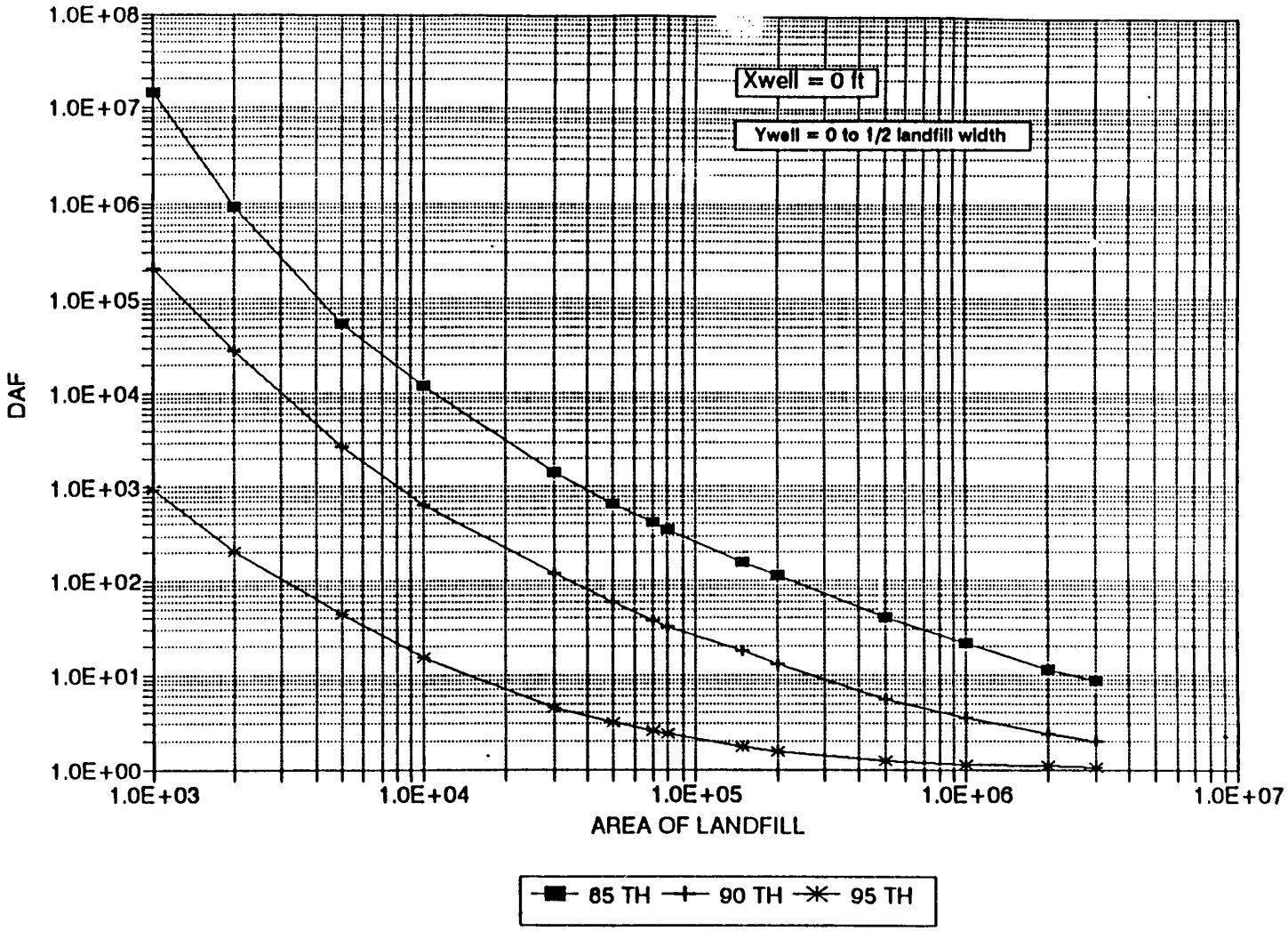


Figure 7
Variation Of DAF With Size Of Source Area For Scenario 3
(x=0, y=uniform within half-width of source area, z=nationwide distribution

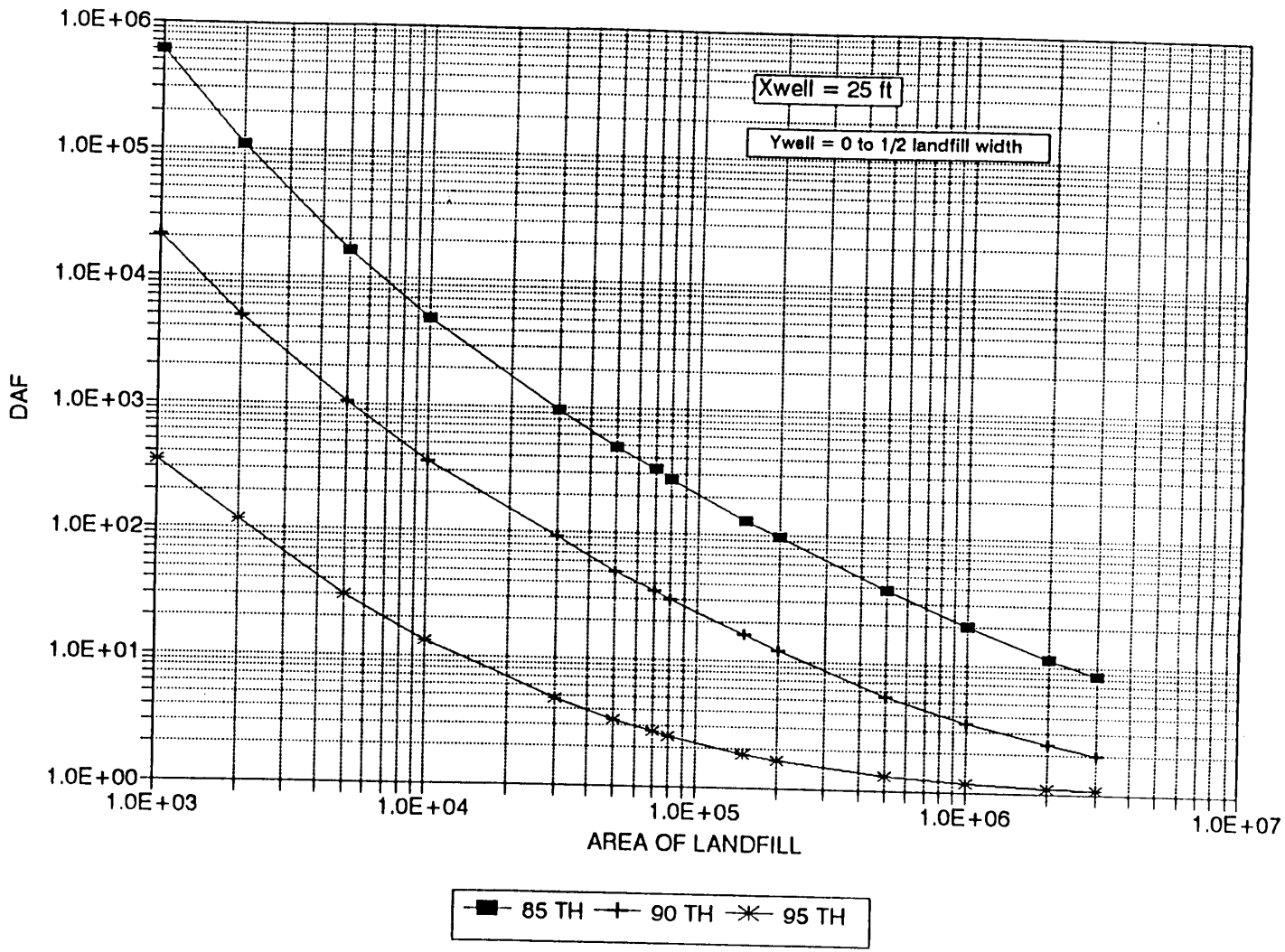


Figure 8
Variation Of DAF With Size Of Source Area For Scenario 4
(x=25 fy, y=uniform within half-width of source area, z=nationwide distribution)

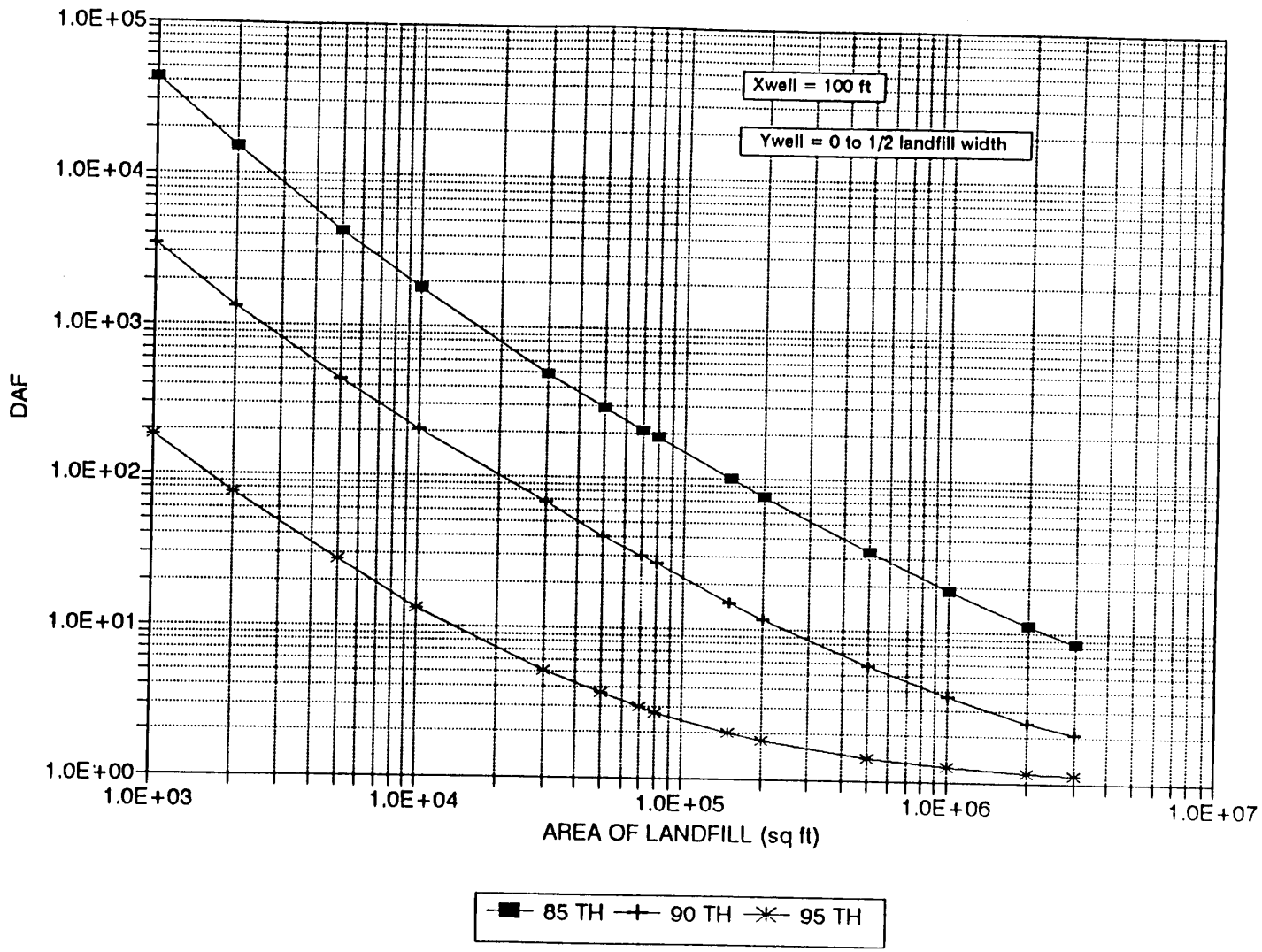


Figure 9
Variation Of DAF With Size Of Source Area For Scenario 5
(x=100 ft, y=uniform within half-width of source area, z=nationwide distribution)

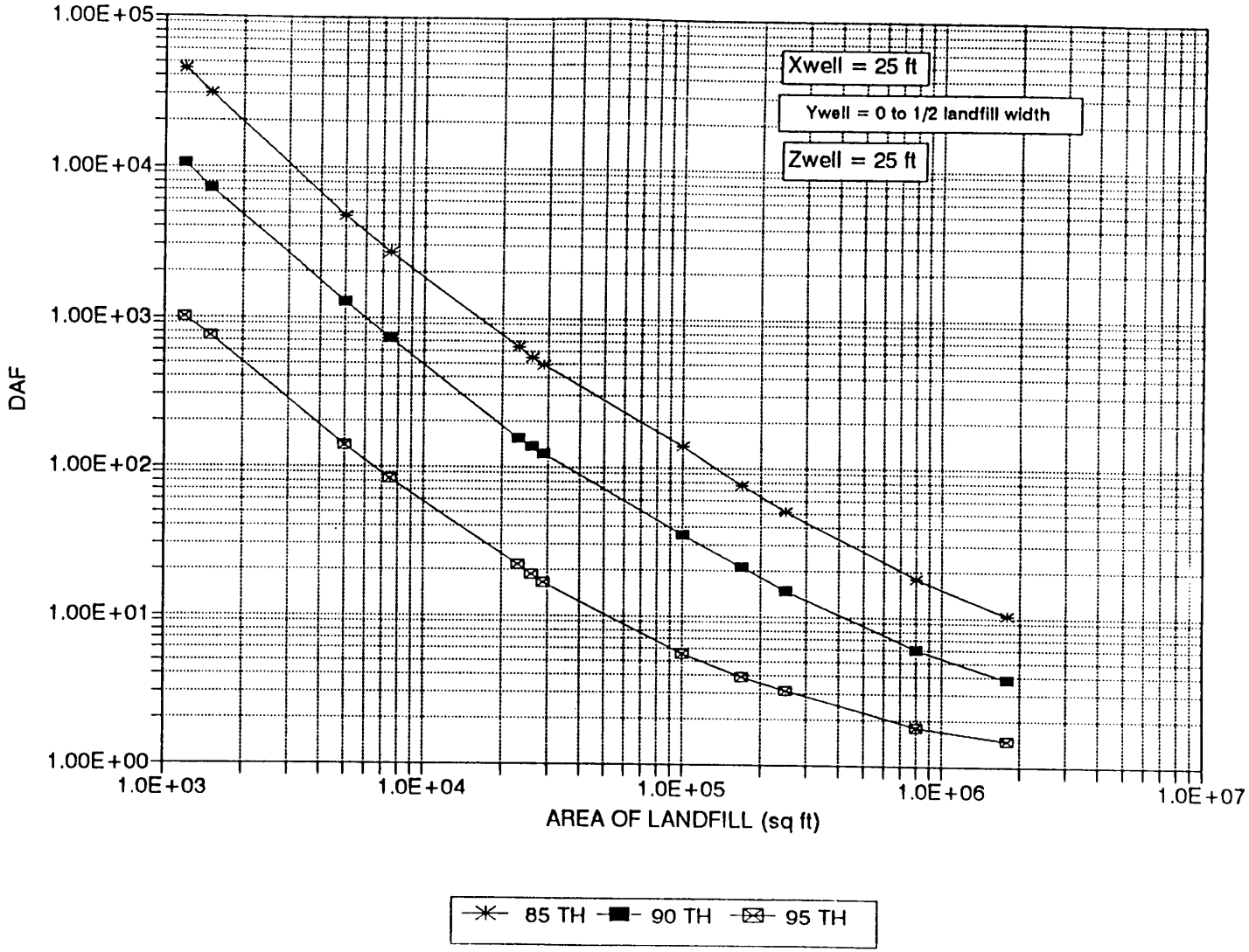


Figure 10
Variation Of DAF With Size Of Source Area For Scenario 6
(x=25 ft, y=width of source area + 25 ft, z=25 ft)

Table 8
DAF values for waste site area of 150,000 ft^2.

Model Scenario	DAF Percentile 85	90	95
1 (base case)	237.5	26.4	2.8
2	300.1	114.7	26.8
3	158.8	17.9	1.7
4	132.1	16.6	1.8
5	98.8	15.1	2.0
6	94.7	25.3	4.4

Because the vertical position of the well was taken as a random variable, with a maximum value of up to 300 feet, the probability that a receptor well samples pristine groundwater underneath the contaminant plume is higher at close distances from the waste area. Conversely, as the distance from the source increases, the plume becomes more dilute but also extends deeper below the water table. The final result is that the overall DAF may actually decrease with distance from the source. The table also shows that at the 95% level, the lowest DAF is obtained in the case where the well is located at the edge of the waste source. This reflects that the highest concentration values will be obtained only very close to the waste source.

The results for the last scenario, in which the x, y, and z locations of the receptor well were all fixed, show that fixing the well depth at 25 feet ensures that the well is placed shallow enough that it will be located inside the plume in nearly all cases, resulting in low DAF values at the 85th and 90th percentile values. On the other hand, the well in this case is never placed immediately at the plume centerline, so that the highest concentrations sampled in this scenario are always lower than in the other scenarios. This is reflected in the higher DAF value at the 95th percentile level.

One of the key objectives of the present analyses was to determine the appropriate groundwater DAF value for a waste area of given size. For the base case scenario, the 90th percentile DAF value is on the order of 100 or higher for a waste area size of 1 acre (43,560 ft^2) and less. For waste areas of 10 acres and greater, the 90th percentile DAF is 10 or less.

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U.S. EPA, 1994. Modeling Approach for Simulating Three-Dimensional Migration of Land and Disposal Leachate with Transformation Products and Consideration of Water-Table Mounding. Volume II: User's Guide for EPA's Composite Model for Leachate Migration with Transformation Products (EPACMTP). Office of Solid Waste, May 1994.

APPENDIX A

Table A1 DAF values as a function of source area for base case scenario (x=25 ft., y=uniform in plume, z-nationwide distribution).

	DAF		
Area (sq. ft.)	85th	90th	95th
1000	1.09E+06	3.76E+04	609.01
2000	1.86E+05	9.63E+03	187.69
5000	2.91 E+04	2.00E+03	53.02
10000	9.31 E+03	680.27	22.57
30000	1647.18	155.21	7.82
50000	869.57	84.25	5.41
70000	569.80	59.28	4.34
80000	477.33	50.56	3.97
150000	237.47	26.36	2.77
200000	174.86	20.19	2.37
500000	64.52	9.12	1.61
1000000	32.27	5.61	1.32
2000000	17.83	3.68	1.16
3000000	12.94	2.94	1.11
5000000	8.91	2.33	1.06

Table A2 DAF values as a function of source area for Scenario 2 (x=nationwide distribution, y=uniform in plume, z=nationwide distribution).

Area (sq. ft.)	DAF		
	85th	90th	95th
5000	6222.78	2425.42	565.61
8000	3977.72	1573.32	371.06
10000	3215.43	1286.01	298.78
45000	817.66	315.06	73.48
50000	745.16	288.27	67.20
100000	424.81	160.82	38.11
150000	300.12	114.71	26.82
220000	218.87	82.30	20.00
500000	110.35	40.10	10.92
1000000	63.45	23.75	6.22
5000000	21.03	7.85	2.55
6000000	19.06	7.01	2.39

Table A3 DAF values as a function of source area for Scenario 3 (x=0 ft, y=uniform within half-width of source area, z=nationwide distribution).

Area (sq. ft.)	DAF		
	85th	90th	95th
1000	1.42E+07	2.09E+05	946.07
2000	9.19E+05	2.83E+04	211.15
5000	5.54E+04	2.74E+ 03	44.23
10000	1.16E+04	644.33	15.29
30000	1.43E+03	120.42	4.48
50000	668.45	60.02	3.10
70000	417.19	37.97	2.53
80000	350.39	33.16	2.34
150000	158.76	17.87	1.74
200000	114.63	12.96	1.56
500000	40.55	5.54	1.23
1000000	21.13	3.50	1.15
2000000	11.58	2.38	1.08
3000000	8.66	1.98	1.06

Table A4 DAF values as a function of source area for Scenario 4 (x=25 ft, y=uniform within half-width of source area, z=nationwide distribution).

	DAF		
Area (sq. ft.)	85th	90th	95th
1000	5.93E + 05	2.07E + 04	348.31
2000	1.09E+05	4.92E+03	118.11
5000	1.64E + 04	1.03E + 03	29.86
10000	4.89E+03	352.49	13.14
30000	928.51	93.98	4.73
50000	490.20	49.78	3.28
70000	323.42	34.79	2.69
80000	272.85	29.82	2.47
150000	132.05	16.55	1.82
200000	97.94	12.29	1.61
500000	37.99	5.50	1.29
1000000	20.08	3.50	1.17
2000000	11.35	2.40	1.10
3000000	8.49	2.00	1.07

Table A5 DAF values as a function of source area for Scenario 5 (x=100 ft, y=uniform within half-width of source, z=nationwide distribution).

	DAF		
Area (sq. ft.)	85th	90th	95th
1000	4.24E+04	3.43E+03	181.88
2000	1.52E + 04	1.33E + 03	74.79
5000	4.24E+ 03	437.25	27.23
10000	1.81 E+03	204.29	13.09
30000	497.27	68.21	5.10
50000	293.34	40.72	3.71
70000	207.77	29.89	2.96
80000	184.57	26.86	2.73
150000	98.81	15.05	2.03
200000	74.63	11.55	1.82
500000	32.99	5.83	1.40
1000000	18.66	3.71	1.26
2000000	11.14	2.53	1.16
3000000	8.33	2.09	1.13

Table A6 DAF values as a function of source area for Scenario 6 (x=25 ft, y=source width + 25 ft, z=25 ft).

	DAF		
Area (sq. ft.)	85th	90th	95th
1200	44247.79	10479.98	1004.72
1500	30759.77	7215.01	744.05
5000	4789.27	1273.40	140.81
7500	2698.33	725.69	82.51
23000	637.76	155.16	21.82
26000	544.66	135.91	18.84
29000	482.63	121.43	16.52
100000	139.66	35.55	5.56
170000	76.69	21.24	3.94
250000	50.40	15.04	3.19
800000	18.10	6.04	1.81
1800000	10.26	3.87	1.48

APPENDIX F

Dilution Factor Modeling Results

Dilution Factor Model Results: DNAPL Sites

Source size (acres)	0.5	10	30	100	600
Source length (m)	45	201	349	636	1,559
Aquifer thickness (m)			9.1		

		Infiltration by Hyd. Region		Average GW Velocity (m/yr)		Mixing zone depth					Dilution factor				
						Site size (acres)					Site size (acres)				
Site Name	**State**	**Region**	**(m/yr)**	**Seepage**	**Darcy**	**0.5**	**10**	**30**	**100**	**600**	**0.5**	**10**	**30**	**100**	**600**
Army Creek Landfill	DE	10	0.24	5,563	1,947	5	21	37	67	165	861	370	214	118	49
Atlantic Wood Ind.	VA	10	0.24	1,261	442	5	21	37	68	166	197	85	49	27	12
AtlasTack Corp.	MA	9	0.22	3	1	10	30	46	76	174	2	1	1	1	1
Auburn Rd. Landfill	NH	9	0.22	61	21	5	23	40	72	173	12	5	4	2	2
Baird & McGuire	MA	9	0.22	61	21	5	23	40	72	173	12	5	4	2	2
Bally Groundwater	PA	6	0.15	3,204	1,121	5	21	37	67	165	793	341	197	108	45
Beacon Hts. Landfill	CT	9	0.22	15	5	6	27	44	76	174	4	2	2	1	1
Berks Sand Pit	PA	6	0.15	10	4	6	27	44	76	174	4	2	2	1	1
Brodhead Creek	PA	7	0.20	11,246	3,936	5	21	37	67	165	2,085	895	517	284	116
Brunswick Naval Air Sta.	ME	9	0.22	230	81	5	22	38	69	168	41	18	11	6	3
Cannon Eng.- Bridgewater	MA	9	0.22	3	1	11	30	46	76	174	2	1	1	1	1
Central Landfill	RI	9	0.22	223	78	5	22	38	69	168	39	17	10	6	3
Centre County Kepone	PA	6	0.15	61,189	21,416	5	21	37	67	165	15,112	6,489	3,747	2,053	839
Chas.-Geo. Reclam. Trust	MA	9	0.22	34	12	6	24	42	74	174	8	3	2	2	1
Coakley Landfill	NH	9	0.22	113	40	5	22	39	70	171	21	9	6	4	2
Craig Farm Drum	PA	6	0.15	451	158	5	21	37	68	166	113	49	29	16	7
Davis Liquid Waste	RI	9	0.22	189	66	5	22	38	69	169	34	15	9	5	3
Delaware City PVC	DE	10	0.24	223	78	5	22	38	69	169	36	16	10	6	3
Dorney Road Landfill	PA	6	0.15	1,913	670	5	21	37	67	165	474	204	118	65	27
Dover Mun. Landfill	NH	9	0.22	289	101	5	22	38	69	168	51	22	13	8	4
DuPont-Newport	DE	10	0.24	33	12	6	25	42	74	174	7	3	2	2	1
Dublin TCE Site	PA	6	0.15	32	11	5	24	41	73	173	10	4	3	2	1
Durham Meadows	CT	9	0.22	612	214	5	21	37	68	166	105	45	27	15	7
East Mt. Zion	PA	6	0.15	1,218	426	5	21	37	68	165	303	130	76	42	18
Elizabethtown Landfill	PA	6	0.15	56	20	5	23	39	71	172	16	7	4	3	2
Gallup's Quarry	CT	9	0.22	67	23	5	23	40	72	172	13	6	4	3	2
Greenwood Chemical	VA	8	0.15	3	1	10	30	46	76	174	2	1	1	1	1
Groveland Wells	MA	9	0.22	612	214	5	21	37	68	166	105	45	27	15	7
Halby Chemical Co.	DE	10	0.24	5	2	9	30	46	76	174	2	1	1	1	1
Harvey & Knott Drum	DE	10	0.24	434	152	5	22	37	68	167	69	30	18	10	5
Havertown PCP	PA	8	0.15	24	9	6	24	41	74	174	8	4	2	2	1
Heleva Landfill	PA	6	0.15	28	10	5	24	41	73	173	9	4	3	2	1
Henderson Road	PA	6	0.15	834	292	5	21	37	68	166	208	89	52	29	12
Hocomonco Pond	MA	9	0.22	1,986	695	5	21	37	68	165	336	145	84	46	20
Holton Circle	NH	9	0.22	2,809	983	5	21	37	67	165	475	204	118	65	27
Hunterstown Road	PA	6	0.15	562	197	5	21	37	68	166	141	61	35	20	9
Industri-plex	MA	9	0.22	289	101	5	22	38	69	168	51	22	13	8	4
Kane and Lombard Street	MD	8	0.15	681	238	5	21	37	68	166	170	73	43	24	10
Kearsarge Metallurgical Corp.	NH	9	0.22	7	2	8	29	46	76	174	3	2	1	1	1
Keefe Environmental Services	NH	9	0.22	12	4	7	28	45	76	174	4	2	2	1	1
Kellogg-Deering Well Field	CT	9	0.22	946	331	5	21	37	68	166	161	69	40	23	10
Kimberton Site	PA	8	0.15	308	108	5	22	37	68	167	78	34	20	11	5
Landfill & Resource Recovery	RI	9	0.22	244	86	5	22	38	69	168	43	19	11	7	3
Lindane Dump	PA	6	0.15	82	29	5	22	39	70	170	22	10	6	4	2

Dilution Factor Model Results: DNAPL Sites

Source size (acres)	0.5	10	30	100	600
Source length (m)	45	201	349	636	1,559
Aquifer thickness (m)			9.1		

		Infiltration by Hyd. Region		Average GW Velocity (m/yr)		Mixing zone depth					Dilution factor				
						Site size (acres)					Site size (acres)				
Site Name	**State**	**Region**	**(m/yr)**	**Seepage**	**Darcy**	**0.5**	**10**	**30**	**100**	**600**	**0.5**	**10**	**30**	**100**	**600**
Linemaster Switch Corp.	CT	9	0.22	1,113	389	5	21	37	68	166	189	81	47	26	11
Maryland Sand, Gravel & Stone	MD	8	0.15	2	1	10	30	46	76	174	2	1	1	1	1
McKin Co.	ME	9	0.22	890	312	5	21	37	68	166	152	65	38	21	9
Metal Banks	PA	6	0.15	5	2	8	29	46	76	174	3	1	1	1	1
Mottolo Pig Famm	NH	9	0.22	131	46	5	22	38	70	170	24	10	6	4	2
MW Manufacturing	PA	7	0.20	21,027	7,359	5	21	37	67	165	3,896	1,673	966	530	217
NCR Corp. Millsboro	DE	10	0.24	223	78	5	22	38	69	169	36	16	10	6	3
Norwood PCBS	MA	9	0.22	389	136	5	22	37	68	167	68	29	17	10	5
Nyanza Chemicals	MA	9	0.22	39	14	5	24	41	74	174	9	4	3	2	1
O'Conner Company	ME	9	0.22	214	75	5	22	38	69	169	38	16	10	6	3
Old City of York Landfill	PA	8	0.15	779	273	5	21	37	68	166	194	84	49	27	12
Old Southington Landfill	CT	7	0.20	134	47	5	22	38	70	170	27	12	7	4	2
Old Springfield Landfill	VT	9	0.22	30	11	6	25	42	74	174	7	3	2	2	1
Osborne Landfill	PA	7	0.20	1,113	389	5	21	37	68	166	208	89	52	29	12
Otis Air Natl. Guard	MA	9	0.22	312	109	5	22	38	69	168	54	24	14	8	4
Ottati & Goss/Kingston Drums	NH	9	0.22	46	16	5	24	41	73	173	10	4	3	2	1
Pease Air Force Base	NH	9	0.22	11	4	7	28	45	76	174	4	2	1	1	1
Peterson/Puritan, Inc.	RI	9	0.22	56	19	5	23	40	72	173	11	5	3	2	2
Picillo Farm	RI	9	0.22	534	187	5	22	37	68	167	92	40	23	13	6
Pinette's SalvageYard	ME	9	0.22	333	117	5	22	38	68	167	58	25	15	9	4
PSC Resources	MA	9	0.22	45	16	5	24	41	73	173	9	4	3	2	1
Re-Solve, Inc.	MA	9	0.22	834	292	5	21	37	68	166	142	61	36	20	9
Recticon/Allied Steel	PA	6	0.15	73	26	5	22	39	70	171	20	9	5	3	2
Rhinehart Tire Fire	VA	6	0.15	1,346	471	5	21	37	68	165	334	144	83	46	19
Saco Tannery Waste Pits	ME	9	0.22	56	19	5	23	40	72	173	11	5	3	2	2
Saunders Supply Co.	VA	10	0.24	28	10	6	25	42	75	174	6	3	2	2	1
Savage Mun. Water Supply	NH	9	0.22	235	82	5	22	38	69	168	42	18	11	6	3
Silresim Chemical Corp.	MA	9	0.22	26	9	6	25	42	75	174	6	3	2	2	1
Somersworth San. Landfill	NH	9	0.22	139	49	5	22	38	70	170	25	11	7	4	2
South Municipal Water Supply	NH	9	0.22	90	32	5	23	39	71	171	17	8	5	3	2
Southern MD Wood Treating	MD	10	0.24	2	1	12	30	46	76	174	2	1	1	1	1
Stamina Mills, Inc.	RI	9	0.22	2,809	983	5	21	37	67	165	475	204	118	65	27
Std. Chlorine/Tybout's Corner LF	DE	10	0.24	39	14	6	24	41	74	174	8	4	2	2	1
Strasburg Landfill	PA	8	0.15	2,160	756	5	21	37	67	165	535	230	133	73	31
Sullivan's Ledge	MA	9	0.22	112	39	5	22	39	70	171	21	9	6	4	2
Sussex County Landfill #5	DE	10	0.24	198	69	5	22	38	69	169	33	14	9	5	3
Sylvester's	NH	9	0.22	490	171	5	22	37	68	167	84	36	21	12	6
Tansitor Electronics	VT	9	0.22	103	36	5	22	39	70	171	19	8	5	3	2
Tibbets Road	NH	9	0.22	28	10	6	25	42	75	174	7	3	2	2	1
US Defense General Supply	VA	8	0.15	37	13	5	23	40	72	173	11	5	3	2	2
US Dover AFB	DE	10	0.24	4	1	10	30	46	76	174	2	1	1	1	1
US Naval Air Development	PA	6	0.15	56	19	5	23	39	71	172	16	7	4	3	2
US Newport Nav. Educ.&Tm. Ctr.	RI	9	0.22	3	1	11	30	46	76	174	2	1	1	1	1
W.R.Grace & Co./Acton	MA	9	0.22	445	156	5	22	37	68	167	77	33	20	11	5

Dilution Factor Model Results: DNAPL Sites

Source size (acres)	0.5	10	30	100	600
Source length (m)	45	201	349	636	1,559
Aquifer thickness (m)			9.1		

		Infiltration by Hyd. Region		Average GW Velocity (m/yr)		Mixing zone depth					Dilution factor				
						Site size (acres)					Site size (acres)				
Site Name	**State**	**Region**	**(m/yr)**	**Seepage**	**Darcy**	**0.5**	**10**	**30**	**100**	**600**	**0.5**	**10**	**30**	**100**	**600**
Western Sand & Gravel	RI	9	0.22	48	17	5	24	40	73	173	10	4	3	2	1
Westinghouse Elevator	PA	6	0.15	562	197	5	21	37	68	166	141	61	35	20	9
Winthrop Landfill	ME	9	0.22	16	6	6	27	44	76	174	5	2	2	1	1
Woodlawn County Landfill	MD	8	0.15	557	195	5	21	37	68	166	140	60	35	20	9

Dilution Factors (DFs) for 208 Sites in the Hydrogeologic Database (HGDB) - National Average

	Source Area (acres)				
	0.5	10	30	100	600
Source Length (m)	45	201	349	636	1,559

						Calculated Mixing Zone Depth (d)					Dilution Factor (DF)				
Hydrogeologic	**Infiltration**	**Average K**	**Hyd. Grad.**	**Darcy v**	**Aq. Thick.**	Source Area (acres)					Source Area (acres)				
Setting	(m/y)	(m/y)	(m/m)	(m/y)	(m)	0.5	10	30	100	600	0.5	10	30	100	600
1.11	0.30	63	3.00E-02	2	30	11	41	62	96	195	3	2	2	1	1
1.11	0.30	946	1.00E-02	9	305	6	28	48	87	211	5	5	5	5	5
1.3	0.03	63	8.00E-02	5	23	5	22	39	70	172	23	23	14	8	4
1.6	0.08	946	9.30E-02	88	15	5	21	37	68	166	124	89	51	29	12
1.6	0.08	5,676	2.00E-03	11	21	5	23	39	71	173	18	17	10	6	3
1.7	0.14	157,680	1.00E-04	16	3	5	23	39	70	168	9	3	2	2	1
1.7	0.14	192,370	1.00E-02	1,924	6	5	21	37	67	165	1,459	419	242	133	55
1.8	0.03	63,072	5.00E-03	315	2	5	21	37	67	165	421	95	55	31	13
1.9	0.08	125,829	1.00E-03	126	5	5	21	37	68	166	169	39	23	13	6
1.9	0.08	2,759,400	3.00E-02	82,782	23	5	21	37	67	165	114,973	114,973	71,160	39,049	15,931
2.12	0.03	126	2.00E-03	0.3	5	8	26	42	72	170	2	1	1	1	1
2.12	0.03	946	2.00E-03	2	3	5	23	39	70	168	6	2	2	1	1
2.12	0.03	1,388	3.00E-03	4	91	5	22	39	71	174	19	19	19	19	11
2.12	0.03	1,577	1.00E-03	2	914	5	25	43	77	190	9	9	9	9	9
2.12	0.03	1,577	5.00E-03	8	24	5	22	38	69	170	35	35	23	13	6
2.12	0.03	23,652	3.00E-03	71	6	5	21	37	68	166	298	86	50	28	12
2.12	0.03	31,536	1.00E-03	32	24	5	21	37	68	166	133	133	88	49	20
2.13	0.03	95	3.00E-04	0.03	9	14	30	46	76	174	1	1	1	1	1
2.13	0.03	158	1.00E-03	0.2	130	12	50	83	138	276	3	3	2	2	2
2.13	0.03	2,838	2.00E-03	6	30	5	22	38	70	171	26	26	21	12	5
2.3	0.22	315	5.70E-03	2	46	10	40	64	104	210	3	3	2	2	1
2.3	0.22	5,992	1.00E-03	6	183	6	28	49	89	213	5	5	5	5	4
2.4	0.22	315	1.00E-03	0.3	15	18	37	52	83	180	1	1	1	1	1
2.4	0.22	315	2.00E-03	1	3	8	24	40	70	168	1	1	1	1	1
2.4	0.22	631	1.00E-02	6	9	6	26	44	76	174	5	2	2	1	1
2.4	0.22	1,892	1.00E-03	2	37	10	38	61	99	201	3	3	2	2	1
2.4	0.22	4,100	1.00E-03	4	3	6	24	40	70	168	2	1	1	1	1
2.4	0.22	11,038	2.00E-03	22	13	5	23	40	72	174	13	8	5	3	2
2.4	0.22	16,714	4.00E-03	67	6	5	22	38	69	168	35	11	7	4	2
2.4	0.22	107,222	5.00E-03	536	7	5	21	37	68	166	265	91	53	30	13

Dilution Factors (DFs) for 208 Sites in the Hydrogeologic Database (HGDB) - National Average

	Source Area (acres)				
	0.5	10	30	100	600
Source Length (m)	45	201	349	636	1,559

						Calculated Mixing Zone Depth (d)					Dilution Factor (DF)				
Hydrogeologic	**Infiltration**	**Average K**	**Hyd. Grad.**	**Darcy v**	**Aq. Thick.**	Source Area (acres)					Source Area (acres)				
Setting	(m/y)	(m/y)	(m/m)	(m/y)	(m)	0.5	10	30	100	600	0.5	10	30	100	600
2.4	0.22	190,793	1.00E-03	191	8	5	21	37	68	167	96	35	20	12	5
2.4	0.22	3,311,280	5.00E-03	16,556	18	5	21	37	67	165	8,118	6,978	4,019	2,206	901
2.5	0.30	946	2.00E-03	2	8	10	29	45	76	173	2	1	1	1	1
2.5	0.30	1,261	3.00E-03	4	305	8	37	64	114	268	3	3	3	3	3
2.5	0.30	4,415	7.00E-04	3	38	9	37	60	98	202	3	3	2	2	1
2.5	0.30	6,938	3.00E-03	21	23	5	24	42	75	179	9	9	5	3	2
2.5	0.30	23,337	4.00E-03	93	37	5	22	38	69	170	34	34	33	19	8
2.5	0.30	56,134	2.00E-03	112	10	5	22	38	69	168	41	19	12	7	3
2.6	0.30	1,577	1.00E-03	2	12	11	33	49	79	177	2	1	1	1	1
2.6	0.30	13,876	2.80E-02	389	34	5	21	37	68	166	137	137	123	68	28
2.6	0.30	50,773	5.00E-03	254	9	5	22	37	68	167	90	39	23	13	6
2.9	0.03	126	2.00E-03	0.3	11	8	31	47	78	176	3	2	1	1	1
2.9	0.03	1,261	1.00E-04	0.1	18	12	38	55	86	183	2	1	1	1	1
2.9	0.03	3,469	2.00E-02	69	15	5	21	37	68	166	291	208	120	66	28
2.9	0.03	22,075	1.00E-03	22	91	5	22	37	68	167	94	94	94	94	52
2.9	0.03	220,752	1.00E-03	221	15	5	21	37	67	165	922	660	381	209	86
3.7	0.14	220,752	2.00E-03	442	9	5	21	37	68	165	336	145	84	46	20
3.7	0.14	296,438	2.00E-04	59	9	5	22	38	69	168	47	20	12	7	3
4.1	0.03	32	1.00E-01	3	21	5	23	40	72	174	15	14	9	5	3
4.2	0.03	22	2.80E-02	1	11	6	27	45	77	176	4	2	2	1	1
4.2	0.03	284	3.20E-03	1	3	6	24	40	70	168	3	2	1	1	1
4.4	0.14	946	8.00E-03	8	3	5	23	40	70	168	5	2	1	1	1
4.4	0.14	9,776	1.30E-02	127	3	5	21	37	68	166	63	15	9	5	3
5.2	0.03	242,827	2.00E-03	486	17	5	21	37	67	165	2,025	1,596	919	505	207
5.3	0.03	2,317,896	2.00E-03	4,636	12	5	21	37	67	165	19,317	11,072	6,377	3,500	1,428
5.8	0.03	631	3.00E-03	2	24	5	24	41	75	179	10	10	6	4	2
5.8	0.03	33,113	2.00E-06	0.07	34	18	51	70	101	199	2	1	1	1	1
6.11	0.22	1,577	1.00E-02	16	24	5	24	41	75	179	10	10	6	4	2
6.11	0.22	4,415	5.00E-03	22	15	5	23	40	72	175	13	9	5	3	2
6.11	0.22	4,415	1.00E-02	44	21	5	22	39	70	171	24	23	14	8	4

Dilution Factors (DFs) for 208 Sites in the Hydrogeologic Database (HGDB) - National Average

	Source Area (acres)				
	0.5	10	30	100	600
Source Length (m)	45	201	349	636	1,559

						Calculated Mixing Zone Depth (d)					Dilution Factor (DF)				
Hydrogeologic	**Infiltration**	**Average K**	**Hyd. Grad.**	**Darcy v**	**Aq. Thick.**	Source Area (acres)					Source Area (acres)				
Setting	(m/y)	(m/y)	(m/m)	(m/y)	(m)	0.5	10	30	100	600	0.5	10	30	100	600
6.11	0.22	81,994	3.00E-03	246	9	5	21	37	68	166	123	49	29	16	7
6.12	0.03	946	8.00E-03	8	6	5	22	38	69	169	34	10	6	4	2
6.12	0.03	3,154	6.00E-03	19	3	5	22	37	68	167	51	12	8	5	2
6.12	0.03	315	1.70E-02	5	9	5	22	38	70	170	24	11	7	4	2
6.14	0.22	1,577	4.00E-02	63	8	5	22	38	69	169	33	12	7	5	2
6.14	0.22	1,892	2.00E-03	4	6	7	26	43	73	171	3	2	1	1	1
6.14	0.22	5,676	1.00E-03	6	6	6	26	42	73	171	5	2	1	1	1
6.14	0.22	14,191	7.00E-04	10	18	6	25	43	77	180	7	5	3	2	2
6.14	0.22	33,113	1.00E-02	331	23	5	21	37	68	166	164	164	101	56	23
6.2	0.14	126	4.00E-03	1	8	11	29	45	75	173	2	1	1	1	1
6.2	0.14	3	1.00E-02	0.03	5	9	26	42	72	170	1	1	1	1	1
6.2	0.14	1,325	5.00E-03	7	21	6	25	43	77	182	7	6	4	3	2
6.2	0.14	2,208	3.30E-02	73	30	5	22	38	69	168	57	57	47	26	11
6.3	0.03	1,892	4.30E-02	81	6	5	21	37	68	165	341	98	57	32	14
6.3	0.03	31,536	1.40E-01	4,415	3	5	21	37	67	165	11,774	2,637	1,519	834	341
6.4	0.08	9,776	1.20E-02	117	30	5	21	37	68	166	165	165	135	75	31
6.5	0.14	63	4.00E-02	3	20	7	30	49	84	185	4	3	2	2	1
6.5	0.14	189	2.30E-02	4	61	6	27	47	85	199	5	5	5	4	2
6.5	0.14	315	5.00E-03	2	21	8	33	53	87	186	3	2	2	1	1
6.5	0.14	315	2.50E-02	8	19	6	25	42	76	180	8	6	4	3	2
6.5	0.14	31,536	5.00E-02	1,577	6	5	21	37	67	165	1,197	343	198	109	45
6.5	0.14	34,690	8.00E-03	278	5	5	21	37	68	166	203	46	27	15	7
6.8	0.14	2,208	2.50E-02	55	2	5	22	38	68	166	14	4	3	2	1
7.11	0.22	95	6.00E-03	0.6	4	9	25	41	71	169	1	1	1	1	1
7.11	0.22	2,523	2.00E-02	50	3	5	22	38	69	168	17	5	3	2	1
7.12	0.22	4,100	3.00E-03	12	32	6	25	43	77	183	8	8	6	4	2
7.12	0.22	12,614	4.90E-02	618	6	5	21	37	68	166	305	92	54	30	13
7.12	0.22	116,052	4.00E-03	464	76	5	21	37	68	166	230	230	230	230	106
7.13	0.14	3,154	1.30E-02	41	17	5	22	38	69	170	33	25	15	9	4
7.13	0.14	5,519	1.00E-02	55	`5	5	22	38	69	168	44	12	7	4	2

Dilution Factors (DFs) for 208 Sites in the Hydrogeologic Database (HGDB) - National Average

	Source Area (acres)				
	0.5	10	30	100	600
Source Length (m)	45	201	349	636	1,559

						Calculated Mixing Zone Depth (d)					Dilution Factor (DF)				
Hydrogeologic	**Infiltration**	**Average K**	**Hyd. Grad.**	**Darcy v**	**Aq. Thick.**	Source Area (acres)					Source Area (acres)				
Setting	(m/y)	(m/y)	(m/m)	(m/y)	(m)	0.5	10	30	100	600	0.5	10	30	100	600
7.13	0.14	15,453	6.00E-03	93	8	5	22	37	68	167	72	27	16	9	4
7.14	0.30	6,307	4.90E-02	309	5	5	21	37	68	166	109	27	16	9	4
7.14	0.30	6,938	4.00E-03	28	8	5	23	40	72	172	12	5	3	2	1
7.14	0.30	11,038	2.50E-01	2,759	5	5	21	37	67	165	921	207	120	66	28
7.14	0.30	14,507	1.20E-02	174	18	5	22	38	68	168	62	53	31	17	8
7.14	0.30	17,660	2.00E-03	35	43	5	23	40	72	177	14	14	14	9	4
7.14	0.30	23,652	3.30E-02	781	18	5	21	37	68	166	273	234	135	75	31
7.15	0.30	7,253	6.00E-04	4	37	8	33	55	93	200	3	3	2	2	1
7.15	0.30	24,314	6.80E-03	165	11	5	22	38	68	168	59	30	18	10	5
7.16	0.14	221	4.00E-03	1	8	9	29	45	75	173	2	1	1	1	1
7.16	0.14	3,154	3.00E-03	9	9	5	24	41	73	173	9	4	3	2	1
7.17	0.14	19	8.00E-03	0.2	5	10	27	42	73	170	1	1	1	1	1
7.17	0.14	32	9.00E-03	0.3	3	8	24	40	70	168	1	1	1	1	1
7.17	0.14	32	3.00E-02	1	11	10	31	48	78	176	2	1	1	1	1
7.17	0.14	63	2.20E-02	1	3	7	24	40	70	168	2	1	1	1	1
7.17	0.14	126	1.50E-01	19	30	5	23	39	72	175	16	16	13	7	4
7.17	0.14	315	1.00E-03	0.3	12	15	33	49	79	177	2	1	1	1	1
7.17	0.14	315	7.00E-03	2	23	7	31	51	86	188	4	3	2	2	1
7.17	0.14	946	5.00E-02	47	14	5	22	38	69	169	38	24	14	8	4
7.17	0.14	3,154	1.00E-02	32	5	5	22	38	69	169	24	6	4	3	2
7.17	0.14	3,469	1.70E-02	59	55	5	22	38	69	169	47	47	47	37	16
7.17	0.14	21,760	4.00E-03	87	15	5	22	37	68	167	68	48	28	16	7
7.18	0.14	1,892	5.00E-03	9	1	5	22	38	68	166	2	1	1	1	1
7.3	0.14	946	5.00E-03	5	5	6	25	41	72	170	5	2	2	1	1
7.3	0.14	25,544	9.00E-04	23	4	5	22	39	70	168	14	4	3	2	1
7.4	0.22	189	1.20E-02	2	61	9	38	63	106	221	3	3	3	2	1
7.4	0.22	2,681	9.00E-03	24	2	5	23	39	70	167	7	2	2	1	1
7.4	0.22	3,784	4.00E-02	151	2	5	22	37	68	166	25	6	4	3	2
7.5	0.30	63	7.00E-03	0.4	518	35	143	230	363	618	2	2	2	2	1
7.5	0.30	11,038	5.00E-04	6	23	7	30	50	85	187	4	3	2	2	1

Dilution Factors (DFs) for 208 Sites in the Hydrogeologic Database (HGDB) - National Average

	Source Area (acres)				
	0.5	10	30	100	600
Source Length (m)	45	201	349	636	1,559

						Calculated Mixing Zone Depth (d)					Dilution Factor (DF)				
Hydrogeologic	**Infiltration**	**Average K**	**Hyd. Grad.**	**Darcy v**	**Aq. Thick.**	Source Area (acres)					Source Area (acres)				
Setting	(m/y)	(m/y)	(m/m)	(m/y)	(m)	0.5	10	30	100	600	0.5	10	30	100	600
7.6	0.14	63	7.00E-03	0.4	4	9	25	41	71	169	1	1	1	1	1
7.6	0.14	126	1.00E-02	1	15	9	33	51	82	180	3	2	1	1	1
7.6	0.14	6,623	2.00E-02	132	21	5	21	37	68	167	102	102	59	33	14
7.7	0.14	158	3.00E-03	0.5	5	9	26	42	72	170	1	1	1	1	1
7.7	0.14	8,830	5.00E-04	4	46	6	27	47	84	195	5	5	5	3	2
7.8	0.14	631	5.00E-03	3	8	7	27	44	75	173	4	2	1	1	1
7.9	0.22	1,892	3.00E-02	57	32	5	22	38	70	170	30	30	25	14	6
7.9	0.22	2,208	9.00E-04	2	23	9	35	55	89	188	3	2	2	1	1
7.9	0.22	3,879	4.00E-03	16	8	5	24	41	73	172	10	4	3	2	1
7.9	0.22	5,676	1.00E-03	6	6	6	26	42	73	171	5	2	1	1	1
7.9	0.22	6,307	1.00E-03	6	61	6	28	48	86	201	5	5	5	4	2
7.9	0.22	7,253	6.00E-04	4	40	7	30	51	89	199	4	4	3	2	2
7.9	0.22	7,884	3.00E-02	237	3	5	21	37	68	166	75	18	11	6	3
7.9	0.22	9,776	7.00E-04	7	15	6	26	45	78	180	5	3	2	2	1
7.9	0.22	13,245	6.00E-03	79	12	5	22	38	69	169	41	23	14	8	4
7.9	0.22	13,876	2.00E-03	28	122	5	23	40	72	177	16	16	16	16	11
7.9	0.22	14,822	1.00E-03	15	61	5	24	42	76	184	9	9	9	8	4
7.9	0.22	15,768	1.00E-03	16	24	5	24	41	75	179	10	10	6	4	2
7.9	0.22	18,922	5.00E-03	95	8	5	22	38	69	168	48	18	11	6	3
7.9	0.22	23,967	2.00E-03	48	23	5	22	38	70	171	25	25	16	9	4
7.9	0.22	29,959	4.00E-03	120	19	5	22	38	68	168	61	53	31	17	8
7.9	0.22	34,374	6.00E-03	206	26	5	21	37	68	167	103	103	73	40	17
7.9	0.22	37,843	3.00E-03	114	9	5	22	38	68	168	58	25	15	9	4
7.9	0.22	44,150	2.00E-03	88	19	5	22	38	69	168	45	39	23	13	6
7.9	0.22	99,654	7.00E-04	70	7	5	22	38	69	168	36	12	7	5	2
7.9	0.22	110,376	4.00E-03	442	21	5	21	37	68	166	218	218	126	70	29
7.9	0.22	662,256	3.00E-03	1,987	6	5	21	37	67	165	976	280	162	89	37
7.9	0.22	64,018,080	9.00E-04	57,616	76	5	21	37	67	165	28,244	28,244	28,244	28,244	13,045
8.6	0.22	2,523	1.10E-02	28	6	5	23	39	71	170	16	5	3	2	2
9.12	0.22	22	4.00E-03	0.09	14	18	35	51	81	179	1	1	1	1	1

Dilution Factors (DFs) for 208 Sites in the Hydrogeologic Database (HGDB) - National Average

	Source Area (acres)				
	0.5	10	30	100	600
Source Length (m)	45	201	349	636	1,559

						Calculated Mixing Zone Depth (d)					Dilution Factor (DF)				
Hydrogeologic	**Infiltration**	**Average K**	**Hyd. Grad.**	**Darcy v**	**Aq. Thick.**	Source Area (acres)					Source Area (acres)				
Setting	(m/y)	(m/y)	(m/m)	(m/y)	(m)	0.5	10	30	100	600	0.5	10	30	100	600
9.12	0.22	158	1.20E-02	2	3	7	24	40	70	168	2	1	1	1	1
9.13	0.30	315	6.00E-03	2	5	8	26	42	72	170	2	1	1	1	1
9.14	0.22	126	5.00E-02	6	5	6	25	41	72	170	4	2	1	1	1
9.14	0.22	126	2.00E-02	3	8	8	28	44	75	173	3	1	1	1	1
9.14	0.22	631	1.50E-01	95	2	5	22	38	68	167	22	6	4	2	2
9.14	0.22	4,100	1.00E-02	41	6	5	22	39	70	169	22	7	4	3	2
9.15	0.30	631	1.00E-02	6	11	7	28	45	77	176	4	2	2	1	1
9.15	0.30	2,208	2.00E-02	44	4	5	22	39	70	168	13	4	3	2	1
9.15	0.30	5,046	3.00E-03	15	12	6	25	42	75	176	7	4	3	2	1
9.15	0.30	11,038	7.50E-02	828	3	5	21	37	68	166	185	42	25	14	6
9.15	0.30	19,237	8.00E-03	154	12	5	22	38	69	168	55	32	19	11	5
9.15	0.30	19,237	1.30E-02	250	11	5	22	37	68	167	89	45	26	15	7
9.15	0.30	27,752	2.00E-03	56	24	5	22	39	71	172	21	21	14	8	4
9.15	0.30	27,752	2.00E-03	56	24	5	22	39	71	172	21	21	14	8	4
9.15	0.30	33,113	4.00E-04	13	30	6	26	44	79	186	7	7	5	3	2
9.15	0.30	60,864	3.00E-03	183	30	5	22	38	68	167	65	65	53	30	13
9.7	0.08	126	3.00E-02	4	107	6	25	44	79	192	7	7	7	7	4
9.9	0.22	284	1.00E-02	3	9	8	29	46	76	174	3	2	1	1	1
9.9	0.22	315	5.10E-01	161	6	5	22	37	68	167	81	24	14	8	4
9.9	0.22	8,830	4.00E-03	35	18	5	22	39	71	172	19	16	10	6	3
10.2	0.30	25	9.50E-03	0.2	5	9	26	42	72	170	1	1	1	1	1
10.2	0.30	32	1.70E-02	0.5	7	11	28	44	74	172	1	1	1	1	1
10.2	0.30	126	3.00E-03	0.4	4	9	25	41	71	169	1	1	1	1	1
10.2	0.30	126	2.50E-02	3	12	8	31	48	79	177	3	2	1	1	1
10.2	0.30	158	6.00E-04	0.1	3	8	24	40	70	168	1	1	1	1	1
10.2	0.30	284	1.00E-02	3	8	8	28	44	75	173	3	1	1	1	1
10.2	0.30	315	4.00E-03	1	6	10	27	43	73	171	2	1	1	1	1
10.2	0.30	315	1.00E-02	3	11	8	30	47	78	176	3	2	1	1	1
10.2	0.30	631	5.00E-03	3	1	6	22	38	68	166	1	1	1	1	1
10.2	0.30	2,208	1.00E-05	0.02	8	12	29	45	75	173	1	1	1	1 -	1

Dilution Factors (DFs) for 208 Sites in the Hydrogeologic Database (HGDB) - National Average

	Source Area (acres)				
	0.5	10	30	100	600
Source Length (m)	45	201	349	636	1,559

						Calculated Mixing Zone Depth (d)					Dilution Factor (DF)				
Hydrogeologic	**Infiltration**	**Average K**	**Hyd. Grad.**	**Darcy v**	**Aq. Thick.**	Source Area (acres)					Source Area (acres)				
Setting	(m/y)	(m/y)	(m/m)	(m/y)	(m)	0.5	10	30	100	600	0.5	10	30	100	600
10.2	0.30	2,208	1.00E-02	22	8	5	24	41	73	172	10	4	3	2	1
10.2	0.30	3,469	2.00E-03	7	3	6	24	40	70	168	3	1	1	1	1
10.2	0.30	4,415	5.00E-03	22	55	5	24	42	75	183	10	10	10	7	4
10.2	0.30	4,415	1.40E-02	62	9	5	22	39	70	170	23	10	6	4	2
10.2	0.30	19,552	3.00E-04	6	21	7	30	49	84	186	4	3	2	2	1
10.2	0.30	607,068	2.00E-03	1,214	15	5	21	37	67	165	424	303	175	96	40
10.5	0.30	315	2.00E-03	0.6	3	8	24	40	70	168	1	1	1	1	1
10.5	0.30	631	1.00E-03	0.6	0	5	22	37	68	165	1	1	1	1	1
10.5	0.30	4,415	2.00E-03	9	20	6	27	46	81	183	5	4	3	2	1
11.3	0.30	631	1.00E-02	6	6	7	26	43	73	171	4	2	1	1	1
11.3	0.30	7,569	6.00E-03	45	46	5	23	39	71	174	18	18	18	12	5
11.3	0.30	12,614	5.00E-03	63	5	5	22	38	70	169	22	6	4	2	2
11.4	0.30	32	5.00E-03	0.2	15	20	37	52	83	180	1	1	1	1	1
11.4	0.30	284	3.00E-03	0.9	30	17	49	67	98	195	2	1	1	1	1
11.4	0.30	315	5.00E-02	16	2	5	23	38	69	167	3	1	1	1	1
11.4	0.30	315	1.00E-03	0.3	24	25	46	61	92	189	2	1	1	1	1
11.4	0.30	946	2.00E-04	0.2	2	6	23	39	69	167	1	1	1	1	1
11.4	0.30	1,261	2.00E-03	3	11	9	31	47	78	176	3	1	1	1	1
11.4	0.30	1,261	1.70E-02	21	3	5	23	39	70	168	6	2	2	1	1
11.4	0.30	1,577	2.30E-02	36	5	5	23	39	70	169	13	4	3	2	1
11.4	0.30	2,523	2.00E-03	5	2	6	23	39	69	167	2	1	1	1	1
11.4	0.30	3,154	1.50E-01	473	6	5	21	37	68	166	166	48	28	16	7
11.4	0.30	8,168	3.30E-03	27	6	5	23	40	72	171	11	4	3	2	1
11.4	0.30	13,876	2.00E-03	28	61	5	23	41	74	180	12	12	12	10	5
11.4	0.30	176,602	1.90E-02	3,355	4	5	21	37	67	165	1,045	235	136	75	31
12.4	0.30	309,053	5.00E-04	155	43	5	22	38	69	168	56	56	56	35	15
13.4	0.08	5,361	1.00E-03	5	6	5	24	40	72	171	9	3	2	2	1
13.4	0.08	7,884	2.00E-02	158	3	5	21	37	68	166	141	32	19	11	5

Hydrogeologic Settings for HGDB Sites

Region	Setting	Reference Number
Western Mountain Ranges		
	Mountain Slopes Facing East	1.1
	Mountain Flanks Facing East	1.3
	Mountain Flanks Facing West	1.4
	Wide Alluvial Valleys Facing East	1.6
	Wide Alluvial Valleys Facing West	1.7
	Alluvial Mountain Valleys Facing West	1.8
	Alluvial Mountain Valleys Facing East	1.9
	Coastal Beaches	1.11
Alluvial Basins		
	Mountain Slopes	2.1
	Alternating Sedimentary Rocks	2.3
	River Alluvium With Overbank Deposits	2.4
	River Alluvium Without Overbank Deposits	2.5
	Coastal Lowlands	2.6
	Alluvial Fans	2.9
	Alluvial Basins with Internal Drainage	2.13
	Playa Lakes	2.11
	Continental Deposits	2.12
Columbia Lava Plateau		
	Lava Flows: Hydraulically Connected	3.3
	Alluvial Fans	3.5
	River Alluvium	3.7
Colorado Plateau and Wyoming Basin		
	Resistant Ridges	4.1
	Consolidated Sedimentary Rocks	4.2
	Alluvium and Dune Sand	4.3
	River Alluvium	4.4
High Plains		
	River Alluvium with Overbank Deposits	5.2
	River Alluvium without Overbank Deposits	5.3
	Playa Lakes	5.7
	Ogalalla	5.8
Non-Glaciated Central Region		
	Triassic Basins	6.2
	Mountain Slopes	6.3
	Mountain Flanks	6.4

Hydrogeologic Settings for HGDB Sites

Region	Setting	Reference Number
Non-Glaciated Central Region (cont.)		
	Alternating Beds of Sandstone, Limestone, or Shale Under Thin Soil	6.5
	Alternating Beds of Sandstone, Limestone, or Shale Under Deep Regolith	6.6
	Alluvial Mountain Valleys	6.8
	Braided River Deposits	6.9
	River Alluvium with Overbank Deposits	6.14
	River Alluvium without Overbank Deposits	6.11
	Unconsolidated and Semi-Consolidated Aquifers	6.12
	Solution Limestone	6.13
Glaciated Central Region		
	Till Over Solution Limestone	7.1
	Outwash Over Solution Limestone	7.2
	Till Over Bedded Sedimentary Rock	7.3
	Thin Till Over Bedded Sedimentary Rock	7.4
	Outwash Over Bedded Sedimentary Rock	7.5
	Till Over Sandstone	7.6
	Till Over Shale	7.7
	Glaciated Lake Deposits	7.8
	Outwash	7 9
	Till Over Outwash	7.18
	Moraine	7.11
	Buried Valley	7.12
	River Alluvium with Overbank Deposits	7.13
	River Alluvium without Overbank Deposits	7.14
	Beaches, Beach Ridges, and Sand Dunes	7.15
	Swamp/Marsh	7.16
	Till	7.17
Piedmont Blue Ridge Region		
	Thick Regolith	8.1
	River Alluvium	8.6
Northeast and Superior Uplands		
	Glacial Till Over Crystalline Bedrock	9.1
	Glacial Lakes/Glacial Marine Deposits	9.2
	Bedrock Uplands	9.4
	Swamp/Marsh	9.5
	Mountain Flanks	9.7
	Glacial Till Over Outwash	9.9
	Outwash	9.15
	Alluvial Mountain Valleys	9.11

Hydrogeologic Settings for HGDB Sites

Region	Setting	Reference Number
Northeast and Superior Uplands (cont.)		
	River Alluvium with Overbank Deposits	9.12
	River Alluvium without Overbank Deposits	9.13
	Till	9.14
Atlantic and Gulf Coast		
	Confined Regional Aquifers	10.1
	Unconsolidated and Semi-Consolidated Shallow Surfacial Aquifers	10.2
	River Alluvium with Overbank Deposits	10.3
	River Alluvium without Overbank Deposits	10.4
	Swamp	10.5
Southeast Coastal Plain		
	Solution Limestone and Shallow Surfacial Aquifers	1.11
	Swamp	11.2
	Beaches and Bars	11.3
	Coastal Deposits	11.4
Hawaii		
	Volcanic Uplands	12.1
	Coastal Beaches	12.4
Alaska		
	Coastal Lowland Deposits	13.2
	Glacial and Glacio-lacustrine Deposits of the Interior Uplands	13.4

APPENDIX G

Background Discussion for Soil-Plant-Human Exposure Pathway

APPENDIX G

Background Discussion for Soil-Plant-Human Exposure Pathway

Introduction

The U.S. Environmental Protection Agency (EPA) has identified the consumption of garden fruits and vegetables as a likely exposure pathway to contaminants in residential soils. To address this pathway within the guidance, the Office of Emergency and Remedial Response (OERR) evaluated methods to calculate soil screening levels (SSLs) for the soil-plant-human exposure pathway. In particular, OERR evaluated algorithms and approaches proposed by other EPA offices or identified in the open literature. Key sources of information included the *Technical Support Document for Land Application of Sewage Sludge* (U.S. EPA, 1992), *Estimating Exposure to Dioxin-like Compounds* (U.S. EPA, 1994), *Plant Contamination* (Trapp and McFarlane, 1995), *Current Studies on Human Exposure to Chemicals with Emphasis on the Plant Route* (Paterson and Mackay, 1991), *Uptake of Organic Contaminants by Plants* (McFarlane, 1991), and *Air-to-Leaf Transfer of Organic Vapors to Plants* (Bacci and Calamari, 1991).

Although empirical data on plant uptake from soil (either through root or leaf transfer) are limited, a comprehensive collection of available empirical data on plant uptake is presented in the *Technical Support Document for the Land Application of Sewage Sludge* (U.S. EPA, 1992), hereafter referred to as the "Sludge Rule." The Sludge Rule presents uptake-response slopes, or bioconcentration factors, for a number of heavy metals found in sewage sludge, including six metals addressed in the *Soil Screening Guidance* (i.e., arsenic, cadmium, mercury, nickel, selenium, and zinc). These empirical bioconcentration factors were used in the development of the generic plant SSLs presented in this appendix.

The Sludge Rule does not present uptake-response slopes for organic chemicals because of a lack of empirical data. Therefore, generic plant SSLs for organic contaminants are not presented in this appendix. Currently, EPA is evaluating mathematical constructs to estimate plant uptake of organic chemicals for several initiatives (e.g., Hazardous Waste Identification Rule, Office of Solid Waste; Indirect Exposure to Combustion Emissions, Office of Research and Development). In addition, new mathematical models are becoming available that use a fugacity-based approach to estimate plant uptake of organic compounds (e.g., PLANTX, Trapp and McFarlane, 1995). Once these methods are reviewed and finalized, OERR may be able to address the soil-plant-human exposure pathway for organic contaminants.

The methods and data used to calculate the generic plant SSLs for arsenic, cadmium, mercury, nickel, selenium, and zinc are presented below. For comparative purposes, data on the potential phytotoxicity of metals have also been included. In addition, the site-specific factors that influence the bioavailability and uptake of metals by plants are discussed. The potentially significant effect of these site-specific factors on plant uptake underscores the need for site-specific assessments where the soil-plant-human pathway may be of concern.

G.1 SSL Calculations from Empirical Data

For uptake of chemicals into edible plants, EPA recommends a simple equation to determine SSLs for the soil-plant-human exposure pathway. The equation is appropriate for both belowground and

aboveground vegetation, provided that the appropriate bioconcentration factor (Br) is used (see Section G.4). The screening level equation for the soil-plant-human pathway is given by:

SSL equation for the Soil-Plant-Human Pathway

$$\text{Screening Level (mg/kg)} = \frac{C_{plant}}{Br} \qquad \textbf{(G-1)}$$

Parameter/Definition (units)	Default
C_{plant}/acceptable plant concentration (mg/kg DW)	see Section G.2
Br/plant-soil bioconcentration factor (mg contaminant/kg plant tissue DW)(mg contaminant/kg soil)$^{-1}$	chemical- and plant-specific (see Section G.2)

It is important to note that the plant concentration is in dry weight (DW) instead of fresh weight (FW). Consequently, the consumption rates for plants must also be given in dry weight. For convenience, Table G-1 presents conversion factors with which to convert fresh weight to dry weight for a variety of garden fruits and vegetables. For example, because the conversion factor for lettuce is 0.052, 10 kg of lettuce fresh weight is equivalent to 0.52 kg of lettuce dry weight.

Several inputs to Equation G-1 are either derived from other equations or identified from empirical studies in the literature. Specifically, the derivation and data sources for C_{plant} and Br are discussed below.

G.2 Acceptable Concentration in Plant Tissue (C_{plant})

The acceptable contaminant concentration in plant tissues (C_{plant}) in mg/kg DW for fruits and vegetables is backcalculated using the following equation:

Acceptable Plant Concentration for Fruits and Vegetables (C_{plant})

$$C_{plant} = \frac{I \times BW}{F \times CR} \qquad \textbf{(G-2)}$$

Parameter/Definition (units)	Default
I/acceptable daily intake of contaminant (mg/kg-d)	see Section G.3
BW/body weight (kg)	70
F/fraction of fruits and vegetables consumed that are contaminated (unitless)	0.4 (see Section G.4)
CR/consumption rate for fruits and vegetables (kg-plant DW-d)	0.0197 (aboveground) 0.0024 (belowground) (see Section G.4)

Table G-1. Fresh-to-Dry Conversion Factors for Fruits and Aboveground Vegetables

Vegetables		Fruits	
Asparagus	0.070	Apple	0.159
Snap beans	0.111	Bushberry	0.151
Cucumber	0.039	Cherry	0.170
Eggplant	0.073	Grape	0.181
Sweet pepper	0.074	Peach	0.131
Squash	0.082	Pear	0.173
Tomato	0.059	Strawberry	0.101
Broccoli	0.101	Plum/prune	0.540
Brussels sprouts	0.151		
Cabbage	0.076		
Cauliflower	0.083		
Celery	0.063		
Escarole	0.134		
Green onions	0.124		
Lettuce	0.052		
Spinach green	0.073		
Average for vegetables	0.085	Average for fruits[a]	0.15

[a] Plum/prune was omitted from the average as an outlier.

Source: Baes et al. (1984).

G.3 Acceptable Daily Intake (I) of Contaminants

For carcinogens, the acceptable daily intake (I) in mg/kg-day is calculated at the target risk level, using default assumptions for exposure duration, exposure frequency, and averaging time. At the target risk level, the acceptable daily intake of carcinogens may be calculated as follows:

Acceptable daily intake for carcinogens

$$I = \frac{TR \times AT \times 365\ d/yr}{ED \times EF \times CSF_{oral}} \qquad \textbf{(G-3)}$$

Parameter/Definition (units)	Default
TR/target risk level (unitless)	10^{-6}
AT/averaging time (years)	70
ED/exposure duration (years)	30
EF/exposure frequency (d/yr)	350
CSF_{oral}/oral cancer slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (see Part 2, Table 1)

For noncarcinogens, the acceptable daily intake (I) in mg/kg-day is calculated at a hazard quotient of 1 using the following equation:

Acceptable daily intake (I) for noncarcinogens

$$I = \frac{HQ \times RfD \times AT \times 365\ d/yr}{ED \times EF} \qquad \textbf{(G-4)}$$

Parameter/Definition (units)	Default
HQ/target hazard quotient (unitless)	1
AT/averaging time (years)	30
ED/exposure duration (years)	30
EF/exposure frequency (d/yr)	350
RfD/oral reference dose (mg/kg-d)	chemical-specific (see Part 2, Table 1)

G.4 Contaminated Fraction (F) and Consumption Rate (CR)

Default values for the fraction of vegetables assumed to be contaminated (F) are recommended in the *Exposure Factors Handbook* (U.S. EPA, 1990). For home gardeners, a high-end dietary fraction of 0.40 is assumed for the ingestion of contaminated fruits and vegetables grown onsite.

The default values for total fruit and vegetable consumption rates (CR) cited in the *Exposure Factors Handbook* are 0.140 and 0.2 kg/d fresh weight, respectively. Assuming that the homegrown fraction is roughly 0.25 to 0.40, EPA estimated fresh weight consumption rates of: (1) 0.088 kg/d of aboveground unprotected fruits, (2) 0.076 kg/d of aboveground unprotected vegetables, and (3) 0.028 kg/d of unprotected belowground vegetables (U.S. EPA, 1994). The consumption rates for fruits and vegetables are converted to dry weight based on the average fresh-to-dry conversion of 0.15 for fruits and 0.085 for vegetables presented in Table G-1. For unprotected belowground vegetables, the consumption rate (CR) is calculated by multiplying the fresh weight consumption rate (0.028 kg FW/d) by the average conversion factor of 0.085 resulting in a CR of 0.0024 kg DW/d. Using this same method, dry weight consumption rates of 0.0132 and 0.0065 kg DW/d were calculated for unprotected aboveground fruits and vegetables, respectively. Consequently, the overall consumption rate (CR) for aboveground, unprotected fruits and vegetables is 0.0197 kg DW/d.

The distinction between protected and unprotected produce reflects evidence that, for protected plants such as cantaloupe and citrus, there is very little translocation of contaminants to the edible parts of the plant. EPA recognizes that, while these assumptions for contaminated fraction and consumption rates are reasonable for general assessment purposes, there is likely to be wide variability on the types of produce grown at home, the percentage that is unprotected, and other exposure-related characteristics (U.S. EPA, 1994).

G.5 Soil-to-Plant Bioconcentration Factors (Br)

For metals, soil-to-plant bioconcentration factors (Br) for both aboveground and belowground plants must be identified from empirical studies because the relationship between soil concentration and plant concentration has not been described adequately to provide a mathematical construct for

modeling. Table G-2 provides empirical plant uptake values for six metals identified in the *Technical Support Document for Land Application of Sewage Sludge* (U.S. EPA, 1992). Because of the variability in site-specific assessments, bioconcentration factors that are appropriate for the type of produce considered in a particular risk assessment should be selected. For general screening purposes, the geometric mean Br values for leafy vegetables and root vegetables are typically selected to represent aboveground and belowground plants, respectively. These values may be used to calculate SSLs for six metals for the soil-plant-human exposure pathway.

G.6 Example Calculation of Soil-Plant-Human SSL: Cadmium

To demonstrate how the methods described in this appendix may be used to calculate an SSL for the soil-plant-human pathway, a sample calculation is provide below for cadmium. Cadmium is considered a noncarcinogen via oral exposure and, therefore, the acceptable daily intake (I) is calculated using Equation G-4. Using the RfD for cadmium ingested in food of 1.0 x 10^{-3} mg/kg (the RfD is 5.0 x 10^{-4} in water), Equation G-4 may be solved for acceptable daily intake (I) of cadmium from a dietary source:

$$I = \frac{HQ \times RfD \times AT \times 365\ d/yr}{ED \times EF}$$

$$I = \frac{1 \times 1.0 \times 10^{-3}\ mg/kg-d \times 30\ yr \times 365\ d/yr}{30\ yrs \times 350\ d/yr}$$

$$I = 1.0 \times 10^{-3}\ mg/kg-d$$

The acceptable daily intake (I) is used in Equation G-2 to estimate the acceptable contaminant concentration in plant tissue (C_{plant}). However, Equation G-2 is designed to solve for the acceptable plant concentration (C_{plant}) in *either* aboveground fruits and vegetables or belowground vegetables. Consequently, Equations G-1 and G-2 must be combined to calculate the screening level for the ingestion of both aboveground and belowground produce. These equations are combined by summing the product of the category-specific produce intake and bioconcentration factors. Since the default contaminated fraction applies to both categories of produce, Equations G-1 and G-2 are combined to solve for the soil screening level:

$$\text{Screening Level}\ (mg/kg) = \frac{I \times BW}{F \times \sum(CR \times Br)} \qquad \textbf{(G-5)}$$

Table G-2. Summary Table of Empirical Bioconcentration Factors for Metals (in mg contaminant per kg plant DW / mg contaminant per kg soil)

	Study observations	pH Range	Bioconcentration factors (Br) Min	Max	Geometric Mean Br
Arsenic					
grains and cereals	1	7.5	0.026	0.026	0.026
potatoes	8	5.5 - 7.5	0.002	0.24	0.004
leafy vegetables	7	5.5 - 7.5	0.002	0.068	0.036
legumes	7	NR - 7.5	0.002	0.004	0.002
root vegetables	7	NR - 7.5	0.002	0.28	0.008
garden fruits	5	NR - 7.5	0.002	0.006	0.002
sweet corn	3	NR	0.002	0.002	0.002
Cadmium					
grains and cereals	14	4.4 - 8.0	0.002	0.346	0.36
potatoes	14	4.7- 8.0	0.002	0.076	0.008
leafy vegetables	71	4.6 - 8.4	0.002	14.12	0.364
legumes	14	5.1 - 7.7	0.002	0.054	0.004
root vegetables	25	4.6- 8.0	0.002	1.188	0.064
garden fruits	19	4.6 - 7.1	0.002	1.272	0.09
sweet corn	12	5.1 - 7.1	0.02	0.666	0.118
Mercury					
grains and cereals	1	5.3 - 7.1	0.0854	0.0854	0.0854
potatoes	1	5.3 - 7.1	0.002	0.002	0.002
leafy vegetables	9	5.3 - 7.1	0.002	0.092	0.008
legumes	3	5.3 - 7.1	0.002	0.002	0.002
root vegetables	6	5.3 - 7.1	0.002	0.086	0.014
garden fruits	7	5.3 - 7.1	0.002	0.086	0.01
sweet corn	default	ND	0.002	0.002	0.002
Nickel					
grains and cereals	10	6.2 - 8.0	0.002	0.11	0.01
potatoes	14	6.4 - 8.0	0.002	0.06	0.01
leafy vegetables	56	5.3 - 8.0	0.002	30	0.032
legumes	11	5.9 - 7.7	0.002	1.004	0.062
root vegetables	25	5.9 - 8.0	0.002	0.232	0.008
garden fruits	14	5.9 - 7.3	0.002	0.19	0.006
sweet corn	4	5.9 - 7.1	0.002	0.002	0.002
Selenium					
grains and cereals	4	5.5 - 7.0	0.002	0.11	0.002
potatoes	2	5.5 - 6.8	0.018	0.096	0.042
leafy vegetables	7	5.5 - 7.8	0.002	0.076	0.016
legumes	4	5.5 - 6.8	0.024	0.11	0.024
root vegetables	8	5.5 - 7.6	0.004	0.096	0.022
garden fruits	8	5.5 - 6.8	0.008	0.078	0.02
sweet corn	default	ND	0.002	0.002	0.002

Table G-2. (continued)

	Study observations	pH Range	Bioconcentration factors (Br) Min	Max	Geometric Mean Br
Zinc					
grains and cereals	13	5.3 - 8.0	0.016	0.368	0.1
potatoes	14	4.7 - 8.0	0.01	0.122	0.024
leafy vegetables	47	4.6 - 8.0	0.012	4.488	0.25
legumes	10	5.1 - 7.7	0.002	0.11	0.036
root vegetables	20	4.6 - 8.0	0.002	0.412	0.044
garden fruits	21	4.6 - 7.3	0.002	0.394	0.046
sweet corn	8	5.1 - 6.5	0.002	0.19	0.02

NR = Not reported
ND = No data

The input parameters in Equation G-5 correspond to input parameters in Equations G-1 and G-2, with a contaminated fraction (F) of 0.4, and consumption rates (CR_{ag} and CR_{bg}) and bioconcentration factors (Br_{ag} and Br_{bg}) specific to either aboveground or belowground produce. Solving Equation G-5 for cadmium using the default parameters in Equation G-2 for F, CR_{ag}, and CR_{bg} results in:

$$\text{Screening Level} = \frac{I \times BW}{0.4 \times \Sigma(CR_{ag} \times Br_{ag}) + (CR_{bg} \times Br_{bg})}$$

$$\text{Screening Level} = \frac{1.0 \times 10^{-3}\ \text{mg/kg-d} \times 70\ \text{kg}}{0.4 \times \Sigma(0.0197 \times 0.364) + (0.0024 \times 0.064)\ \text{kg soil/d}}$$

$$\text{Screening Level} = 24\ \text{mg/kg soil}$$

As described above, the geometric mean Br values for leafy vegetables and root vegetables were selected to represent the bioconcentration factors (Br) for aboveground fruits and vegetables (Br_{ag}) and belowground vegetables (Br_{bg}), respectively (see Table G-2). SSLs for the plant pathway that are calculated using the bioconcentration factors for leafy and root vegetables are considered to be generic SSLs by OERR. During site-specific assessments, OERR recommends that a weighted average bioconcentration factor be used to reflect the type of produce grown and eaten locally.

G.7 Generic SSLs for Selected Metals

Table G-3 presents the generic SSLs for the soil-plant-human exposure pathway along with the SSLs for direct soil ingestion. In addition, this table presents plant toxicity values identified in the *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1994 Revision* (Will and Suter, 1994). The phytotoxicity values are either: (1) the

estimated 90th percentile of lowest observed effects concentrations (LOECs) from a data set consisting of 10 or more values, or (2) the lowest LOEC from a data set with less than 10 values. The toxicological endpoints for the phytotoxicity were limited to growth and yield parameters because they are the most common endpoints reported in phytotoxicity studies and are ecologically significant in terms of plant populations.

Table G-3. Comparison of Generic SSLs for Plant Pathway with the SSLs for Soil Ingestion and LOEC Values for Phytotoxicity (all values in mg/kg)

	Arsenic	Cadmium	Mercury	Nickel	Selenium	Zinc
Generic plant SSL	0.4	24	270	5400	2400	10000
Soil ingestion SSL	0.4	78	23	1600	390	23000
Migration to ground water SSL[a]	29(1)	8(0.4)	2(0.1)	130(7)	5(0.3)	12000(620)
Phytotoxicity LOEC	10	3	0.3	30	1	50

[a] Values based on DAF of 20 (DAF of 1).

The comparison of the generic SSLs for the plant pathway with SSLs for soil ingestion and migration to ground water suggests that this pathway may be of concern at sites contaminated with arsenic or cadmium. For mercury, nickel, and selenium, the generic plant SSLs are well above the SSLs based on soil ingestion and migration to ground water. Thus, although SSLs based on these other pathways are likely to be protective of the soil-plant-human pathway, other data suggest that phytotoxicity is likely to be the factor limiting exposure through plant uptake for these metals.

Phytotoxicity - The data in Table G-3 suggest that, for cadmium, mercury, nickel, and selenium, toxicity to plants will be observed at levels well below those estimated to elicit adverse effects in humans. The phytotoxicity of arsenic, nickel, and zinc have been well documented. However, despite the low phytotoxicity value for selenium, some authors have demonstrated that selenium can accumulate in certain plants at high levels (Bitton et al., 1980). Moreover, many phytotoxicity values are based on a reduction in yield that may result in higher levels in the surviving produce. Thus, with the exception of zinc, phytotoxicity should not be used to rule out this exposure pathway unless empirical data are available that are relevant to the site conditions (e.g., similar pH, organic matter) and the type of crops likely to be grown.

Soil Characteristics - Because the majority of the plant uptake data for metals were generated in sludge application studies, the empirical bioconcentration factors listed in Table G-2 may not be appropriate for use at all sites. For example, the adsorption "power" of sludge in the presence of phosphates, manganese, hydrous oxides of iron, and Ca^{+2} may reduce the amount of metal that is bioavailable to plants. In addition, soil pH strongly influences the ability of plants to absorb metals from soil. Several studies document that, as pH decreases, the bioavailability of many metals increases. In fact, agricultural practices maintain a soil pH of 5.5 or greater to protect against aluminum and manganese phytotoxicity. However, 40 percent of the data evaluated for the Sludge Rule were from studies in which the pH was less than 6, and, as a result, bioconcentration factors may be artificially skewed.

Chemical Characteristics - Another factor that heavily influences plant uptake of metals is the chemical form of the metal. Researchers have observed that plant uptake rates of metal salts in sludge tend to be higher than plant uptake rates in studies on elemental metals. Metal salts do not

adsorb to sludge the same way as "metals in nonsalt forms" and, consequently, they are more bioavailable to plants.

Type of produce - The bioconcentration potential of metals varies with plant type. As shown in Table G-2, the range of bioconcentration factors covers an order of magnitude for most metals across the seven categories of produce. Certain types of plants are resistant to some metals while these same metals may be highly toxic to other plant species. Depending on the type of crops grown, the generic soil-plant-human SSLs may not reflect the most appropriate measures of bioconcentration.

Dietary habits - The dietary habits of the home gardener may result in an increase or decrease in exposure. The default values for consumption rate (CR) and contaminated fraction (F) represent reasonably conservative estimates for these exposure parameters. However, individual consumers may ingest significantly different quantities of produce and, depending on their fruit/vegetable preferences, may rely on crops that are efficient accumulators of metals.

G.8 SSL Calculations for Organics Lacking Empirical Data

The lack of plant bioconcentration data on organics presented in the *Technical Support Document for Land Application of Sewage Sludge* (U.S. EPA, 1992) has been discussed in several other sources. For example, the status of empirical data on plant uptake and accumulation of organics was recently evaluated for a database on uptake/accumulation, translocation, adhesion, and biotransformation of chemicals in plants (Nellessen and Fletcher, 1993). This database, referred to as UTAB, is one of the most comprehensive data sources available on chemical processes in plants and contains over 42,000 records taken from more than 2,100 published papers. The authors found that, with the exception of pesticides, uptake-response data for organic chemicals are available for roughly 25 percent of the chemicals monitored by EPA. Given the comprehensive nature of the UTAB database, modeling may be the only alternative to evaluating the soil-plant-human pathway in the near future for many organic chemicals.

Recently, several authors have developed models to predict the uptake and accumulation of organic chemicals in plants (e.g., Matthies and Behrendt, 1994; McKone, 1994; Trapp et al., 1994). One of the most promising models for use as a risk assessment tool is PLANTX, a peer-reviewed partitioning model that describes the dynamic uptake from soil, or solution, and the metabolism and accumulation of xenobiotic chemicals in roots, stems, leaves, and fruits (Trapp et al., 1994). Unlike a number of other models used to estimate plant uptake, PLANTX is not based on regression equations that correlate log K_{ow} with plant bioconcentration; it is a mechanistic model that accounts for major plant processes and requires only a few well-known input data. Moreover, it was designed as a risk assessment tool and has been validated for the herbicide bromicil and several nitrobenzenes. A follow-on model (PLANTE) has recently been made available that also incorporates plant uptake during transpiration (i.e., accumulation directly from the air). The results on bromocil, nitrobenzene, etc., as well as ongoing validation studies suggest that the PLANT models may be a scientifically defensible alternative to the uptake-response slopes generated by log K_{ow} regressions.

G.9 Conclusions and Recommendations

The comparison of generic plant SSLs with generic SSLs for soil ingestion and migration to ground water indicate that the soil-plant-human exposure pathway may be of concern for two of the six metals evaluated (arsenic and cadmium). For mercury, nickel, and selenium, SSLs based on the other pathways are likely to be adequately protective of the soil-plant-human exposure pathway. In addition, data presented on the phytotoxicity of these metals and zinc suggest that toxic effects in plants are likely to be observed below levels that would be harmful to humans. Although this pathway

may not be of concern from a human health standpoint, these data suggest that metals could be of particular concern for ecological receptors.

Currently, EPA is developing methods to evaluate the uptake of organics into plants. In addition to the efforts of the Office of Solid Waste and the Office of Research and Development mentioned in the Introduction, OERR has jointly funded research on plant uptake of organics with the State of California. These studies support ongoing revisions to the indirect, multimedia exposure model, CalTOX. Until these efforts are reviewed and finalized, OERR will continue to address the potential for plant uptake of organics on a case-by-case basis.

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APPENDIX H

Evaluation of the Effect on the Draft SSLs of the Johnson and Ettinger Model (EQ, 1994a)

ENVIRONMENTAL QUALITY MANAGEMENT, INC.

MEMORANDUM

TO:	Janine Dinan	**DATE:**	October 7, 1994
SUBJECT:	Evaluation of the Effect on the Draft SSLs of the Johnson and Ettinger (1991) Model for the Intrusion of Contaminant Vapors Into Buildings	**FROM:**	Craig S. Mann
FILE:	5099-3	**cc:**	

Under U.S. Environmental Protection Agency (EPA) Contract No. 68-D3-0035, Task order No. 0-25, Environmental Quality Management, Inc. (EQ) was directed to evaluate the effect on the draft soil screening levels (SSLs) of employing the Johnson and Ettinger (1991) model for estimating the intrusion rate of contaminant vapors from soil into buildings. This memorandum summarizes the evaluation.

Model Review:

Johnson and Ettinger (1991) is a closed-form analytical solution for both convective and diffusive transport of vapor-phase contaminants fully incorporated in soil into enclosed structures. The nondimensionalized mass balance is written as:

$$\frac{\partial \sum_i \epsilon_i C_i^*}{\partial t^*} - \left(\frac{L_p}{L_D}\right)\left(\nabla^* P^*\right) \cdot \left(\nabla^* C_v^*\right) = \nabla^* \cdot \left[\frac{D^{eff}\, \mu\, L_p}{k_v\, \Delta P_r\, L_D}\right] \nabla^* C_v^* + \sum_i R_i^* \qquad (1)$$

where $*$ = Nondimensional variables

ϵ_i = Volume fraction of phase i, unitless

C_i = Concentration of contaminant in phase i, g/cm^3

t = Time, s

L_P = Convection path length, cm

L_D = Diffusion path length, cm

P = Pressure in vapor-phase, g/cm-s^2

∇ = Del operator, 1/cm

C_v = Contaminant concentration in vapor phase, g/cm3

D^{eff} = Effective diffusion coefficient, cm^2/s

μ = Vapor viscosity, g/cm-s

k_v = Soil permeability to vapor flow, cm^2

ΔP_r = Reference indoor-outdoor pressure differential, $g/cm\text{-}s^2$

R_i = Formation rate of contaminant in phase i, $g/cm^3\text{-}s$

and,

C_i^* = C_i/C_r

∇^* = $L_D \nabla$

P^* = $P/\Delta P_r$

t^* = $t\,(k_v \Delta P_r / L_D L_P \mu)$

R_i^* =$R_i L_D L_P \mu / C_r k_r \Delta P_r$

where C_r, L_P and L_D are characteristic concentration, convection pathway length, and diffusion pathway length, chosen to give the dependent concentration variable and derivatives of C_i^* and P^* magnitudes of order unity.

The mass balance solution includes the following assumptions:

1. The soil column is isotropic within any horizontal plane.

2. The effective diffusion coefficient is constant within any horizontal plane.

3. Concentration at the soil-air interface is zero (i.e., boundary layer resistance is zero).

4. No loss of contaminant occurs across the lower boundary (i.e., no leaching).

5. Source degradation and transformation are not considered.

6. Convective vapor flow near the building foundation is uniform.

7. Contaminant vapors enter the building primarily through openings in the walls and foundation at or below grade.

8. Convective velocities decrease with increasing contaminant source-building distance.

9. All contaminant vapors directly below a basement will enter the basement, unless the floor and walls are perfect vapor barriers.

10. The building contains no other contaminant sources or sinks, and the air volume is well mixed.

Therefore,

$$Q_{building}\ C_{building} = E \tag{2}$$

where $Q_{building}$, $C_{building}$, and E represent the volumetric flow rate or ventilation rate of the building (cm^3/s), contaminant concentration within the building (g/cm^3), and rate of contaminant entry (g/s), respectively.

Also,

$$\alpha = Q_{building}/C_{source} \tag{3}$$

where C_{source} is the vapor-phase contaminant concentration within the soil at the source, and α represents the attenuation coefficient. C_{source} is written as:

$$C_{source} = \frac{H\ C_s\ \rho_b}{\Theta_w + K_d \rho_b + H\Theta_a} \tag{4}$$

where H = Henry's law constant, unitless

C_s = Soil bulk concentration, g/g

ρ_b = Soil dry bulk density, g/cm^3

Θ_w = Soil water-filled porosity, unitless

K_d = Soil-water partion coefficient, cm^3/g

Θ_a = Soil air-filled porosity, unitless.

The authors derive a solution for α for both steady-state conditions (i.e., depth of contamination, $z = \infty$) and for quasi-steady-state conditions ($0 < z < L$). For steady-state conditions α is written as:

$$\alpha = \left[\left[\frac{D^{eff}\ A_B}{Q_{building}\ L_T}\right] x \exp\left(\frac{Q_{soil}\ L_{crack}}{D^{crack}\ A_{crack}}\right)\right] /$$

$$\left[\exp\left(\frac{Q_{soil}\ L_{crack}}{D^{crack}\ A_{crack}}\right) + \left[\frac{D^{eff}\ A_B}{Q_{building}\ L_T}\right] + \left[\frac{D^{eff}\ A_B}{Q_{soil}\ L_T}\right]\left[\exp\left(\frac{Q_{soil}\ L_{crack}}{D^{crack}\ A_{crack}}\right) -1\right]\right] \tag{5}$$

where D^{eff} = Effective diffusion coefficient, cm^2/s

A_B = Area of basement, cm^2

L^T = Source-building separation, cm

Q_{soil} = Volumetric flow rate of soil gas into the building, cm^3/s

L_{Crack} = Building foundation thickness, cm

D^{Crack} = Effective diffusion coefficient through crack, cm^2/s ($D^{Crack} = D^{eff}$)

A_{Crack} = Area of crack, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s.

For quasi-steady-state conditions the long-term average attenuation coefficient <a> is:

$$<\alpha> = \frac{\rho_b\, C_R\, \Delta H_C\, A_B}{Q_{building}\, C_{source}\, \tau} \left(\frac{L_T^0}{\Delta H_C}\right)\left[\left(\beta^2 + 2\Psi\tau\right)^{1/2} - \beta\right] \tag{6}$$

where ρ_b = Soil dry bulk density, g/cm^3

C_R = Average contaminant level in soil, g/g

ΔH_c = Thickness of depth over which contaminant is distributed, cm

A_B = Area of basement, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s

C_{source} = Vapor-phase soil concentration at source, g/cm^3

τ = Exposure averaging period, s

L_T^0 = Source-building separation at t=0, cm

and,

$$\beta = \left(\frac{D^{eff}\, A_B}{L_T^0\, Q_{soil}}\right)\left[1 - \exp\left(-\frac{Q_{soil}\, L_{crack}}{D^{crack}\, A_{crack}}\right)\right] + 1 \tag{7}$$

$$\Psi = D^{eff}\, C_{source}/\left(L_T^0\right)^2\, \rho_b\, C_R \tag{8}$$

The time required to deplete a finite source (τ_D) of depth ΔH_c is given as:

$$\tau_D = \frac{[\Delta H_C / L_T^0 + \beta] - \beta^2}{2\Psi} \tag{9}$$

If the exposure period (τ) is greater than τ_D, the average emission rate into the building <E> is given as a simple mass balance:

$$\langle E \rangle = \rho_b \, C_R \, \Delta H_C \, A_B / \tau \tag{10}$$

and the average building concentration ($C_{building}$) is:

$$C_{building} = \langle E \rangle / Q_{building} \tag{11}$$

Evaluation

In order to evaluate the effects of using the model on the SSLs for volatile contaminants, a case example was constructed which best estimates a reasonable high end exposure point concentration for residential land use. Where possible, values of model variables were taken directly from Johnson and Ettinger (1991).

The case example assumes that a residential dwelling with a basement is constructed within the area of homogeneous residual contamination such that the contaminant source lies directly below the basement floor at t = 0. Therefore, the diffusion and convection path lengths were set equal to the thickness of the basement slab (15 cm). Soil permeability to vapor flow from the basement floor to the bottom of contamination was set equal to 1.0 x 10^{-8} cm^2 (1 darcy) which is representative of silty to fine sand. Soil column-building pressure differential was set equal to 1 pascal (10g/cm-s^2) as a reasonable long-term average value (Johnson and Ettinger, 1991). Values for all other soil properties were set equal to those of the Generic SSLs in the July 1994 Technical Background Document for Draft Soil Screening Level Framework (TBD). Building variables, i.e., basement area, ventilation rate, etc., were taken from Johnson and Ettinger (1991).

In the analysis, the values for $C_{building}$ (kg/m^3) were calculated for the 42 chemicals in the TBD for which human health benchmarks are available. Please note that the values of C_{source} and $C_{building}$ were calculated for an initial soil concentration of 1 mg/kg instead of 1 x 10^{-6} g/g. This was done to facilitate reverse calculation of the SSL in units of mg/kg. Therefore, these values are artificially high by a factor of 1 x 10^6. The inverse of the value of $C_{building}$ (m^3/kg) was used as the indoor volatilization factor (VF_{indoor}) and substituted into Equations 2-4 or 2-5 of the TBD as appropriate to calculate the resulting carcinogenic and noncarcinogenic inhalation SSLs. SSLs were calculated for both steadystate conditions (infinite source depth) and quasi-steady-state conditions (finite source depth). In each case were the exposure period exceeded the time required for source depletion (finite source depth), the volatilization factor was normalized to an average contaminant level in soil (C_r) of 1 mg/kg. For quasi-steady-state conditions, the depth to the bottom of contamination was set equal to 2 meters below the basement floor.

The value of the indoor SSL for each contaminant was compared to the respective SSL calculated for outdoor exposures of the same duration using the Generic SSL calculations found in the TBD. The outdoor SSLs were computed for a 30 acre square area source of emissions. Table 1 summarizes the results of this comparison. The attachment to this memorandum gives the detailed computations for this evaluation.

TABLE 1.
SUMMARY OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Indoor SSL, infinite source (mg/kg)	Indoor SSL, finite source (mg/kg)	Outdoor SSL, infinite source (mg/kg)
Aldrin	0.4	0.4	0.5
Benzene	0.002	0.02	0.5
Bis(2-chloroethyl)ether	0.02	0.05	0.3
Bromoform	0.8	0.9	43
Carbon disulfide	0.03	0 7	11
Carbon tetrachloride	0.0007	0.01	0.2
Chlordane	51	53	54
Chlorobenzene	0.7	2	87
Chloroform	0.001	0.007	0.2
DDT	5[a]	5[a]	5[a]
1,2-Dichlorobenzene	26	65	297[a]
1,4-Dichlorobenzene	102	235[a]	235[a]
1,1-Dichloroethane	4	35	939
1,2-Dichloroethane	0.002	0.007	0.3
1,1-Dichloroethylene	0.0001	0.003	0.04
1,2-Dichloropropane	0.06	0.3	10
1,3-Dichloropropene	0.0007	0.004	0.1
Dieldrin	3	4	2
Ethylbenzene	21	69	257[a]
Heptachlor	0.04	0.04	0.3
Heptachlor epoxide	1	1	1
Hexachloro-1,3-butadiene	0.03	0.05	1
Hexachlorobenzene	0.3	0.6	1
HCH-alpha(alpha-BHC)	0.5	0.6	0.9
HCH-beta(beta-BHC)	7[a]	7[a]	7[a]
Hexachlorocyclopentadiene	0.06	0.07	2
Hexachloroethane	0.6	0.6	45
Methyl bromide	0.01	0.3	3
Methylene chloride	0.04	0.3	7
Nitrobenzene	9	25	100
Styrene	185	472	1439[a]
1,1,2,2-Tetrachloroethane	0.007	0.02	0.4
Tetrachloroethylene	0.05	0.3	11
Toluene	6	28	521[a]
Toxaphene	2	2	2[a]
1,2,4-Trichlorobenzene	6	9	214
1,1,1-Trichloroethane	5	69	980[a]
1,1,2-Trichloroethane	0.009	0.02	1
Trichloroethylene	0.01	0.09	3
2,4,6-Trichlorophenol	64	94	190
Vinyl acetate	5	14	351
Vinyl chloride	0.00002	0.002	0.01

[a] = SSL based on C_{sat}

As can be seen from Table 1, results on a chemical-specific basis indicate a rate of change as high as three orders of magnitude between the outdoor SSL and the infinite source indoor SSLs in the case of highly volatile contaminants. For very persistent contaminants, the relative difference was considerably less, and in some cases there was no difference in SSL concentrations.

This variability is due to: 1) the variability in the human health benchmarks used to calculate the risk-based SSLs, and 2) the apparent diffusion coefficient of each compound. The apparent diffusion coefficient can be expressed as the effective diffusion coefficient through soil divided by the liquid-phase partition coefficient (Jury et al., 1983). The apparent diffusion coefficient (D_A) is given here so as not to be confused with the effective diffusion coefficient (D^{eff}) from Johnson and Ettinger (1991):

$$DA = \left[\left(\Theta_a^{10/3} D_a H + \Theta_w^{10/3} D_w\right) / \Theta_t^2\right] / (\rho_b K_d + \Theta_w + \Theta_a H) \qquad (12)$$

where D_A = Apparent diffusion coefficient, cm^2/s

Θ_a = Air-filled soil porosity, unitless

D_a = Diffusivity in air, cm^2/s

H = Henry's law constant, unitless

Θ_w = Water-filled soil porosity, unitless

D_w = Diffusivity in water, cm^2/s

Θ_t = Total soil porosity, unitless

ρ_b = Soil dry bulk density, g/cm^3

K_d = Soil-water partition coefficient, cm3/g.

With all nonchemical-specific variables held constant, Figure 1 shows the exponential relationship between the apparent diffusion coefficient and the building concentration for quasi-steady-state conditions (finite source).

For nonchemical-specific variables, a sensitivity analysis was performed for soil permeability to vapor flow (k_v), soil-building pressure differential (Δ P), depth of contamination (ΔH_c), source-building separation at t = 0 (L_T^0), crack-to-total area ratio (η), and building ventilation rate ($Q_{building}$).

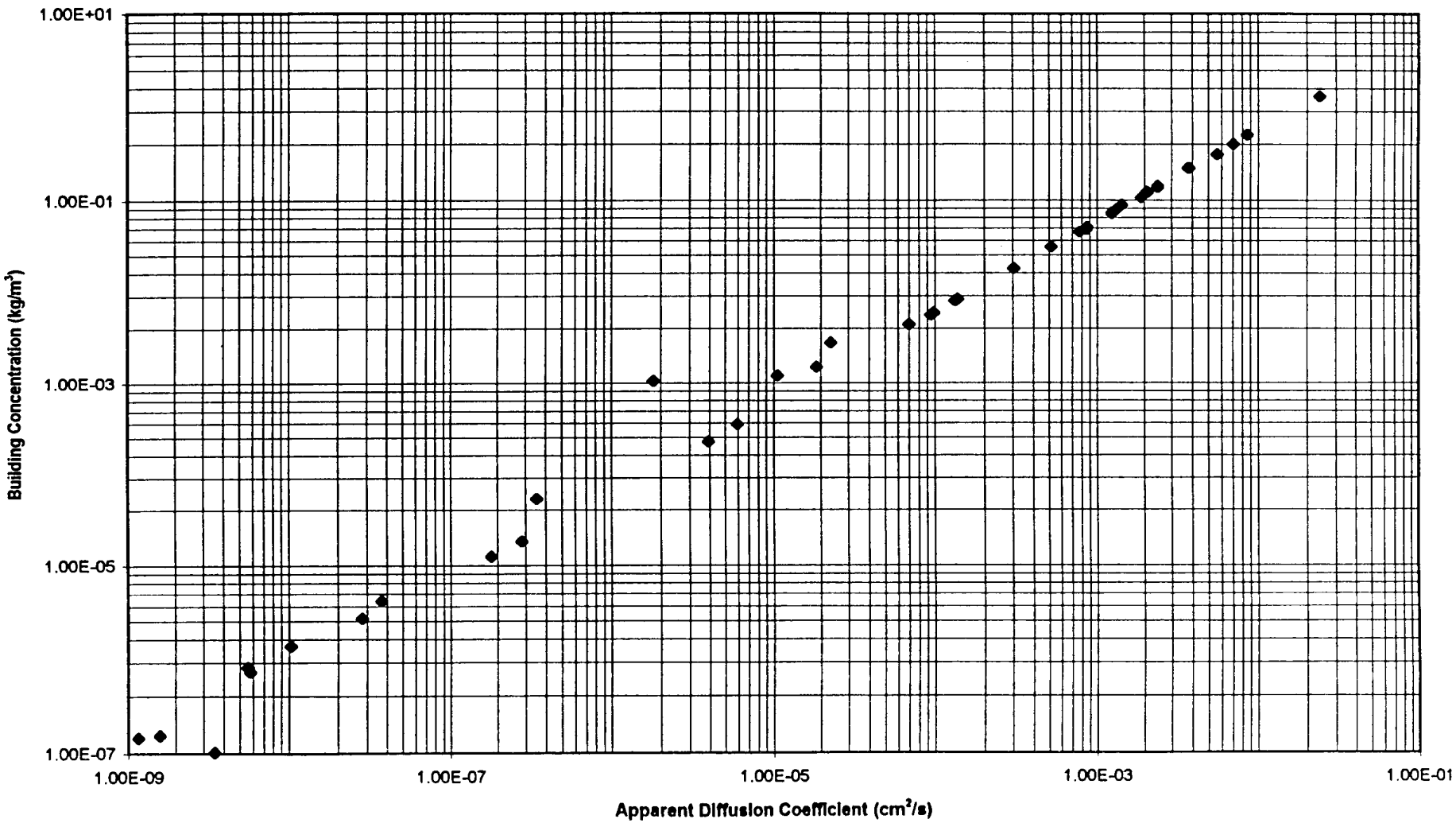

Figure 1
Building Concentration Versus Apparent Diffusion Coefficient

Table 2 shows the results of the sensitivity analysis for the quasi-steady-state condition (finite source). As can be seen from Table 2, the effect of the building ventilation rate is linear if the value of C_{sat} is not included in limiting the value of the SSL. Depth of contamination (ΔH_c) has the greatest effect for contaminants with higher apparent diffusion coefficients (e.g., benzene, chloroform, vinyl chloride, etc.), in that as ΔH_c increases, the time required for source depletion (τ_D) also increases. Therefore, with greater initial contaminant mass in the soil, these compounds are emitted for a longer period of time thus reducing the SSL. For the more persistent contaminants, an increase in k_v or ΔP produces the greatest results. This is to be expected as values of τ_D for these contaminants exceed the exposure duration. Table 2 also indicates that an order of magnitude change in values Of L_T^0 and η produce same order of magnitude results. It must be remembered, however, that in the case of L_T^0, the model assumes isotropic soil conditions from the point of building entry to the bottom of contamination. As L_T^0 increases, α decreases until diffusion not convection limits the rate of contaminant vapor transport. The effect of changes in the value of η decrease as values of k_v decrease such that for very permeable soils and convection-dominated vapor transport, the effect of crack size is relatively insignificant.

Conclusions

Use of the Johnson and Ettinger (1991) model to calculate SSLs based on indoor chronic exposures can have significant impacts on the values of the SSLs for contaminants with high apparent diffusion coefficients. When comparing the infinite source indoor model to the infinite source outdoor model for these contaminants, values of the SSL differ by orders of magnitude for case example conditions. Under these conditions, diffusion is the limiting transport mechanisms for all but one contaminant for both steady-state and quasi-steady-state conditions. To effect case example conditions, the following must be true:

1. The contaminant source must be relatively close or directly beneath the structure.

2. The soil between the structure and the source must be very permeable (k_v, $\geq 10^{-8}$ cm^2).

3. The structure must be underpressurized.

4. The air within the structure must be well mixed (i.e., little or no soil-air boundary layer resistance).

5. The combination of diffusion coefficient through the cracks, area of the cracks, and building underpressurization must offer no more resistance than the soil column beneath the structure.

From this evaluation, the four most important factors affecting the average long-term building concentration and thus the SSL are building ventilation rate, source-building separation, soil permeability to vapor flow, and source depth. If the source of contamination is relatively deep and close to the building, and if the soil between the source and the building is very permeable, building concentrations of contaminants with relatively high apparent diffusion coefficients will increase dramatically.

TABLE 2.
MODEL SENSITIVITY TO NONCHEMICAL SPECIFIC VARIABLES

Chemical	Apparent diffusion coefficient, D_A (cm^2/s)	Test condition SSL, (mg/kg)	Ratio of Variable-to-Test Condition SSL: Soil vapor permeability, k_v x 10	Soil-bldg. pressure differential, ΔP x 10	Depth to source lower boundary, ΔH_c x 10	Source-bldg. separation at t=0, L_T^0 x 10	Inverse of crack-to-total area ratio, $1/\eta$ x 10	Bldg. ventilation rate, $Q_{building}$ x 10
DDT	1.16E-09	5[a]	1	1	1	1	1	1.0
Dieldrin	1.59E-09	4	0.1	0.1	1	1.2	1.5	3.4
HCH-beta(beta-BHC)	3.54E-09	7[a]	0.8	0.8	1	1	1	1.0
Chlordane	5.63E-09	53	0.1	0.1	1	1.3	1.3	1.3
Heptachlor epoxide	5 78E-09	1	0.1	0.1	1	1.3	1.5	8.4
Aldrin	1.03E-08	0.4	0.1	0.1	1	1.2	1.5	10
HCH-alpha(alpha-BHC)	2.81E-08	0.6	0.1	0.1	1	1.2	1.5	10
Toxaphene	3.69E-08	2	0.1	0.1	1	1.1	1.1	1.1
2,4,6-Trichlorophenol	1.81E-07	94	0.1	0.1	1	1.1	1.5	10
Hexachlorobenzene	284E-07	0.6	0.1	0.1	1	1.1	1.5	3.2
Heptachlor	3.52E-07	0.04	0.1	0.1	1	1.3	1.5	10
Hexachloroethane	1.80E-06	0.6	0.3	0.3	1	2	1.4	10
Nitrobenzene	3.92E-06	25	0.1	0.1	1	1	1.5	10
Bis(2-chloroethyl)ether	5.94E-06	0.05	0.1	0.1	1	1	1.5	10
Hexachlorocyclo-pentadiene	1.06E-05	0.07	0.2	0.2	1	1.2	1.5	10
1,2,4-Trichlorobenzene	1.89E-05	9	0.1	0.1	1	1.1	1.5	10
Bromoform	2.32E-05	0.9	0.2	0.2	1	1.2	1.5	10
Hexachloro-1,3-butadiene	6.97E-05	0.05	0.1	0.1	1	1.1	1.5	10
Styrene	9.50E-05	472	0.1	0.1	1	1	1 5	3.0
1,1,2,2-Tetrachloroethane	9.89E-05	0.02	0.2	0 2	1	1	1 5	10
1,2-Dichlorobenzene	1.34E-04	65	0.2	0.2	1	1	1.5	4.5
1,4-Dichlorobenzene	1.38E-04	235[a]	0.2	0.2	1	1	1	1.0
1,1,2-Trichloroethane	3.04E-04	0.02	0.4	0.4	1	1	1.5	10
Chlorobenzene	5.18E-04	2	0.8	0.8	1	1	1.5	10
Vinyl acetate	7.79E-04	14	1	1	1	1	1.5	10
1,2-Dichloropropane	8.57E-04	0.007	0.9	0.9	1	1	1.5	10
Ethylbenzene	8.64E-04	69	1	1	0.8	1	1.2	3.7
1,2-Dichbropropane	1.24E-03	0.3	1	1	0.6	1	1	10
Toluene	1.25E-03	28	1	1	0.7	1	1	10
Tetrachloroethylene	1.34E-03	0.3	1	1	0.5	1	1	10
1,3-Dichloropropene	1.44E-03	0.004	1	1	0.4	1	1	10
Chloroform	1.91E-03	0.007	1	1	0.5	1	1	10
1,1-Dichloroethane	2.08E-03	35	1	1	0.4	1	1	10
Benzene	2.12E-03	0.02	1	1	0.4	1	1	10
Trichloroethylene	2.44E-03	0.09	1	1	0.3	1	1	10
Methylene chloride	2.45E-03	0.3	1	1	0.4	1	1	10
1,1,1-Trichioroethane	3.79E-03	69	1	1	0.2	1	1	10
Carbon tetrachloride	3.82E-03	0.01	1	1	0.2	1	1	10
Carbon disulfide	5.67E-03	0.7	1	1	0.2	1	1	10
1,1-Dichloroethylene	7.09E-03	0.003	1	1	0.1	1	1	10
Methyl bromide	8.56E-03	0.3	1	1	0.1	1	1	10
Vinyl chloride	2.40E-02	0.002	1	1	0.1	1	1	10

[a] = SSL based C_{sat}

It should be noted, however, that soil permeability, k_V, is the most variable parameter at any given site, and may vary by three orders of magnitude across a typical residential lot (Johnson and Ettinger, 1991). For this reason, the overall effective diffusion coefficient should be determined by integration across each soil type. Overall diffusion/convection vapor transport will therefore be limited by the soil stratum offering the greatest resistance to vapor flow.

References

Johnson, Paul C., and Robert A. Ettinger. 1991. Heuristic model for predicting the intrusion rate of contaminant vapors into buildings. Environ. Sci. Technol., 25(8):1445-1452.

Jury, W. A., W. J. Farmer, and W. F. Spencer. 1983. Behavior Assessment Model for Trace Organics in Soil, l, Model description. J. Environ. Qual., 12:558-564.

Attachment

ATTACHMENT

DETAILED MODEL EVALUATION

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	CAS No.	Soil bulk density, ρ_b (g/cm^3)	Soil moisture, w (g/g)	Soil moisutre, Θ_w (cm^3/cm^3)	Soil total porosity, η (unitless)	Soil air-filled porosity, Θ_a (unitless)	Soil water-filled porosity, Θ_w (unitless)	Diffusivity in air, D_a (cm^2/s)	Diffusity in water, D_w (cm^2/s)	Effective diffusion coeffi-cient, D_o (cm^2/s)	Soil vapor permea-bility, K_v (cm^3)	Soil-bldg. pressure differen-tial ΔP (g/cm-s^2)	Diffusion path length, L_d (cm)	Convec-tion path length, L_p (cm)	Vapor viscosity, μ (g/cm-s)	Peclet number, Pe (unitless)	Henry's law constant, H (unitless)	Organic carbon partition coeffi-cient, K_{oc} (cm^3/g)
Aldrin	309-00-2	1.5	0.1	0.15	0.434	0.284	0.150	1.32E-02	4.86E-06	1.05E-03	1.00E-08	10	15	15	1.80E-04	0.53	4.20E-03	4.84E+04
Benzene	71-43-2	1.5	0.1	0.15	0.434	0.284	0.150	8.70E 02	9.80E-066	6.95E-03	1.00E-08	10	15	15	1.80E-04	0.08	2.20E-01	5.70E+01
Bis(2-chloroethyl)ether	111-44-4	1.5	0.1	0.15	0.434	0.284	0.150	6.92E-02	7.53E-06	5.53E-03	1.00E-08	10	15	15	1.80E-04	0.10	8.80E-04	7.60E+01
Bromoform	75-25-2	1.5	0.1	0.15	0.434	0.284	0.150	1.49E-02	1.03E-05	1.19E-03	1.00E-08	10	15	15	1.80E-04	0.47	2.50E-02	1.26E+02
Carbon disulfide	75-15-0	1.5	0.1	0.15	0.434	0.284	0.150	1.04E-01	1.00E-05	8.31E-03	1.00E-08	10	15	15	1.80E-04	0.07	5.20E-01	5.20E+01
Carbon tetrachloride	56-23-5	1.5	0.1	0.15	0.434	0.284	0.150	7.80E-02	8.80E-06	6.23E-03	1.00E-08	10	15	15	1.80E-04	0.09	1.20E+00	1.64E+02
Chlordane	57-74-9	1.5	0.1	0.15	0.434	0.284	0.150	1.18E-02	4.37E-06	9.43E-04	1.00E-08	10	15	15	1.80E-04	0.59	2.70E-03	5.13E+04
Chlorobenzene	108-90-7	1.5	0.1	0.15	0.434	0.284	0.150	7.30E-02	8.70E-06	5.83E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.80E-01	2.04E+02
Chloroform	67-66-03	1.5	0.1	0.15	0.434	0.284	0.150	1.04E-01	1.00E-05	8.31E-03	1.00E-08	10	15	15	1.80E-04	0.07	1.60E-01	5.60E+01
DDT	50-29-3	1.5	0.1	0.15	0.434	0.284	0.150	1.37E-02	4.95E-06	1.09E-03	1.00E-08	10	15	15	1.80E-04	0.51	2.20E43	2.37E+05
1,2-Dichlorobenzene	95-50-1	1.5	0.1	0.15	0.434	0.284	0.150	6.90E-02	7.90E-06	5.51E-03	1.00E-08	10	15	15	1.00E-04	0.10	8.60E-02	3.76E+02
1,4-Dichlorobenzene	106-46-7	1.5	0.1	0.15	0.434	0.284	0.150	6.90E-02	7.90E-06	5.51E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.20E-01	5.16E+02
1,1-Dichloroethane	75-34-3	1.5	0.1	0.15	0.434	0.284	0.150	7.42E-02	1.04E-05	5.93E-03	1.00E-08	10	15	15	1.80E-04	0.09	2.40E41	5.20E+01
1,2-Dichloroethane	107-06-2	1.5	0.1	0.15	0.434	0.284	0.150	1.04E-01	9.90E-06	8.31E-03	1.00E-08	10	15	15	1.80E-04	0.07	5.20E-02	3.80E+01
1,1-Dichloroethylene	75-35 -4	1.5	0.1	0.15	0.434	0.284	0.150	9.00E-02	1.04E-05	7.19E-03	1.00E-08	10	15	15	1.80E-04	0.08	1.00E+00	6.50E+01
1,2-Dichloropropane	78-87-5	1.5	0.1	0.15	0.434	0.284	0.150	7.82E-02	8.73E-06	6.25E-03	1.00E-08	10	15	15	1.80E-04	0.09	1.20E-01	4.70E+01
1,3-Dichloropropene	542-75-6	1.5	0.1	0.15	0.434	0.284	0.150	6.26E-02	1.00E-05	5.00E-03	1.00E-08	10	15	15	1.80E-04	0.11	1.20E-01	2.60E+01
Dieldrin	60-57-1	1.5	0.1	0.15	0.434	0.284	0.150	1.25E-02	4.74E4-6	9.99E-04	1.00E-08	10	15	15	1.80E-04	0.56	1.10E-04	1.09E+04
Ethylbenzene	100-41-4	1.5	0.1	0.15	0.434	0.284	0.150	7.50E-02	7.80E-06	5.99E-03	1.00E-08	10	15	15	1.80E-04	0.09	3.20E-01	2.21E+02
Heptachlor	76-44-8	1.5	0.1	0.15	0.434	0.284	0.150	1.12E-02	5.69E-06	8.95E-04	1.00E-08	10	15	15	1.80E-04	0.62	2.40E-02	6.81E+03
Heptachlor epoxide	1024-57-3	1.5	0.1	0.15	0.434	0.284	0.150	1.22E-02	4.68E-06	9.75E-04	1.00E-08	10	15	15	1.80E-04	0.57	3.40E-04	7.24E+03
Hexachloro-1,3-butadiene	87-68-3	1.5	0.1	0.15	0.434	0.284	0.150	5.61E-02	6.16E-06	4.48E-03	1.00E-08	10	15	15	1.80E-04	0.12	9.80E-01	6.99E+03
Hexachlorobenzene	118-74-1	1.5	0.1	0.15	0.434	0.284	0.150	5.42E-02	5.91E-06	4.33E-03	1.00E-08	10	15	15	1.80E-04	0.13	220E-02	3.75E+04
HCH-alpha(alpha-BHC)	319-84-6	1.5	0.1	0.15	0.434	0.284	0.150	1.76E-02	5.57E-06	1.41E-03	1.00E-08	10	15	15	1.80E-04	0.39	2.80E-04	1.76E+03
HCH-beta(beta-BHC)	319-85-7	1.5	0.1	0.15	0.434	0.284	0.150	1.76E-02	5.57E-06	1.41E-03	1.00E-08	10	15	15	1.80E-04	0.39	1.40E-05	2.28E+03
Hexachlorocyclopentadiene	77-47-4	1.5	0.1	0.15	0.434	0.284	0.150	1.61E-02	7.21E-06	1.29E-03	1.00E-08	10	15	15	1.80E-04	0.43	7.10E-01	9.59E+03
Hexachloroethane	67-72-1	1.5	0.1	0.15	0.434	0.284	0.150	2.49E-03	6.80E-06	1.99E-04	1.00E-08	10	15	15	1.80E-04	2.79	1.50E-01	1.83E+03
Methyl bromide	74-83-9	1.5	0.1	0.15	0.434	0.284	0.150	7.28E-02	1.21E-05	5.82E-03	1.00E-08	10	15	15	1.80E-04	0.10	5.80E-01	9.00E+00
Methylene chloride	75-09-2	1.5	0.1	0.15	0.434	0.284	0.150	1.01E-01	1.17E-05	8.07E-03	1.00E-08	10	15	15	1.80E-04	0.07	9.70E-02	1.60E+01
Nitrobenzene	98-95-3	1.5	0.1	0.15	0.434	0.284	0.150	7.60E-02	8.60E-06	6.07E-03	1.00E-08	10	15	15	1.80E-04	0.09	8.40E-04	1.31E+02
Styrene	100-42-5	1.5	0.1	0.15	0.434	0.284	0.150	7.10E-02	8.00E-06	5.67E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.40E-01	9.12E+02
1,1,2,2-Tetrachloroethane	79-34-5	1.5	0.1	0.15	0.434	0.284	0.150	7.10E-02	7.90E-06	5.67E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.50E-02	7.90E+01
Tetrachloroethylene	127-18-4	1.5	0.1	0.15	0.434	0.284	0.150	7.20E-02	8.20E-06	5.75E-03	1.00E-08	10	15	15	1.80E-04	0.10	7.10E-01	3.00E+02
Toluene	108-88-3	1.5	0.1	0.15	0.434	0.284	0.150	8.70E-02	8.60E-06	6.95E-03	1.00E-08	10	15	15	1.80E-04	0.08	2.50E-01	1.31E+02
Toxaphene	8001-35-2	1.5	0.1	0.15	0.434	0.284	0.150	1.16E-02	4.34E-06	9.27E-04	1.00E-08	10	15	15	1.80E-04	0.60	1.40E-04	5.01E+02
1,2,4-Trichlorobenzene	120-82-1	1.5	0.1	0.15	0.434	0.284	0.150	3.00E-02	8.23E-06	2.40E-03	1.00E-08	10	15	15	1.80E-04	0.23	1.10E-01	1.54E+03
1,1,1-Trichloroethane	71-55-6	1.5	0.1	0.15	0.434	0.284	0.150	7.80E-02	8.80E-06	6.23E-03	1.00E-08	10	15	15	1.80E-04	0.09	7.60E-01	9.90E+01
1,1,2-Trichloroethane	79-00-5	1.5	0.1	0.15	0.434	0.284	0.150	7.80E-02	8.80E-06	6.23E-03	1.00E-08	10	15	15	1.80E-04	0. 09	4.10E-02	7.60E+01
Trichloroethylene	79-01-6	1.5	0.1	0.15	0.434	0.284	0.150	7.90E-02	9.10E-06	6.31E-03	1.00E-08	10	15	15	1.80E-04	0.09	4.30E-01	9.40E+01
2,4,6-Trichlorophenol	88-06-2	1.5	0.1	0.15	0.434	0.284	0.150	3.14E-02	6.36E-06	2.51E-03	1.00E-08	10	15	15	1.80E-04	0.22	1.70E-04	2.83E+02
Vinyl acetate	108-05-4	1.5	0.1	0.15	0.434	0.284	0.150	8.50E-02	9.20E-06	6.79E-03	1.00E-08	10	15	15	1.80E-04	0.08	2.30E-02	5.00E+00
Vinyl chloride	75-01-4	1.5	0.1	0.15	0.434	0.284	0.150	1.06E-01	1.23E-05	8.47E-03	1 00E-08	10	15	15	1.80E-04	0.07	3.50E+00	1.10E+01

NA = not appilcable
[a] = SSL based on C_{sat}

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Soil organic carbon fraction, f_{oc} (unitless)	Soil-water partition coefficient K_4 (cm^3/g)	Initial soil conc., C_r (mg/kg)	Source vapor conc., C_{source} (g/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)	Crack depth below grade, Z_{crack} (cm)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg. Q_{soil} (cm^3/s)	Source-bldg. separation at t=0, L_t^o (cm)	Indoor ψ	Area of base-ment, A_s (cm^2)	Bldg. foundation thick-nesses, L_{crack} (cm)	Crack effective diffusion coeffi-cient, D_{crack} (cm^2/s)	Crack-to-total area ratio, η	Area of crack, A_{crack} (cm^2)	Indoor β	Buiilding ventilation rate, $Q_{building}$ (cm^3/s)	Depth to source lower boundary, ΔH_c (cm)	Exposure duration, τ (sec)
Aldrin	0.006	2.90E+02	1.00E+00	1.45E-05	3400	200	4.06	2.59	15	4.52E-11	1.38E+06	15	1.05E-03	0.01	1.38E+04	3.85E+01	2.90E+04	200	9.46E+08
Benzene	0.006	3.42E-01	1.00E+00	4.55E-01	3400	200	4.06	2.59	15	9.37E-06	1.38E+06	15	6.95E-03	0.01	1.38E+04	2.48E+02	2.90E+04	200	9.46E+08
Bis(2-chloroethyl)ether	0.006	4.56E-01	1.00E+00	1.58E-03	3400	200	4.06	2.59	15	2.59E-08	1.38E+06	15	5.53E-03	0.01	1.38E+04	1.98E+02	2.90E+04	200	9.46E+08
Bromoform	0.006	7.56E-01	1.00E+00	2.90E-02	3400	200	4.06	2.59	15	1.02E-07	1.38E+06	15	1.19E-03	0.01	1.38E+04	4.34E+01	2.90E+04	200	9.46E+08
Carbon disulfide	0.006	3.12E-01	1.00E+00	1.02E+00	3400	200	4.06	2.59	15	2.51E-05	1.38E+06	15	8.31E-03	0.01	1.38E+04	2.97E+02	2.90E+04	200	9.46E+08
Carbon tetrachloride	0.006	9.84E-01	1.00E+00	9.15E-01	3400	200	4.06	2.59	15	1.69E-05	1.38E+06	15	6.23E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
Chlordane	0.006	3.08E+02	1.00E+00	8.77E-06	3400	200	4.06	2.59	15	2.45E-11	1.38E+06	15	9.43E-04	0.01	1.38E+04	3.46E+01	2.90E+04	200	9.46E+08
Chlorobenzene	0.006	1.22E+00	1.00E+00	1.33E-01	3400	200	4.06	2.59	15	2.29E-06	1.38E+06	15	5.83E-03	0.01	1.38E+04	2.09E+02	2.90E+04	200	9.46E+08
Chloroform	0.005	3.36E-01	1.00E+00	3.43E-01	3400	200	4.06	2.59	15	8.45E-06	1.38E+06	15	8.31E-03	0.01	1.38E+04	2.97E+02	2.90E+04	200	9.46E+08
DDT	0.006	1.42E+03	1.00E+00	1.55E-06	3400	200	4.06	2.59	15	5.02E-12	1.38E+06	15	1.09E-03	0.01	1.38E+04	4.00E+01	2.90E+04	200	9.46E+08
1,2-Dichlorobenzene	0.006	2.26E+00	1.00E+00	3.63E-02	3400	200	4.06	2.59	15	5.92E-07	1.38E+06	15	5.51E-03	0.01	1.38E+04	1.97E+02	2.90E+04	200	9.46E+08
1,4-Dichlorobenzene	0.006	3.10E+00	1.00E+00	3.73E-02	3400	200	4.06	2.59	15	6.09E-07	1.38E+06	15	5.51E-03	0.01	1.38E+04	1.97E+02	2.90E+04	200	9.46E+08
1,1-Dichloroethane	0.006	3.12E-01	1.00E+00	5.25E-01	3400	200	4.06	2.59	15	9.22E-06	1.38E+06	15	5.93E-03	0.01	1.38E+04	2.12E+02	2.90E+04	200	9.46E+08
1,2-Dichloroethane	0.006	2.28E-01	1.00E+00	1.54E-01	3400	200	4.06	2.59	15	3.79E-06	1.38E+06	15	8.31E-03	0.01	1.38E+04	2.97E+02	2.90E+04	200	9.46E+08
1,1-Dichloroethylene	0.006	3.90E-01	1.00E+00	1.47E+00	3400	200	4.06	2.59	15	3.14E-05	1.38E+06	15	7.19E-03	0.01	1.38E+04	2.57E+02	2.90E+04	200	9.46E+08
1,2-Dichloropropane	0.006	2.82E-01	1.00E+00	2.97E-01	3400	200	4.06	2.59	15	5.49E-06	1.38E+06	15	6.25E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
1,3-Dichloropropene	0.006	1.56E-01	1.00E+00	4.31E-01	3400	200	4.06	2.59	15	6.38E-06	1.38E+06	15	5.00E-03	0.01	1.38E+04	1.79E+02	2.90E+04	200	9.46E+08
Dieldrin	0.006	6.54E+01	1.00E+00	1.68E-06	3400	200	4.06	2.59	15	4.97E-12	1.38E+06	15	9.99E-04	0.01	1.38E+04	3.66E+01	2.90E+04	200	9.46E+08
Ethylbenzene	0.006	1.33E+00	1.00E+00	2.15E-01	3400	200	4.06	2.59	15	3.82E-06	1.38E+06	15	5.99E-03	001	1.38E+04	2.14E+02	2.90E+04	200	9.46E+08
Heptachlor	0.006	4.09E+01	1.00E+00	5.86E-04	3400	200	4.06	2.59	15	1.55E-09	1.38E+06	15	8.95E-04	001	1.38E+04	3.29E+01	2.90E+04	200	9.46E+08
Heptachlor epoxide	0.006	4.34E+01	1.00E+00`	7.81E-06	3400	200	4.06	2.59	15	2.26E-11	1.38E+06	15	9.75E-04	0.01	1.38E+04	3.57E+01	2.90E+04	200	9.46E+08
Hexachloro-1,3-butadiene	0.006	4.19E+01	1.00E+00	2.32E-02	3400	200	4.06	2.59	15	3.08E-07	1.38E+06	15	4.48E-03	0.01	1.38E+04	1.61E+02	2.90E+04	200	9.46E+08
Hexachlorobenzene	0.006	2.25E+02	1.00E+00	9.77E-05	3400	200	4.06	2.59	15	1.25E-09	1.38E+06	15	4.33E-03	0.01	1.38E+04	1.55E+02	2.90E+04	200	9.46E+08
HCH-alpha(alpha-BHC)	0.006	1.06E+01	1.00E+00	2.63E-05	3400	200	4.06	2.59	15	1.09E-10	1.38E+06	15	1.41E-03	001	1.38E+04	5.11E+01	2.90E+04	200	9.46E+08
HCH-beta(beta-BHC)	0.006	1.37E+01	1.00E+00	1.02E-06	3400	200	4.06	2.59	15	4.23E-12	1.38E+06	15	1.41E-03	0.01	1.38E+04	5.11E+01	2.90E+04	200	9.46E+08
Hexachlorocyclopentadiene	0.006	5.75E+01	1.00E+00	1.23E-02	3400	200	4.06	2.59	15	4.69E-08	1.38E+06	15	1.29E-03	0.01	1.38E+04	4.68E+01	2.90E+04	200	9.46E+08
Hexachloroethane	0.006	1.10E+01	1.00E+00	1.35E-02	3400	200	4.06	2.59	15	7.96E-09	1.38E+06	15	1.99E-04	0.01	1 38E+04	8.08E+00	2.90E+04	200	9.46E+08
Methyl bromide	0.006	5.40E-02	1.00E+00	2.20E+00	3400	200	4.06	2.59	15	3.79E-05	1.38E+06	15	5.82E-03	0.01	1.38E+04	2.08E+02	2.90E+04	200	9.46E+08
Methylene chloride	0.006	9.60E-02	1.00E+00	4.53E-01	3400	200	4.06	2.59	15	1.08E-05	1.38E+06	15	8.07E-03	0.01	1.38E+04	2.88E+02	2.90E+04	200	9.46E+08
Nitrobenzene	0.006	7.86E-01	1.00E+00	9.48E-04	3400	200	4.06	2.59	15	1.71E-08	1.38E+06	15	6.07E-03	0 01	1 38E+04	2.17E+02	2.90E+04	200	9.46E+08
Styrene	0.006	5.47E+00	1.00E+00	2.50E-02	3400	200	4.06	2.59	15	4.20E-07	1.38E+06	15	5.67E-03	0.01	1.38E+04	2.03E+02	2.90E+04	200	9.46E+08
1,1,2,2-Tetrachloroethane	0.006	4.74E-01	1.00E+00	2.60E-02	3400	200	4.06	2.59	15	4.37E-07	1.38E+06	15	5.67E-03	0.01	1.38E+04	2.03E+02	2.90E+04	200	9.46E+08
Tetrachloroethylene	0.006	1.80E+00	1.00E+00	3.49E-01	3400	200	4.06	2.59	15	5.95E-06	1.38E+06	15	5.75E-03	0.01	1.38E+04	2.06E+02	2.90E+04	200	9.46E+08
Toluene	0.006	7.86E-01	1.00E+00	2.68E-01	3400	200	4.06	2.59	15	5.52E-06	1.38E+06	15	6.95E-03	0.01	1.38E+04	2.48E+02	2.90E+04	200	9.46E+08
Toxaphene	0.006	3.01E+00	1.00E+00	4.51E-05	3400	200	4.06	2.59	15	1.24E-10	1.38E+06	15	9.27E-04	0.01	1.38E+04	3.40E+01	2.90E+04	200	9.46E+08
1,2,4-Trichlorobenzene	0.006	9.24E+00	1.00E+00	1.18E-02	3400	200	4.06	2.59	15	8.35E-08	1.38E+06	15	2.40E-03	0.01	1.38E+04	8.63E+01	2.90E+04	200	9.46E+08
1,1,1-Trichloroethane	0.006	5.94E-01	1.00E+00	9.07E-01	3400	200	4.06	2.59	15	1.68E-05	1.38E+06	15	6.23E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
1,1,2-Trichloroethane	0.006	4.56E-01	1.00E+00	7.27E-02	3400	200	4.06	2.59	15	1.34E-06	1.38E+06	15	6.23E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
Trichloroethylene	0.006	5.64E-01	1.00E+00	5.77E-01	3400	200	4.06	2.59	15	1.08E-05	1.38E+06	15	6.31E-03	0.01	1.38E+04	2.26E+02	2.90E+04	200	9.46E+08
2,4,6-Trichlorophenol	0.006	1.70E+00	1.00E+00	9.45E-05	3400	200	4.06	2.59	15	7.03E-10	1.38E+06	15	2.51E-03	0.01	1.38E+04	9.03E+01	2.90E+04	200	9.46E+08
Vinyl acetate	0.006	3.00E-02	1.00E+00	1.71E-01	3400	200	4.06	2.59	15	3.45E-06	1.38E+06	15	6.79E-03	0.01	1.38E+04	2.43E+02	2.90E+04	200	9.46E+08
Vinyl chloride	0.006	6.60E-02	1.00E+00	4.22E+00	3400	200	4.06	2.59	15	1.06E-04	1.38E+06	15	8.47E-03	0.01	1.38E+04	3.02E+02	2.90E+04	200	9.46E+08

NA = not appilcable
[a] = SSL based on C_{sat}

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Infinite source indoor attenuation coefficient, α (unitless)	Finite source indoor attenuation coefficient, α (unitless)	Time for source depletion, Indoor τ_D (sec)	Exposure duration > time for depletion (yes/no)	Infinite source bldg. conc., $C_{building}$ (kg/m^3)	Finite source bldg. conc., $C_{building}$ (kg/m^3)	Infinite source indoor volatilization factor VF_{indoor} (m^3/kg)	Finite source indoor volatilization factor VF_{indoor} (m^3/kg)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)	Infinite source indoor SSL, carcinogen (mg/kg)	Infinite source indoor SSL, non-carcinogen (mg/kg)	Finite source indoor SSL, carcinogen (mg/kg)	Finite source indoor SSL, non-carcinogen (mg/kg)	Infinite soure risk-based indoor SSL, (mg/kg)	Finite soure risk-based indoor SSL, (mg/kg)	Outdoor apparent diffusion coefficient, α (cm^2/s)	Outdoor volalitization factor, $VF_{outdoor}$ (m^3/kg)
Aldrin	9.32E-05	8.68E-05	1.33E+13	no	1.35E-06	1.26E-06	7.42E+05	7.97E+05	4.90E-03	NA	3.69E-01	NA	3.96E-01	NA	3.69E-.01	3.96E-01	1.99E-09	9.84E+05
Benzene	2.65E-04	8.32E-05	3.63E+08	yes	1.20E-01	1.51E-02	8.30E+00	6.63E+01	8.30E-06	NA	2.43E-03	NA	1.94E-02	NA	2.43E-03	1.94E-02	5.82E-04	1.82E+03
Bis(2-chloroethyl)ether	2.21E-04	8.87E-05	1.05E+11	no	3.50E-04	1.40E-04	2.86E+03	7.13E+03	3.30E-04	NA	2.11E-02	NA	5.26E-02	NA	2.11E-02	5.26E-02	1.39E-06	3.72E+04
Bromoform	9.59E-05	8.50E-05	6.51E+09	no	2.79E-03	2.47E-03	3.59E+02	4.05E+02	1.10E-06	NA	7.94E-01	NA	8.96E-01	NA	7.94E-01	8.96E-01	5.13E-06	1.94E+04
Carbon disulfide	3.07E-04	7.93E-05	1.61E+08	yes	3.13E-01	1.51E-02	3.20E+00	6.63E+01	NA	1.00E-02	NA	3.33E-02	NA	6.91E-01	3.33E-02	6.91E-01	1.80E-03	1.03E+03
Carbon tetrachloride	2.43E-04	7.78E-05	1.81E+08	yes	2.22E-01	1.51E-02	4.50E+00	6.63E+01	1.50E-05	NA	7.31E-04	NA	1.08E-02	NA	7.31E-04	1.08E-02	9.90E-04	1.39E+03
Chlordane	9.11E-05	8.66E-05	2.24E+13	no-	7.99E-07	7.59E-07	1.25E+06	1.32E+06	6.00E-05	NA	5.08E+01	NA	5.34E+01	NA	5.08E+01	5.34E+01	1.08E-09	1.34E+06
Chlorobenzene	2.30E-04	8.66E-05	1.25E+09	no	3.05E-02	1.15E-02	3.28E+01	8.71E+01	NA	2.00E-02	NA	6.83E-01	NA	1.82E+00	6.83E-01	1.82E+00	1.12E-04	4.15E+03
Chloroform	3.07E-04	8.51E-05	4.79E+08	yes	1.05E-01	1.51E-02	9.49E+00	6.63E+01	2.30E-05	NA	1.00E-03	NA	7.01E-03	NA	1 00E-03	7.01E-03	5.15E-04	1.93E+03
DDT	9.40E-05	8.69E-05	1.24E+14	no	1.45E-07	1.34E-07	6.88E+06	7.44E+06	9.70E-05	NA	1.73E+02	NA	1.87E+02	NA	1.73E+02	1.87E+02	2.21E-10	2.95E+06
1,2-Dichlorobenzene	2.20E-04	8.81E-05	4.59E+09	no	7.99E-03	3.19E-03	1.25E+02	3.13E+02	NA	2.00E-01	NA	2.61E+01	NA	6.53E+01	2.61E+01	6.53E+01	2.74E-05	8.38E+03
1,4-Dichlorobenzene	2.20E-04	8.81E-05	4.46E+09	no	8.22E-03	3.28E-03	1.22E+02	3.05E+02	NA	8.00E-01	NA	1.02E+02	NA	2.54E+02	1.02E+02	2.54E+02	2.78E-05	8.32E+03
1,1-Dichloroethane	2.33E-04	8.15E-05	3.16E+08	yes	1.22E-01	1.51E-02	8.17E+00	6.63E+01	NA	5.00E-01	NA	4.26E+00	NA	3.46E+01	4.26E+00	3.46E+01	5.94E-04	1.80E+03
1,2-Dichloroethane	3.07E-04	8.71E-05	1.07E+09	no	4.73E-02	1.34E-02	2.12E+01	7.46E+01	2.60E-05	NA	1.98E-03	NA	6.98E-03	NA	1.98E-03	6.98E-03	2.47E-04	2.79E+03
1,1-Dichloroethylene	2.72E-04	7.47E-05	1.12E+08	yes	4.01E-01	1.51E-02	2.49E+00	6.63E+01	5.00E-05	NA	1.21E-04	NA	3.23E-03	NA	1.21E-04	3.23E-03	2.40E-03	8.95E+02
1,2-Dichloropropane	2.43E-04	8.46E-05	5.59E+08	yes	7.21E-02	1.51E-02	1.39E+01	6.63E+01	NA	4.00E-03	NA	5.79E-02	NA	2.76E-01	5.79E-02	2.76E-01	3.46E-04	2.36E+03
1,3-Dichloropropene	2.05E-04	8.16E-05	3.88E+08	yes	8.82E-02	1.51E-02	1.13E+01	6.63E+01	3.70E-05	2.00E-02	7.46E-04	2.37E-01	4.36E-03	1.38E+00	7.46E-04	4.36E-03	5.01E-04	1.96E+03
Dieldrin	9.21E-05	8.67E-05	1.16E+14	no	1.55E-07	1.46E-07	6.47E+06	6.87E+06	4.60E-03	NA	3.42E+00	NA	3.63E+00	NA	3.42E+00	3.63E+00	2.19E-10	2.97E+06
Ethylbenzene	2.35E-04	8.55E-05	7.71E+08	yes	5.06E-02	1.51E-02	1.97E+01	6.63E+01	NA	1.00E+00	NA	2.06E+01	NA	6.91E+01	2.06E+01	6.91E+01	1.88E-04	3.20E+03
Heptachlor	9.02E-05	8.64E-05	3.39E+11	no	5.29E-05	5.06E-05	1.89E+04	1.98E+04	1.30E-03	NA	3.54E-02	NA	3.70E-02	NA	3.54E-02	3.70E-02	6.84E-08	1.68E+05
Heptachlor epoxide	9.16E-05	8.67E-05	2.50E+13	no	7.16E-07	6.77E-07	1.40E+06	1.48E+06	2.60E-03	NA	1.31E+00	NA	1.38E+00	NA	1.31E+00	1.38E+00	9.93E-10	1.39E+06
Hexachloro-1,3-butadiene	1.89E-04	8.81E-05	7.23E+09	no	4.38E-03	2.04E-03	2.28E+02	4.89E+02	2.20E-05	NA	2.52E-02	NA	5.41E-02	NA	2.52E-02	5.41E-02	1.36E-05	1.19E+04
Hexachlorobenzene	1.84E-04	8.86E-05	1.72E+12	no	1.80E-05	8.66E-06	5.55E+04	1.16E+05	4.60E-04	NA	2.94E-01	NA	6.11E-01	NA	2.94E-01	6.11E-01	5.51E-08	1.87E+05
HCH-alpha(alpha-BHC)	1.01E-04	8.74E-05	7.03E+12	no	2.65E-06	2.30E-06	3.78E+05	4.36E+05	1.80E-03	NA	5.11E-01	NA	5.89E-01	NA	5.11E-01	5.89E-01	4.85E-09	6.29E+05
HCH-beta(beta-BHC)	1.01E-04	8.74E-05	1.82E+14	no	1.02E-07	8.88E-08	9.76E+06	1.13E+07	5.30E-04	NA	4.48E+01	NA	5.17E+01	NA	4.48E+01	5.17E+01	1.87E-10	3.20E+06
Hexachlorocyclopentadiene	9.80E-05	8.64E-05	1.52E+10	no	1.20E-03	1.06E-03	8.30E+02	9.42E+02	NA	7.00E-05	NA	6.06E-02	NA	6.88E-02	6.06E-02	6.88E-02	2.07E-06	3.05E+04
Hexachloroethane	7.81E-05	7.41E-05	2.47E+10	no	1.05E-03	1.00E-03	9.48E+02	1.00E+03	4.00E-06	NA	5.77E-01	NA	6.08E-01	NA	5.77E-01	6.08E-01	3.54E-07	7.37E+04
Methyl bromide	2.30E-04	6.75E-05	7.55E+07	yes	5.05E-01	1.51E-02	1.98E+00	6.63E+01	NA	5.00E-03	NA	1.03E-02	NA	3.46E-01	1.03E-02	3.46E-01	8.13E-03	4.86E+02
Methylene chloride	3.00E-04	8.40EE-05	3.63E+08	yes	1.36E-01	1.51E-02	7.38E+00	6.63E+01	4.70E-07	3.00E+00	3.82E-02	2.31E+01	3.43E-01	2.07E+02	3.82E-02	3.43E-01	1.06E-03	1.35E+03
Nitrobenzene	2.38E-04	8.87E-05	1.75E+11	no	2.25E-04	8.41E-05	4.44E+03	1.19E+04	NA	2.00E-03	NA	9.26E+00	NA	2.48E+01	9.26E+00	2.48E+01	8.45E-07	4.77E+04
Styrene	2.25E-04	8.83E-05	6.65E+09	no	5.64E-03	2.21E-03	1.77E+02	4.53E+02	NA	1.00E+00	NA	1.85E+02	NA	4.72E+02	1.85E+02	4.72E+02	1.89E-05	1.01E+04
1,1,2,2-Tetrachloroethane	2.25E-04	8.83E-05	6.39E+09	no	5.86E-03	2.30E-03	1.71E+02	4.36E+02	5.80E-05	NA	7.16E-03	NA	1.83E-02	NA	7.16E-03	1.83E-02	2.34E-05	9.07E+03
Tetrachloroethylene	2.28E-04	8.35E-05	4.76E+08	yes	7.95E-02	1.51E-02	1.26E+01	6.63E+01	5.80E-07	NA	5.28E-02	NA	2.78E-01	NA	5.28E-02	2.78E-01	2.95E-04	2.55E+03
Toluene	2.65E-04	8.53E-05	6.16E+08	yes	7.10E-02	1.51E-02	1.41E+01	6.63E+01	NA	4.00E-01	NA	5.88E+00	NA	2.76E+01	5.88E+00	2.76E+01	2.88E-04	2.59E+03
Toxaphene	9.08E-05	8.65E-05	4.38E+12	no	4.09E-06	3.90E-06	2.44E+05	2.56E+05	3.20E-04	NA	1.86E+00	NA	1.95E+00	NA	1.86E+00	1.95E+00	5.62E-09	5.85E+05
1,2,4-Trichlorobenzene	1.27E-04	8.77E-05	1.49E+10	no	1.49E-03	1.03E-03	6.70E+02	9.71E+02	NA	9.00E-03	NA	6.29E+00	NA	9.11E+00	6.29E+00	9.11E+00	3.72E-06	2.28E+04
1,1,1-Trichloroethane	2.43E-04	7.79E-05	1.83E+08	yes	2.20E-01	1.51E-02	4.54E+00	6.63E+01	NA	1.00E+00	NA	4.74E+00	NA	6.91E+01	4.74E+00	6.91E+01	1.04E-03	1.36E+03
1,1,2-Trichloroethane	2.43E-04	8.76E-05	2.28E+09	no	1.76E-02	6.37E-03	5.67E+01	1.57E+02	1.60E-05	NA	8.62E-03	NA	2.39E-02	NA	8.62E-03	2.39E-02	7.30E-05	5.13E+03
Trichloroethylene	2.45E-04	8.13E-05	2.87E+08	yes	1.41E-01	1.51E-02	7.07E+00	6.63E+01	1.70E-06	NA	1.01E-02	NA	9.49E-02	NA	1.01E-02	9.49E-02	6.27E-04	1.75E+03
2,4,6-Trichlorophenol	1.30E-04	8.82E-05	1.84E+12	no	1.23E-05	8.34E-06	8.13E+04	1.20E+05	3.10E-06	NA	6.38E+01	NA	9.42E+01	NA	6.38E+01	9.42E+01	3.27E-08	2.43E+05
Vinyl acetate	2.60E-04	8.65E-05	9.65E+08	no	4.45E-02	1.48E-02	2.25E+01	6.76E+01	NA	2.00E-01	NA	4.69E+00	NA	1.41E+01	4.69E+00	1.41E+01	6.78E-04	1.68E+03
Vinyl chloride	3.12E-04	6.38E-05	3.89E+07	yes	1.32E+00	1.51E-02	7.59E-01	6.63E+01	8.40E-05	NA	2.20E-05	NA	1.92E-03	NA	2.20E-05	1.92E-03	5.85E-02	1.81E+02

NA = not appilcable
[a] = SSL based on C_{sat}

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Outdoor SSL, carcinogen (mg/kg)	Outdoor SSL, non-carcinogen (mg/kg)	Risk-based outdoor SSL (mg/kg)	Pure component solubility, S (mg/L)	Soil saturation conc., C_{sat} (mg/kg)	Indoor SSL, infinite source (mg/kg)	Indoor SSL, finite source (mg/kg)	Outdoor SSL, infinite source (mg/kg)
Aldrin	4.89E-01	NA	4.89E-01	7.84E-02	2.28E+01	0.4	0.4	0.5
Benzene	5.33E-01	NA	5.33E-01	1.78E+03	8.61E+02	0.002	0.02	0.5
Bis(2-chloroethyl)ether	2.74E-01	NA	2.74E-01	1.18E+04	6.56E+03	0.02	0.05	0.3
Bromoform	4.29E+01	NA	4.29E+01	3.21E+03	2.76E+03	0.8	0.9	43
Carbon disulfide	NA	1.08E+01	1.08E+01	2.67E+03	1.36E+03	0.03	0.7	11
Carbon tetrachloride	2.26E-01	NA	2.26E-01	7.92E+02	1.04E+03	0.0007	0.01	0.2
Chlordane	5.42E+01	NA	5.42E+01	2.19E-01	6.74E+01	51	53	54
Chlorobenzene	NA	8.66E+01	8.66E+01	4.09E+02	5.55E+02	0.7	2	87
Chloroform	2.04E-01	NA	2.04E-01	7.96E+03	3.71E+03	0.001	0.007	0.2
DDT	7.41E+01	NA	7.41E+01	3.41E-03	4.85E+00	5[a]	5[a]	5[a]
1,2-Dichlorobenzene	NA	1.75E+03	1.75E+03	1.25E+02	2.97E+02	26	65	297[a]
1,4-Dichlorobenzene	NA	6.94E+03	6.94E+03	7.30E+01	2.35E+02	102	235	235[a]
1,1-Dichloroethane	NA	9.39E+02	9.39E+02	5.16E+03	2.36E+03	4	35	939
1,2-Dichloroethane	2.61E-01	NA	2.61E-01	8.31E+03	2.81E+03	0.002	0.007	0.3
1,1-Dichloroethylene	4.36E-02	NA	4.36E-02	3.00E+03	2.04E+03	0.0001	0.003	0.04
1,2-Dichloropropane	NA	9.83E+00	9.83E+00	2.68E+03	1.08E+03	0.06	0.3	10
1,3-Dichloropropene	1.29E-01	4.09E+01	1.29E-01	1.55E+03	4.32E+02	0.0007	0.004	0.1
Dieldrin	1.57E+00	NA	1.57E+00	1.87E-01	1.22E+01	3	4	2
Ethylbenzene	NA	3.33E+03	3.33E+03	1.73E+02	2.57E+02	21	69	257[a]
Heptachlor	3.14E-01	NA	3.14E-01	2.73E-01	1.12E+01	0.04	0.04	0.3
Heptachlor epoxide	1.30E+00	NA	1.30E+00	2.68E-01	1.17E+01	1	1	1
Hexachloro-1,3-butadiene	1.31E+00	NA	1.31E+00	2.54E+00	1.07E+02	0.03	0.05	1
Hexachlorobenzene	9.88E-01	NA	9.88E-01	8.62E-03	1.94E+00	0.3	0.6	1
HCH-alpha(alpha-BHC)	8.51E-01	NA	8.51E-01	2.40E+00	2.56E+01	0.5	0.6	0.9
HCH-beta(beta-BHC)	1.47E+01	NA	1.47E+01	5.42E-01	7.47E+00	7[a]	7[a]	7[a]
Hexachlorocyclopentadiene	NA	2.23E+00	2.23E+00	1.53E+00	8.84E+01	0.06	0.07	2
Hexachloroethane	4.48E+01	NA	4.48E+01	4.08E+01	4.53E+02	0.6	0.6	45
Methyl bromide	NA	2.54E+00	2.54E+00	1.45E+04	3.83E+03	0.01	0.3	3
Methylene chloride	6.97E+00	4.21E+03	6.97E+00	1.74E+04	3.73E+03	0.04	0.3	7
Nitrobenzene	NA	9.95E+01	9.95E+01	1.92E+03	1.70E+03	9	25	100
Styrene	NA	1.05E+04	1.05E+04	2.57E+02	1.44E+03	185	472	1439
1,1,2,2-Tetrachloroethane	3.81E-01	NA	3.81E-01	3.07E+03	1.77E+03	0.007	0.02	0.4
Tetrachloroethylene	1.07E+01	NA	1.07E+01	2.32E+02	4.72E+02	0.05	0.3	11
Toluene	NA	1.08E+03	1.08E+03	5.58E+02	5.21E+02	6	28	521[a]
Toxaphene	4.45E+00	NA	4.45E+00	6.79E-01	2.11E+00	2	2	2[a]
1,2,4-Trichlorobenzene	NA	2.14E+02	2.14E+02	3.07E+01	2.87E+02	6	9	214
1,1,1-Trichloroethane	NA	1.42E+03	1.42E+03	1.17E+03	9.80E+02	5	69	980[a]
1,1,2-Trichloroethane	7.81E-01	NA	7.81E-01	4.40E+03	2.48E+03	0.009	0.02	1
Trichloroethylene	2.51E+00	NA	2.51E+00	1.18E+03	8.80E+02	0.01	0.09	3
2,4,6-Trichlorophenol	1.90E+02	NA	1.90E+02	7.53E+02	1.35E+03	64	94	190
Vinyl acetate	NA	3.51E+02	3.51E+02	2.24E+04	3.01E+03	5	14	351
Vinyl chloride	5.25E-03	NA	5.25E-03	2.73E+03	2.26E+03	0.00002	0.002	0.01

NA = not appilcable

[a] = SSL based on C_{sat}

APPENDIX I

SSL Simulation Results

APPENDIX I

SSL Simulation Results

Section 4.3.3 contains a complete description of the simulation setup and parameters. The following notation is used in the tables of this appendix.

C	=	the number of specimens per composite
N	=	the number of composite samples chemically analyzed
MU	=	the assumed true site mean (= 0.5 SSL or 2 SSL)
CV	=	the assumed true value of the site coefficient of variation, (i.e. the true site standard deviation divided by the true site mean MU)
MIX	=	the proportion of the site which is uncontaminated

The remaining variables give the estimated probability of deciding to investigate further (PDIF) for a given method and simulation distribution. The variable names indicate the method of testing (Mx = Max test, C = Chen test, L = Land test) and the type of probability distribution used to generate values for the contaminated part of the EA (L = lognormal, G = gamma, W = Weibull).

MxL, MxG, MxW	=	PDIF for Max rule applied to lognormal, gamma or Weibull data
C40L, C40G, C40W	=	PDIF for Chen test at the nominal .40 significance level applied to lognormal, gamma or Weibull data
C30L, C30G, C30W	=	PDIF for Chen test at the nominal .30 significance level applied to lognormal, gamma or Weibull data
C20L, C20G, C20W	=	PDIF for Chen test at the nominal .20 significance level applied to lognormal, gamma or Weibull data
C1OL, C1OG, C1OW	=	PDIF for Chen test at the nominal .10 significance level applied to lognormal, gamma or Weibull data
C05L, C05G, C05W	=	PDIF for Chen test at the nominal .05 significance level applied to lognormal, gamma or Weibull data
COlL, CO1G, CO1W	=	PDIF for Chen test at the nominal .01 significance level applied to lognormal, gamma or Weibull data
LfL, LfG, LfW	=	PDIF for Land test of the flipped null hypothesis at the nominal .10 significance level applied to lognormal, gamma or Weibull data
LoL, LoG, LoW	=	PDIF for Land test of the original null hypothesis at the nominal .05 significance level applied to lognormal, gamma or Weibull data.

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=1 N=4 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.124	.314	.246	.161	.087	.042	.016	.099	.835	.195	.350	.276	.195	.088	.043	.011	.172	.975	.176	.360	.286	.209	.104	.042	.009	.151	.945
0.5	.50	.192	.371	.295	.182	.089	.039	.016	.297	.937	.194	.347	.270	.170	.072	.028	.013	.257	.931	.194	.373	.294	.197	.086	.039	.017	.265	.929
2.0	.00	.750	.974	.960	.926	.858	.759	.426	.873	.972	.757	.874	.838	.775	.650	.494	.188	.742	.991	.760	.903	.870	.808	.707	.551	.240	.768	.988
2.0	.50	.848	.863	.816	.745	.569	.361	.132	.703	.947	.792	.813	.774	.699	.540	.334	.106	.659	.925	.825	.839	.799	.729	.589	.370	.117	.686	.952

C=1 N=4 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.140	.296	.227	.150	.073	.036	.007	.088	.887	.255	.338	.277	.198	.106	.046	.009	.182	.965	.219	.315	.261	.169	.084	.033	.006	.143	.961
0.5	.50	.213	.320	.240	.167	.080	.036	.010	.214	.932	.273	.343	.273	.191	.084	.031	.007	.201	.905	.241	.330	.261	.167	.075	.032	.009	.214	.902
0.5	.75	.343	.387	.298	.193	.067	.021	.004	.241	.673	.366	.407	.302	.170	.061	.023	.008	.205	.680	.377	.414	.305	.175	.055	.016	.003	.215	.676
2.0	.00	.700	.919	.890	.838	.733	.593	.260	.765	.964	.676	.740	.698	.645	.493	.341	.072	.624	.988	.695	.809	.770	.716	.596	.433	.138	.663	.995
2.0	.50	.753	.813	.766	.688	.524	.339	.112	.680	.941	.694	.712	.675	.625	.466	.291	.072	.522	.926	.713	.747	.698	.620	.481	.295	.073	.585	.938
2.0	.75	.699	.698	.689	.657	.456	.176	.028	.433	.704	.675	.673	.658	.615	.430	.161	.030	.406	.681	.669	.664	.642	.596	.442	.175	.027	.425	.694

C=1 N=4 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.157	.266	.203	.138	.072	.026	.002	.088	.900	.256	.317	.257	.197	.089	.034	.004	.183	.944	.225	.306	.236	.168	.078	.028	.005	.145	.948
0.5	.50	.212	.296	.227	.165	.085	.038	.007	.186	.927	.267	.324	.260	.187	.093	.033	.003	.194	.868	.264	.310	.263	.189	.091	.032	.006	.191	.896
0.5	.85	.459	.445	.357	.208	.060	.014	.001	.103	.490	.449	.437	.350	.215	.063	.015	.006	.117	.486	.441	.432	.350	.213	.064	.012	.005	.120	.499
2.0	.00	.642	.857	.816	.764	.648	.512	.192	.672	.962	.620	.668	.623	.562	.423	.266	.044	.526	.972	.624	.718	.671	.605	.469	.331	.073	.558	.986
2.0	.50	.692	.752	.699	.620	.468	.312	.089	.617	.930	.613	.630	.592	.537	.404	.219	.040	.496	.885	.635	.672	.627	.567	.412	.233	.036	.530	.918
2.0	.85	.481	.481	.481	.480	.438	.082	.009	.421	.481	.474	.474	.474	.474	.425	.096	.008	.406	.474	.473	.473	.470	.464	.419	.091	.011	.404	.474

C=1 N=4 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.180	.280	.234	.163	.091	.034	.002	.119	.912	.263	.291	.238	.178	.093	.030	.004	.164	.859	.226	.275	.226	.163	.087	.029	.005	.142	.950
0.5	.50	.206	.277	.225	.158	.074	.029	.002	.170	.941	.277	.297	.244	.179	.075	.028	.002	.142	.764	.270	.302	.253	.181	.087	.024	.003	.163	.872
0.5	.85	.366	.364	.289	.207	.090	.023	.001	.135	.501	.316	.309	.265	.198	.075	.015	.002	.105	.450	.359	.353	.306	.235	.098	.028	.003	.133	.480
2.0	.00	.632	.820	.778	.724	.593	.429	.143	.631	.965	.566	.589	.552	.502	.377	.225	.030	.455	.921	.581	.657	.615	.558	.430	.280	.048	.514	.986
2.0	.50	.631	.683	.637	.558	.434	.277	.068	.574	.939	.531	.555	.501	.447	.329	.179	.024	.388	.860	.591	.616	.588	.530	.395	.242	.038	.489	.905
2.0	.85	.457	.457	.456	.438	.336	.106	.005	.314	.459	.451	.450	.444	.422	.356	.123	.002	.348	.465	.471	.468	.455	.435	.353	.138	.005	.348	.491

C=1 N=4 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.187	.267	.221	.152	.085	.035	.002	.104	.905	.231	.252	.203	.149	.078	.019	.003	.124	.784	.226	.259	.214	.163	.080	.034	.002	.137	.945
0.5	.50	.210	.262	.217	.154	.082	.029	.002	.151	.897	.268	.273	.242	.186	.098	.022	.002	.145	.722	.231	.266	.214	.170	.079	.026	.004	.141	.860
0.5	.90	.312	.306	.275	.199	.070	.021	.002	.071	.336	.301	.299	.266	.222	.101	.018	.000	.094	.341	.299	.293	.266	.216	.096	.023	.001	.099	.348
2.0	.00	.616	.791	.746	.674	.555	.397	.103	.580	.962	.489	.509	.466	.416	.311	.179	.017	.361	.862	.558	.631	.587	.509	.398	.247	.037	.477	.983
2.0	.50	.607	.659	.601	.532	.403	.270	.058	.521	.945	.512	.516	.492	.445	.338	.199	.014	.376	.819	.524	.549	.506	.448	.331	.190	.023	.410	.891
2.0	.90	.346	.346	.346	.346	.310	.131	.002	.307	.346	.363	.363	.362	.356	.321	.111	.000	.311	.364	.328	.328	.327	.324	.291	.120	.004	.289	.331

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=1 N=4 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.173	.241	.203	.141	.061	.024	.003	.091	.920	.255	.265	.234	.177	.093	.029	.002	.141	.727	.194	.213	.178	.131	.068	.025	.001	.105	.910
0.5	.50	.198	.239	.190	.142	.072	.027	.001	.135	.916	.232	.235	.191	.146	.078	.027	.001	.106	.643	.235	.254	.215	.147	.074	.023	.000	.125	.822
0.5	.90	.273	.268	.235	.184	.078	.012	.000	.089	.329	.280	.269	.242	.196	.111	.032	.003	.115	.375	.240	.234	.207	.155	.082	.020	.000	.092	.324
2.0	.00	.594	.750	.708	.632	.502	.387	.104	.534	.963	.443	.450	.426	.387	.294	.162	.009	.333	.753	.511	.579	.526	.466	.342	.213	.018	.445	.979
2.0	.50	.590	.655	.596	.501	.385	.239	.039	.513	.942	.453	.459	.424	.380	.283	.150	.009	.315	.751	.505	.517	.486	.427	.318	.166	.017	.380	.878
2.0	.90	.354	.354	.351	.340	.305	.123	.001	.296	.355	.330	.330	.325	.314	.277	.132	.004	.270	.340	.330	.326	.320	.301	.254	.145	.000	.254	.353

C=1 N=6 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.183	.338	.252	.180	.089	.039	.005	.099	.636	.250	.353	.270	.173	.098	.047	.006	.172	.953	.218	.357	.279	.184	.061	.027	.005	.128	.916
0.5	.50	.233	.367	.285	.206	.100	.055	.014	.320	.981	.276	.371	.298	.206	.104	.049	.007	.300	.971	.320	.418	.303	.208	.107	.045	.007	.304	.965
2.0	.00	.860	.986	.979	.971	.939	.896	.658	.945	.946	.873	.928	.902	.861	.789	.677	.356	.843	.992	.882	.956	.940	.908	.841	.733	.417	.878	.992
2.0	.50	.931	.924	.901	.844	.722	.565	.242	.799	.992	.926	.899	.868	.830	.730	.573	.235	.781	.980	.920	.891	.869	.821	.705	.543	.213	.768	.988

C=1 N=6 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.220	.301	.237	.168	.081	.032	.004	.099	.728	.348	.348	.280	.189	.100	.039	.005	.182	.957	.317	.346	.276	.202	.101	.040	.004	.157	.947
0.5	.50	.260	.304	.253	.176	.085	.034	.005	.223	.965	.366	.369	.281	.183	.088	.034	.002	.209	.931	.387	.372	.289	.217	.114	.039	.003	.243	.958
0.5	.75	.459	.385	.293	.197	.083	.038	.007	.188	.844	.486	.395	.296	.199	.082	.030	.003	.179	.833	.504	.393	.298	.187	.068	.023	.003	.172	.809
2.0	.00	.816	.960	.946	.917	.849	.760	.481	.855	.947	.822	.832	.802	.752	.630	.497	.167	.721	.993	.831	.887	.849	.805	.689	.539	.229	.758	.990
2.0	.50	.891	.891	.842	.777	.633	.497	.189	.732	.989	.837	.818	.786	.718	.609	.453	.155	.657	.966	.846	.834	.787	.713	.607	.450	.147	.675	.980
2.0	.75	.819	.796	.769	.697	.506	.353	.068	.461	.824	.804	.777	.747	.696	.518	.360	.058	.478	.812	.786	.768	.738	.665	.473	.313	.058	.423	.804

C=1 N=6 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.267	.292	.241	.163	.095	.047	.004	.105	.796	.356	.324	.254	.172	.088	.044	.005	.162	.921	.286	.297	.243	.162	.090	.040	.005	.138	.942
0.5	.50	.312	.333	.266	.190	.092	.035	.004	.219	.956	.371	.329	.252	.179	.073	.034	.002	.152	.892	.373	.340	.263	.183	.089	.035	.004	.178	.919
0.5	.85	.591	.409	.300	.194	.082	.031	.003	.154	.631	.597	.434	.311	.200	.085	.027	.000	.154	.637	.559	.434	.318	.203	.073	.019	.001	.156	.618
2.0	.00	.804	.932	.905	.868	.791	.681	.340	.801	.947	.759	.745	.705	.649	.521	.362	.086	.585	.980	.781	.815	.772	.715	.599	.474	.150	.664	.990
2.0	.50	.827	.834	.789	.724	.591	.435	.151	.710	.973	.765	.734	.700	.636	.520	.367	.076	.552	.951	.795	.756	.708	.641	.512	.370	.107	.576	.963
2.0	.85	.628	.628	.628	.621	.456	.221	.014	.226	.628	.596	.596	.596	.586	.431	.223	.019	.226	.596	.650	.649	.646	.629	.470	.230	.020	.232	.651

C=1 N=6 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.249	.282	.230	.159	.083	.034	.001	.091	.808	.380	.327	.275	.211	.101	.036	.003	.155	.854	.336	.322	.254	.191	.100	.039	.004	.149	.941
0.5	.50	.305	.296	.235	.164	.083	.031	.008	.173	.950	.393	.337	.274	.208	.100	.040	.001	.161	.844	.337	.296	.239	.183	.094	.035	.007	.144	.877
0.5	.85	.495	.377	.290	.188	.072	.024	.003	.118	.647	.486	.397	.329	.228	.099	.033	.005	.132	.647	.460	.371	.306	.211	.081	.027	.001	.112	.624
2.0	.00	.797	.899	.865	.833	.745	.595	.261	.760	.956	.705	.669	.621	.560	.444	.307	.060	.487	.947	.720	.752	.707	.652	.517	.391	.112	.595	.985
2.0	.50	.778	.780	.740	.670	.544	.379	.114	.644	.980	.690	.646	.602	.537	.429	.287	.049	.443	.892	.704	.676	.634	.557	.442	.312	.068	.477	.952
2.0	.85	.637	.623	.607	.556	.403	.215	.023	.230	.638	.611	.585	.564	.524	.403	.209	.029	.239	.627	.583	.560	.536	.500	.406	.203	.023	.224	.604

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=1 N=6 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.240	.251	.203	.140	.079	.028	.002	.082	.833	.361	.309	.271	.201	.102	.034	.002	.130	.785	.296	.265	.216	.160	.085	.037	.003	.117	.927
0.5	.50	.289	.271	.212	.154	.080	.040	.003	.137	.931	.369	.307	.240	.164	.087	.037	.003	.103	.784	.340	.287	.237	.176	.099	.040	.002	.126	.854
0.5	.90	.407	.326	.258	.185	.093	.032	.001	.091	.441	.417	.340	.290	.202	.079	.037	.002	.086	.460	.403	.357	.311	.223	.085	.033	.000	.084	.457
2.0	.00	.771	.870	.832	.777	.680	.544	.217	.706	.958	.616	.586	.529	.470	.373	.234	.034	.371	.873	.714	.727	.684	.614	.489	.344	.080	.562	.987
2.0	.50	.756	.744	.687	.629	.513	.354	.099	.598	.980	.647	.602	.564	.508	.410	.259	.038	.389	.851	.672	.636	.596	.535	.433	.270	.058	.463	.936
2.0	.90	.442	.440	.440	.433	.354	.123	.014	.123	.442	.449	.445	.442	.428	.350	.140	.014	.141	.451	.472	.468	.459	.448	.375	.143	.009	.144	.476

C=1 N=6 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.246	.255	.200	.131	.062	.023	.004	.084	.839	.342	.275	.229	.181	.092	.028	.001	.099	.725	.289	.268	.216	.153	.088	.034	.002	.121	.883
0.5	.50	.299	.271	.213	.153	.086	.037	.002	.134	.922	.315	.269	.220	.160	.084	.020	.000	.087	.691	.325	.275	.226	.173	.080	.035	.001	.112	.818
0.5	.90	.396	.324	.269	.196	.082	.022	.000	.065	.453	.400	.340	.296	.211	.099	.041	.001	.078	.497	.350	.301	.254	.196	.078	.030	.003	.058	.438
2.0	.00	.723	.847	.797	.724	.600	.470	.179	.626	.956	.559	.523	.494	.450	.334	.214	.023	.323	.821	.675	.679	.634	.568	.457	.317	.057	.519	.982
2.0	.50	.745	.735	.683	.609	.482	.342	.093	.597	.968	.576	.532	.495	.429	.334	.200	.023	.299	.792	.623	.574	.531	.468	.348	.236	.032	.380	.906
2.0	.90	.477	.472	.464	.439	.337	.140	.007	.145	.479	.471	.449	.437	.415	.335	.164	.013	.168	.489	.446	.428	.411	.390	.326	.160	.013	.175	.473

C=1 N=9 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.286	.335	.274	.205	.112	.057	.010	.112	.452	.363	.390	.293	.202	.089	.043	.006	.216	.937	.336	.375	.287	.188	.092	.036	.008	.168	.880
0.5	.50	.365	.380	.298	.203	.108	.050	.014	.380	.984	.420	.411	.301	.213	.103	.046	.009	.336	.980	.416	.392	.290	.201	.095	.046	.008	.335	.972
2.0	.00	.948	.999	.999	.995	.989	.965	.891	.987	.950	.955	.973	.963	.936	.887	.815	.577	.933	.999	.957	.985	.974	.965	.927	.855	.648	.950	.994
2.0	.50	.983	.956	.940	.904	.820	.719	.449	.856	.995	.978	.954	.930	.900	.817	.697	.430	.841	.994	.973	.955	.936	.907	.828	.713	.403	.863	.991

C=1 N=9 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.312	.314	.247	.173	.101	.049	.005	.110	.592	.472	.369	.297	.199	.096	.034	.005	.206	.934	.397	.317	.239	.159	.087	.048	.009	.151	.907
0.5	.50	.425	.366	.289	.205	.092	.045	.007	.287	.962	.496	.384	.285	.199	.102	.045	.010	.250	.940	.495	.385	.301	.220	.112	.058	.010	.255	.940
0.5	.75	.629	.418	.307	.215	.107	.053	.008	.198	.840	.642	.417	.324	.208	.102	.051	.005	.187	.841	.656	.396	.306	.209	.102	.037	.003	.193	.840
2.0	.00	.913	.987	.983	.974	.955	.910	.714	.953	.948	.913	.897	.864	.828	.742	.619	.341	.808	.997	.933	.950	.930	.905	.826	.727	.409	.872	.989
2.0	.50	.951	.923	.892	.842	.756	.630	.338	.816	.989	.930	.908	.884	.844	.710	.576	.271	.743	.987	.938	.888	.860	.790	.696	.558	.267	.720	.986
2.0	.75	.918	.873	.826	.752	.615	.464	.138	.456	.920	.925	.872	.842	.761	.642	.469	.170	.472	.927	.920	.866	.838	.764	.609	.465	.170	.470	.923

C=1 N=9 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.364	.323	.256	.179	.092	.044	.006	.097	.667	.477	.346	.283	.196	.090	.046	.004	.166	.864	.435	.350	.287	.199	.103	.049	.003	.159	.906
0.5	.50	.416	.315	.250	.172	.096	.042	.006	.216	.957	.525	.377	.297	.209	.101	.045	.007	.184	.862	.473	.341	.270	.188	.107	.049	.004	.179	.871
0.5	.85	.706	.384	.280	.186	.083	.027	.002	.118	.744	.737	.407	.315	.197	.093	.036	.004	.118	.754	.719	.406	.307	.185	.081	.025	.001	.100	.746
2.0	.00	.910	.980	.970	.954	.905	.846	.593	.912	.952	.867	.821	.782	.725	.623	.486	.191	.656	.983	.886	.892	.861	.811	.712	.601	.316	.788	.992
2.0	.50	.931	.900	.868	.823	.731	.607	.322	.790	.990	.888	.823	.788	.729	.628	.489	.179	.629	.961	.902	.834	.798	.738	.615	.489	.203	.649	.976
2.0	.85	.743	.741	.731	.681	.458	.367	.073	.364	.743	.764	.762	.750	.686	.432	.355	.064	.351	.764	.782	.773	.760	.708	.459	.370	.090	.366	.782

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=1 N=9 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.354	.292	.218	.153	.074	.030	.006	.093	.729	.494	.338	.276	.205	.115	.049	.008	.144	.817	.426	.313	.256	.172	.079	.038	.003	.133	.850
0.5	.50	.443	.313	.239	.166	.091	.041	.003	.191	.948	.507	.337	.265	.173	.082	.029	.002	.121	.801	.464	.330	.264	.194	.105	.047	.004	.156	.854
0.5	.85	.615	.391	.310	.203	.103	.040	.003	.101	.686	.604	.363	.284	.200	.085	.030	.002	.080	.660	.609	.379	.284	.187	.083	.032	.005	.085	.671
2.0	.00	.888	.953	.930	.895	.840	.739	.438	.834	.937	.851	.785	.731	.676	.548	.399	.099	.537	.955	.863	.856	.823	.777	.684	.560	.226	.751	.988
2.0	.50	.900	.878	.848	.803	.693	.570	.232	.767	.983	.833	.744	.707	.644	.519	.368	.111	.485	.927	.855	.805	.761	.700	.597	.446	.166	.610	.958
2.0	.85	.763	.726	.690	.618	.467	.306	.069	.287	.764	.753	.708	.682	.622	.479	.315	.089	.303	.764	.736	.692	.660	.612	.476	.306	.077	.299	.744

C=1 N=9 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.353	.271	.222	.158	.085	.046	.002	.096	.742	.474	.323	.271	.198	.092	.046	.006	.112	.728	.418	.293	.249	.190	.106	.051	.004	.127	.835
0.5	.50	.427	.319	.259	.186	.103	.038	.005	.179	.911	.471	.329	.265	.194	.094	.053	.002	.102	.701	.427	.293	.241	.175	.080	.040	.003	.119	.790
0.5	.90	.572	.350	.276	.201	.099	.036	.002	.053	.595	.537	.353	.288	.199	.097	.040	.003	.058	.560	.553	.383	.322	.214	.108	.043	.003	.059	.584
2.0	.00	.880	.927	.902	.876	.800	.699	.385	.819	.951	.766	.690	.652	.604	.483	.333	.083	.434	.896	.836	.796	.748	.693	.572	.435	.171	.639	.982
2.0	.50	.885	.841	.795	.739	.606	.503	.198	.688	.983	.779	.699	.659	.612	.493	.335	.087	.409	.873	.819	.721	.683	.618	.506	.369	.097	.507	.954
2.0	.90	.624	.620	.614	.577	.390	.195	.030	.189	.624	.610	.592	.581	.560	.401	.209	.056	.203	.611	.620	.594	.573	.537	.424	.213	.041	.204	.624

C=1 N=9 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.385	.301	.230	.168	.097	.042	.005	.108	.755	.475	.315	.255	.182	.099	.043	.003	.079	.673	.408	.267	.211	.154	.076	.038	.002	.118	.798
0.5	.50	.431	.307	.252	.181	.097	.033	.003	.152	.876	.444	.323	.270	.215	.116	.040	.004	.089	.628	.431	.299	.239	.174	.088	.034	.005	.098	.747
0.5	.90	.520	.326	.267	.197	.099	.042	.007	.057	.546	.483	.324	.267	.191	.095	.037	.003	.044	.527	.471	.321	.275	.181	.077	.030	.001	.038	.510
2.0	.00	.858	.895	.862	.809	.723	.619	.292	.740	.952	.730	.640	.596	.535	.429	.280	.056	.348	.845	.836	.774	.729	.665	.558	.410	.143	.607	.977
2.0	.50	.864	.808	.774	.719	.610	.475	.173	.690	.982	.709	.608	.568	.520	.399	.257	.046	.308	.822	.797	.733	.674	.603	.488	.330	.089	.477	.924
2.0	.90	.636	.609	.582	.523	.395	.223	.040	.205	.636	.594	.544	.523	.484	.385	.201	.031	.171	.601	.588	.544	.523	.478	.373	.201	.035	.179	.594

C=1 N=12 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.350	.368	.276	.206	.102	.054	.014	.109	.280	.480	.386	.296	.207	.097	.045	.004	.241	.922	.438	.353	.276	.189	.096	.056	.008	.185	.821
0.5	.50	.450	.397	.311	.209	.122	.057	.009	.441	.989	.494	.398	.312	.208	.094	.048	.014	.398	.974	.507	.396	.313	.223	.107	.052	.013	.386	.975
2.0	.00	.985	1.00	1.00	1.00	.999	.993	.962	.998	.955	.989	.993	.984	.971	.939	.906	.751	.967	.998	.987	.996	.990	.986	.972	.948	.808	.980	.990
2.0	.50	.998	.977	.965	.950	.904	.822	.598	.905	.998	.995	.981	.963	.948	.897	.815	.571	.902	.996	.992	.971	.948	.926	.877	.800	.560	.876	.994

C=1 N=12 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.390	.330	.273	.186	.084	.041	.004	.094	.439	.576	.383	.300	.199	.101	.043	.006	.223	.949	.524	.377	.305	.214	.124	.059	.008	.204	.919
0.5	.50	.496	.367	.281	.189	.093	.046	.008	.313	.964	.593	.351	.264	.178	.085	.046	.009	.231	.943	.590	.393	.321	.225	.119	.057	.012	.285	.940
0.5	.75	.738	.396	.290	.181	.100	.057	.008	.171	.856	.747	.414	.320	.201	.090	.041	.011	.186	.822	.741	.402	.302	.198	.085	.047	.007	.181	.809
2.0	.00	.967	.997	.995	.993	.977	.959	.865	.978	.946	.977	.952	.927	.899	.821	.746	.480	.890	.999	.977	.978	.965	.946	.895	.840	.595	.937	.998
2.0	.50	.988	.967	.949	.918	.852	.763	.500	.867	1.00	.971	.933	.910	.878	.778	.682	.399	.786	.991	.981	.947	.920	.880	.793	.684	.402	.811	.995
2.0	.75	.963	.907	.875	.821	.702	.580	.301	.565	.905	.972	.928	.900	.840	.724	.598	.305	.575	.929	.954	.900	.866	.818	.706	.558	.281	.542	.907

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=1 N=12 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.435	.296	.223	.159	.084	.038	.005	.089	.520	.627	.375	.293	.201	.092	.040	.006	.176	.902	.530	.340	.273	.190	.088	.038	.005	.164	.898
0.5	.50	.492	.305	.234	.175	.083	.041	.006	.227	.942	.623	.384	.287	.195	.087	.042	.007	.159	.878	.614	.377	.285	.197	.093	.045	.005	.187	.910
0.5	.85	.833	.413	.312	.194	.104	.036	.003	.092	.596	.802	.411	.308	.216	.097	.046	.009	.091	.558	.814	.387	.290	.195	.086	.037	.003	.086	.539
2.0	.00	.968	.991	.984	.982	.959	.921	.720	.963	.956	.939	.879	.852	.803	.703	.583	.289	.742	.991	.965	.948	.919	.877	.816	.709	.406	.873	.996
2.0	.50	.969	.940	.914	.877	.799	.686	.395	.844	.995	.951	.882	.850	.795	.691	.577	.257	.684	.976	.954	.894	.860	.824	.736	.624	.307	.731	.983
2.0	.85	.859	.844	.812	.720	.544	.406	.116	.250	.842	.851	.835	.807	.715	.568	.455	.120	.264	.830	.856	.829	.798	.730	.549	.438	.134	.255	.822

C=1 N=12 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.429	.311	.239	.162	.079	.042	.005	.092	.612	.600	.365	.283	.197	.099	.043	.004	.119	.806	.547	.337	.258	.190	.090	.047	.006	.145	.870
0.5	.50	.510	.322	.253	.187	.109	.043	.005	.217	.930	.610	.365	.300	.211	.114	.059	.005	.148	.778	.565	.355	.269	.192	.093	.048	.006	.149	.842
0.5	.85	.728	.381	.290	.205	.117	.056	.012	.088	.593	.707	.358	.283	.198	.107	.052	.004	.089	.540	.713	.404	.315	.225	.118	.053	.004	.090	.591
2.0	.00	.933	.972	.959	.932	.900	.843	.605	.909	.932	.925	.821	.784	.724	.608	.492	.183	.587	.964	.933	.901	.873	.832	.754	.634	.310	.808	.992
2.0	.50	.955	.917	.883	.843	.748	.634	.318	.797	.991	.909	.826	.786	.719	.599	.458	.167	.520	.943	.912	.852	.814	.752	.634	.510	.227	.637	.972
2.0	.85	.844	.769	.718	.631	.511	.364	.124	.252	.760	.852	.786	.745	.680	.535	.378	.130	.267	.784	.820	.755	.716	.657	.529	.380	.119	.250	.762

C=1 N=12 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.437	.307	.237	.174	.095	.044	.005	.111	.660	.608	.360	.294	.214	.108	.042	.005	.109	.735	.505	.316	.260	.194	.110	.046	.004	.139	.841
0.5	.50	.508	.305	.238	.174	.094	.040	.003	.173	.908	.589	.325	.259	.182	.082	.046	.004	.088	.708	.541	.301	.247	.179	.093	.039	.006	.110	.788
0.5	.90	.680	.377	.299	.196	.085	.037	.001	.033	.409	.666	.388	.304	.204	.100	.050	.004	.055	.424	.632	.386	.316	.235	.121	.047	.005	.049	.434
2.0	.00	.940	.957	.934	.912	.857	.777	.522	.863	.952	.870	.760	.712	.648	.529	.394	.134	.445	.929	.918	.870	.838	.792	.677	.563	.238	.747	.991
2.0	.50	.945	.900	.863	.809	.715	.596	.284	.765	.989	.866	.749	.690	.627	.506	.359	.108	.398	.889	.886	.783	.737	.668	.572	.438	.176	.561	.963
2.0	.90	.723	.710	.684	.628	.420	.295	.083	.147	.703	.709	.685	.656	.598	.439	.283	.092	.158	.681	.708	.672	.654	.605	.445	.288	.091	.166	.670

C=1 N=12 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.470	.290	.226	.169	.090	.043	.005	.103	.699	.559	.317	.261	.197	.107	.049	.005	.081	.640	.525	.328	.273	.201	.099	.047	.004	.116	.848
0.5	.50	.495	.313	.263	.173	.098	.043	.002	.152	.904	.563	.319	.260	.182	.108	.043	.004	.080	.632	.559	.340	.274	.197	.097	.045	.006	.107	.785
0.5	.90	.638	.351	.289	.193	.094	.051	.007	.052	.425	.605	.365	.304	.204	.095	.043	.004	.040	.442	.585	.343	.282	.196	.093	.049	.002	.046	.412
2.0	.00	.942	.950	.926	.899	.824	.740	.471	.838	.955	.830	.705	.667	.605	.490	.347	.093	.374	.861	.883	.803	.760	.710	.618	.497	.181	.668	.983
2.0	.50	.930	.849	.819	.769	.673	.561	.227	.736	.985	.817	.689	.640	.586	.481	.317	.087	.325	.830	.880	.774	.735	.678	.555	.415	.136	.508	.945
2.0	.90	.713	.672	.640	.575	.425	.286	.074	.151	.666	.710	.652	.621	.569	.437	.257	.051	.139	.654	.706	.647	.611	.568	.443	.252	.061	.148	.643

C=1 N=16 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.438	.354	.279	.202	.102	.053	.007	.092	.161	.565	.393	.307	.216	.100	.058	.012	.293	.900	.542	.371	.287	.196	.111	.054	.010	.223	.801
0.5	.50	.535	.387	.303	.205	.110	.062	.014	.482	.986	.586	.411	.291	.200	.111	.052	.004	.459	.976	.595	.400	.292	.204	.103	.062	.007	.447	.978
2.0	.00	.996	1.00	1.00	1.00	1.00	1.00	.997	1.00	.957	.994	.995	.992	.989	.975	.956	.872	.989	.999	.993	.997	.996	.990	.983	.973	.924	.988	.995
2.0	.50	1.00	.990	.982	.973	.950	.910	.761	.945	1.00	.999	.988	.982	.959	.925	.875	.714	.932	.998	.998	.987	.976	.962	.928	.885	.734	.922	.999

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=1 N=16 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.502	.331	.258	.173	.099	.061	.007	.103	.291	.682	.401	.319	.219	.113	.057	.009	.279	.937	.628	.378	.304	.209	.108	.050	.008	.217	.870
0.5	.50	.596	.379	.291	.202	.112	.058	.011	.371	.966	.736	.394	.296	.213	.092	.041	.006	.276	.935	.691	.400	.308	.205	.100	.047	.009	.290	.950
0.5	.75	.804	.401	.314	.229	.098	.051	.007	.197	.805	.809	.389	.308	.206	.093	.046	.004	.173	.783	.849	.404	.300	.218	.103	.038	.005	.187	.794
2.0	.00	.990	.997	.997	.996	.993	.987	.939	.992	.957	.994	.981	.976	.957	.919	.851	.623	.956	.998	.997	.995	.991	.980	.961	.925	.753	.982	1.00
2.0	.50	.997	.984	.975	.957	.920	.850	.659	.925	.999	.992	.971	.952	.929	.866	.778	.528	.862	.996	.995	.960	.947	.928	.871	.790	.566	.875	.997
2.0	.75	.992	.950	.927	.886	.805	.697	.404	.599	.946	.987	.950	.920	.873	.789	.672	.413	.563	.928	.987	.941	.917	.876	.781	.690	.394	.607	.924

C=1 N=16 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.541	.327	.265	.188	.110	.047	.009	.112	.420	.700	.375	.298	.204	.106	.057	.009	.195	.872	.636	.335	.252	.179	.094	.044	.006	.170	.868
0.5	.50	.629	.364	.294	.209	.110	.053	.009	.300	.947	.725	.347	.276	.196	.107	.060	.014	.155	.834	.693	.392	.305	.194	.096	.046	.004	.193	.872
0.5	.85	.892	.405	.319	.204	.101	.043	.003	.085	.576	.898	.420	.307	.212	.099	.050	.009	.079	.604	.908	.398	.306	.206	.111	.049	.002	.090	.600
2.0	.00	.984	.994	.991	.985	.978	.962	.849	.978	.953	.979	.922	.905	.864	.785	.688	.425	.813	.992	.980	.971	.955	.940	.897	.837	.581	.935	.998
2.0	.50	.991	.965	.948	.923	.871	.799	.557	.885	.995	.972	.918	.899	.860	.784	.671	.384	.736	.976	.982	.932	.912	.873	.807	.717	.423	.799	.988
2.0	.85	.926	.899	.847	.772	.657	.489	.199	.285	.719	.935	.904	.868	.794	.710	.520	.244	.337	.755	.928	.896	.861	.787	.675	.478	.201	.297	.731

C=1 N=16 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.559	.322	.240	.173	.096	.036	.005	.094	.504	.705	.367	.267	.186	.096	.045	.007	.119	.776	.621	.333	.262	.179	.082	.042	.004	.144	.845
0.5	.50	.618	.330	.268	.181	.087	.039	.006	.226	.924	.716	.375	.289	.210	.113	.052	.008	.128	.729	.680	.358	.281	.200	.107	.054	.007	.160	.822
0.5	.85	.808	.391	.304	.220	.123	.060	.007	.079	.543	.821	.396	.309	.203	.103	.060	.009	.076	.540	.812	.405	.311	.210	.092	.045	.006	.061	.539
2.0	.00	.976	.986	.981	.966	.949	.907	.747	.949	.948	.973	.895	.868	.814	.710	.579	.294	.656	.979	.968	.943	.925	.890	.824	.739	.467	.877	.996
2.0	.50	.982	.948	.929	.899	.831	.732	.457	.860	.995	.962	.874	.848	.790	.682	.550	.257	.596	.952	.967	.902	.868	.822	.733	.627	.338	.732	.974
2.0	.85	.926	.850	.800	.734	.615	.478	.195	.285	.720	.905	.830	.773	.721	.576	.449	.193	.277	.705	.909	.841	.805	.739	.611	.451	.177	.282	.716

C=1 N=16 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.531	.287	.224	.156	.080	.038	.004	.084	.520	.676	.354	.286	.209	.108	.046	.007	.094	.683	.621	.331	.268	.202	.103	.045	.005	.130	.820
0.5	.50	.642	.331	.273	.200	.102	.056	.007	.209	.906	.667	.352	.278	.192	.099	.048	.004	.079	.636	.675	.359	.291	.201	.113	.053	.004	.123	.746
0.5	.90	.787	.387	.302	.211	.097	.044	.004	.033	.415	.760	.390	.303	.197	.097	.048	.004	.034	.419	.750	.381	.288	.212	.114	.052	.012	.045	.399
2.0	.00	.978	.984	.978	.961	.924	.880	.691	.938	.960	.935	.804	.769	.710	.599	.473	.221	.499	.914	.952	.892	.869	.820	.750	.652	.337	.791	.996
2.0	.50	.973	.932	.913	.872	.792	.677	.397	.830	.995	.915	.787	.756	.695	.582	.455	.180	.432	.876	.955	.874	.849	.801	.705	.565	.256	.657	.968
2.0	.90	.803	.772	.728	.655	.506	.380	.128	.190	.504	.799	.744	.714	.639	.485	.357	.125	.168	.493	.813	.758	.725	.665	.510	.360	.111	.167	.524

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=1 N=16 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.543	.306	.249	.184	.112	.056	.003	.108	.576	.652	.327	.262	.190	.095	.038	.003	.058	.576	.629	.311	.264	.173	.086	.035	.002	.108	.771
0.5	.50	.611	.302	.250	.168	.087	.042	.005	.144	.858	.663	.336	.273	.199	.100	.044	.006	.064	.555	.647	.314	.245	.179	.086	.037	.005	.094	.705
0.5	.90	.721	.351	.280	.185	.095	.045	.004	.025	.383	.700	.346	.279	.189	.093	.037	.003	.018	.359	.707	.370	.296	.221	.095	.046	.011	.029	.356
2.0	.00	.973	.980	.966	.944	.900	.841	.598	.905	.957	.897	.753	.709	.649	.535	.399	.127	.372	.866	.954	.857	.820	.766	.682	.574	.275	.722	.987
2.0	.50	.976	.898	.869	.823	.738	.634	.352	.787	.994	.896	.742	.695	.635	.513	.393	.144	.342	.836	.932	.825	.785	.718	.606	.491	.195	.560	.951
2.0	.90	.810	.745	.714	.642	.493	.346	.106	.158	.533	.784	.700	.663	.611	.456	.304	.099	.138	.504	.793	.708	.672	.611	.466	.329	.099	.155	.507

C=4N=4 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.035	.336	.261	.176	.088	.045	.018	.084	.687	.029	.403	.307	.221	.122	.082	.043	.126	.814	.030	.377	.291	.204	.095	.059	.031	.107	.797
0.5	.50	.026	.374	.280	.211	.113	.073	.033	.156	.852	.019	.390	.295	.204	.125	.073	.039	.177	.868	.013	.398	.301	.202	.117	.076	.042	.178	.850
2.0	.00	.835	1.00	1.00	1.00	.997	.991	.890	.997	.960	.857	.994	.988	.984	.966	.924	.674	.977	.983	.840	.996	.994	.993	.980	.946	.739	.983	.976
2.0	.50	.887	.994	.989	.978	.943	.845	.631	.989	.990	.886	.982	.976	.958	.909	.823	.572	.974	.994	.891	.989	.979	.955	.897	.795	.540	.965	.995

C=14N=4 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.070	.331	.255	.188	.100	.059	.029	.106	.753	.089	.383	.292	.183	.103	.058	.020	.136	.931	.072	.381	.288	.195	.104	.054	.015	.126	.871
0.5	.50	.091	.354	.292	.206	.120	.066	.024	.161	.889	.089	.385	.303	.205	.110	.064	.029	.187	.930	.067	.364	.277	.187	.097	.052	.026	.174	.925
0.5	.75	.055	.385	.293	.197	.117	.074	.036	.339	.939	.059	.394	.300	.205	.107	.074	.042	.358	.932	.056	.379	.268	.183	.104	.065	.030	.312	.947
2.0	.00	.788	.999	.997	.993	.983	.964	.762	.983	.966	.820	.964	.952	.931	.860	.737	.436	.905	.994	.821	.983	.979	.966	.923	.858	.568	.939	.982
2.0	.50	.855	.976	.964	.947	.890	.791	.512	.960	.985	.870	.967	.953	.923	.837	.683	.360	.928	.996	.839	.974	.963	.927	.832	.704	.408	.930	.992
2.0	.75	.884	.939	.911	.864	.742	.560	.283	.900	.987	.885	.954	.924	.861	.723	.543	.267	.914	.991	.889	.933	.904	.846	.695	.518	.243	.877	.989

C=4 N=4 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.093	.295	.240	.172	.096	.047	.010	.101	.769	.133	.354	.283	.194	.085	.043	.018	.162	.963	.117	.332	.267	.181	.091	.045	.015	.112	.898
0.5	.50	.102	.319	.241	.172	.097	.050	.021	.144	.918	.136	.362	.260	.180	.094	.050	.015	.201	.967	.128	.342	.255	.170	.078	.038	.016	.153	.956
0.5	.85	.129	.401	.303	.179	.076	.050	.038	.394	.914	.121	.396	.283	.174	.080	.058	.046	.415	.907	.126	.378	.274	.160	.081	.046	.036	.371	.906
2.0	.00	.764	.994	.992	.982	.963	.904	.653	.964	.957	.814	.945	.910	.868	.771	.611	.296	.836	.991	.797	.969	.952	.927	.868	.762	.427	.889	.985
2.0	.50	.832	.966	.959	.935	.846	.735	.422	.928	.991	.808	.915	.883	.832	.720	.573	.268	.842	.988	.810	.925	.902	.855	.754	.610	.279	.857	.993
2.0	.85	.893	.888	.833	.751	.525	.327	.129	.668	.922	.886	.886	.845	.757	.538	.355	.143	.677	.917	.880	.882	.836	.761	.554	.339	.140	.683	.913

C=4 N=4 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.107	.321	.249	.176	.090	.041	.013	.098	.844	.192	.371	.277	.181	.077	.033	.009	.194	.975	.149	.328	.258	.178	.090	.041	.014	.122	.929
0.5	.50	.119	.321	.241	.165	.076	.039	.014	.134	.918	.188	.351	.273	.180	.082	.036	.011	.197	.977	.177	.349	.270	.175	.082	.039	.009	.176	.958
0.5	.85	.195	.364	.279	.187	.087	.036	.010	.328	.927	.211	.404	.317	.212	.096	.052	.017	.351	.918	.212	.368	.298	.209	.084	.037	.016	.327	.920
2.0	.00	.762	.987	.979	.971	.943	.872	.586	.948	.964	.762	.875	.840	.783	.656	.462	.171	.761	.995	.749	.933	.909	.864	.777	.628	.306	.811	.978
2.0	.50	.791	.947	.920	.878	.784	.664	.340	.890	.990	.801	.887	.853	.793	.668	.491	.163	.810	.997	.762	.897	.863	.817	.697	.511	.211	.820	.995
2.0	.85	.819	.826	.782	.710	.549	.355	.121	.668	.928	.824	.833	.796	.731	.568	.342	.111	.690	.929	.828	.842	.797	.738	.552	.332	.109	.696	.936

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=4 N=4 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.116	.279	.220	.154	.082	.038	.008	.091	.834	.242	.376	.295	.196	.090	.033	.008	.219	.975	.171	.303	.246	.174	.082	.038	.008	.126	.932
0.5	.50	.140	.308	.239	.166	.083	.042	.009	.134	.934	.236	.362	.287	.201	.097	.042	.009	.239	.978	.183	.327	.255	.168	.083	.038	.010	.165	.980
0.5	.90	.260	.371	.289	.188	.083	.038	.013	.315	.806	.291	.403	.304	.189	.080	.032	.010	.330	.822	.284	.376	.278	.173	.078	.029	.009	.295	.803
2.0	.00	.749	.979	.974	.952	.902	.829	.517	.909	.970	.712	.808	.763	.697	.573	.406	.125	.712	.992	.728	.903	.871	.834	.715	.568	.241	.770	.983
2.0	.50	.753	.928	.901	.857	.756	.629	.306	.853	.988	.736	.806	.769	.714	.582	.371	.125	.720	.994	.750	.871	.828	.770	.642	.488	.193	.757	.996
2.0	.90	.784	.780	.744	.675	.510	.278	.074	.574	.826	.786	.782	.732	.671	.495	.255	.067	.569	.826	.773	.764	.730	.665	.488	.251	.050	.574	.824

C=4 N=4 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.125	.263	.210	.148	.079	.038	.007	.090	.849	.277	.358	.291	.202	.096	.040	.007	.226	.964	.174	.302	.236	.173	.087	.037	.009	.131	.938
0.5	.50	.162	.303	.240	.173	.085	.039	.008	.146	.945	.251	.339	.261	.182	.082	.034	.007	.205	.957	.233	.336	.286	.198	.108	.043	.010	.192	.969
0.5	.90	.297	.371	.293	.196	.070	.024	.007	.276	.823	.307	.376	.288	.198	.076	.033	.009	.266	.800	.307	.382	.297	.182	.066	.029	.009	.265	.813
2.0	.00	.711	.966	.953	.929	.856	.768	.441	.865	.959	.680	.751	.714	.655	.512	.330	.086	.664	.994	.709	.859	.832	.780	.671	.519	.171	.729	.984
2.0	.50	.737	.907	.871	.825	.728	.559	.238	.814	.990	.699	.753	.704	.640	.519	.319	.075	.657	.981	.690	.798	.765	.699	.573	.410	.134	.713	.992
2.0	.90	.721	.718	.684	.626	.442	.244	.056	.544	.814	.716	.720	.686	.627	.458	.236	.047	.543	.833	.695	.696	.660	.603	.445	.239	.054	.539	.800

C=4 N=6 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.048	.336	.262	.185	.092	.039	.013	.087	.315	.042	.390	.305	.203	.103	.056	.022	.122	.604	.043	.391	.293	.196	.088	.045	.018	.098	.572
0.5	.50	.047	.401	.309	.209	.120	.060	.028	.205	.685	.024	.383	.308	.214	.106	.062	.030	.210	.741	.027	.407	.306	.212	.111	.064	.021	.213	.769
2.0	.00	.928	1.00	1.00	1.00	1.00	.999	.993	1.00	.965	.961	1.00	1.00	1.00	.997	.994	.918	.999	.986	.940	1.00	1.00	1.00	1.00	.993	.931	.998	.981
2.0	.50	.964	.999	.998	.995	.981	.947	.803	.997	.992	.966	.998	.996	.988	.973	.941	.783	.996	.998	.962	.999	.998	.995	.985	.951	.781	.999	.995

C=4 N=6 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.091	.368	.288	.193	.105	.058	.020	.111	.481	.106	.369	.285	.187	.089	.044	.013	.129	.843	.113	.364	.278	.182	.091	.046	.008	.111	.738
0.5	.50	.089	.378	.293	.205	.108	.049	.011	.174	.805	.112	.382	.293	.206	.118	.073	.019	.231	.900	.122	.390	.300	.198	.100	.053	.018	.214	.899
0.5	.75	.075	.390	.298	.209	.114	.066	.026	.457	.944	.090	.398	.311	.207	.101	.054	.022	.434	.951	.088	.409	.303	.194	.100	.051	.022	.446	.960
2.0	.00	.906	1.00	1.00	1.00	.998	.996	.966	.999	.963	.930	.991	.984	.978	.960	.913	.693	.966	.992	.923	.997	.996	.991	.977	.960	.810	.978	.978
2.0	.50	.937	.994	.992	.982	.965	.916	.715	.995	.992	.943	.985	.979	.966	.916	.852	.594	.972	.997	.947	.996	.987	.977	.946	.884	.642	.984	.996
2.0	.75	.952	.967	.951	.924	.848	.753	.429	.941	.998	.960	.973	.960	.942	.879	.770	.431	.953	.999	.964	.971	.960	.931	.851	.741	.408	.941	1.00

C=4 N=6 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.134	.347	.274	.187	.109	.062	.009	.119	.554	.200	.385	.292	.206	.099	.040	.010	.183	.906	.158	.336	.268	.188	.096	.053	.006	.133	.805
0.5	.50	.186	.383	.293	.210	.097	.048	.010	.176	.844	.212	.385	.294	.195	.095	.042	.008	.234	.958	.198	.376	.299	.203	.093	.049	.007	.212	.938
0.5	.85	.175	.363	.264	.163	.087	.050	.023	.406	.970	.178	.389	.292	.204	.091	.043	.014	.435	.975	.196	.418	.308	.203	.107	.048	.019	.445	.968
2.0	.00	.889	.997	.997	.997	.990	.983	.891	.993	.968	.907	.975	.957	.929	.885	.805	.514	.923	.994	.893	.993	.987	.976	.941	.895	.658	.952	.981
2.0	.50	.911	.989	.983	.963	.936	.887	.642	.977	.997	.917	.963	.950	.923	.860	.771	.455	.941	.997	.926	.976	.967	.948	.898	.810	.531	.956	.999
2.0	.85	.980	.941	.913	.854	.710	.534	.204	.837	.984	.953	.913	.885	.834	.685	.517	.186	.818	.972	.974	.944	.914	.869	.744	.565	.204	.854	.983

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further.

C=4 N=6 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.159	.305	.235	.161	.082	.037	.006	.089	.639	.274	.384	.306	.212	.098	.053	.014	.230	.977	.224	.351	.273	.185	.083	.046	.010	.125	.847
0.5	.50	.201	.350	.272	.183	.093	.050	.006	.175	.888	.283	.373	.293	.211	.105	.040	.010	.258	.983	.236	.339	.272	.187	.097	.052	.005	.209	.949
0.5	.85	.270	.399	.307	.204	.102	.045	.012	.394	.972	.290	.366	.281	.182	.071	.033	.007	.338	.969	.308	.386	.308	.197	.087	.040	.012	.360	.963
2.0	.00	.862	.998	.995	.994	.988	.965	.797	.988	.957	.867	.923	.901	.871	.791	.668	.328	.863	.994	.875	.983	.969	.950	.908	.835	.533	.924	.984
2.0	.50	.887	.978	.972	.948	.897	.814	.528	.944	.992	.886	.938	.914	.874	.774	.631	.315	.885	.997	.887	.942	.921	.891	.817	.716	.393	.894	.995
2.0	.85	.924	.901	.878	.812	.668	.523	.202	.791	.978	.917	.896	.863	.805	.684	.526	.195	.774	.979	.923	.898	.872	.822	.700	.544	.198	.786	.980

C=4 N=6 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.182	.332	.260	.195	.110	.048	.007	.122	.687	.316	.359	.280	.193	.106	.051	.008	.221	.984	.254	.354	.279	.207	.104	.046	.011	.168	.896
0.5	.50	.194	.308	.249	.182	.104	.050	.005	.158	.882	.315	.355	.283	.194	.085	.032	.008	.238	.986	.292	.352	.281	.199	.115	.048	.010	.215	.958
0.5	.90	.372	.378	.311	.199	.092	.041	.005	.298	.912	.387	.407	.308	.204	.090	.037	.007	.314	.934	.376	.366	.273	.174	.081	.036	.006	.258	.915
2.0	.00	.852	.993	.989	.982	.970	.933	.738	.970	.959	.843	.884	.851	.799	.692	.531	.234	.808	.994	.854	.953	.939	.914	.862	.764	.434	.883	.981
2.0	.50	.862	.968	.956	.929	.862	.774	.469	.937	.996	.886	.896	.867	.824	.722	.555	.212	.837	.998	.865	.917	.898	.860	.770	.632	.288	.868	.997
2.0	.90	.885	.844	.796	.735	.582	.408	.099	.640	.910	.880	.841	.813	.743	.584	.397	.102	.645	.913	.882	.832	.794	.714	.572	.394	.099	.613	.917

C=4 N=6 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.185	.305	.248	.184	.101	.042	.006	.109	.689	.366	.371	.295	.200	.103	.040	.005	.230	.975	.272	.325	.245	.183	.095	.040	.004	.145	.916
0.5	.50	.208	.318	.239	.175	.087	.035	.008	.157	.899	.355	.380	.307	.210	.102	.047	.007	.258	.980	.302	.342	.275	.191	.084	.039	.004	.181	.969
0.5	.90	.395	.390	.301	.200	.100	.041	.005	.289	.916	.402	.366	.298	.196	.082	.033	.005	.255	.895	.396	.368	.280	.180	.083	.031	.005	.248	.871
2.0	.00	.856	.991	.991	.985	.962	.921	.699	.969	.967	.822	.839	.805	.750	.650	.496	.174	.755	.992	.835	.931	.908	.871	.789	.680	.359	.829	.987
2.0	.50	.856	.956	.941	.910	.839	.743	.398	.915	.990	.844	.850	.820	.777	.655	.495	.170	.768	.994	.828	.889	.855	.803	.698	.583	.259	.819	.999
2.0	.90	.870	.820	.774	.707	.557	.404	.113	.625	.916	.865	.828	.786	.721	.577	.411	.111	.621	.935	.830	.791	.754	.673	.540	.369	.105	.570	.922

C=4 N=9 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.093	.390	.311	.214	.124	.071	.016	.126	.106	.074	.416	.317	.215	.112	.063	.017	.141	.376	.068	.379	.290	.199	.109	.056	.012	.120	.287
0.5	.50	.076	.400	.311	.202	.110	.069	.017	.249	.575	.047	.411	.313	.224	.116	.063	.022	.287	.663	.040	.428	.329	.220	.113	.061	.022	.269	.671
2.0	.00	.981	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.963	.988	1.00	1.00	1.00	.998	.998	.990	.999	.989	.988	1.00	1.00	1.00	1.00	.999	.997	1.00	.987
2.0	.50	.994	1.00	1.00	1.00	.999	.997	.962	1.00	.999	.993	1.00	1.00	1.00	.997	.992	.951	1.00	.998	.990	1.00	1.00	.999	.997	.995	.955	1.00	.998

C=4 N=9 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.153	.364	.281	.201	.111	.053	.009	.109	.239	.179	.390	.290	.206	.095	.053	.014	.165	.744	.188	.384	.311	.218	.093	.055	.014	.125	.571
0.5	.50	.156	.365	.267	.184	.101	.049	.011	.213	.746	.160	.387	.288	.209	.114	.055	.015	.292	.879	.177	.369	.288	.190	.093	.045	.010	.247	.868
0.5	.75	.130	.398	.312	.204	.094	.046	.011	.591	.983	.120	.386	.287	.190	.101	.047	.019	.595	.973	.118	.400	.296	.185	.084	.046	.010	.573	.982
2.0	.00	.968	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.954	.982	1.00	1.00	.996	.988	.972	.917	.995	.995	.978	1.00	.999	.999	.996	.991	.969	.997	.988
2.0	.50	.989	.999	.998	.996	.991	.982	.924	.999	.998	.990	.995	.995	.992	.978	.956	.857	.997	.998	.990	.997	.997	.993	.981	.966	.877	.997	1.00
2.0	.75	.991	.991	.986	.982	.956	.911	.698	.984	1.00	.992	.994	.989	.977	.946	.897	.697	.990	1.00	.993	.996	.993	.988	.967	.911	.683	.992	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=4 N=9 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.216	.348	.264	.180	.106	.051	.008	.109	.341	.278	.360	.270	.190	.090	.036	.003	.206	.912	.250	.373	.307	.221	.115	.050	.008	.167	.716
0.5	.50	.217	.368	.277	.200	.115	.067	.016	.216	.818	.280	.402	.296	.196	.092	.053	.017	.319	.968	.268	.374	.297	.192	.088	.040	.010	.246	.907
0.5	.85	.253	.408	.302	.200	.094	.042	.008	.502	.989	.247	.383	.282	.186	.089	.046	.013	.497	.984	.247	.404	.313	.204	.095	.046	.008	.529	.988
2.0	.00	.964	1.00	1.00	1.00	1.00	.999	.991	1.00	.958	.963	.987	.979	.970	.951	.909	.753	.973	.993	.970	.999	.997	.994	.986	.965	.895	.989	.981
2.0	.50	.967	1.00	.997	.995	.979	.962	.871	.997	.994	.974	.987	.979	.967	.941	.891	.717	.977	1.00	.971	.989	.985	.979	.962	.925	.768	.985	.998
2.0	.85	.995	.977	.956	.930	.851	.746	.443	.885	.998	.992	.967	.948	.914	.841	.743	.447	.874	.998	.991	.971	.954	.931	.869	.760	.447	.891	.995

C=4 N=9 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.236	.349	.263	.168	.096	.048	.008	.100	.426	.355	.360	.287	.208	.097	.056	.009	.274	.963	.301	.348	.274	.186	.094	.047	.004	.146	.776
0.5	.50	.268	.360	.273	.183	.098	.045	.008	.196	.851	.364	.365	.269	.178	.088	.040	.004	.301	.988	.342	.366	.295	.207	.107	.046	.008	.254	.947
0.5	.85	.380	.384	.305	.214	.110	.066	.013	.432	.989	.415	.376	.286	.177	.092	.039	.009	.406	.979	.416	.401	.316	.211	.085	.041	.012	.428	.972
2.0	.00	.957	1.00	1.00	1.00	.999	.998	.960	.999	.962	.963	.981	.966	.944	.889	.827	.561	.948	.999	.957	.993	.991	.982	.956	.921	.769	.964	.989
2.0	.50	.966	.996	.993	.984	.964	.926	.781	.992	.993	.962	.961	.952	.932	.869	.792	.551	.953	.997	.962	.980	.970	.955	.925	.866	.636	.964	.999
2.0	.85	.981	.954	.935	.905	.825	.725	.417	.879	1.00	.975	.954	.938	.901	.806	.698	.382	.868	.997	.965	.935	.918	.886	.796	.684	.379	.858	.998

C=4 N=9 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.253	.321	.266	.205	.111	.051	.012	.131	.471	.431	.366	.294	.209	.113	.048	.011	.281	.979	.329	.335	.265	.190	.095	.044	.007	.158	.825
0.5	.50	.302	.360	.270	.181	.102	.044	.010	.194	.888	.436	.385	.302	.218	.116	.064	.011	.310	.982	.371	.377	.289	.192	.105	.048	.005	.253	.953
0.5	.90	.487	.394	.304	.198	.092	.044	.004	.308	.947	.498	.372	.280	.179	.091	.040	.007	.309	.927	.527	.410	.305	.207	.112	.062	.009	.332	.943
2.0	.00	.930	1.00	1.00	.998	.989	.981	.917	.989	.951	.943	.946	.928	.905	.826	.734	.460	.914	1.00	.957	.986	.983	.969	.932	.884	.676	.943	.987
2.0	.50	.964	.992	.987	.978	.944	.909	.731	.983	.992	.933	.934	.912	.879	.797	.703	.411	.903	.999	.945	.960	.941	.921	.877	.805	.521	.938	1.00
2.0	.90	.967	.916	.888	.836	.717	.584	.282	.689	.975	.972	.919	.878	.836	.712	.554	.242	.684	.987	.963	.899	.873	.804	.680	.547	.254	.656	.975

C=4 N=9 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.287	.344	.266	.196	.104	.048	.006	.103	.557	.476	.374	.298	.207	.103	.047	.008	.267	.969	.362	.337	.268	.187	.086	.038	.009	.165	.889
0.5	.50	.274	.311	.240	.166	.083	.042	.004	.163	.881	.484	.378	.310	.222	.109	.051	.008	.276	.972	.400	.355	.278	.205	.109	.050	.009	.237	.962
0.5	.90	.510	.377	.301	.212	.113	.058	.007	.309	.930	.578	.406	.307	.202	.105	.044	.007	.292	.925	.538	.390	.298	.210	.112	.056	.003	.276	.934
2.0	.00	.958	.998	.998	.997	.991	.971	.897	.991	.964	.925	.901	.879	.834	.745	.620	.332	.839	.996	.937	.978	.973	.959	.912	.837	.584	.934	.986
2.0	.50	.938	.982	.972	.958	.922	.884	.664	.970	.993	.920	.893	.873	.838	.744	.614	.326	.842	.998	.927	.938	.919	.885	.832	.742	.474	.906	1.00
2.0	.90	.960	.894	.872	.813	.702	.553	.239	.685	.979	.936	.865	.839	.788	.674	.541	.236	.682	.972	.937	.876	.845	.788	.681	.531	.244	.671	.970

C=4 N=12 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.118	.381	.300	.209	.107	.055	.014	.108	.030	.087	.412	.311	.192	.107	.055	.013	.134	.231	.088	.397	.308	.212	.115	.066	.013	.132	.129
0.5	.50	.066	.404	.295	.186	.092	.049	.016	.302	.586	.062	.406	.300	.201	.107	.053	.012	.343	.669	.048	.392	.296	.203	.113	.062	.018	.326	.672
2.0	.00	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.974	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.995	.998	1.00	1.00	1.00	1.00	1.00	.999	1.00	.987
2.0	.50	1.00	1.00	1.00	1.00	1.00	.999	.994	1.00	.999	1.00	1.00	1.00	1.00	1.00	.999	.992	1.00	.998	.999	1.00	1.00	1.00	1.00	.999	.990	1.00	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=4 N=12 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.185	.342	.266	.185	.083	.050	.010	.092	.095	.248	.401	.320	.202	.101	.055	.016	.199	.660	.228	.385	.287	.201	.108	.052	.006	.143	.396
0.5	.50	.214	.374	.306	.218	.126	.059	.014	.303	.692	.210	.402	.314	.208	.108	.051	.015	.358	.879	.214	.407	.294	.188	.094	.049	.009	.321	.852
0.5	.75	.172	.422	.319	.219	.116	.055	.016	.739	.988	.136	.375	.286	.189	.102	.055	.016	.699	.991	.160	.437	.326	.213	.102	.048	.013	.739	.987
2.0	.00	.992	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.964	.998	1.00	1.00	1.00	.999	.999	.978	1.00	.999	.998	1.00	1.00	1.00	1.00	.998	.992	1.00	.990
2.0	.50	.994	1.00	1.00	1.00	.999	.997	.983	1.00	.996	.992	1.00	1.00	1.00	.994	.982	.926	1.00	1.00	.996	1.00	1.00	.998	.997	.990	.957	1.00	.998
2.0	.75	.999	.999	.997	.994	.987	.971	.865	.995	1.00	.998	.999	.998	.996	.989	.976	.875	.997	1.00	.999	.996	.995	.994	.984	.967	.871	.994	1.00

C=4 N=12 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.250	.368	.269	.193	.109	.057	.009	.112	.184	.354	.372	.277	.184	.084	.036	.007	.252	.911	.318	.361	.275	.195	.093	.050	.012	.143	.598
0.5	.50	.332	.389	.299	.203	.111	.063	.014	.245	.764	.346	.368	.280	.186	.097	.056	.012	.367	.968	.353	.385	.296	.212	.114	.056	.009	.324	.921
0.5	.85	.309	.380	.286	.180	.102	.053	.016	.579	.997	.333	.385	.288	.211	.105	.046	.011	.577	.991	.320	.408	.308	.202	.088	.045	.007	.566	.996
2.0	.00	.989	1.00	1.00	1.00	1.00	1.00	.999	1.00	.962	.992	.998	.996	.994	.982	.959	.878	.993	1.00	.992	1.00	1.00	1.00	.998	.994	.971	1.00	.992
2.0	.50	.992	1.00	1.00	.999	.995	.992	.963	.999	.995	.991	.996	.992	.984	.969	.954	.860	.994	1.00	.993	.998	.997	.994	.980	.965	.878	.996	1.00
2.0	.85	.999	.989	.978	.960	.918	.860	.631	.930	.997	1.00	.987	.977	.960	.909	.855	.607	.917	.998	.999	.989	.983	.963	.926	.871	.656	.936	.998

C=4 N=12 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.290	.322	.257	.191	.089	.041	.008	.101	.261	.457	.392	.304	.207	.109	.049	.009	.306	.964	.373	.358	.284	.197	.112	.050	.006	.181	.735
0.5	.50	.358	.370	.294	.194	.106	.047	.010	.242	.821	.470	.399	.308	.217	.099	.042	.010	.377	.990	.441	.367	.276	.188	.099	.056	.012	.292	.960
0.5	.85	.487	.404	.300	.218	.123	.060	.011	.506	.987	.504	.383	.294	.196	.093	.045	.010	.465	.981	.491	.420	.314	.219	.116	.051	.007	.494	.990
2.0	.00	.984	1.00	1.00	1.00	1.00	.999	.991	1.00	.961	.989	.983	.980	.976	.949	.897	.744	.979	1.00	.984	.998	.998	.996	.986	.974	.897	.994	.992
2.0	.50	.989	.999	.999	.997	.992	.987	.922	1.00	.995	.984	.981	.977	.967	.935	.877	.683	.978	1.00	.985	.995	.990	.980	.960	.920	.786	.995	1.00
2.0	.85	.991	.975	.964	.938	.892	.823	.586	.923	.999	.987	.972	.963	.935	.883	.813	.557	.906	.995	.993	.977	.966	.938	.881	.806	.561	.905	.998

C=4 N=12 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.311	.325	.253	.183	.092	.053	.010	.095	.323	.520	.363	.276	.187	.093	.039	.008	.310	.983	.431	.341	.267	.194	.102	.054	.010	.169	.809
0.5	.50	.398	.365	.285	.197	.094	.046	.006	.231	.849	.525	.373	.280	.198	.108	.047	.005	.325	.979	.486	.374	.308	.214	.112	.051	.010	.301	.966
0.5	.90	.597	.399	.309	.191	.094	.048	.007	.359	.954	.651	.401	.302	.203	.094	.045	.007	.327	.944	.619	.400	.316	.205	.088	.041	.007	.369	.955
2.0	.00	.977	1.00	1.00	1.00	1.00	.997	.978	1.00	.959	.984	.975	.966	.948	.908	.838	.596	.961	1.00	.975	.997	.993	.990	.972	.953	.833	.985	.986
2.0	.50	.985	.998	.997	.990	.979	.964	.869	.996	.997	.985	.974	.962	.939	.882	.818	.588	.952	.999	.978	.984	.974	.964	.936	.888	.698	.977	1.00
2.0	.90	.986	.955	.939	.906	.818	.722	.429	.791	.986	.981	.942	.920	.876	.791	.695	.372	.759	.974	.988	.959	.931	.889	.805	.692	.410	.766	.988

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=4 N=12 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.339	.321	.258	.190	.099	.050	.003	.102	.376	.536	.353	.284	.204	.094	.046	.008	.287	.978	.466	.365	.288	.201	.103	.046	.007	.190	.838
0.5	.50	.398	.331	.252	.173	.096	.046	.005	.203	.852	.555	.378	.299	.198	.088	.049	.010	.297	.985	.498	.369	.290	.194	.096	.052	.007	.270	.967
0.5	.90	.626	.397	.310	.212	.115	.057	.010	.321	.941	.644	.393	.292	.196	.094	.046	.006	.275	.924	.681	.399	.306	.213	.125	.045	.008	.280	.937
2.0	.00	.978	1.00	.999	.999	.998	.991	.959	.999	.949	.967	.948	.937	.909	.850	.770	.492	.924	1.00	.973	.991	.982	.973	.940	.907	.731	.959	.992
2.0	.50	.979	.996	.996	.989	.975	.948	.837	.996	.996	.975	.948	.930	.896	.832	.746	.468	.911	.999	.968	.971	.958	.935	.892	.811	.587	.956	1.00
2.0	.90	.978	.926	.892	.850	.770	.654	.364	.740	.981	.972	.930	.893	.844	.740	.629	.361	.708	.977	.969	.911	.883	.845	.735	.644	.321	.706	.973

C=4 N=16 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.152	.406	.317	.214	.126	.061	.020	.129	.005	.112	.372	.288	.199	.099	.051	.013	.126	.106	.126	.417	.315	.222	.119	.065	.014	.138	.036
0.5	.50	.096	.383	.287	.207	.105	.053	.015	.397	.644	.073	.415	.327	.217	.116	.066	.014	.430	.672	.049	.389	.283	.193	.102	.051	.012	.415	.699
2.0	.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.964	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.994	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.995
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	1.00	1.00	1.00	1.00	1.00	1.00	.999	1.00	.999	.999	1.00	1.00	1.00	1.00	1.00	.998	1.00	1.00

C=4 N=16 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.246	.370	.269	.190	.098	.051	.012	.101	.025	.285	.382	.288	.200	.110	.059	.016	.251	.602	.285	.378	.303	.210	.101	.056	.011	.150	.252
0.5	.50	.247	.392	.310	.210	.112	.056	.014	.340	.664	.272	.398	.306	.213	.115	.058	.012	.438	.876	.278	.369	.278	.199	.100	.052	.011	.400	.867
0.5	.75	.204	.400	.305	.202	.091	.053	.012	.851	.998	.207	.402	.296	.205	.099	.051	.017	.832	.999	.196	.387	.298	.197	.101	.048	.015	.843	1.00
2.0	.00	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.969	1.00	1.00	1.00	1.00	1.00	1.00	.995	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.994
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	.996	1.00	.998	.998	1.00	1.00	1.00	1.00	.998	.988	1.00	1.00	.999	1.00	.999	.999	.999	.998	.985	1.00	.999
2.0	.75	1.00	1.00	.999	.998	.996	.990	.964	.999	1.00	1.00	.999	.999	.998	.996	.989	.952	.999	1.00	1.00	.999	.998	.995	.990	.984	.941	.998	1.00

C=4 N=16 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.313	.350	.272	.193	.100	.051	.007	.104	.080	.465	.387	.293	.202	.102	.055	.010	.310	.893	.411	.387	.293	.211	.104	.048	.009	.159	.477
0.5	.50	.401	.400	.309	.212	.100	.051	.008	.319	.778	.464	.393	.293	.187	.089	.044	.004	.466	.975	.463	.408	.311	.196	.105	.052	.009	.403	.920
0.5	.85	.436	.408	.306	.213	.112	.058	.012	.660	.997	.410	.404	.316	.213	.107	.054	.017	.665	.999	.413	.383	.287	.204	.102	.052	.009	.615	.995
2.0	.00	.997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.961	.997	1.00	1.00	1.00	.999	.993	.957	1.00	1.00	.998	1.00	1.00	1.00	1.00	.999	.991	1.00	.995
2.0	.50	1.00	1.00	1.00	1.00	.999	.997	.985	1.00	.999	.998	.999	.998	.997	.987	.981	.944	1.00	1.00	.998	1.00	.998	.998	.993	.991	.959	1.00	.999
2.0	.85	1.00	.998	.996	.993	.969	.940	.807	.968	1.00	1.00	.994	.990	.985	.972	.938	.794	.971	1.00	1.00	.998	.994	.990	.976	.941	.797	.972	1.00

C=4 N=16 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.342	.344	.288	.206	.103	.052	.007	.112	.161	.576	.396	.305	.199	.107	.049	.004	.377	.974	.497	.360	.273	.175	.088	.048	.011	.160	.660
0.5	.50	.463	.381	.287	.203	.110	.054	.014	.279	.809	.575	.372	.289	.202	.109	.052	.010	.420	.989	.538	.393	.306	.202	.098	.045	.004	.376	.959
0.5	.85	.604	.434	.322	.213	.115	.059	.010	.613	.992	.602	.402	.310	.212	.108	.052	.008	.540	.991	.600	.409	.302	.198	.114	.055	.011	.532	.989
2.0	.00	.993	1.00	1.00	1.00	1.00	1.00	.999	1.00	.962	.995	.996	.991	.988	.972	.949	.866	.995	1.00	.996	1.00	.999	.999	.999	.993	.970	.998	.995
2.0	.50	.999	1.00	.999	.999	.997	.996	.978	1.00	.999	.997	.997	.996	.993	.979	.953	.854	.997	1.00	.998	.998	.998	.994	.983	.970	.906	.999	1.00
2.0	.85	1.00	.993	.988	.977	.951	.906	.749	.958	.999	1.00	.988	.984	.965	.934	.889	.727	.954	.999	1.00	.991	.984	.971	.932	.881	.716	.946	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=4 N=16 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.392	.324	.249	.173	.088	.040	.015	.097	.195	.617	.399	.301	.189	.080	.042	.009	.374	.990	.514	.356	.286	.192	.092	.049	.010	.173	.725
0.5	.50	.452	.355	.272	.189	.091	.047	.010	.261	.831	.663	.396	.298	.214	.094	.040	.009	.410	.988	.570	.381	.283	.191	.101	.047	.005	.339	.963
0.5	.90	.709	.409	.319	.210	.106	.046	.006	.396	.965	.745	.428	.323	.229	.117	.063	.013	.401	.967	.749	.420	.315	.223	.113	.055	.009	.374	.962
2.0	.00	.993	1.00	1.00	1.00	1.00	1.00	.993	1.00	.961	.994	.990	.982	.970	.949	.901	.741	.985	1.00	.998	.999	.999	.998	.994	.982	.939	.996	.995
2.0	.50	.997	.999	.999	.998	.992	.991	.961	.999	.999	.992	.986	.981	.963	.946	.903	.722	.983	1.00	.993	.995	.992	.987	.966	.947	.834	.996	1.00
2.0	.90	.998	.972	.961	.937	.873	.799	.569	.832	.993	.997	.975	.957	.930	.870	.790	.566	.811	.993	1.00	.978	.969	.941	.889	.809	.559	.831	.993

C=4 N=16 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.437	.321	.251	.181	.094	.040	.008	.106	.245	.673	.368	.293	.200	.111	.060	.014	.331	.988	.516	.318	.243	.176	.092	.044	.006	.170	.778
0.5	.50	.489	.326	.230	.173	.092	.039	.008	.221	.859	.677	.364	.279	.198	.103	.047	.010	.329	.979	.593	.372	.295	.203	.116	.066	.010	.316	.975
0.5	.90	.700	.381	.299	.206	.108	.045	.012	.337	.947	.786	.395	.304	.207	.114	.055	.005	.338	.935	.786	.408	.325	.219	.122	.054	.012	.326	.941
2.0	.00	.992	1.00	1.00	1.00	1.00	.998	.988	1.00	.962	.991	.974	.965	.942	.913	.857	.606	.962	1.00	.992	.998	.997	.992	.985	.961	.862	.988	.995
2.0	.50	.996	.999	.998	.994	.990	.973	.918	.999	1.00	.996	.979	.972	.957	.908	.838	.619	.960	1.00	.995	.993	.988	.978	.956	.925	.752	.991	1.00
2.0	.90	.992	.954	.938	.911	.841	.761	.506	.805	.982	.991	.954	.929	.892	.820	.715	.459	.758	.986	.992	.944	.927	.892	.823	.725	.440	.778	.980

C=6 N=4 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.028	.361	.278	.190	.097	.059	.024	.089	.572	.012	.368	.280	.196	.110	.074	.035	.109	.719	.013	.385	.310	.224	.127	.073	.040	.123	.697
0.5	.50	.004	.379	.296	.198	.116	.076	.039	.120	.738	.003	.364	.283	.204	.124	.089	.044	.140	.765	.003	.414	.317	.196	.098	.066	.033	.123	.788
2.0	.00	.861	1.00	1.00	1.00	1.00	1.00	.958	1.00	.975	.889	1.00	1.00	.998	.998	.981	.823	.997	.982	.879	1.00	1.00	.999	.997	.979	.872	.996	.985
2.0	.50	.890	.999	.999	.993	.976	.922	.783	.997	.994	.893	.998	.995	.988	.969	.926	.729	.991	.986	.895	.995	.995	.990	.974	.912	.704	.988	.987

C=6 N=4 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.033	.314	.237	.140	.075	.037	.012	.074	.688	.035	.377	.284	.198	.113	.072	.028	.134	.881	.049	.358	.275	.178	.091	.051	.025	.100	.831
0.5	.50	.045	.370	.280	.186	.099	.071	.029	.127	.828	.031	.375	.289	.205	.123	.082	.039	.161	.870	.033	.389	.289	.215	.113	.066	.033	.140	.862
0.5	.75	.032	.396	.314	.213	.129	.086	.044	.278	.898	.022	.407	.311	.223	.132	.082	.043	.267	.907	.014	.373	.278	.184	.109	.078	.036	.261	.911
2.0	.00	.819	1.00	1.00	1.00	1.00	.995	.884	.999	.952	.870	.997	.995	.989	.956	.878	.605	.971	.992	.836	.998	.992	.988	.978	.923	.705	.977	.977
2.0	.50	.839	.998	.992	.986	.945	.884	.658	.973	.988	.859	.988	.983	.966	.915	.814	.535	.960	.992	.853	.990	.985	.969	.917	.845	.582	.963	.991
2.0	.75	.892	.982	.964	.919	.815	.682	.444	.968	.997	.892	.966	.957	.934	.826	.679	.445	.960	.995	.895	.980	.971	.933	.844	.670	.434	.971	.994

C=6 N=4 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.065	.321	.238	.172	.086	.050	.012	.087	.746	.086	.383	.282	.179	.092	.051	.022	.141	.920	.099	.348	.280	.195	.099	.045	.023	.131	.853
0.5	.50	.070	.356	.284	.187	.099	.053	.025	.116	.858	.079	.378	.277	.210	.115	.060	.022	.185	.936	.087	.382	.297	.190	.085	.051	.022	.144	.921
0.5	.85	.067	.410	.315	.209	.135	.099	.059	.419	.934	.048	.394	.302	.215	.129	.088	.043	.404	.932	.064	.410	.292	.188	.116	.090	.060	.433	.945
2.0	.00	.786	1.00	1.00	1.00	.994	.973	.796	.995	.965	.832	.974	.962	.931	.863	.740	.435	.909	.995	.829	.989	.986	.975	.945	.884	.573	.951	.983
2.0	.50	.832	.991	.985	.973	.923	.844	.572	.961	.984	.836	.965	.957	.919	.830	.693	.384	.906	.997	.833	.967	.961	.933	.860	.739	.446	.919	.993
2.0	.85	.913	.935	.897	.843	.661	.492	.233	.854	.989	.918	.935	.908	.856	.678	.509	.257	.856	.980	.906	.931	.897	.843	.667	.483	.228	.850	.979

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=6 N=4 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.081	.307	.244	.169	.090	.041	.011	.097	.766	.124	.346	.259	.160	.074	.038	.013	.144	.970	.099	.318	.241	.172	.075	.037	.008	.117	.879
0.5	.50	.113	.371	.301	.210	.111	.051	.016	.137	.893	.145	.385	.290	.195	.097	.057	.022	.206	.967	.131	.375	.295	.184	.102	.054	.019	.167	.941
0.5	.85	.126	.366	.277	.189	.090	.052	.023	.333	.955	.125	.373	.290	.185	.096	.052	.030	.358	.955	.123	.388	.283	.190	.089	.059	.023	.346	.970
2.0	.00	.766	.997	.994	.991	.972	.936	.726	.979	.958	.827	.942	.923	.879	.779	.629	.272	.862	.992	.784	.977	.964	.941	.889	.788	.452	.918	.980
2.0	.50	.788	.977	.964	.947	.874	.777	.471	.933	.988	.831	.928	.908	.861	.759	.599	.279	.860	.998	.793	.939	.913	.888	.789	.674	.361	.873	.987
2.0	.85	.847	.894	.857	.815	.658	.445	.190	.843	.981	.860	.912	.882	.810	.654	.440	.184	.850	.982	.849	.893	.853	.797	.643	.462	.201	.825	.988

C=6 N=4 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.109	.303	.241	.177	.084	.034	.008	.098	.787	.159	.332	.269	.168	.074	.033	.014	.180	.971	.144	.360	.281	.202	.120	.053	.009	.147	.913
0.5	.50	.120	.322	.245	.166	.097	.046	.013	.125	.905	.163	.336	.266	.175	.076	.037	.006	.183	.969	.153	.353	.275	.184	.084	.047	.012	.165	.961
0.5	.90	.187	.397	.293	.199	.093	.047	.022	.392	.912	.179	.402	.276	.175	.063	.029	.013	.376	.923	.172	.367	.279	.171	.065	.037	.016	.376	.923
2.0	.00	.761	.996	.992	.981	.957	.896	.626	.961	.963	.780	.883	.850	.796	.676	.524	.199	.775	.997	.739	.956	.941	.905	.815	.711	.365	.846	.978
2.0	.50	.799	.975	.963	.939	.865	.746	.445	.913	.990	.801	.893	.861	.812	.674	.479	.180	.825	.997	.794	.903	.887	.844	.744	.590	.275	.828	.990
2.0	.90	.855	.858	.827	.738	.550	.365	.143	.692	.925	.834	.840	.808	.736	.569	.356	.122	.713	.916	.832	.840	.799	.736	.524	.338	.089	.689	.923

C=6 N=4 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.104	.296	.232	.165	.093	.041	.012	.107	.809	.212	.337	.277	.179	.087	.046	.010	.209	.970	.148	.331	.250	.184	.104	.044	.011	.144	.913
0.5	.50	.118	.278	.222	.149	.091	.048	.012	.124	.892	.227	.365	.286	.201	.093	.042	.009	.234	.974	.187	.366	.270	.177	.092	.041	.014	.186	.963
0.5	.90	.226	.361	.282	.179	.076	.031	.014	.337	.923	.248	.383	.273	.174	.079	.037	.012	.324	.909	.243	.383	.296	.189	.074	.034	.015	.340	.914
2.0	.00	.763	.991	.988	.973	.935	.864	.588	.938	.971	.761	.839	.806	.758	.642	.453	.150	.760	.996	.751	.936	.914	.874	.771	.639	.300	.820	.977
2.0	.50	.745	.956	.941	.901	.819	.681	.357	.870	.988	.731	.817	.775	.714	.572	.388	.129	.721	.992	.761	.895	.864	.818	.699	.543	.222	.800	.990
2.0	.90	.802	.823	.778	.698	.532	.362	.124	.683	.927	.767	.778	.744	.675	.499	.302	.069	.669	.911	.768	.791	.746	.680	.518	.323	.082	.675	.927

C=6 N=6 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.025	.354	.267	.180	.089	.045	.015	.091	.218	.016	.392	.301	.208	.112	.056	.023	.115	.408	.021	.387	.294	.190	.095	.053	.017	.098	.352
0.5	.50	.014	.402	.309	.212	.119	.062	.034	.151	.457	.008	.392	.291	.200	.118	.079	.028	.152	.542	.005	.397	.305	.219	.116	.071	.023	.140	.547
2.0	.00	.924	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.954	.962	1.00	1.00	1.00	1.00	.998	.976	1.00	.985	.960	1.00	1.00	1.00	1.00	.999	.989	1.00	.982
2.0	.50	.965	1.00	.999	.999	.996	.991	.928	1.00	.996	.963	1.00	.998	.997	.996	.986	.905	.998	.996	.958	.999	.999	.998	.994	.988	.903	.998	.992

C=6 N=6 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.065	.342	.265	.184	.091	.048	.015	.093	.346	.067	.392	.297	.212	.111	.055	.022	.138	.720	.075	.397	.305	.206	.102	.054	.016	.110	.581
0.5	.50	.057	.356	.266	.182	.094	.052	.013	.125	.626	.055	.409	.308	.200	.107	.055	.016	.166	.768	.062	.374	.294	.202	.097	.053	.014	.157	.770
0.5	.75	.035	.387	.302	.198	.105	.062	.023	.359	.857	.033	.378	.285	.214	.110	.067	.026	.379	.848	.026	.367	.289	.206	.111	.071	.030	.342	.864
2.0	.00	.934	1.00	1.00	1.00	1.00	.999	.990	1.00	.968	.945	1.00	.997	.995	.990	.971	.853	.991	.987	.940	1.00	1.00	.999	.997	.993	.916	.998	.979
2.0	.50	.956	.998	.998	.998	.994	.981	.861	.999	.992	.958	.998	.996	.993	.978	.945	.792	.990	.995	.956	.997	.995	.993	.980	.953	.792	.990	.997
2.0	.75	.965	.995	.989	.974	.952	.897	.650	.995	1.00	.972	.994	.993	.979	.947	.881	.652	.993	.997	.963	.993	.985	.977	.940	.872	.618	.991	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=6 N=6 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.114	.371	.299	.200	.103	.056	.011	.111	.468	.115	.372	.286	.200	.106	.052	.017	.167	.848	.128	.352	.268	.193	.102	.052	.015	.119	.715
0.5	.50	.109	.334	.235	.171	.079	.037	.009	.119	.702	.142	.366	.296	.208	.102	.053	.018	.213	.919	.127	.366	.269	.199	.099	.048	.019	.177	.843
0.5	.85	.091	.394	.298	.190	.101	.056	.027	.526	.965	.084	.390	.284	.186	.100	.061	.027	.524	.954	.085	.418	.324	.227	.113	.065	.026	.529	.957
2.0	.00	.909	1.00	1.00	1.00	1.00	.997	.964	1.00	.956	.919	.989	.985	.976	.942	.901	.684	.965	.993	.914	.997	.994	.990	.980	.959	.828	.982	.981
2.0	.50	.919	.998	.998	.998	.986	.966	.842	.992	.982	.936	.991	.984	.972	.933	.866	.630	.974	.998	.935	.993	.991	.978	.952	.915	.700	.981	.993
2.0	.85	.963	.966	.948	.920	.828	.701	.378	.933	.993	.974	.975	.956	.920	.841	.728	.378	.938	.998	.970	.963	.943	.915	.831	.718	.366	.929	.996

C=6 N=6 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.116	.327	.256	.172	.092	.051	.008	.108	.532	.187	.365	.285	.195	.088	.041	.011	.202	.944	.198	.373	.292	.205	.106	.047	.006	.138	.798
0.5	.50	.145	.351	.275	.188	.097	.047	.009	.136	.777	.195	.395	.314	.204	.101	.050	.009	.232	.952	.192	.368	.283	.190	.094	.045	.011	.186	.925
0.5	.85	.174	.378	.300	.204	.094	.052	.017	.424	.979	.180	.364	.287	.188	.090	.052	.015	.441	.985	.186	.410	.313	.198	.089	.038	.013	.469	.988
2.0	.00	.890	1.00	.999	.999	.996	.992	.933	.996	.957	.918	.968	.960	.933	.881	.807	.513	.924	.996	.911	.990	.985	.981	.957	.919	.699	.965	.987
2.0	.50	.909	1.00	.997	.988	.970	.931	.744	.983	.983	.909	.965	.948	.925	.859	.774	.479	.937	1.00	.918	.990	.982	.968	.923	.857	.579	.970	.994
2.0	.85	.938	.954	.933	.889	.794	.679	.346	.916	.995	.936	.942	.925	.883	.790	.660	.322	.902	.993	.937	.944	.924	.895	.810	.670	.326	.916	.999

C=6 N=6 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.138	.319	.255	.185	.101	.045	.009	.107	.573	.226	.353	.262	.162	.077	.037	.007	.200	.965	.214	.367	.294	.206	.102	.045	.008	.143	.841
0.5	.50	.169	.323	.259	.180	.095	.049	.007	.137	.798	.250	.362	.284	.201	.099	.039	.007	.259	.964	.244	.355	.289	.199	.110	.048	.008	.203	.923
0.5	.90	.261	.375	.297	.200	.100	.051	.011	.416	.977	.270	.401	.303	.200	.088	.039	.011	.424	.985	.278	.422	.330	.204	.100	.052	.014	.449	.972
2.0	.00	.888	.999	.998	.997	.995	.991	.889	.995	.964	.886	.938	.922	.896	.801	.700	.374	.886	.997	.886	.979	.974	.957	.911	.858	.604	.927	.980
2.0	.50	.897	.991	.988	.976	.949	.902	.690	.972	.982	.907	.951	.932	.896	.809	.692	.367	.911	.996	.874	.960	.941	.916	.864	.778	.486	.920	.994
2.0	.90	.944	.917	.887	.832	.708	.549	.197	.819	.982	.954	.923	.894	.837	.700	.533	.187	.827	.989	.940	.916	.886	.832	.710	.563	.192	.817	.982

C=6 N=6 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.157	.300	.235	.175	.096	.053	.006	.103	.594	.310	.380	.285	.202	.089	.040	.003	.253	.980	.216	.361	.280	.186	.085	.034	.005	.133	.877
0.5	.50	.192	.316	.249	.177	.105	.055	.008	.143	.835	.294	.377	.306	.204	.097	.043	.008	.270	.985	.221	.322	.250	.171	.076	.033	.006	.181	.944
0.5	.90	.310	.382	.289	.193	.099	.057	.012	.390	.979	.338	.370	.289	.193	.084	.042	.008	.340	.969	.342	.388	.288	.184	.067	.027	.006	.359	.969
2.0	.00	.883	.998	.998	.996	.990	.971	.837	.991	.954	.871	.915	.891	.857	.753	.621	.298	.866	.998	.856	.972	.961	.942	.886	.808	.516	.912	.979
2.0	.50	.866	.980	.969	.948	.906	.848	.582	.940	.987	.881	.901	.876	.830	.731	.591	.245	.851	.999	.877	.953	.936	.902	.834	.734	.405	.907	.993
2.0	.90	.906	.878	.857	.789	.671	.518	.183	.780	.979	.892	.872	.835	.783	.664	.500	.176	.771	.971	.904	.883	.854	.802	.671	.502	.180	.768	.983

C=6 N=9 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.047	.383	.295	.203	.112	.066	.010	.115	.036	.010	.402	.298	.201	.109	.062	.017	.117	.149	.026	.387	.292	.195	.095	.046	.013	.098	.111
0.5	.50	.016	.399	.299	.194	.105	.054	.012	.153	.282	.006	.388	.296	.194	.102	.048	.015	.178	.363	.007	.376	.310	.222	.114	.062	.012	.170	.381
2.0	.00	.980	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.963	.995	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.993	.987	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.976
2.0	.50	.994	1.00	1.00	1.00	1.00	1.00	.995	1.00	.992	.989	1.00	1.00	1.00	1.00	1.00	.997	1.00	.994	.996	1.00	1.00	1.00	1.00	1.00	.992	1.00	.997

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further.

C=6 N=9 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.119	.382	.297	.210	.107	.061	.010	.108	.140	.088	.368	.276	.196	.110	.067	.017	.147	.534	.077	.363	.267	.173	.090	.048	.009	.097	.323
0.5	.50	.088	.395	.299	.198	.097	.060	.013	.157	.497	.065	.386	.295	.196	.100	.056	.011	.198	.657	.076	.397	.305	.185	.094	.050	.010	.201	.656
0.5	.75	.057	.408	.316	.218	.117	.063	.012	.529	.852	.049	.391	.286	.182	.097	.050	.014	.497	.843	.042	.367	.274	.182	.097	.055	.021	.538	.887
2.0	.00	.980	1.00	1.00	1.00	1.00	1.00	.999	1.00	.973	.988	1.00	1.00	1.00	1.00	.999	.984	1.00	.996	.982	1.00	1.00	1.00	1.00	.999	.997	1.00	.987
2.0	.50	.987	1.00	1.00	1.00	1.00	.999	.983	1.00	.988	.986	1.00	.999	.999	.993	.989	.949	1.00	.997	.987	1.00	1.00	1.00	.998	.996	.969	1.00	.994
2.0	.75	.991	.998	.996	.993	.987	.971	.873	1.00	.999	.993	.996	.996	.996	.992	.977	.876	.997	.999	.998	.998	.996	.994	.987	.972	.871	1.00	1.00

C=6 N=9 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.136	.351	.272	.180	.097	.050	.014	.107	.225	.189	.391	.287	.199	.093	.045	.008	.187	.820	.180	.351	.281	.184	.086	.047	.006	.110	.543
0.5	.50	.146	.362	.284	.195	.110	.065	.011	.167	.605	.179	.392	.316	.216	.111	.052	.009	.273	.882	.176	.375	.291	.199	.104	.057	.012	.201	.810
0.5	.85	.114	.363	.290	.199	.099	.055	.016	.658	.992	.136	.368	.292	.189	.098	.054	.009	.660	.986	.133	.402	.304	.208	.084	.050	.011	.670	.988
2.0	.00	.977	1.00	1.00	1.00	1.00	1.00	.999	1.00	.969	.986	.997	.996	.995	.992	.983	.912	.994	.997	.974	1.00	1.00	1.00	1.00	.997	.958	1.00	.984
2.0	.50	.980	1.00	1.00	1.00	1.00	.996	.957	1.00	.994	.984	.998	.997	.992	.978	.955	.851	.995	.999	.985	1.00	.999	.995	.990	.981	.897	.997	1.00
2.0	.85	.994	.991	.985	.967	.937	.877	.631	.972	1.00	.992	.991	.987	.975	.943	.885	.669	.982	1.00	.995	.991	.985	.975	.942	.886	.648	.980	1.00

C=6 N=9 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.199	.346	.261	.188	.096	.049	.008	.111	.320	.286	.386	.294	.195	.112	.054	.008	.256	.933	.229	.368	.279	.180	.081	.043	.007	.116	.655
0.5	.50	.204	.366	.283	.203	.109	.051	.011	.171	.664	.278	.393	.303	.196	.109	.051	.009	.309	.955	.255	.376	.285	.176	.092	.050	.008	.206	.888
0.5	.85	.247	.394	.300	.199	.099	.045	.010	.583	.992	.266	.389	.314	.214	.103	.058	.007	.575	.996	.268	.409	.323	.214	.090	.049	.007	.562	.994
2.0	.00	.964	1.00	1.00	1.00	1.00	1.00	.994	1.00	.949	.972	.991	.987	.978	.962	.931	.787	.974	.995	.966	1.00	1.00	1.00	.996	.984	.921	.996	.985
2.0	.50	.978	1.00	1.00	.999	.996	.985	.929	1.00	.991	.973	.989	.984	.980	.956	.905	.741	.984	1.00	.978	.996	.994	.987	.966	.933	.813	.989	.999
2.0	.85	.988	.978	.969	.947	.907	.846	.611	.963	.999	.990	.984	.972	.958	.915	.840	.581	.963	.997	.986	.979	.968	.953	.907	.842	.588	.962	1.00

C=6 N=9 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.224	.368	.289	.202	.092	.046	.004	.099	.380	.369	.402	.305	.198	.112	.064	.018	.289	.966	.265	.337	.257	.174	.092	.049	.008	.131	.712
0.5	.50	.239	.354	.283	.191	.109	.054	.007	.180	.731	.342	.374	.288	.189	.091	.048	.006	.306	.977	.305	.372	.289	.202	.099	.051	.012	.233	.920
0.5	.90	.351	.394	.299	.203	.090	.035	.003	.509	.984	.376	.403	.306	.211	.105	.057	.011	.498	.987	.368	.420	.310	.208	.098	.049	.008	.497	.987
2.0	.00	.958	1.00	1.00	1.00	1.00	.999	.989	1.00	.959	.970	.986	.976	.958	.914	.852	.633	.967	.996	.963	.996	.995	.992	.982	.952	.841	.988	.993
2.0	.50	.958	.996	.992	.990	.985	.965	.889	.991	.989	.972	.980	.971	.954	.911	.838	.601	.970	.998	.967	.996	.991	.984	.960	.903	.719	.988	.998
2.0	.90	.985	.966	.951	.911	.827	.710	.402	.885	.996	.990	.973	.958	.925	.845	.743	.427	.894	.998	.984	.949	.924	.884	.798	.689	.387	.847	.996

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=6 N=9 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.217	.314	.241	.171	.082	.036	.007	.093	.393	.392	.367	.299	.207	.100	.044	.009	.302	.977	.295	.342	.264	.194	.101	.045	.005	.160	.763
0.5	.50	.267	.328	.249	.185	.088	.044	.005	.153	.758	.394	.350	.262	.184	.106	.050	.008	.310	.989	.338	.353	.270	.197	.108	.048	.006	.236	.938
0.5	.90	.430	.380	.297	.207	.113	.056	.013	.446	.987	.484	.420	.333	.222	.095	.036	.005	.449	.974	.459	.397	.296	.195	.091	.040	.011	.417	.982
2.0	.00	.960	1.00	1.00	.999	.997	.993	.969	.996	.965	.954	.962	.952	.929	.867	.772	.498	.942	.998	.956	.996	.990	.986	.973	.937	.780	.978	.981
2.0	.50	.963	.999	.998	.995	.980	.961	.844	.990	.993	.957	.955	.945	.927	.862	.767	.509	.946	.999	.956	.988	.981	.960	.922	.857	.638	.962	.998
2.0	.90	.963	.942	.916	.880	.795	.688	.394	.863	.996	.968	.947	.926	.880	.784	.646	.351	.851	.993	.965	.941	.920	.877	.779	.661	.343	.849	.993

C=6 N=12 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.070	.392	.305	.208	.102	.052	.014	.108	.008	.020	.369	.279	.177	.086	.042	.008	.104	.042	.030	.362	.294	.188	.098	.046	.010	.111	.030
0.5	.50	.029	.386	.297	.202	.103	.060	.012	.178	.228	.012	.404	.316	.204	.120	.064	.018	.193	.285	.007	.403	.299	.192	.104	.058	.017	.187	.299
2.0	.00	.997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.976	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.993	.995	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.986
2.0	.50	.998	1.00	1.00	1.00	1.00	1.00	.999	1.00	.995	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.997

C=6 N=12 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.132	.393	.313	.200	.113	.063	.008	.122	.045	.110	.377	.273	.188	.122	.060	.012	.171	.373	.128	.399	.302	.207	.093	.053	.017	.119	.167
0.5	.50	.124	.401	.313	.218	.123	.060	.011	.190	.388	.089	.378	.276	.195	.098	.052	.017	.241	.603	.093	.383	.294	.209	.101	.052	.014	.233	.573
0.5	.75	.071	.409	.322	.214	.102	.049	.010	.698	.920	.071	.402	.290	.196	.102	.051	.015	.692	.912	.061	.439	.330	.208	.115	.066	.017	.695	.912
2.0	.00	.992	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.963	.997	1.00	1.00	1.00	1.00	1.00	.998	1.00	.992	.993	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.985
2.0	.50	.998	1.00	1.00	1.00	1.00	1.00	.999	1.00	.996	1.00	1.00	1.00	1.00	1.00	1.00	.995	1.00	.997	.999	1.00	1.00	1.00	1.00	1.00	.996	1.00	.997
2.0	.75	1.00	1.00	1.00	1.00	.998	.995	.962	1.00	1.00	1.00	1.00	1.00	1.00	.999	.995	.970	1.00	1.00	.997	1.00	1.00	1.00	.997	.995	.959	1.00	1.00

C=6 N=12 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.199	.361	.284	.199	.110	.053	.012	.117	.098	.251	.395	.305	.222	.105	.054	.012	.243	.744	.210	.371	.289	.212	.104	.044	.011	.134	.358
0.5	.50	.222	.377	.279	.187	.112	.054	.013	.182	.502	.252	.419	.330	.222	.110	.068	.009	.331	.837	.258	.390	.303	.228	.122	.063	.016	.268	.756
0.5	.85	.163	.405	.307	.203	.097	.045	.012	.770	.998	.143	.400	.297	.187	.089	.045	.012	.789	.994	.155	.393	.301	.208	.095	.056	.014	.773	.995
2.0	.00	.989	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.958	.993	1.00	.999	.999	.997	.991	.962	.998	.997	.996	1.00	1.00	1.00	1.00	1.00	.996	1.00	.987
2.0	.50	.993	1.00	.999	.999	.999	.998	.990	.999	.995	1.00	.999	.999	.999	.997	.992	.960	.999	.999	.996	1.00	1.00	.999	.997	.993	.969	1.00	1.00
2.0	.85	.999	.995	.992	.986	.970	.944	.800	.988	.998	1.00	.993	.991	.985	.970	.940	.807	.984	1.00	1.00	.999	.998	.991	.980	.949	.815	.997	1.00

C=6 N=12 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.247	.360	.289	.200	.114	.056	.012	.121	.164	.351	.411	.311	.218	.110	.047	.014	.307	.894	.326	.385	.303	.190	.109	.051	.008	.144	.550
0.5	.50	.298	.362	.284	.191	.086	.052	.010	.178	.625	.318	.367	.289	.205	.105	.056	.009	.360	.945	.325	.368	.266	.183	.093	.050	.006	.254	.864
0.5	.85	.322	.401	.309	.208	.109	.054	.008	.657	.996	.332	.382	.279	.180	.096	.047	.011	.632	.999	.320	.388	.291	.199	.084	.043	.008	.647	.999
2.0	.00	.992	1.00	1.00	1.00	1.00	1.00	.999	1.00	.975	.991	1.00	.998	.993	.986	.972	.904	.999	.999	.992	1.00	1.00	.999	.998	.996	.981	.999	.989
2.0	.50	.989	.999	.998	.997	.997	.995	.984	.999	.991	.995	.999	.997	.994	.983	.966	.875	.996	1.00	.993	.997	.997	.996	.993	.986	.938	.996	.999
2.0	.85	.994	.992	.990	.987	.958	.925	.771	.983	.999	.999	.993	.985	.975	.949	.911	.761	.981	1.00	.997	.992	.984	.975	.941	.908	.760	.982	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further.

C=6 N=12 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.279	.327	.269	.189	.105	.049	.009	.113	.216	.421	.364	.271	.188	.095	.051	.011	.327	.967	.366	.359	.277	.202	.125	.071	.016	.172	.631
0.5	.50	.326	.352	.286	.204	.109	.061	.011	.186	.642	.439	.392	.300	.202	.105	.050	.007	.376	.981	.386	.369	.275	.193	.108	.051	.008	.270	.899
0.5	.90	.470	.408	.303	.204	.102	.051	.009	.559	.991	.458	.384	.302	.209	.103	.050	.009	.543	.990	.449	.384	.286	.196	.090	.049	.011	.502	.988
2.0	.00	.988	1.00	1.00	1.00	1.00	1.00	.999	1.00	.963	.991	.997	.995	.985	.971	.934	.778	.990	1.00	.977	1.00	.999	.996	.989	.984	.938	.993	.989
2.0	.50	.992	1.00	1.00	1.00	.999	.996	.968	1.00	.993	.992	.992	.988	.984	.970	.936	.796	.989	1.00	.993	.996	.995	.992	.980	.969	.878	.992	.997
2.0	.90	.998	.975	.969	.953	.885	.818	.570	.933	.995	.997	.981	.972	.936	.887	.807	.563	.914	.999	.996	.975	.965	.939	.891	.812	.572	.920	.999

C=6 N=12 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.286	.333	.254	.169	.085	.035	.004	.092	.242	.506	.390	.295	.199	.095	.047	.008	.353	.988	.365	.322	.259	.173	.081	.040	.008	.152	.696
0.5	.50	.313	.331	.251	.171	.087	.044	.012	.166	.696	.550	.415	.336	.231	.108	.058	.011	.402	.994	.438	.371	.285	.196	.099	.051	.008	.273	.928
0.5	.90	.511	.388	.301	.210	.118	.053	.016	.487	.987	.586	.401	.309	.220	.122	.057	.008	.465	.988	.564	.408	.297	.203	.089	.049	.009	.463	.973
2.0	.00	.982	1.00	1.00	1.00	1.00	1.00	.996	1.00	.962	.985	.983	.975	.956	.927	.879	.676	.974	1.00	.978	.997	.995	.994	.985	.968	.889	.992	.990
2.0	.50	.988	.999	.999	.998	.995	.989	.934	.998	.990	.981	.978	.969	.953	.910	.843	.643	.975	1.00	.987	.994	.992	.983	.969	.937	.800	.989	.998
2.0	.90	.993	.974	.962	.939	.878	.791	.559	.913	.999	.991	.965	.941	.919	.858	.762	.498	.899	.996	.995	.972	.958	.928	.861	.778	.506	.901	1.00

C=6 N=16 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.084	.393	.302	.206	.104	.062	.006	.111	.000	.042	.398	.296	.197	.100	.049	.012	.121	.015	.044	.396	.314	.213	.104	.057	.009	.124	.004
0.5	.50	.033	.410	.305	.212	.112	.060	.012	.206	.214	.022	.373	.292	.184	.097	.057	.015	.228	.284	.010	.395	.301	.185	.098	.036	.011	.224	.288
2.0	.00	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.977	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.996	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.992
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999

C=6 N=16 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.180	.373	.284	.195	.112	.061	.014	.117	.011	.138	.403	.315	.220	.107	.056	.013	.190	.221	.182	.394	.308	.201	.107	.060	.016	.140	.066
0.5	.50	.168	.406	.315	.216	.104	.058	.017	.213	.292	.134	.370	.269	.198	.104	.058	.014	.299	.572	.143	.399	.297	.199	.103	.065	.013	.303	.522
0.5	.75	.086	.414	.302	.215	.118	.060	.020	.838	.946	.066	.385	.289	.194	.105	.053	.017	.815	.956	.063	.409	.315	.218	.094	.052	.016	.812	.942
2.0	.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.972	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.988
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	.999	1.00	1.00	1.00	1.00	1.00	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2.0	.75	1.00	1.00	1.00	1.00	1.00	1.00	.996	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.996	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.995	1.00	1.00

C=6 N=16 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.255	.377	.281	.195	.097	.048	.010	.105	.029	.308	.404	.302	.203	.097	.048	.009	.263	.666	.304	.393	.316	.209	.109	.054	.009	.155	.219
0.5	.50	.251	.359	.272	.187	.087	.039	.007	.190	.387	.293	.380	.292	.196	.101	.046	.017	.364	.839	.291	.395	.297	.207	.101	.056	.013	.316	.717
0.5	.85	.196	.392	.304	.214	.107	.061	.018	.861	.999	.200	.371	.276	.180	.085	.046	.009	.871	1.00	.225	.433	.330	.225	.129	.074	.015	.869	1.00
2.0	.00	.996	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.965	.998	1.00	1.00	1.00	1.00	.999	.994	1.00	.999	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.991
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	.998	1.00	.994	.999	1.00	1.00	1.00	.999	.996	.985	1.00	1.00	.998	1.00	1.00	1.00	.999	.999	.994	1.00	.998
2.0	.85	.999	1.00	.999	.999	.994	.986	.944	.999	1.00	.999	1.00	1.00	.998	.991	.985	.927	.997	1.00	1.00	.999	.998	.997	.992	.978	.923	.999	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=6 N=16 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.318	.369	.287	.198	.105	.048	.009	.112	.065	.434	.394	.304	.199	.100	.053	.009	.374	.896	.397	.381	.295	.201	.112	.071	.014	.175	.404
0.5	.50	.338	.356	.281	.196	.098	.052	.010	.209	.515	.434	.408	.308	.202	.093	.051	.011	.448	.954	.439	.381	.305	.214	.103	.053	.011	.328	.835
0.5	.85	.418	.407	.298	.205	.107	.052	.012	.772	1.00	.423	.393	.310	.214	.105	.052	.012	.748	1.00	.438	.418	.334	.236	.115	.054	.009	.762	1.00
2.0	.00	.999	1.00	1.00	1.00	1.00	1.00	.999	1.00	.964	.998	1.00	.998	.997	.996	.993	.967	1.00	1.00	.998	1.00	1.00	1.00	1.00	1.00	.998	1.00	.992
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.997	.999	.999	.998	.998	.995	.990	.955	1.00	1.00	.998	1.00	1.00	.999	.999	.998	.981	1.00	.999
2.0	.85	.998	.998	.996	.993	.985	.970	.895	.996	1.00	1.00	.997	.995	.991	.983	.957	.872	.995	1.00	.999	.999	.997	.991	.978	.958	.882	.997	1.00

C=6 N=16 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.347	.347	.287	.201	.112	.052	.007	.126	.102	.547	.405	.297	.207	.112	.056	.011	.417	.968	.437	.386	.306	.217	.111	.056	.015	.192	.536
0.5	.50	.392	.360	.286	.206	.099	.060	.011	.206	.569	.563	.394	.297	.218	.135	.071	.015	.458	.983	.491	.382	.287	.215	.101	.056	.017	.326	.901
0.5	.90	.563	.390	.275	.185	.105	.050	.006	.607	.991	.546	.403	.301	.213	.109	.055	.017	.615	.998	.539	.383	.296	.198	.108	.055	.007	.608	.994
2.0	.00	.993	1.00	1.00	1.00	1.00	1.00	.998	1.00	.962	.999	.999	.999	.996	.987	.974	.899	.998	.999	1.00	1.00	1.00	1.00	1.00	.999	.990	1.00	.995
2.0	.50	.999	1.00	1.00	1.00	.999	.997	.989	1.00	.996	.997	.997	.996	.994	.981	.967	.891	.998	1.00	.997	.999	.998	.998	.995	.989	.946	1.00	1.00
2.0	.90	.998	.989	.982	.977	.945	.911	.751	.956	.999	.999	.995	.990	.976	.945	.907	.726	.954	.998	.998	.986	.980	.969	.944	.912	.727	.958	1.00

C=6 N=16 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.386	.345	.267	.192	.108	.067	.010	.119	.152	.606	.386	.289	.194	.099	.060	.011	.402	.987	.496	.366	.285	.204	.095	.042	.008	.184	.620
0.5	.50	.404	.333	.247	.163	.091	.045	.007	.200	.595	.652	.435	.335	.230	.128	.068	.014	.481	.995	.547	.390	.303	.217	.103	.060	.007	.329	.926
0.5	.90	.642	.395	.308	.205	.102	.053	.015	.546	.994	.647	.407	.308	.208	.114	.056	.013	.538	.983	.670	.407	.302	.215	.114	.059	.012	.511	.981
2.0	.00	.993	1.00	1.00	1.00	1.00	1.00	.999	1.00	.958	.994	.995	.990	.979	.952	.929	.810	.992	1.00	.999	1.00	1.00	.999	.999	.996	.971	.999	.993
2.0	.50	1.00	1.00	1.00	1.00	1.00	.999	.990	1.00	1.00	.998	.990	.987	.978	.950	.923	.791	.989	1.00	.996	.999	.998	.998	.989	.974	.901	.997	.998
2.0	.90	.998	.986	.981	.960	.927	.872	.703	.945	1.00	.996	.982	.973	.962	.922	.860	.668	.947	.997	.999	.981	.967	.956	.913	.857	.655	.938	.999

C=9 N=4 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.006	.368	.275	.188	.107	.067	.029	.091	.468	.001	.384	.301	.187	.118	.072	.038	.115	.645	.003	.402	.292	.200	.102	.062	.028	.092	.603
0.5	.50	.003	.370	.279	.180	.103	.071	.040	.095	.610	.002	.385	.290	.213	.130	.084	.043	.125	.660	.001	.423	.336	.224	.130	.087	.045	.114	.710
2.0	.00	.864	1.00	1.00	1.00	1.00	1.00	.981	1.00	.972	.889	1.00	1.00	1.00	.998	.993	.905	.999	.981	.881	1.00	1.00	1.00	1.00	.996	.947	1.00	.984
2.0	.50	.903	.999	.998	.998	.996	.984	.910	.998	.985	.905	1.00	.999	.999	.995	.980	.869	.997	.980	.886	1.00	.998	.997	.985	.963	.836	.994	.987

C=9 N=4 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.025	.355	.267	.195	.102	.064	.028	.102	.619	.014	.382	.286	.197	.120	.069	.031	.118	.795	.018	.368	.283	.204	.117	.070	.026	.112	.716
0.5	.50	.014	.377	.295	.206	.114	.067	.029	.109	.724	.019	.398	.308	.213	.120	.081	.041	.132	.809	.008	.380	.287	.211	.117	.066	.034	.119	.803
0.5	.75	.011	.405	.297	.211	.129	.082	.045	.199	.825	.005	.395	.297	.213	.123	.075	.045	.198	.856	.006	.397	.306	.199	.126	.090	.042	.176	.834
2.0	.00	.845	1.00	1.00	1.00	1.00	1.00	.946	1.00	.968	.856	.999	.998	.997	.985	.954	.777	.994	.986	.852	.999	.999	.998	.998	.980	.858	.997	.982
2.0	.50	.866	1.00	.999	.999	.990	.967	.828	.995	.987	.869	.997	.995	.993	.982	.934	.723	.990	.984	.879	.998	.995	.989	.969	.930	.722	.981	.981
2.0	.75	.906	.993	.983	.975	.932	.856	.662	.994	.991	.903	.993	.989	.974	.924	.828	.644	.989	.993	.885	.991	.985	.974	.915	.814	.598	.988	.994

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=9 N=4 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.053	.344	.265	.188	.107	.060	.022	.109	.683	.028	.379	.279	.184	.082	.051	.023	.111	.877	.061	.384	.303	.212	.107	.065	.029	.118	.802
0.5	.50	.037	.359	.286	.198	.103	.056	.022	.102	.806	.039	.374	.284	.199	.101	.051	.019	.144	.902	.056	.390	.312	.202	.095	.054	.024	.130	.872
0.5	.85	.018	.366	.280	.201	.101	.060	.030	.344	.910	.014	.367	.276	.187	.107	.071	.045	.344	.897	.021	.411	.313	.230	.135	.088	.043	.390	.925
2.0	.00	.824	.999	.999	.999	.999	.994	.910	.999	.970	.857	.994	.990	.984	.956	.871	.604	.968	.994	.811	.999	.998	.992	.976	.928	.720	.980	.978
2.0	.50	.820	.998	.995	.990	.975	.914	.717	.984	.983	.873	.992	.986	.978	.930	.843	.583	.967	.992	.844	.992	.985	.977	.941	.863	.618	.966	.988
2.0	.85	.895	.976	.967	.924	.824	.620	.359	.973	.992	.881	.975	.956	.908	.807	.642	.402	.968	.997	.908	.976	.951	.922	.812	.651	.373	.968	.998

C=9 N=4 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.065	.333	.259	.190	.111	.066	.025	.116	.728	.084	.380	.301	.200	.095	.042	.015	.153	.917	.074	.354	.280	.184	.091	.045	.015	.106	.843
0.5	.50	.065	.342	.270	.186	.095	.054	.020	.115	.840	.077	.376	.291	.195	.095	.046	.013	.166	.936	.084	.373	.284	.202	.112	.059	.022	.155	.905
0.5	.85	.074	.409	.297	.194	.101	.063	.029	.336	.945	.080	.406	.309	.194	.106	.064	.031	.336	.958	.064	.361	.269	.180	.103	.069	.040	.333	.955
2.0	.00	.810	1.00	1.00	.998	.998	.991	.844	.997	.967	.830	.972	.959	.934	.863	.758	.465	.917	.992	.830	.987	.982	.975	.949	.886	.633	.954	.983
2.0	.50	.817	.992	.991	.986	.956	.886	.648	.967	.980	.836	.966	.953	.925	.856	.727	.428	.926	.990	.846	.984	.980	.963	.915	.825	.530	.946	.991
2.0	.85	.846	.956	.918	.879	.761	.598	.362	.954	.991	.867	.953	.931	.885	.757	.596	.300	.949	.996	.875	.955	.930	.872	.759	.587	.318	.940	.995

C=9 N=4 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.075	.332	.265	.181	.111	.063	.021	.118	.748	.126	.363	.281	.187	.100	.049	.019	.177	.950	.115	.346	.270	.181	.097	.049	.018	.124	.861
0.5	.50	.094	.343	.260	.190	.105	.055	.019	.124	.859	.117	.380	.283	.193	.103	.054	.023	.199	.953	.110	.356	.275	.188	.086	.046	.021	.143	.903
0.5	.90	.114	.385	.296	.197	.105	.060	.033	.406	.963	.106	.388	.287	.184	.085	.049	.026	.417	.967	.112	.381	.275	.192	.083	.046	.024	.415	.965
2.0	.00	.760	1.00	1.00	.999	.996	.974	.809	.997	.959	.818	.944	.926	.893	.816	.685	.331	.880	.991	.784	.983	.979	.967	.912	.839	.530	.930	.967
2.0	.50	.800	.995	.993	.977	.937	.858	.575	.955	.988	.819	.941	.916	.879	.787	.627	.327	.892	.997	.802	.968	.953	.928	.862	.728	.436	.923	.992
2.0	.90	.882	.922	.891	.826	.681	.500	.199	.874	.976	.869	.910	.879	.820	.657	.460	.186	.852	.970	.865	.901	.873	.814	.652	.459	.175	.855	.968

C=9 N=4 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.098	.327	.246	.166	.088	.041	.006	.101	.783	.149	.352	.262	.174	.086	.042	.010	.186	.962	.131	.326	.260	.172	.077	.035	.006	.108	.905
0.5	.50	.102	.343	.259	.174	.097	.053	.017	.114	.872	.152	.368	.281	.184	.092	.043	.019	.207	.971	.125	.350	.267	.187	.088	.042	.010	.155	.943
0.5	.90	.151	.375	.282	.192	.091	.060	.027	.366	.963	.159	.394	.307	.194	.102	.058	.026	.383	.963	.149	.365	.278	.179	.082	.043	.024	.379	.969
2.0	.00	.754	1.00	.999	.994	.985	.959	.738	.990	.958	.798	.913	.882	.848	.741	.592	.258	.842	.995	.764	.973	.960	.931	.862	.774	.443	.889	.982
2.0	.50	.780	.982	.976	.951	.904	.826	.530	.934	.981	.773	.898	.862	.816	.702	.554	.247	.830	.994	.776	.938	.909	.880	.797	.657	.323	.845	.987
2.0	.90	.797	.872	.835	.765	.620	.430	.164	.831	.978	.832	.872	.835	.779	.632	.434	.172	.822	.971	.841	.890	.847	.794	.618	.420	.165	.838	.983

C=9 N=6 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.013	.366	.275	.180	.093	.045	.018	.088	.112	.003	.412	.303	.207	.114	.071	.024	.113	.240	.006	.380	.295	.199	.099	.062	.025	.097	.185
0.5	.50	.007	.403	.302	.204	.107	.059	.017	.117	.293	.001	.404	.324	.220	.120	.072	.025	.120	.302	.001	.390	.292	.200	.103	.062	.024	.104	.333
2.0	.00	.944	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.964	.964	1.00	1.00	1.00	1.00	.999	.994	1.00	.988	.969	1.00	1.00	1.00	1.00	1.00	.997	1.00	.985
2.0	.50	.963	1.00	1.00	1.00	1.00	1.00	.991	1.00	.990	.976	1.00	1.00	1.00	1.00	.997	.974	1.00	.995	.973	1.00	1.00	1.00	1.00	.998	.969	1.00	.997

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=9 N=6 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.044	.369	.279	.197	.115	.061	.015	.112	.253	.023	.378	.284	.190	.108	.061	.029	.118	.511	.027	.372	.285	.191	.096	.053	.018	.105	.428
0.5	.50	.032	.376	.278	.191	.100	.060	.024	.115	.464	.014	.401	.302	.194	.085	.052	.022	.120	.601	.014	.371	.286	.200	.109	.065	.026	.130	.559
0.5	.75	.006	.399	.307	.207	.110	.069	.027	.253	.656	.012	.388	.296	.210	.111	.068	.025	.247	.651	.009	.391	.300	.191	.111	.070	.028	.245	.689
2.0	.00	.945	1.00	1.00	1.00	1.00	1.00	.998	1.00	.967	.950	1.00	1.00	1.00	.999	.999	.960	.999	.989	.953	1.00	1.00	1.00	1.00	1.00	.989	1.00	.984
2.0	.50	.963	1.00	1.00	1.00	1.00	.997	.969	1.00	.991	.964	1.00	.999	.999	.995	.990	.923	.999	.994	.957	1.00	1.00	1.00	.997	.987	.910	1.00	.990
2.0	.75	.979	1.00	1.00	.996	.986	.968	.837	1.00	.998	.964	.999	.997	.992	.980	.953	.819	.999	.993	.972	.999	.997	.996	.985	.965	.812	.999	.996

C=9 N=6 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.062	.327	.236	.164	.082	.038	.009	.086	.356	.051	.363	.291	.179	.099	.049	.010	.141	.740	.070	.401	.316	.212	.110	.059	.016	.119	.577
0.5	.50	.069	.371	.286	.191	.108	.052	.019	.121	.570	.059	.403	.294	.200	.101	.056	.016	.172	.790	.066	.385	.298	.205	.096	.053	.017	.138	.715
0.5	.85	.041	.420	.325	.207	.111	.063	.028	.528	.873	.026	.419	.331	.224	.118	.075	.033	.543	.856	.034	.401	.306	.211	.122	.070	.030	.520	.871
2.0	.00	.918	1.00	1.00	1.00	1.00	1.00	.995	1.00	.959	.949	.999	.999	.995	.988	.966	.851	.993	.988	.936	1.00	1.00	.999	.998	.998	.950	.998	.982
2.0	.50	.929	1.00	1.00	1.00	.998	.990	.928	.999	.980	.949	.996	.994	.991	.979	.948	.781	.988	.993	.948	.999	.999	.997	.987	.961	.823	.992	.991
2.0	.85	.964	.990	.983	.971	.918	.841	.581	.986	.999	.975	.992	.986	.979	.938	.862	.595	.987	.999	.957	.989	.981	.971	.920	.851	.588	.983	1.00

C=9 N=6 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.084	.330	.254	.186	.099	.042	.005	.106	.409	.131	.390	.305	.189	.101	.048	.017	.171	.856	.128	.367	.290	.189	.097	.050	.011	.125	.699
0.5	.50	.101	.353	.271	.192	.106	.050	.014	.128	.622	.098	.363	.283	.188	.088	.043	.017	.197	.889	.122	.403	.301	.196	.113	.057	.013	.156	.812
0.5	.85	.105	.406	.305	.194	.096	.052	.018	.458	.930	.102	.415	.331	.208	.106	.053	.019	.448	.953	.103	.393	.289	.198	.091	.044	.013	.424	.956
2.0	.00	.907	1.00	1.00	1.00	1.00	.999	.982	1.00	.955	.939	.990	.983	.978	.953	.913	.695	.967	.993	.919	.998	.997	.996	.990	.978	.879	.991	.983
2.0	.50	.932	1.00	.999	.999	.993	.978	.873	.998	.986	.941	.994	.990	.985	.955	.900	.669	.985	.996	.927	.996	.993	.989	.964	.931	.753	.981	.993
2.0	.85	.950	.984	.971	.953	.890	.792	.521	.978	.998	.952	.983	.969	.945	.892	.802	.502	.976	1.00	.956	.979	.969	.946	.892	.795	.518	.974	1.00

C=9 N=6 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.122	.343	.278	.185	.096	.043	.005	.106	.482	.165	.364	.278	.176	.078	.037	.002	.197	.934	.137	.325	.255	.185	.085	.040	.011	.116	.730
0.5	.50	.118	.353	.271	.177	.086	.038	.010	.121	.691	.171	.362	.294	.197	.104	.053	.013	.237	.929	.152	.351	.274	.176	.097	.054	.012	.167	.864
0.5	.90	.165	.395	.307	.208	.103	.063	.020	.527	.974	.156	.392	.299	.212	.113	.059	.021	.510	.979	.159	.386	.285	.193	.088	.055	.019	.512	.982
2.0	.00	.888	1.00	1.00	1.00	.998	.994	.963	.998	.959	.935	.985	.976	.961	.916	.845	.561	.950	.997	.910	.995	.994	.989	.979	.959	.785	.984	.980
2.0	.50	.919	.998	.998	.997	.985	.971	.867	.990	.973	.925	.978	.965	.945	.894	.815	.511	.944	.996	.910	.980	.977	.965	.933	.890	.655	.957	.982
2.0	.90	.961	.965	.944	.906	.819	.710	.370	.931	.998	.950	.956	.929	.881	.799	.665	.353	.917	.994	.971	.959	.930	.896	.807	.670	.314	.920	.997

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=9 N=6 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.134	.323	.261	.182	.103	.059	.010	.112	.535	.221	.358	.275	.191	.086	.025	.007	.232	.955	.200	.371	.289	.194	.088	.047	.008	.129	.777
0.5	.50	.148	.321	.260	.193	.116	.058	.012	.151	.756	.250	.390	.321	.218	.105	.048	.007	.277	.968	.176	.349	.271	.176	.083	.031	.004	.166	.889
0.5	.90	.229	.372	.286	.202	.088	.041	.011	.454	.986	.266	.404	.294	.192	.104	.039	.011	.452	.989	.232	.372	.270	.190	.088	.050	.010	.419	.986
2.0	.00	.889	1.00	1.00	1.00	1.00	.998	.947	1.00	.956	.882	.950	.929	.901	.825	.723	.381	.906	.993	.887	.991	.988	.978	.952	.916	.687	.960	.975
2.0	.50	.891	.998	.997	.994	.969	.944	.764	.983	.981	.911	.959	.945	.915	.856	.759	.447	.936	.997	.909	.980	.971	.957	.913	.854	.591	.948	.992
2.0	.90	.931	.941	.912	.872	.791	.672	.331	.914	.996	.932	.933	.914	.872	.762	.630	.285	.905	.997	.937	.941	.919	.879	.787	.639	.278	.910	.998

C=9 N=9 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.028	.411	.305	.201	.110	.060	.017	.107	.012	.006	.412	.315	.205	.113	.066	.018	.121	.046	.004	.372	.278	.184	.094	.047	.024	.091	.026
0.5	.50	.003	.382	.281	.201	.097	.057	.017	.107	.084	.000	.406	.295	.200	.120	.068	.021	.138	.118	.002	.388	.287	.190	.102	.053	.012	.116	.136
2.0	.00	.991	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.974	.993	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.989	.986	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.982
2.0	.50	.993	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.992	.993	1.00	1.00	1.00	1.00	1.00	.999	1.00	.992	.996	1.00	1.00	1.00	1.00	1.00	.999	1.00	.998

C=9 N=9 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.064	.379	.283	.196	.112	.056	.019	.119	.065	.025	.388	.283	.187	.089	.043	.012	.114	.273	.047	.380	.284	.191	.094	.053	.009	.101	.164
0.5	.50	.052	.380	.294	.204	.105	.059	.014	.130	.242	.029	.397	.284	.195	.103	.061	.019	.162	.397	.023	.395	.301	.206	.111	.060	.021	.153	.328
0.5	.75	.016	.404	.293	.199	.109	.064	.017	.395	.598	.016	.397	.307	.210	.117	.068	.014	.384	.629	.011	.397	.302	.202	.103	.056	.024	.367	.619
2.0	.00	.977	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.959	.992	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.993	.977	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.978
2.0	.50	.992	1.00	1.00	1.00	1.00	.999	.997	1.00	.992	.994	1.00	1.00	1.00	.998	.998	.994	.999	.995	.990	1.00	1.00	1.00	1.00	1.00	.992	1.00	.992
2.0	.75	.994	1.00	1.00	1.00	1.00	.998	.966	1.00	.998	.991	.999	.999	.999	.998	.994	.966	1.00	.996	.995	1.00	1.00	1.00	.999	.994	.970	1.00	.999

C=9 N=9 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.089	.361	.286	.191	.097	.052	.008	.103	.127	.076	.368	.270	.181	.095	.051	.012	.159	.566	.118	.381	.303	.194	.111	.057	.014	.128	.349
0.5	.50	.081	.361	.280	.175	.091	.049	.012	.127	.348	.080	.384	.282	.184	.104	.050	.024	.182	.654	.090	.401	.304	.212	.112	.062	.018	.185	.586
0.5	.85	.040	.432	.330	.211	.096	.056	.016	.727	.912	.047	.388	.284	.189	.100	.062	.023	.702	.903	.046	.400	.311	.207	.119	.055	.019	.728	.914
2.0	.00	.979	1.00	1.00	1.00	1.00	1.00	.999	1.00	.968	.986	1.00	1.00	1.00	.999	.997	.977	1.00	.992	.987	1.00	1.00	1.00	1.00	1.00	.999	1.00	.987
2.0	.50	.978	1.00	1.00	1.00	1.00	1.00	.991	1.00	.984	.988	1.00	1.00	.999	.998	.994	.955	.998	.993	.985	1.00	1.00	1.00	1.00	.998	.973	1.00	.993
2.0	.85	.994	.998	.996	.992	.981	.960	.842	1.00	.999	.994	.999	.998	.997	.982	.959	.832	.999	1.00	.996	.998	.996	.994	.982	.962	.839	.998	.999

C=9 N=9 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.144	.336	.255	.177	.089	.057	.015	.093	.191	.171	.359	.271	.196	.098	.057	.014	.214	.788	.167	.367	.282	.190	.082	.036	.008	.116	.457
0.5	.50	.140	.377	.284	.186	.095	.043	.013	.139	.484	.164	.388	.291	.194	.091	.041	.005	.228	.847	.176	.384	.278	.189	.097	.046	.011	.186	.727
0.5	.85	.152	.413	.324	.225	.114	.065	.016	.596	.933	.151	.404	.304	.201	.106	.059	.021	.609	.959	.141	.404	.306	.202	.106	.049	.017	.604	.967
2.0	.00	.979	1.00	1.00	1.00	1.00	1.00	.998	1.00	.969	.981	.998	.997	.993	.984	.972	.909	.991	.997	.977	1.00	1.00	.999	.997	.995	.980	.997	.989
2.0	.50	.986	1.00	1.00	1.00	.999	.998	.988	.999	.986	.988	.999	.998	.997	.992	.979	.890	.998	.999	.976	1.00	.999	.998	.993	.989	.943	.997	.993
2.0	.85	.993	.999	.995	.983	.968	.927	.781	.999	1.00	.990	.997	.991	.982	.963	.931	.757	.997	1.00	.989	.993	.992	.979	.959	.925	.751	.994	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=9 N=9 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.156	.358	.271	.179	.088	.046	.006	.096	.250	.221	.372	.287	.201	.111	.048	.015	.254	.887	.192	.357	.276	.197	.092	.043	.010	.132	.594
0.5	.50	.169	.369	.270	.179	.095	.055	.007	.135	.525	.241	.387	.291	.183	.102	.051	.007	.288	.921	.228	.357	.282	.201	.097	.043	.004	.196	.796
0.5	.90	.232	.378	.297	.199	.096	.046	.010	.656	.994	.241	.420	.313	.191	.099	.047	.010	.667	.995	.246	.398	.311	.220	.106	.055	.014	.652	.990
2.0	.00	.964	1.00	1.00	1.00	1.00	1.00	.996	1.00	.954	.971	.996	.995	.985	.966	.932	.802	.989	.994	.968	1.00	1.00	.999	.994	.991	.956	.995	.976
2.0	.50	.968	1.00	1.00	.999	.998	.992	.967	.998	.991	.983	.994	.992	.985	.963	.937	.787	.990	1.00	.968	.999	.996	.995	.983	.972	.898	.995	.993
2.0	.90	.993	.988	.976	.963	.926	.849	.621	.974	1.00	.987	.981	.971	.959	.921	.847	.605	.966	.999	.990	.984	.975	.948	.909	.834	.591	.966	1.00

C=9 N=9 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.177	.354	.269	.190	.102	.058	.015	.113	.295	.320	.404	.310	.222	.121	.054	.013	.337	.970	.268	.368	.291	.204	.113	.049	.011	.160	.689
0.5	.50	.186	.321	.240	.173	.085	.040	.006	.127	.558	.321	.385	.301	.211	.105	.055	.009	.354	.962	.319	.393	.311	.221	.118	.053	.012	.232	.839
0.5	.90	.294	.375	.293	.202	.096	.046	.009	.592	.996	.308	.385	.286	.201	.109	.062	.015	.559	.996	.308	.373	.276	.179	.074	.037	.010	.543	.993
2.0	.00	.956	1.00	1.00	1.00	1.00	1.00	.995	1.00	.959	.965	.988	.976	.963	.938	.893	.699	.977	1.00	.957	1.00	.999	.993	.990	.980	.905	.991	.989
2.0	.50	.959	1.00	1.00	.998	.991	.986	.941	.997	.979	.971	.989	.980	.966	.951	.891	.693	.977	.999	.968	.998	.996	.988	.978	.955	.835	.988	.992
2.0	.90	.984	.983	.969	.949	.890	.809	.520	.968	1.00	.980	.966	.957	.936	.879	.796	.538	.949	.999	.983	.976	.966	.938	.871	.779	.492	.960	.999

C=9 N=12 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.025	.397	.293	.196	.100	.053	.013	.104	.000	.005	.375	.280	.181	.102	.059	.018	.111	.006	.010	.388	.290	.209	.096	.053	.010	.103	.002
0.5	.50	.004	.380	.291	.197	.117	.063	.009	.136	.041	.001	.366	.262	.170	.083	.049	.017	.102	.071	.003	.422	.321	.200	.108	.056	.022	.136	.075
2.0	.00	.997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.974	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.989	.997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.985
2.0	.50	.996	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.987	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.994	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.994

C=9 N=12 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.091	.391	.293	.207	.113	.060	.019	.120	.015	.049	.412	.324	.225	.115	.061	.016	.147	.117	.057	.384	.284	.194	.107	.060	.019	.126	.041
0.5	.50	.067	.407	.308	.216	.107	.056	.017	.140	.113	.036	.426	.321	.214	.107	.065	.016	.170	.262	.042	.396	.311	.218	.108	.064	.013	.168	.219
0.5	.75	.018	.394	.293	.197	.107	.049	.012	.459	.625	.022	.371	.282	.176	.095	.058	.014	.442	.624	.013	.412	.310	.208	.107	.054	.016	.509	.650
2.0	.00	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.976	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.994	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.986
2.0	.50	.997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.991	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.996	.996	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.997
2.0	.75	.998	1.00	1.00	1.00	1.00	1.00	.992	1.00	1.00	.998	1.00	1.00	1.00	1.00	.999	.992	1.00	1.00	.999	1.00	1.00	1.00	.999	.999	.994	1.00	.999

C=9 N=12 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.144	.391	.306	.202	.113	.056	.013	.120	.045	.119	.406	.317	.219	.103	.051	.009	.179	.457	.149	.396	.287	.201	.118	.059	.015	.137	.154
0.5	.50	.134	.388	.290	.198	.112	.058	.009	.151	.226	.097	.381	.273	.183	.089	.045	.009	.214	.584	.131	.384	.297	.183	.093	.049	.010	.194	.440
0.5	.85	.077	.423	.330	.227	.102	.054	.009	.870	.959	.054	.392	.307	.184	.099	.051	.010	.858	.968	.069	.404	.306	.209	.108	.065	.014	.837	.955
2.0	.00	.992	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.971	.998	1.00	1.00	1.00	1.00	1.00	.999	1.00	.996	.994	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.984
2.0	.50	.991	1.00	1.00	1.00	1.00	1.00	.998	1.00	.984	.996	1.00	1.00	1.00	.999	.999	.996	1.00	.999	.997	1.00	1.00	1.00	1.00	1.00	.996	1.00	.996
2.0	.85	1.00	1.00	1.00	1.00	1.00	.992	.953	1.00	1.00	.998	.999	.999	.997	.995	.991	.954	1.00	1.00	.999	.998	.998	.997	.995	.987	.932	.998	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=9 N=12 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.150	.356	.260	.184	.089	.038	.007	.101	.073	.234	.406	.318	.211	.117	.055	.015	.268	.745	.222	.385	.302	.205	.107	.048	.012	.145	.349
0.5	.50	.176	.350	.264	.160	.087	.050	.009	.127	.297	.233	.405	.309	.223	.123	.057	.012	.309	.822	.237	.382	.305	.208	.098	.053	.014	.209	.624
0.5	.85	.174	.413	.317	.220	.123	.068	.012	.752	.977	.188	.400	.299	.206	.111	.056	.010	.728	.974	.180	.406	.296	.192	.094	.051	.010	.730	.980
2.0	.00	.996	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.968	.995	1.00	1.00	1.00	1.00	.998	.971	1.00	.997	.992	1.00	1.00	1.00	1.00	1.00	.998	1.00	.989
2.0	.50	.992	1.00	1.00	1.00	1.00	1.00	.999	1.00	.989	.998	.999	.999	.999	.997	.993	.967	.999	.999	.996	1.00	1.00	.999	.998	.995	.981	1.00	.998
2.0	.85	.999	1.00	.998	.995	.983	.976	.908	.999	1.00	.995	.995	.995	.995	.989	.980	.905	.996	1.00	.998	1.00	.999	.996	.991	.976	.898	1.00	1.00

C=9 N=12 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.215	.378	.308	.208	.105	.047	.010	.122	.152	.338	.384	.308	.207	.102	.054	.008	.342	.892	.288	.383	.284	.197	.089	.043	.009	.144	.449
0.5	.50	.237	.372	.288	.201	.097	.048	.011	.160	.400	.303	.378	.293	.175	.090	.047	.006	.359	.921	.305	.388	.310	.224	.106	.057	.012	.242	.738
0.5	.90	.293	.392	.303	.202	.109	.058	.010	.772	.997	.289	.397	.309	.203	.094	.034	.009	.753	.998	.317	.409	.300	.207	.113	.066	.015	.744	1.00
2.0	.00	.988	1.00	1.00	1.00	1.00	1.00	.998	1.00	.953	.990	1.00	.999	.993	.986	.980	.917	.996	.999	.994	1.00	1.00	1.00	.999	.998	.993	1.00	.988
2.0	.50	.990	1.00	1.00	1.00	1.00	.999	.991	1.00	.990	.995	.999	.999	.996	.987	.976	.895	.995	.998	.989	1.00	.999	.999	.998	.995	.962	.998	.994
2.0	.90	.998	.989	.986	.979	.962	.933	.787	.984	1.00	.998	.994	.989	.983	.958	.921	.766	.988	1.00	.999	.997	.993	.987	.960	.931	.772	.994	1.00

C=9 N=12 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.225	.334	.261	.180	.087	.036	.004	.097	.149	.410	.397	.323	.219	.112	.059	.012	.374	.949	.309	.359	.262	.171	.084	.043	.005	.139	.555
0.5	.50	.279	.368	.286	.208	.107	.050	.006	.153	.476	.372	.371	.273	.195	.092	.041	.013	.379	.967	.360	.383	.288	.192	.103	.045	.007	.255	.821
0.5	.90	.389	.401	.294	.214	.111	.063	.017	.687	.997	.428	.412	.323	.212	.101	.058	.011	.664	.999	.429	.415	.312	.217	.116	.057	.012	.678	.998
2.0	.00	.987	1.00	1.00	1.00	1.00	1.00	.999	1.00	.961	.992	.997	.992	.990	.970	.944	.841	.994	1.00	.990	1.00	.999	.999	.999	.998	.972	.999	.994
2.0	.50	.992	1.00	1.00	1.00	1.00	.999	.994	1.00	.986	.990	.991	.990	.988	.972	.948	.832	.992	1.00	.992	.999	.998	.996	.995	.988	.920	.997	.996
2.0	.90	.997	.993	.986	.977	.953	.903	.746	.987	1.00	1.00	.996	.990	.980	.955	.907	.712	.991	1.00	.994	.989	.981	.971	.940	.892	.720	.986	1.00

C=9 N=16 CV=1.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.052	.412	.318	.213	.100	.052	.010	.110	.000	.004	.390	.313	.205	.099	.053	.008	.117	.000	.020	.415	.306	.212	.110	.050	.009	.131	.000
0.5	.50	.010	.388	.286	.181	.102	.058	.014	.139	.038	.005	.378	.288	.193	.091	.042	.011	.146	.051	.009	.397	.304	.200	.108	.055	.015	.148	.040
2.0	.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.978	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.990	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.986
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.991	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.988	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.997

C=9 N=16 CV=2.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.091	.372	.283	.198	.103	.058	.014	.110	.002	.070	.393	.306	.191	.096	.043	.012	.137	.050	.064	.363	.263	.186	.091	.046	.008	.121	.005
0.5	.50	.077	.372	.287	.197	.111	.062	.019	.145	.059	.048	.374	.286	.187	.104	.065	.016	.204	.191	.058	.396	.311	.216	.103	.056	.015	.200	.156
0.5	.75	.020	.373	.295	.197	.105	.058	.014	.566	.701	.023	.394	.300	.208	.096	.047	.010	.567	.702	.023	.398	.311	.213	.114	.066	.020	.614	.735
2.0	.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.976	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.985
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.989	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999
2.0	.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	1.00	1.00

Appendix I. SSL Simulation Results: Estimated Probabilities of Investigating Further

C=9 N=16 CV=2.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.163	.379	.281	.198	.113	.052	.008	.124	.012	.170	.397	.297	.199	.098	.054	.009	.216	.331	.170	.380	.279	.186	.103	.053	.013	.140	.066
0.5	.50	.187	.396	.306	.209	.113	.056	.019	.158	.121	.145	.388	.282	.190	.090	.048	.013	.269	.467	.161	.404	.301	.208	.105	.051	.008	.226	.330
0.5	.85	.071	.420	.322	.207	.098	.053	.014	.952	.984	.065	.438	.331	.232	.107	.062	.015	.963	.986	.085	.406	.304	.201	.106	.058	.018	.942	.988
2.0	.00	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.966	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.996	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.986
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.995	1.00	1.00	1.00	1.00	1.00	1.00	.999	1.00	1.00	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.996
2.0	.85	1.00	1.00	1.00	1.00	.998	.997	.982	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.998	.989	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.997	.983	1.00	1.00

C=9 N=16 CV=3.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.227	.400	.315	.210	.105	.053	.005	.125	.026	.279	.366	.269	.192	.099	.047	.007	.287	.655	.278	.383	.292	.205	.106	.057	.013	.170	.174
0.5	.50	.256	.390	.302	.224	.124	.049	.011	.184	.207	.297	.376	.291	.204	.104	.047	.007	.361	.766	.286	.399	.299	.192	.097	.060	.017	.271	.548
0.5	.85	.252	.387	.277	.186	.093	.050	.011	.860	.982	.225	.368	.282	.186	.093	.045	.011	.829	.991	.247	.430	.336	.229	.135	.074	.015	.851	.987
2.0	.00	.998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.961	.999	1.00	1.00	1.00	.999	.998	.997	.999	.997	.999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.989
2.0	.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.993	.999	1.00	1.00	1.00	1.00	1.00	.991	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2.0	.85	1.00	1.00	1.00	.999	.997	.991	.971	1.00	1.00	1.00	1.00	1.00	1.00	.998	.993	.964	1.00	1.00	1.00	1.00	1.00	1.00	.996	.995	.968	1.00	1.00

C=9 N=16 CV=3.5

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.271	.365	.283	.202	.114	.071	.009	.130	.070	.392	.368	.276	.180	.085	.041	.010	.387	.867	.348	.374	.294	.201	.103	.056	.014	.166	.291
0.5	.50	.319	.353	.278	.190	.098	.058	.009	.162	.271	.382	.366	.282	.199	.097	.050	.013	.441	.918	.397	.419	.319	.220	.113	.052	.011	.295	.678
0.5	.90	.396	.432	.338	.224	.118	.058	.015	.846	1.00	.351	.387	.289	.198	.106	.044	.010	.822	1.00	.351	.411	.325	.223	.113	.061	.006	.843	1.00
2.0	.00	.995	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.961	.999	1.00	1.00	1.00	1.00	.998	.976	1.00	1.00	.999	1.00	1.00	1.00	1.00	1.00	.999	1.00	.991
2.0	.50	.999	1.00	1.00	1.00	1.00	1.00	.999	1.00	.991	.998	1.00	1.00	1.00	.999	.993	.968	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.994	.999	1.00
2.0	.90	1.00	.997	.996	.993	.985	.970	.902	.995	1.00	1.00	.999	.997	.997	.991	.975	.887	.999	1.00	1.00	.998	.996	.993	.980	.970	.881	.996	1.00

C=9 N=16 CV=4.0

MU	MIX	MxL	C40L	C30L	C20L	C10L	C05L	C01L	LfL	LoL	MxG	C40G	C30G	C20G	C10G	C05G	C01G	LfG	LoG	MxW	C40W	C30W	C20W	C10W	C05W	C01W	LfW	LoW
0.5	.00	.297	.353	.276	.202	.111	.052	.014	.125	.072	.502	.379	.282	.176	.088	.049	.010	.438	.949	.414	.358	.280	.183	.090	.039	.005	.165	.394
0.5	.50	.379	.393	.305	.209	.102	.053	.004	.181	.337	.513	.413	.325	.215	.116	.066	.015	.513	.967	.441	.377	.288	.207	.095	.046	.010	.293	.779
0.5	.90	.481	.402	.294	.198	.100	.049	.011	.793	1.00	.493	.387	.298	.201	.091	.047	.011	.738	.999	.493	.389	.315	.196	.102	.053	.010	.773	1.00
2.0	.00	.998	1.00	1.00	1.00	1.00	1.00	.999	1.00	.950	.996	.998	.998	.995	.991	.981	.932	.997	1.00	.998	1.00	1.00	1.00	1.00	1.00	.996	1.00	.994
2.0	.50	.997	1.00	1.00	1.00	1.00	1.00	.998	1.00	.990	.999	.998	.998	.995	.991	.982	.923	1.00	1.00	.997	1.00	1.00	1.00	.999	.997	.979	1.00	.999
2.0	.90	1.00	1.00	.997	.991	.979	.952	.872	.998	1.00	.999	.998	.995	.992	.970	.934	.817	.994	1.00	1.00	.998	.995	.986	.973	.939	.820	.994	1.00

APPENDIX J

Piazza Road Simulation Results

APPENDIX J

Piazza Road Simulation Results

Section 4.3.6 contains background information on the Piazza Road site and its seven exposure areas (EAs), as well as a complete description of the simulation setup and parameters. The following notation is used in the tables of this appendix.

EA	=	exposure area number (from 1 to 7)
MEAN	=	the true mean for the EA (an average of 96 measurements)
CV	=	the true value of the coefficient of variation for the EA
DES	=	indicator of whether compositing within strata (DES = W) or compositing across strata (DES = X) was used
C	=	the number of specimens per composite
N	=	the number of composite samples chemically analyzed.

The remaining four variables give the estimated error rates at 0.5 SSL and 2 SSL for the Max test (labelled as MAX 0.5SSL and MAX 2.0SSL) and the Chen test at the nominal .10 level (labelled as CHEN 0.5SSL and CHEN 2.0SSL).

Appendix J. Estimated decision error rates for Chen test at the 0.1 level, and Max test, for compositing within sector (DES=W) or across sector (DES=X), based on simulations from Piazza Road Data.

EA = EA # (1 to 7). MEAN and CV denote EA true mean and CV.
M = # of samples per composite. N = # of composite samples.

---------- EA=1 MEAN=2.1 CV=1.0 ----------

DES	M	N	MAX 0.5SSL	MAX 2.0SSL	CHEN 0.5SSL	CHEN 2.0SSL
W	4	4	.01	.03	.02	.00
X	4	4	.00	.12	.12	.00
W	4	6	.01	.01	.04	.00
X	4	6	.00	.04	.11	.00
W	4	8	.02	.00	.01	.00
X	4	8	.00	.01	.15	.00
W	6	4	.00	.01	.01	.00
X	6	4	.00	.11	.13	.00
W	6	6	.00	.01	.04	.00
X	6	6	.00	.04	.12	.00
W	6	8	.01	.00	.01	.00
X	6	8	.00	.01	.12	.00
W	8	4	.00	.02	.00	.00
X	8	4	.00	.09	.12	.00
W	8	6	.00	.01	.02	.00
X	8	6	.00	.04	.13	.00
W	8	8	.00	.00	.01	.00
X	8	8	.00	.02	.10	.00

---------- EA=2 MEAN=2.4 CV=1.6 ----------

DES	M	N	MAX 0.5SSL	MAX 2.0SSL	CHEN 0.5SSL	CHEN 2.0SSL
W	4	4	.07	.13	.08	.05
X	4	4	.04	.13	.11	.05
W	4	6	.09	.04	.05	.02
X	4	6	.05	.05	.11	.01
W	4	8	.11	.02	.05	.00
X	4	8	.07	.01	.11	.00
W	6	4	.04	.13	.09	.02
X	6	4	.01	.14	.09	.02
W	6	6	.05	.03	.04	.00
X	6	6	.01	.04	.09	.00
W	6	8	.06	.01	.04	.00
X	6	8	.01	.01	.13	.00
W	8	4	.03	.08	.09	.00
X	8	4	.00	.12	.10	.01
W	8	6	.04	.02	.04	.00
X	8	6	.00	.04	.10	.00
W	8	8	.04	.00	.04	.00
X	8	8	.00	.02	.12	.00

Appendix J. Estimated decision error rates for Chen test at the 0.1 level, and Max test, for compositing within sector (DES=W) or across sector (DES=X), based on simulations from Piazza Road Data.

EA = EA # (1 to 7). MEAN and CV denote EA true mean and CV.
M = # of samples per composite. N = # of composite samples.

----------EA=3 MEAN=5.1 CV=1.1----------

DES	M	N	MAX 0.5SSL	MAX 2.0SSL	CHEN 0.5SSL	CHEN 2.0SSL
W	4	4	.01	.03	.03	.01
X	4	4	.00	.11	.14	.00
W	4	6	.02	.00	.00	.00
X	4	6	.00	.03	.11	.00
W	4	8	.06	.00	.00	.00
X	4	8	.00	.01	.10	.00
W	6	4	.00	.02	.01	.00
X	6	4	.00	.09	.12	.00
W	6	6	.01	.00	.00	.00
X	6	6	.00	.03	.11	.00
W	6	8	.02	.00	.00	.00
X	6	8	.00	.01	.11	.00
W	8	4	.00	.02	.01	.00
X	8	4	.00	.10	.14	.00
W	8	6	.01	.00	.00	.00
X	8	6	.00	.03	.12	.00
W	8	8	.03	.00	.00	.00
X	8	8	.00	.01	.12	.00

----------EA=4 MEAN=3.8 CV=1.2----------

DES	M	N	MAX 0.5SSL	MAX 2.0SSL	CHEN 0.5SSL	CHEN 2.0SSL
W	4	4	.01	.11	.07	.00
X	4	4	.00	.11	.10	.00
W	4	6	.02	.04	.06	.00
X	4	6	.00	.04	.11	.00
W	4	8	.02	.01	.05	.00
X	4	8	.00	.01	.09	.00
W	6	4	.01	.10	.05	.00
X	6	4	.00	.10	.12	.00
W	6	6	.00	.02	.04	.00
X	6	6	.00	.03	.09	.00
W	6	8	.01	.01	.04	.00
X	6	8	.00	.02	.10	.00
W	8	4	.00	.09	.04	.00
X	8	4	.00	.12	.12	.00
W	8	6	.00	.03	.06	.00
X	8	6	.00	.03	.11	.00
W	8	8	.00	.01	.03	.00
X	8	8	.00	.01	.11	.00

Appendix J. Estimated decision error rates for Chen test at the 0.1 level, and Max test, for compositing within sector (DES=W) or across sector (DES=X), based on simulations from Piazza Road Data.

EA = EA # (1 to 7). MEAN and CV denote EA true mean and CV.
M = # of samples per composite. N = # of composite samples.

----------EA=5 MEAN=9.3 CV=2.0----------

DES	M	N	MAX 0.5SSL	MAX 2.0SSL	CHEN 0.5SSL	CHEN 2.0SSL
W	4	4	.22	.13	.01	.12
X	4	4	.03	.17	.07	.04
W	4	6	.48	.03	.00	.02
X	4	6	.03	.06	.08	.00
W	4	8	.71	.00	.00	.00
X	4	8	.05	.03	.10	.00
W	6	4	.18	.06	.00	.05
X	6	4	.00	.10	.10	.01
W	6	6	.47	.01	.00	.00
X	6	6	.00	.02	.10	.00
W	6	8	.76	.00	.00	.00
X	6	8	.00	.01	.11	.00
W	8	4	.19	.05	.00	.03
X	8	4	.00	.08	.12	.00
W	8	6	.45	.01	.00	.00
X	8	6	.00	.03	.14	.00
W	8	8	.76	.00	.00	.00
X	8	8	.00	.01	.10	.00

----------EA=6 MEAN=15.8 CV=2.2----------

DES	M	N	MAX 0.5SSL	MAX 2.0SSL	CHEN 0.5SSL	CHEN 2.0SSL
W	4	4	.18	.16	.03	.21
X	4	4	.07	.20	.10	.19
W	4	6	.22	.06	.03	.07
X	4	6	.10	.08	.09	.07
W	4	8	.34	.03	.02	.03
X	4	8	.13	.03	.09	.03
W	6	4	.13	.11	.02	.11
X	6	4	.02	.16	.09	.09
W	6	6	.15	.04	.02	.03
X	6	6	.05	.06	.08	.02
W	6	8	.33	.01	.02	.01
X	6	8	.07	.03	.09	.01
W	8	4	.08	.09	.00	.07
X	8	4	.01	.14	.09	.03
W	8	6	.11	.03	.01	.01
X	8	6	.01	.04	.09	.01
W	8	8	.31	.01	.01	.00
X	8	8	.01	.02	.10	.00

Appendix J. Estimated decision error rates for Chen test at the 0.1 level, and Max test, for compositing within sector (DES=W) or across sector (DES=X), based on simulations from Piazza Road Data.

EA = EA # (1 to 7). MEAN and CV denote EA true mean and CV.
M = # of samples per composite. N = # of composite samples.

----------EA=7 MEAN=2.8 CV=1.4----------

DES	M	N	MAX 0.5SSL	MAX 2.0SSL	CHEN 0.5SSL	CHEN 2.0SSL
W	4	4	.03	.11	.02	.00
X	4	4	.00	.13	.09	.00
W	4	6	.09	.03	.02	.00
X	4	6	.01	.06	.07	.00
W	4	8	.16	.01	.02	.00
X	4	8	.01	.02	.09	.00
W	6	4	.02	.08	.01	.00
X	6	4	.00	.10	.12	.00
W	6	6	.06	.02	.01	.00
X	6	6	.00	.03	.09	.00
W	6	8	.10	.00	.01	.00
X	6	8	.00	.02	.09	.00
W	8	4	.01	.06	.01	.00
X	8	4	.00	.10	.12	.00
W	8	6	.04	.01	.00	.00
X	8	6	.00	.03	.10	.00
W	8	8	.06	.00	.00	.00
X	8	8	.00	.01	.11	.00

APPENDIX K

Soil Organic Carbon (K_{oc}) / Water (K_{ow}) Partition Coefficients

Table K-1. Values Used for K_{oc} / K_{ow} Correlation

Chemical	log K_{ow}	Calculated log K_{oc}	Calculated K_{oc}	Measured log K_{oc}	Measured K_{oc} (geomean)
Benzene	2.13	1.77	59	1.79	61.7
Bromoform	2.35	1.94	87	2.10	126
Carbon tetrachloride	2.73	2.24	174	2.18	152
Chlorobenzene	2.86	2.34	219	2.35	224
Chloroform	1.92	1.60	40	1.72	52.5
Dichlorobenzene, 1,2- *(o)*	3.43	2.79	617	2.58	379
Dichlorobenzene, 1,4- *(p)*	3.42	2.79	617	2.79	616
Dichloroethane, 1,1-	1.79	1.50	32	1.73	53.4
Dichloroethane, 1,2-	1.47	1.24	17	1.58	38.0
Dichloroethylene, 1,1-	2.13	1.77	59	1.81	65
Dichloroethylene, *trans* -1,2-	2.07	1.72	52	1.58	38
Dichloropropane, 1,2-	1.97	1.64	44	1.67	47.0
Dieldrin	5.37	4.33	21,380	4.41	25,546
Endosulfan	4.10	3.33	2,138	3.31	2,040
Endrin	5.06	4.09	12,303	4.03	10,811
Ethylbenzene	3.14	2.56	363	2.31	204
Hexachlorobenzene	5.89	4.74	54,954	4.90	80,000
Methyl bromide	1.19	1.02	10	0.95	9.0
Methyl chloride	0.91	0.80	6	0.78	6.0
Methylene chloride	1.25	1.07	12	1.00	10
Pentachlorobenzene	5.26	4.24	17,378	4.51	32,148
Tetrachloroethane, 1,1,2,2-	2.39	1.97	93	1.90	79.0
Tetrachloroethylene	2.67	2.19	155	2.42	265
Toluene	2.75	2.26	182	2.15	140
Trichlorobenzene, 1,2,4-	4.01	3.25	1,778	3.22	1,659
Trichloroethane, 1,1,1-	2.48	2.04	110	2.13	135
Trichloroethane, 1,1,2-	2.05	1.70	50	1.88	75.0
Trichloroethylene	2.71	2.22	166	1.97	94.3
Xylene, *o*-	3.13	2.56	363	2.38	241
Xylene, *m*-	3.20	2.61	407	2.29	196
Xylene, *p*-	3.17	2.59	389	2.49	311

Regression Statistics	
Multiple R	0.9870
R Square	0.9742
Adjusted R Square	0.9733
Standard Error	0.1640
Observations	31

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	29.4358	29.4358	1,094	1.4032E-24
Residual	29	0.7804	0.0269		
Total	30	30.2161			

	Coefficients	*Std. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.0784	0.0748	1.0481	0.3033	-0.0746	0.2314
X Variable 1	0.7919	0.0239	33.0742	0.0000	0.7430	0.8409

Figure K-1. Correlation Plot: log K_{ow} and log K_{oc}

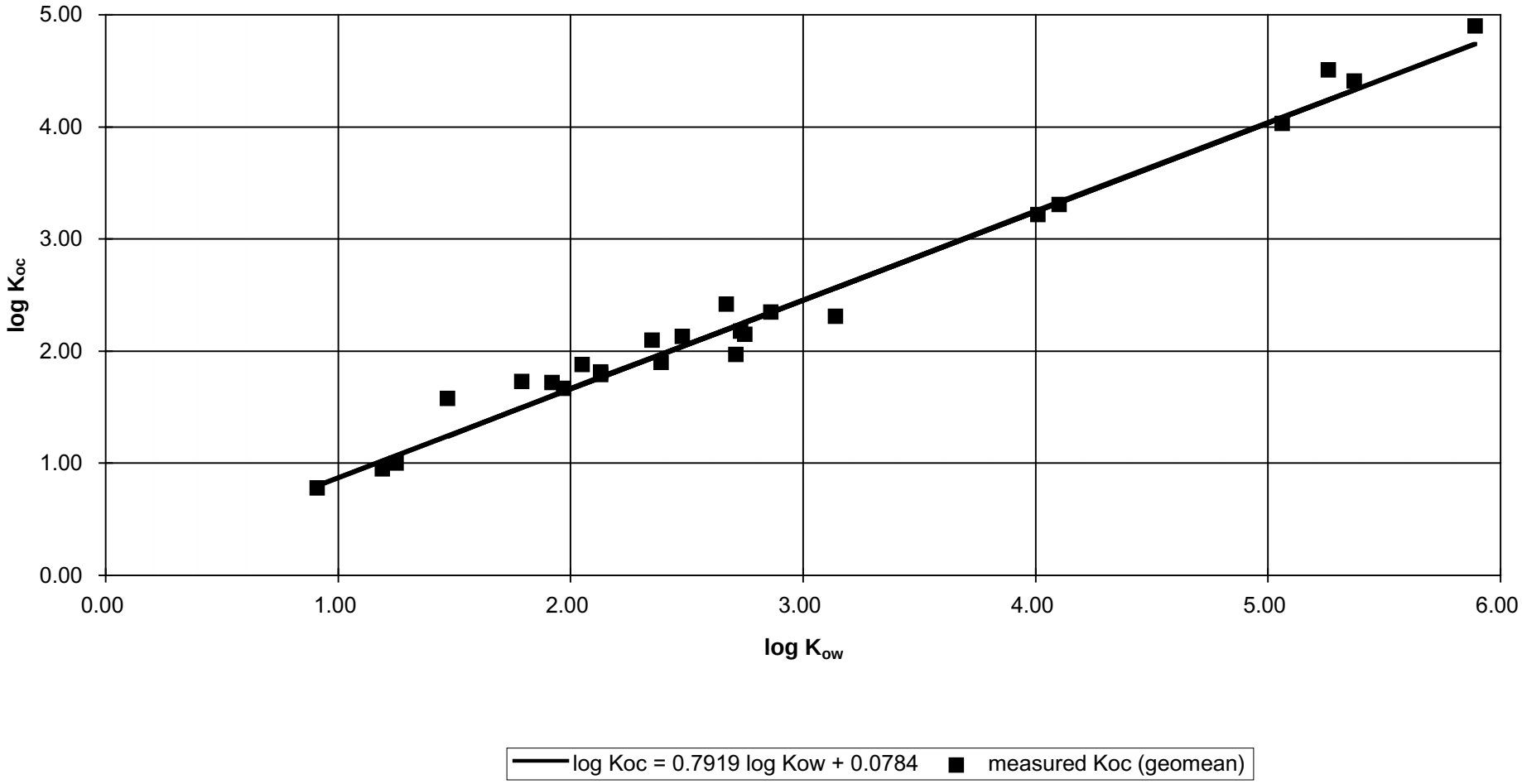

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Acenaphthene	83-32-9				
		3,890	3.59	Szabo (1990a)	RP-HPLC on PIHAC (humic acids)
		6,166	3.79	Szabo (1990a)	RP-HPLC on CIHAC (humic acids)
Average		***5,028***	3.70		
Geometric Mean		***4,898***	3.69		
Acetone	67-64-1				
Aldrin	309-00-2				
		48,394	4.68	Lord et al. (1980)	"Geescroft/Rothamsted Farm" soil; 2.6% OM; pH=5.1; suspect
		48,978	4.69	Briggs (1981)	Batcombe silt loam (Gr. Br.); 2.05% OC; pH=6.1
Average		***48,686***	4.69		
Geometric Mean		***48,685***	4.69		
Anthracene	120-12-7				
		14,500	4.16	McCarthy & Jimenez (1985)	humic acids
		15,849	4.20	Karichkoff (1981)	soil/sediments average; shake-flask UV
		19,562	4.29	Landrum et al. (1984)	surface water (geomean 5 values)
		23,988	4.38	Hodson & Williams (1988)	cyanopropyl column; HPLC
		26,000	4.41	Karickhoff et al. (1979)	avg. coarse silt fraction, Doe Run & Hickory Hill sediments
		26,303	4.42	Szabo et al. (1990a)	RP-HPLC on PIHAC (humic acids)
		27,840	4.44	Abdul & Gibson (1986)	Flint aquifer sample; 87% sand; foc = 0.0187
		31,329	4.50	Landrum et al. (1984)	humic acid (geomean 8 values)
		33,884	4.53	Szabo et al. (1990a)	RP-HPLC on CIHAC (humic acids)
Average		***24,362***	4.39		
Geometric Mean		***23,493***	4.37		
Benz(α)anthracene	56-55-3				
		150,000	5.18	McCarthy & Jimenez (1985)	humic acid
		199,526	5.30	Landrum et al. (1984)	humic acid
		650,000	5.81	Karickhoff et al. (1979)	avg. coarse silt fraction, Doe Run & Hickory Hill seds.
		840,000	5.92	Smith et al. (1978) as cited in Di Toro et al. (1985)	40% OC
Average		***459,882***	5.66		
Geometric Mean		***357,537***	5.55		
Benzene	71-43-2				
		31	1.50	Chiou et al. (1983)	Woodburn silt loam; fom = 0.019; 21% clay
		38.2	1.58	Seip et al. (1986)	forest soil with 0.2% OC; column study
		43.5	1.64	Seip et al. (1986)	agricultural soil with 2.2% OC; column study
		49	1.69	Abdul et al. (1987)	batch equilibrium experiments; aquifer material; foc = 0.0105
		53.5	1.73	Seip et al. (1986)	forest soil with 3.7% OC; column study
		60	1.78	Karickhoff (1981)	soils/sediments average; shake flask UV

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Benzene	71-43-2				
(continued)		63	1.80	Piwoni & Banerjee (1989)	0.19 percent organic carbon
		66	1.82	Szabo et al. (1990a)	RP-HPLC on PIHAC (humic acids)
		74	1.87	Szabo et al. (1990a)	RP-HPLC on CIHAC (humic acids)
		83	1.92	Karickhoff et al. (1979)	avg. coarse silt fraction, Doe Run & Hickory Hill seds.
		92	1.97	Rogers et al. (1980)	Hastings silty clay loam with 2.6% OC
		98	1.99	Pavlou (1987) as cited in Mackay et al. (1992)	
		100	2.00	Rogers et al. (1980)	Overton silty clay loam with 1.8% OC
Average		***66***	1.82		
Geometric Mean		***62***	1.79		
Benzo(*a*)pyrene	50-32-8				
		478,947	5.68	Smith et al. (1978) as cited in Di Toro (1985)	3.8% OC
		891,251	5.95	Landrum et al. (1984)	humic acids
		2,130,000	6.33	McCarthy & Jimenez (1985)	humic acids (average 8 values)
Average		***1,166,733***	6.07		
Geometric Mean		***968,774***	5.99		
Benzo(*b*)fluoranthene	205-99-2				
Benzo(*k*)fluoranthene	207-08-9				
Bis(2-chlorethyl)ether	111-44-4				
		75.9	1.88	Wilson et al. (1981)	Lincoln sand; 0.087% OC
Average		***76***	1.88		
Geometric Mean		***76***	1.88		
Bis(2-ethylhexyl)phthalate	117-81-7				
(Bis(2-ethylhexyl)ester)		87,420	4.94	Russell & McDuffie (1986)	Broome Co., NY, composite soil; 1.59% OC; column study
		141,254	5.15	Carter & Suffet (1983)	measured change in sorption in presence of humic acids
Average		***114,337***	5.06		
Geometric Mean		***111,123***	5.05		
Bromodichloromethane	75-27-4				
Bromoform	75-25-2				
(Tribromomethane)		126	2.10	Hutzler et al. (1986)	column, Keweenaw 7 soil; 0.85% OC
Average		***126***	2.10		
Geometric Mean		***126***	2.10		

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Butyl benzyl phthalate	85-68-7				
		16,981	4.23	Russell & McDuffie (1986)	Broome County, NY, composite soil with 1.59% OC; column
		11,128	4.05	Gledhill (1980)	3 soils; 1.2-3.4% OC - geomean value calculated from range
Average		***14,055***	4.15		
Geometric Mean		***13,746***	4.14		
Carbazole	86-74-8				
Carbon disulfide	75-15-0				
Carbon tetrachloride	56-23-5				
		123	2.09	Koch (1983)	sorption coefficient (assume Kom) from unpublished source
		127	2.10	Rutherford et al. (1992)	extracted peat; 64% OC
		224	2.35	Abdul et al. (1987)	from MS thesis
Average		***158***	2.20		
Geometric Mean		***152***	2.18		
Chlordane	57-74-9				
		44,711	4.65	Johnson-Logan et al. (1992)	geologic material, N. Hollywood dump (avg. 14 values)
		58,884	4.77	Chin & Weber (1989)	humic acid polymers
Average		***51,798***	4.71		
Geometric Mean		***51,310***	4.71		
Chlorobenzene	108-90-7				
		83	1.92	Chiou et al. (1983)	Woodburn silt loam; fom = 0.019; 21% clay
		117	2.07	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		164	2.22	Schwarzenbach & Westall (1981)	KS1 collected from field site location; foc = 0.0073
		200	2.30	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not given
		219	2.34	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not given
		260	2.41	Schwarzenbach & Westall (1981)	average of six measurements;foc = 0.0015
		389	2.59	Roberts et al. (1980)	calculated from field data assuming foc = 0.0099
		407	2.61	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not given
		500	2.70	Schwarzenbach & Westall (1981)	field sample; 0.08% OC
Average		***260***	2.41		
Geometric Mean		***224***	2.35		
Chlorodibromomethane	124-48-1				
Chloroform	67-66-3				
		28	1.44	Grathwohl (1990)	20 C; soil, sand & loess
		40	1.60	Hutzler et al. (1983)	average of two soils
		76	1.88	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		59	1.77	Loch et al. (1986)	top 20 cm, Eerd soil; 4.06% OC (from unpublished work)

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Chloroform	67-66-3				
(continued)		81	1.91	Loch et al. (1986)	top 20 cm, peat soil ; 11.6% OC (from unpublished work)
Average		***57***	1.75		
Geometric Mean		***53***	1.72		
Chrysene	218-01-9				
DDD	72-54-8				
		45,800	4.66	Gustafson (1989)	average value from collected measured values
Average		***45,800***	4.66		
Geometric Mean		***45,800***	4.66		
DDE	72-55-9				
		86,405	4.94	Koch (1983)	sorption coefficient (assume Kom) from unpublished source
Average		***86,405***	4.94		
Geometric Mean		***86,405***	4.94		
DDT	50-29-3				
		285,467	5.46	Gerstl & Mingelgrin (1984)	Malkiya soil; 5.82% OM
		496,476	5.70	Gerstl & Mingelgrin (1984)	Neve Yaar soil; 2.82% OM
		589,537	5.77	Gerstl & Mingelgrin (1984)	Kinneret G sediment; 4.39% OM
		747,887	5.87	Gerstl & Mingelgrin (1984)	Kinneret A sediment; 7.85% OM
		892,067	5.95	Gerstl & Mingelgrin (1984)	Gilat soil; 1.25% OM
		1,741,516	6.24	Gerstl & Mingelgrin (1984)	Mivtahim soil; 0.45% OM
Average		***792,158***	5.90		
Geometric Mean		***677,934***	5.83		
Dibenz(*a,h*)anthracene	53-70-3				
		565,014	5.75	Means et al. (1980); Hasset et al. (1980)	IL soil; 1.30% OC (EPA-20)
		805,292	5.91	Means et al. (1980); Hasset et al. (1980)	ND sediment; 2.28% OC (EPA-5)
		808,991	5.91	Means et al. (1980); Hasset et al. (1980)	IL sediment; 2.38% OC (EPA-23)
		1,172,847	6.07	Means et al. (1980); Hasset et al. (1980)	IA sediment; 0.15% OC (EPA-8)
		1,690,971	6.23	Means et al. (1980); Hasset et al. (1980)	GA sediment; 1.21% OC (EPA-B2)
		1,687,404	6.23	Means et al. (1980); Hasset et al. (1980)	MO sediment; 2.07% OC (EPA-4)
		2,277,875	6.36	Means et al. (1980); Hasset et al. (1980)	IA loess; 0.11% OC (EPA-9)
		2,383,765	6.38	Means et al. (1980); Hasset et al. (1980)	IL sediment; 1.67% OC (EPA-22)
		2,622,453	6.42	Means et al. (1980); Hasset et al. (1980)	SD sediment; 0.72% OC (EPA-6)
		2,663,317	6.43	Means et al. (1980); Hasset et al. (1980)	IN sediment; 0.95% OC (EPA-15)
		2,691,870	6.43	Means et al. (1980); Hasset et al. (1980)	IL sediment; 1.48% OC (EPA-26)
		2,962,603	6.47	Means et al. (1980); Hasset et al. (1980)	IL sediment; 1.88% OC (EPA-21)
		3,020,262	6.48	Means et al. (1980); Hasset et al. (1980)	WV soil; 0.48% OC (EPA-14)

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Dibenz(*a,h*)anthracene	53-70-3				
(continued)		3,059,425	6.49	Means et al. (1980); Hasset et al. (1980)	KY sediment; 0.66% OC (EPA-18)
Average		***2,029,435***	6.31		
Geometric Mean		***1,789,101***	6.25		
1,2-Dichlorobenzene (*o*)	95-50-1				
		267	2.43	Lee et al. (1989)	untreated Marlette soil, B+ horizon; 0.3% OC
		280	2.45	Lee et al. (1989)	untreated Marlette soil, A horizon; 2.59% OC
		310	2.49	Chiou et al. (1979)	Willamette silt loam; 0.928% OC; 3.5 degrees Celsius
		321	2.51	Chiou et al. (1983)	Woodburn silt loam; 1.9% OM; 9% sand; 68% silt; 21% clay
		386	2.59	Stauffer & MacIntyre (1986)	Appalachee sorbent; 1.4% OC; pH = 6.3
		438	2.64	Stauffer & MacIntyre (1986)	Appalachee sorbent; 1.4% OC; pH = 4.1
		485	2.69	Friesel et al. (1984)	peaty soil; 29% OM
		497	2.70	Piwoni & Banerjee (1989)	sediment, 0.19% OC; avg. 2 values
		529	2.72	Friesel et al. (1984)	foc reported as a range; avg. of several exper.
Average		***390***	2.59		
Geometric Mean		***379***	2.58		
1,4-Dichlorobenzene (*p*)	106-46-7				
		273	2.44	Chiou et al. (1983)	Woodburn silt loam; fom = 0.019; 21% clay
		280	2.45	Southworth & Keller (1986)	Dormont soil with 1.2% OC; 60% clay
		300	2.48	Hutzler et al. (1983)	column; Grayling soil; 1.52% OC; B21 horizon
		398	2.60	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		429	2.63	Friesel et al. (1984)	reported as Kom; foc given as a range
		603	2.78	Schwarzenbach & Westall (1981)	KS1 field sample; 0.73% OC
		665	2.82	Southworth & Keller (1986)	Apison soil with 0.11% OC; 86% clay
		700	2.85	Hutzler et al. (1983)	batch; average of five soils
		724	2.86	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not provided
		733	2.87	Schwarzenbach & Westall (1981)	average of six measurements; aquifer material; foc = 0.0015
		832	2.92	Chin & Weber (1989)	humic acid polymers
		850	2.93	Southworth & Keller (1986)	Fullerton soil with 0.06% OC
		911	2.96	Loch et al. (1986)	top 20 cm of Eerd soil; 0.06% OC; column
		1,024	3.01	Wu & Gschwend (1986)	Charles River sediment; 8.5% OC
		1,259	3.10	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not provided
		1,375	3.14	Schwarzenbach & Westall (1981)	field sample; 0.08% OC
Average		***687***	2.84		
Geometric Mean		***616***	2.79		
3,3-Dichlorobenzidine	91-94-1				

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
1,1-Dichloroethane	75-34-3				
		46	1.66	Jury et al. (1990)	soil; selected
		62	1.79	Roy et al. (1987)	computed from an isotherm; 4.04% OC
Average		***54***	1.73		
Geometric Mean		***53***	1.73		
1,2-Dichloroethane	107-06-2				
		22	1.34	Jury et al. (1990)	soil; selected
		33	1.52	Chiou et al. (1979)	Willamette silt loam; 0.928% OC; 20 degrees Celsius
		76	1.88	Wilson et al. (1981)	Lincoln sand; 0.087% OC
Average		***44***	1.64		
Geometric Mean		***38***	1.58		
1,1-Dichloroethylene	75-35-4				
		65	1.81	Schwille (1988) (secondary)	
Average		***65***	1.81		
Geometric Mean		***65***	1.81		
***cis* -1,2-Dichloroethylene**	156-59-2				
***trans* -1,2-Dichloroethylene**	156-60-5				
		38	1.58	Brusseau & Rao (1991)	Tampa sandy aquifer material; 0.13% OC; < 2mm
Average		***38***	1.58		
Geometric Mean		***38***	1.58		
1,2-Dichloropropane	78-87-5				
		47	1.67	Chiou et al. (1979)	Willamette silt loam; 0.928% OC; 20 degrees Celsius
Average		***47***	1.67		
Geometric Mean		***47***	1.67		
1,3-Dichloropropene	542-75-6				
		24	1.38	Leistra (1970)	cis- , avg. 3 soils; computed from vapor phase sorption
		26	1.41	Leistra (1970)	trans- , avg. 3 soils; computed from vapor phase sorption
		32	1.51	Wauchope et al. (1992)	trans-, personal comm. (unpublished source, Dow Chemical)
Average		***27***	1.44		
Geometric Mean		***27***	1.43		
Dieldrin	60-57-1				
		23,308	4.37	Sharom et al. (1980)	Beverly sandy loam; 2.5% OM
		26,106	4.42	Sharom et al. (1980)	Plainfield sand; 0.7% OM
		27,399	4.44	Sharom et al. (1980)	Big Creek sediment; 2.8% OM
Average		***25,604***	4.41		
Geometric Mean		***25,546***	4.41		

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Diethyl phthalate	84-66-2				
		69	1.84	Russell & McDuffie (1986)	Broome County, NY, composite soil with 1.59% OC; column
		98	1.99	Russell & McDuffie (1986)	Conklin, NY, sand; 0.26% OC; column; avg. 4 values
Average		***84***	1.92		
Geometric Mean		***82***	1.92		
Dimethyl phthalate	131-11-3				
		7.6	0.88	Seip et al. (1986)	forest soil with 0.2% OC; column study
		42.8	1.63	Seip et al. (1986)	agricultural soil with 2.2% OC; column study
		72.7	1.86	Seip et al. (1986)	forest soil with 3.7% OC; column study
Average		***41***	1.61		
Geometric Mean		***29***	1.46		
Di-*n* -butyl phthalate	84-74-2				
		1,384	3.14	Russell & McDuffie (1986)	Broome County, NY, composite soil with 1.59% OC; column
		1,775	3.25	Russell & McDuffie (1986)	Conklin, NY, sand; 0.26% OC; adsorp.; avg. 4 values; column
Average		***1,580***	3.20		
Geometric Mean		***1,567***	3.20		
2,4-Dinitrotoluene	121-14-2				
2,6-Dinitrotoluene	606-20-2				
Di-*n* -octyl phthalate	117-84-0				
Endosulfan	115-29-7				
		2,040	3.31	Gustafson (1989)	average value from collected measured values
Average		***2,040***	3.31		
Geometric Mean		***2,040***	3.31		
Endrin	72-20-8				
		7,724	3.89	Sharom et al. (1980)	Beverly sandy loam; 2.5% OM
		7,793	3.89	Sharom et al. (1980)	organic soil; 75.3% OM
		14,285	4.15	Sharom et al. (1980)	Plainfield sand; 0.7% OM
		15,885	4.20	Sharom et al. (1980)	Big Creek sediment; 2.8% OM
Average		***11,422***	4.06		
Geometric Mean		***10,811***	4.03		
Ethylbenzene	100-41-4				
		165	2.22	Chiou et al. (1983)	Woodburn silt loam; fom = 0.019; 21% clay
		184	2.27	Lee et al. (1989)	untreated St. Clair soil; 0.44% OC; 44% clay; B+ horizon
		191	2.28	Lee et al. (1989)	untreated Oshtemo soil; 0.11% OC; 6.3% clay; B+ horizon
		240	2.38	Hodson & Williams (1988)	HPLC; cyanopropyl column

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Ethylbenzene	100-41-4				
(continued)		255	2.41	Vowles & Mantoura (1987)	Tamar estuary sediment; 4.02% OC; 0.2% synth. sea salt
Average		***207***	2.32		
Geometric Mean		***204***	2.31		
Fluoranthene	206-44-0				
		41,687	4.62	Szabo et al. (1990a)	RP & HPLC on PIHAC (humic acids)
		51,658	4.71	Abdul & Gibson (1986)	Flint aquifer sample; 87% sand; foc = 0.0187
		54,954	4.74	Szabo et al. (1990a)	RP & HPLC on CIHAC (humic acids)
Average		***49,433***	4.69		
Geometric Mean		***49,096***	4.69		
Fluorene	86-73-7				
		3,989	3.60	Abdul et al. (1986)	Borden aquifer material (avg. 2 values, foc = 0.0091,0.0121)
		4,615	3.66	Abdul et al. (1986)	Flint aquifer material (avg. 8 values)
		5,576	3.75	Abdul et al. (1986)	Warren aquifer material (avg. 8 values)
		8,913	3.95	Carter & Suffet (1983)	humic materials (DOC)
		14,125	4.15	Szabo et al. (1990a)	RP-HPLC on CIHAC (humic acids)
		16,218	4.21	Szabo et al. (1990a)	RP-HPLC on PIHAC (humic acids)
Average		***8,906***	3.95		
Geometric Mean		***7,707***	3.89		
Heptachlor	76-44-8				
		6,810	3.83	Jury et al. (1990)	selected
		13,330	4.12	Gustafson (1989)	average value from collected measured values
Average		***10,070***	4.00		
Geometric Mean		***9,528***	3.98		
Heptachlor epoxide	1024-57-3				
Hexachlorobenzene	118-74-1				
		80,000	4.90	Karickhoff & Morris (1985a)	GA sediments; 0.5-1.5% OC
Average		***80,000***	4.90		
Geometric Mean		***80,000***	4.90		
Hexachloro-1,3-butadiene	87-68-3				
α-Hexachlorocyclohexane	319-84-6				
(alpha-BHC)		1,022	3.01	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.62% OM
		1,253	3.10	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.27% OM
		1,330	3.12	Wahid & Sethunathan (1979)	single measurement; Kari soil; 24.6% OM
		1,386	3.14	Wahid & Sethunathan (1979)	single measurement; sandy soil; 12.6% OM
		1,532	3.19	Wahid & Sethunathan (1979)	single measurement; alluvial soil; 0.75% OM

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
α-Hexachlorocyclohexane	319-84-6				
(continued)		2,004	3.30	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 2.88% OM
		2,024	3.31	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.00% OM
		2,090	3.32	Wahid & Sethunathan (1979)	single measurement; Pokkali soil; 5.52% OM
		2,123	3.33	Wahid & Sethunathan (1979)	single measurement; Kari soil; 8.21% OM
		2,168	3.34	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 0.60% OM
		2,200	3.34	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 0.92% OM
		2,891	3.46	Wahid & Sethunathan (1979)	single measurement; alluvial soil; 0.70% OM
Average		***1,835***	3.26		
Geometric Mean		***1,762***	3.25		
β-Hexachlorocyclohexane	319-85-7				
(beta-BHC)		1,156	3.06	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.27% OM
		1,470	3.17	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.62% OM
		1,681	3.23	Wahid & Sethunathan (1979)	single measurement; Kari soil; 24.6% OM
		1,794	3.25	Mills & Biggar (1969b)	Venado clay; 3.5% OC; 50% montmorillonite; 20° C; 1/n=0.861
		1,821	3.26	Wahid & Sethunathan (1979)	single measurement; sandy soil; 12.6% OM
		1,868	3.27	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.00% OM
		1,958	3.29	Wahid & Sethunathan (1979)	single measurement; alluvial soil; 0.75% OM
		2,098	3.32	Wahid & Sethunathan (1979)	single measurement; alluvial soil; 0.70% OM
		2,415	3.38	Wahid & Sethunathan (1979)	single measurement; Kari soil; 8.21% OM
		2,548	3.41	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 0.60% OM
		2,697	3.43	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 0.92% OM
		3,143	3.50	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 2.88% OM
		3,158	3.50	Wahid & Sethunathan (1979)	single measurement; Pokkali soil; 5.52% OM
		3,563	3.55	Mills & Biggar (1969b)	Staten peaty muck, 12.8% OC; 20° C; 1/n = 0.950
Average		***2,241***	3.35		
Geometric Mean		***2,139***	3.33		
γ-Hexachlorocyclohexane	58-89-9				
(Lindane)		731	2.86	Adams & Li (1971)	Svea sil, A horizon ; foc = 0.031
		735	2.87	McCall et al. (1980)	average for three soils, 0.68-2.01% OC
		757	2.88	Huggenberger et al. (1972)	Gila silt loam; foc = 0.0038; coulmn study
		760	2.88	Kishi et al. (1990)	clay loam (allophane); soil pH = 4.89; foc = 0.104
		760	2.88	Wahid & Sethunathan (1980)	latertic soil; 2.88% OM; 1:1
		764	2.88	Adams & Li (1971)	Hegne sic, A horizon ; foc = 0.043
		764	2.88	Adams & Li (1971)	Hegne sic, B horizon ; foc = 0.006
		769	2.89	Adams & Li (1971)	Fargo sic, A horizon ; foc = 0.052
		812	2.91	Adams & Li (1971)	Hubbard ls, A horizon ; foc = 0.012
		814	2.91	Adams & Li (1971)	Ontonagon c, A horizon ; foc = 0.035
		826	2.92	Adams & Li (1971)	Milaca sl, A horizon ; foc = 0.017
		852	2.93	Mills & Biggar (1969a)	1.1% OC; Ca Columbia silt loam

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
γ-Hexachlorocyclohexane	58-89-9				
(continued)		855	2.93	Adams & Li (1971)	Kranzburg sicl, B horizon ; foc = 0.01
		878	2.94	Adams & Li (1971)	Svea sil, B horizon ; foc = 0.008
		960	2.98	Kishi et al. (1990)	sandy loam (allophane); soil pH = 5.41; foc = 0.0791
		968	2.99	Kay & Elrick (1967)	Muck (38% OC)
		985	2.99	Adams & Li (1971)	Fayette sil, A horizon ; foc = 0.023
		986	2.99	Kay & Elrick (1967)	Honeywood loam (2.1% OC)
		1,005	3.00	Adams & Li (1971)	Canisteo cl, B horizon ; foc = 0.006
		1,010	3.00	Rippen et al. (1982)	Alfisol; Udalf, Para brown earth; 0.76% OC; soil pH = 7.45
		1,030	3.01	Kay & Elrick (1967)	Fox loamy sand (1.7% OC)
		1,079	3.03	Adams & Li (1971)	Lester fsl, A horizon ; foc = 0.023
		1,103	3.04	Huggenberger et al. (1972)	Pachappa sandy loam; foc = 0.005
		1,103	3.04	Sharom et al. (1980)	Beverly sand loam; 2.5% OM
		1,109	3.04	Wahid & Sethunathan (1979)	single measurement; sandy soil; 12.6% OC
		1,125	3.05	Adams & Li (1971)	Zimmerman s, A horizon ; foc = 0.007
		1,130	3.05	Huggenberger et al. (1972)	Kentwood sandy loam; foc = 0.0093
		1,200	3.08	Kishi et al. (1990)	light clay (montmorillonite - illite); pH = 5.26; foc = 0.0323
		1,204	3.08	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.27% OM
		1,227	3.09	Kay & Elrick (1967)	Brookstone sandy loam (1.9% OC)
		1,263	3.10	Adams & Li (1971)	Brainerd fsl, A horizon ; foc = 0.026
		1,274	3.11	Adams & Li (1971)	Bearden sil, B horizon ; foc = 0.002
		1,300	3.11	Kishi et al. (1990)	light clay (montmorillonite); soil pH = 5.18; foc = 0.0151
		1,300	3.11	McCall et al. (1983)	Not stated if these are original data
		1,318	3.12	Miller & Weber (1986)	Ann Arbor soil; 1.14% OC
		1,322	3.12	Moreale & van Bladel (1978)	Lubbeek II soil; 0.53% OC; 10% clay
		1,335	3.13	Moreale & van Bladel (1978)	Lubbeek I soil; 0.07% OC; 2% clay
		1,452	3.16	Mills & Biggar (1969a)	3.1% OC; Ca Venado clay
		1,455	3.16	Adams & Li (1971)	Brainerd sl, B horizon ; foc = 0.001
		1,458	3.16	Miller & Weber (1986)	Delta soil; 0.12% TOC
		1,478	3.17	Sharom et al. (1980)	Big Creek sediment; 2.8% OM
		1,525	3.18	Wahid & Sethunathan (1978)	Pokkali soil; 5.52% OM; 1:10; 5 min eq.
		1,580	3.20	Wahid & Sethunathan (1980)	Pokkali soil; 5.52% OM; 1:1
		1,681	3.23	Wahid & Sethunathan (1979)	single measurement; Kari soil; 24.6% OM
		1,724	3.24	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.00% OM
		1,830	3.26	Adams & Li (1971)	Blue Earth sil, A horizon ; foc = 0.11
		1,859	3.27	Caron et al. (1985)	Powerville sediment (NJ); 2-4% OC
		1,896	3.28	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 2.88% OM
		1,935	3.29	Wahid & Sethunathan (1979)	single measurement; alluvial soil; 0.70% OM
		1,970	3.29	Sharom et al. (1980)	Plainfield sand; 0.7% OM
		1,976	3.30	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 1.62% OM
		2,058	3.31	Sharom et al. (1980)	organic soil; 75.3% OM
		2,090	3.32	Wahid & Sethunathan (1979)	single measurement; Pokkali soil; 5.52% OM
		2,122	3.33	Wahid & Sethunathan (1979)	single measurement; alluvial soil; 0.75% OM

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
γ-Hexachlorocyclohexane	58-89-9				
(continued)		2,123	3.33	Wahid & Sethunathan (1979)	single measurement; Kari soil; 8.21% OM
		2,260	3.35	Spencer & Cliath (1970)	Gila silt loam; 0.35% OC; from vapor phase desorp.; 30° C
		2,268	3.36	Adams & Li (1971)	Blue Earth sil, B horizon ; foc = 0.083
		2,290	3.36	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 0.92% OM
		2,448	3.39	Wahid & Sethunathan (1979)	single measurement; lateritic soil; 0.60% OM
		2,584	3.41	Mills & Biggar (1969a)	11.9% OC; Staten peaty muck
		2,646	3.42	Miller & Weber (1986)	Michaywe soil; 0.13% TOC
		2,710	3.43	Moreale & van Bladel (1978)	Zolder soil; 0.19% OC; 1% clay
		2,926	3.47	Wahid & Sethunathan (1978)	alluvial soil; 0.75% OM; 1:20; 5 min equlibration
		2,983	3.47	Chiou et al. (1979)	Willamette silt loam; 1.6% OM; 26% clay
		3,249	3.51	Adams & Li (1971)	Ulen sl, B horizon ; foc = 0.003
Average		***1,477***	3.17		
Geometric Mean		***1,352***	3.13		
Hexachlorocyclopentadiene	77-47-4				
Hexachloroethane	67-72-1				
Indeno(1,2,3-*cd*)pyrene	193-39-5				
Isophorone	78-59-1				
(Isooctaphenone)					
Methoxychlor	72-43-5				
		80,000	4.90	Karickhoff et al. (1979)	avg. Doe Run and Hickory Hill coarse silt sed. fractions
Average		***80,000***	4.90		
Geometric Mean		***80,000***	4.90		
Methyl bromide	74-83-9				
(Bromomethane)		9	0.95	Briggs (1981)	presented as a value for several chemicals
Average		***9***	0.95		
Geometric Mean		***9***	0.95		
Methyl chloride	75-09-2				
(chloromethane)		6	0.78	Jury et al. (1990)	soil; selected
Average		***6***	0.78		
Geometric Mean		***6***	0.78		
Methylene chloride	75-09-2				
(Dichloromethane)		10	1.00	Daniels et al. (1985)	selected
Average		***10***	1.00		
Geometric Mean		***10***	1.00		

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Naphthalene	91-20-3				
		830	2.92	Kishi et al. (1990)	light clay; 1.51% OC
		843	2.93	Vowles & Mantoura (1987)	Tamar estuary sediment; 4.02% OC; 0.2% synth. sea salt
		871	2.94	Karickhoff (1981)	soils/sediments average; shake flask UV
		907	2.96	Stauffer & MacIntyre (1986)	Appalachee soil; 1.4% OC; pH = 3.1
		912	2.96	Hodson & Williams (1988)	unpublished experimental results by same authors
		960	2.98	Southworth & Keller (1986)	Fullerton soil; 0.06% OC
		1,000	3.00	Southworth & Keller (1986)	Apison soil; 0.11% OC
		1,000	3.00	Kan & Tomson (1990)	DOM
		1,096	3.04	McCarthy & Jiminez (1985)	humic acid polymers
		1,161	3.06	Lokke (1984)	avg. 10 values
		1,290	3.11	Rippen et al. (1982)	Alfisol; 0.76% OC
		1,300	3.11	Karickhoff et al. (1979)	average of Doe Run & Hickory Hill sediments
		1,333	3.12	Karickhoff (1982)	Mississippi River sediment; foc = 0.015
		1,400	3.15	Podoll et al. (1989)	Menlo Park soil; 1.6% OC
		1,413	3.15	Szabo et al. (1990a)	RP-HPLC on CIHAC (humic acids)
		1,440	3.16	Rippen et al. (1982)	Entisol; 1.11% OC
		1,445	3.16	Szabo et al. (1990a)	RP-HPLC on PIHAC (humic acids)
		1,610	3.21	Rippen et al. (1982)	Speyer soil, 0.15-0.5 mm; 1.12% OC
		1,861	3.27	Barrett et al. (1994)	soil; 0.13% OC
		1,950	3.29	Wood et al. (1990)	Eustis sand; 0.74% OC; batch & column data
Average		***1,231***	3.09		
Geometric Mean		***1,191***	3.08		
Nitrobenzene	98-95-3				
		30.6	1.49	Seip et al. (1986)	forest soil with 0.2% OC; column study
		76	1.88	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		86	1.93	Briggs (1981)	average for four soils; 0.6-2.5% OC
		88.8	1.95	Seip et al. (1986)	agricultural soil with 2.2% OC; column study
		103	2.01	Seip et al. (1986)	forest soil with 3.7% OC; column study
		142	2.15	Miller & Weber (1986)	Delta soil with foc = 0.0012
		190	2.28	Lokke (1984)	Gribskov B horizon soil; 2.58%OC; avg. 2 values
		191	2.28	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		229	2.36	Hodson & Williams (1988)	unpublished experimental results by same authors
		270	2.43	Lokke (1984)	Gribskov C horizon soil; 1.82%OC; avg. 2 values
Average		***141***	2.15		
Geometric Mean		***119***	2.08		
Pentachlorobenzene	608-93-5				
		11,381	4.06	Wu & Gschwend (1986)	Iowa soil; 2.1% OC
		35,455	4.55	Wu & Gschwend (1986)	North River sediments; approx. 4.4% OC
		38,560	4.59	Barber et al. (1992)	sand/gravel aquifer; avg, 2 measurements; 0.054, 0.062% OC
		40,000	4.60	Karickhoff & Morris (1985a)	GA sediments; 0.5-1.5% OC

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Pentachlorobenzene	608-93-5				
(continued)		55,176	4.74	Wu & Gschwend (1986)	Charles River sediments; approx. 8.5% OC
Average		***36,114***	4.56		
Geometric Mean		***32,148***	4.51		
Pyrene	129-00-0				
		43,807	4.64	Means et al. (1980)	IL sediment with 2.38% OC (EPA-23)
		45,709	4.66	Abdul et al. (1987)	aquifer material, 1.05% OC
		48,236	4.68	Means et al. (1980)	IL sediment with 1.67% OC (EPA-22)
		50,650	4.70	Means et al. (1980)	ND sediment with 2.28% OC (EPA-5)
		51,469	4.71	Means et al. (1980)	ND sediment with 2.07% OC (EPA-4)
		54,767	4.74	Woodburn et al. (1989)	Webster soil; 2.23% OC; 14 C; 30:70 methanol:water
		57,763	4.76	Means et al. (1980)	WV soil with 0.48% OC (EPA-14)
		58,884	4.77	Szabo et al. (1990a)	RP-HPLC on PIHAC (humic acids)
		59,515	4.77	Means et al. (1980)	IL sediment with 1.88% OC (EPA-21)
		59,646	4.78	Means et al. (1980)	IL soil with 1.30% OC (EPA-20)
		61,936	4.79	Abdul & Gibson (1986)	Flint aquifer sample; 87% sand; foc = 0.0187
		62,860	4.80	Means et al. (1980)	GA sediment with 1.21% OC (EPA-B2)
		63,400	4.80	Hassett et al. (1980)	from regression of 14 sediments/soil samples
		64,706	4.81	Means et al. (1980)	IA loess with 0.11% OC (EPA-9)
		66,069	4.82	Szabo et al. (1990a)	RP-HPLC on CIHAC (humic acids)
		67,189	4.83	Means et al. (1980)	IL sediment with 1.48% OC (EPA-26)
		67,467	4.83	Means et al. (1980)	IA sediment with 0.15% OC (EPA-8)
		67,608	4.83	Karickhoff (1981)	soils/sediments average
		76,316	4.88	Means et al. (1980)	KY sediment with 0.66% OC (EPA-18)
		82,421	4.92	Means et al. (1980)	IN sediment with 0.95% OC (EPA-15)
		84,000	4.92	Karickhoff et al. (1979)	avg. Doe Run, Hickory Hill coarse silt sediment fractions
		84,000	4.92	Karickhoff (1982)	Mississippi R. sediment, 1.5% OC
		85,256	4.93	Means et al. (1980)	SD sediment with 0.72% OC (EPA-6)
		87,833	4.94	Karickhoff & Morris (1985b)	Mississippi R. sediment, 1.48% OC (desorption)
		95,395	4.98	Karickhoff & Morris (1985b)	Ohio R. sediment; 3.04% OC (desorption)
		131,325	5.12	Gauthier et al. (1986)	fluoresc. quench. tech.; 13 soil humic & fulvic acids (avg.)
		133,590	5.13	Vowles & Mantoura (1987)	Tamar estuary sediment; 4.02% OC; 0.2% synth. sea salt
Average		***70,808***	4.85		
Geometric Mean		***67,992***	4.83		
Stryene	100-42-5				
		912	2.96	Bedient et al. (1983) as cited in Meylan et al. (1992)	experimental measurement
Average		***912***	2.96		
Geometric Mean		***912***	2.96		

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
1,1,2,2-Tetrachloroethane	79-34-5				
		79	1.90	Chiou et al. (1979)	Willamette silt loam; 0.928% OC; 20 degrees Celsius
Average		***79***	1.90		
Geometric Mean		***79***	1.90		
Tetrachloroethylene	127-18-4				
		177	2.25	Seip et al. (1986)	forest soil with 0.2% OC; column stufy
		205	2.31	Seip et al. (1986)	agricultural soil wtih 2.2% OC; column study
		224	2.35	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	specific system information not provided
		224	2.35	Piwoni & Banerjee (1989)	n-core sediment; foc = 0.0133
		225	2.35	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		235	2.37	Piwoni & Banerjee (1989)	avg. 8 values; J-core sed.; foc = 0.0015 - 0.0089; avg. 1/n>0.94
		237	2.38	Friesel et al. (1984)	reported as Ksom; foc reported as a range; 32 soils
		263	2.42	Abdul et al. (1987)	equilibrium batch experiments; aquifer material; foc = 0.0105
		268	2.43	Pignatello (1990)	Agawam fine sandy loam soil; 2.57% OC; avg. 2 values
		269	2.43	Brusseau & Rao (1991)	Tampa sandy aquifer material; 0.13% OC; < 2mm
		311	2.49	Loch et al. (1986)	top 20 cm of Podzol soil; 0.87% OC
		348	2.54	Seip et al. (1986)	forest soil with 3.7% OC; column study
		356	2.55	Paviostathis & Mathavan (1992)	coarse sand with 0.09% OC
		362	2.56	Chiou et al. (1979)	Willamette silt loam; 0.93% OC; 20 degrees Celsius
		373	2.57	Schwarzenbach & Westall (1981)	avg. of 6 meas. w/ different Co & sorbents; 0.15% OC
Average		***272***	2.43		
Geometric Mean		***265***	2.42		
Toluene	108-88-3				
		94.4	1.97	Seip et al. (1986)	agricultural soil wtih 2.2% OC; column study
		99	2.00	Vowles & Mantoura (1987)	Tamar estuary sediment; 4.02% OC; 0.2% synth. sea salt
		115	2.06	Abdul et al. (1987)	equilibrium batch experiments, aquifer material; foc = 0.0105
		123	2.09	Garbarini & Lion (1986)	zein; 57% OC
		126	2.10	Szabo et al. (1990a)	RP-HPLC on PIHAC (avg., humic acids)
		134	2.13	Seip et al. (1986)	forest soil with 3.7% OC; column study
		150	2.18	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		151	2.18	Garbarini & Lion (1986)	Sapsucker Woods soil with 7.51%C
		151	2.18	Garbarini & Lion (1986)	lignin; 65% OC
		164	2.21	Garbarini & Lion (1986)	Sapsucker Woods ether extracted soil with 7.05%C
		182	2.26	Szabo et al. (1990a)	RP-HPLC on CIHAC (avg., humic acids)
		247	2.39	Schwarzenbach & Westall (1981)	avg. of 6 meas. w/ different Co & sorbents; 0.15% OC
Average		***145***	2.16		
Geometric Mean		***140***	2.15		

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Toxaphene	8001-35-2				
		95,816	4.98	Gustafson (1989)	average value from collected measured values
Average		***95,816***	4.98		
Geometric Mean		***95,816***	4.98		
1,2,4-Trichlorobenzene	120-82-1				
		864	2.94	Chiou et al. (1983)	Woodburn silt loam; fom = 0.019; 21% clay
		885	2.95	Southworth & Keller (1986)	Dormont soil; 1.2% OC
		1,033	3.01	Scheunert et al. (1994)	soil; 2.06% OC
		1,300	3.11	Southworth & Keller (1986)	Fullerton soil; 0.06% OC
		1,303	3.11	Banerjee et al. (1985)	average of 21 values; subsurface alluvial soil
		1,389	3.14	Wilson et al. (1981)	average of two values
		1,435	3.16	Friesel et al. (1984)	peaty soil; 0.29% OM
		1,441	3.16	Friesel et al. (1984)	reported as Ksom; foc reported as a range
		1,554	3.19	Lee et al. (1989)	untreated Marlette soil, A horizon; 2.59% OC
		1,867	3.27	Lee et al. (1989)	untreated Marlette soil, Bt horizon; 0.3% OC
		1,986	3.30	Schwarzenbach & Westall (1981)	KS1 field material; foc = 0.0073
		1,995	3.30	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not provided
		2,100	3.32	Southworth & Keller (1986)	Apison soil with 0.11% OC
		2,347	3.37	Schwarzenbach & Westall (1981)	avg. of 6 meas. w/ different Co & sorbents; 0.15% OC
		2,570	3.41	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not provided
		3,118	3.49	Wu & Gschwend (1986)	Charles River sediment with approximately 8.8% OC
		3,125	3.49	Schwarzenbach & Westall (1981)	field sample; 0.8% OC
Average		***1,783***	3.25		
Geometric Mean		***1,659***	3.22		
1,1,1-Trichloroethane	71-55-6				
		105.9	2.02	Loch et al. (1986)	top 20 cm of Eerd soil; 4% OC
		107	2.03	Friesel et al. (1984)	reported as Ksom; foc reported as a range
		129	2.11	Hodson & Williams (1988)	cyanopropyl column, HPLC
		172	2.24	Loch et al. (1986)	top 20 cm of Podzol soil; 0.87% OC
		179	2.25	Chiou et al. (1979)	Willamette silt loam; 0.93% OC; 3.5 degrees Celsius
Average		***139***	2.14		
Geometric Mean		***135***	2.13		
1,1,2-Trichloroethane	79-00-5				
		60.0	1.78	Seip et al. (1986)	forest soil with 0.2% OC; column study
		63.7	1.80	Seip et al. (1986)	agricultural soil wtih 2.2% OC; column study
		76	1.88	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		108	2.03	Seip et al. (1986)	forest soil with 3.7% OC; column study
Average		***77***	1.89		
Geometric Mean		***75***	1.87		

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
Trichloroethylene	79-01-6				
		57	1.76	Rutherford & Chiou (1992)	peat; 57% OC
		63	1.80	Smith et al. (1990)	soil; 4.02% OC (from vapor phase experiments)
		65	1.81	Abdul et al. (1987)	equilibrium batch experiments; aquifer material; foc = 0.0105
		69	1.84	Brusseau & Rao (1991)	Tampa sandy aquifer material; 0.13% OC; < 2mm
		72.5	1.86	Seip et al. (1986)	forest soil with 0.2% OC; column study
		84	1.92	Stauffer & MacIntyre (1986)	Appalachee soil; 1.4% OC; pH = 3.2
		84	1.93	Piwoni & Banerjee (1989)	aquifer solid; 0.19% OC
		87	1.94	Rogers & McFarlane (1981)	Overton silty clay loam; foc=0.018; 1/n=0.93
		92	1.96	Wilson et al. (1981)	Lincoln sand; 0.087% OC
		95.8	1.98	Seip et al. (1986)	agricultural soil wtih 2.2% OC; column study
		99	2.00	Pignatello (1990a)	Agawam soil; 2.57% OC (2 values)
		100	2.00	Doust & Huang (1992) as cited in Mackay et al. (1993)	organic carbon soil
		101	2.00	Friesel et al. (1984)	reported as Kom; foc reported as a range; 32 soils
		103	2.01	Loch et al. (1986)	top 20 cm of Eerd soil; 4% OC
		106	2.03	Garbarini & Lion (1986)	Sapsucker Woods soil with 7.51%C
		111	2.05	Garbarini & Lion (1986)	zein; 57% OC
		120	2.08	Garbarini & Lion (1986)	lignin; 65% OC
		122	2.09	Garbarini & Lion (1986)	sapsucker woods ether extracted soil; 7.05% OC
		123	2.09	Hutzler et al. (1986)	column; Keweenaw 7 soil; 0.85% OC (avg. 3 values)
		142	2.15	Seip et al. (1986)	forest soil with 3.7% OC; column study
		150	2.17	Rogers & McFarlane (1981)	Hastings silty clay loam; foc = 0.026; Freundlich; 1/n = 0.82
Average		***97***	1.99		
Geometric Mean		***94***	1.97		
Vinyl chloride	75-01-4				
***o* -Xylene**	95-47-6				
		222	2.35	Vowles & Mantoura (1987)	Tamar estuary sediment; 4.02% OC; 0.2% synth. sea salt
		234	2.37	Szabo et al. (1990a)	RP-HPLC, CIHAC (humic acids)
		251	2.40	Szabo et al. (1990a)	RP-HPLC, PIHAC (humic acids)
		258	2.41	Roy et al. (1987)	Catlin sorbent at 23 degrees Celsius; 4.04% OC
Average		***241***	2.38		
Geometric Mean		***241***	2.38		
***m* -Xylene**	108-38-3				
		158	2.20	Seip et al. (1986)	agricultural soil with 2.2% OC; column study
		166	2.22	Abdul et al. (1987)	equilibrium batch experiments; aquifer material; foc = 0.0105
		289	2.46	Seip et al. (1986)	forest soil; 3.7% OC; column study
Average		***204***	2.31		
Geometric Mean		***196***	2.29		

Table K-2. Collected K_{oc} Values (Hydrophobic Organics)

Chemical	CAS No.	K_{oc} (L/kg)	Log K_{oc}	Source	Comments
***p* -Xylene**	106-42-3				
		260	2.41	Vowles & Mantoura (1987)	Tamar estuary sed.; 4.02% OC; 0.2% synthetic sea salt
		333	2.52	Schwarzenbach & Westall (1984)	soil; 0.15% OC; avg. 6 values
		347	2.54	Schwarzenbach & Giger (1982) as cited in Gerstl (1990)	system specific information not provided
Average		***313***	2.50		
Geometric Mean		***311***	2.49		

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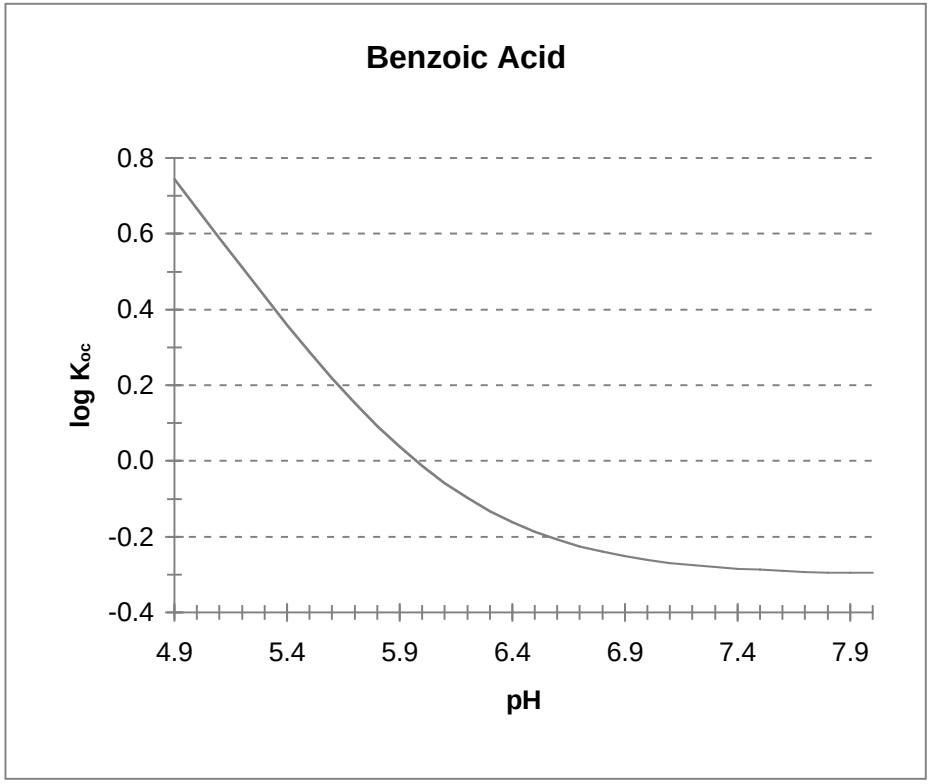
APPENDIX L

K_{oc} Values for Ionizing Organics as a Function of pH

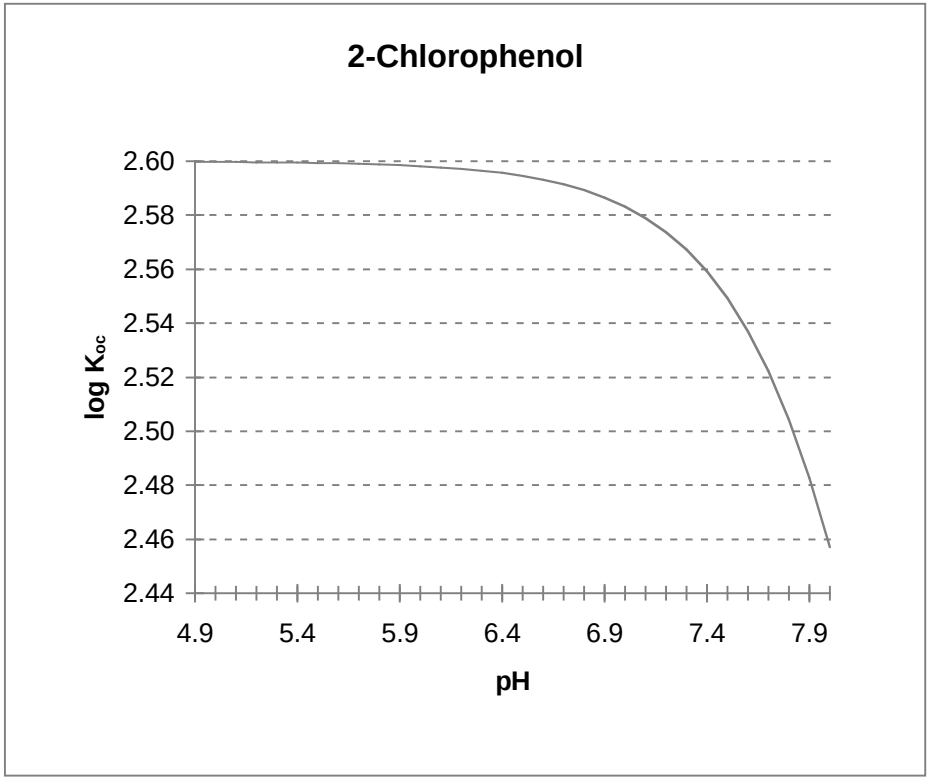
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
32	4.9	4.18	0.1600	0.5	5.5	0.74
32	5.0	4.18	0.1315	0.5	4.6	0.67
32	5.1	4.18	0.1073	0.5	3.9	0.59
32	5.2	4.18	0.0872	0.5	3.2	0.51
32	5.3	4.18	0.0705	0.5	2.7	0.43
32	5.4	4.18	0.0568	0.5	2.3	0.36
32	5.5	4.18	0.0457	0.5	1.9	0.29
32	5.6	4.18	0.0366	0.5	1.7	0.22
32	5.7	4.18	0.0293	0.5	1.4	0.15
32	5.8	4.18	0.0234	0.5	1.2	0.09
32	5.9	4.18	0.0187	0.5	1.1	0.04
32	6.0	4.18	0.0149	0.5	1.0	-0.01
32	6.1	4.18	0.0119	0.5	0.9	-0.06
32	6.2	4.18	0.0095	0.5	0.8	-0.10
32	6.3	4.18	0.0075	0.5	0.7	-0.13
32	6.4	4.18	0.0060	0.5	0.7	-0.16
32	6.5	4.18	0.0048	0.5	0.7	-0.19
32	6.6	4.18	0.0038	0.5	0.6	-0.21
32	6.7	4.18	0.0030	0.5	0.6	-0.23
32	6.8	4.18	0.0024	0.5	0.6	-0.24
32	6.9	4.18	0.0019	0.5	0.6	-0.25
32	7.0	4.18	0.0015	0.5	0.5	-0.26
32	7.1	4.18	0.0012	0.5	0.5	-0.27
32	7.2	4.18	0.0010	0.5	0.5	-0.27
32	7.3	4.18	0.0008	0.5	0.5	-0.28
32	7.4	4.18	0.0006	0.5	0.5	-0.28
32	7.5	4.18	0.0005	0.5	0.5	-0.29
32	7.6	4.18	0.0004	0.5	0.5	-0.29
32	7.7	4.18	0.0003	0.5	0.5	-0.29
32	7.8	4.18	0.0002	0.5	0.5	-0.30
32	7.9	4.18	0.0002	0.5	0.5	-0.30
32	8.0	4.18	0.0002	0.5	0.5	-0.30



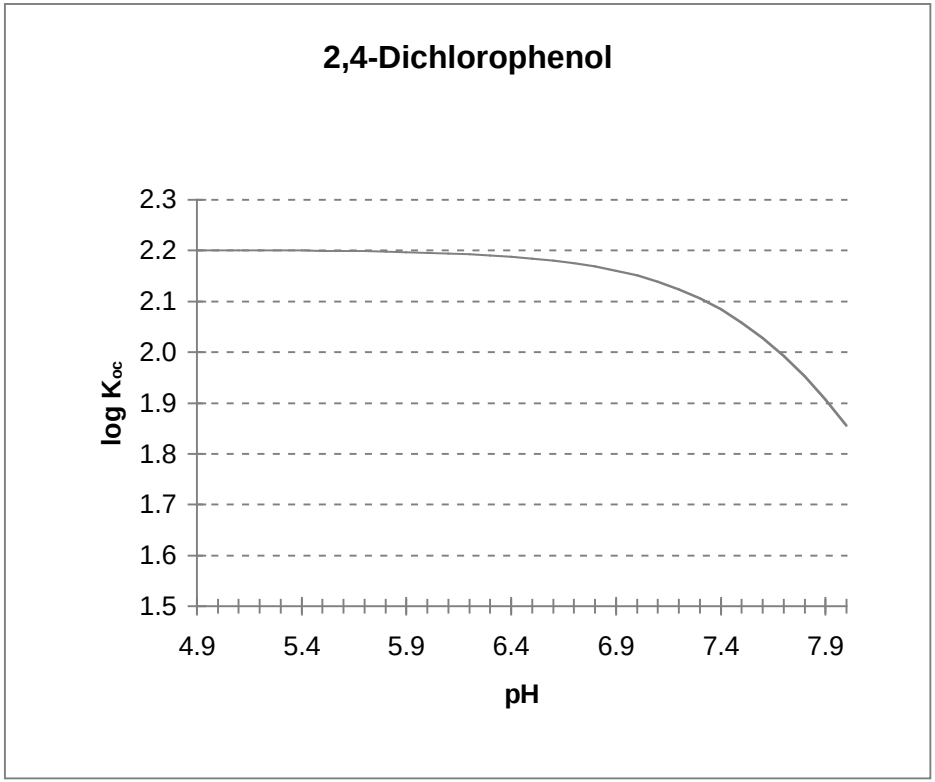
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
398	4.9	8.40	0.9997	6	398	2.60
398	5.0	8.40	0.9996	6	398	2.60
398	5.1	8.40	0.9995	6	398	2.60
398	5.2	8.40	0.9994	6	398	2.60
398	5.3	8.40	0.9992	6	398	2.60
398	5.4	8.40	0.9990	6	398	2.60
398	5.5	8.40	0.9987	6	397	2.60
398	5.6	8.40	0.9984	6	397	2.60
398	5.7	8.40	0.9980	6	397	2.60
398	5.8	8.40	0.9975	6	397	2.60
398	5.9	8.40	0.9968	6	397	2.60
398	6.0	8.40	0.9960	6	396	2.60
398	6.1	8.40	0.9950	6	396	2.60
398	6.2	8.40	0.9937	6	396	2.60
398	6.3	8.40	0.9921	6	395	2.60
398	6.4	8.40	0.9901	6	394	2.60
398	6.5	8.40	0.9876	6	393	2.59
398	6.6	8.40	0.9844	6	392	2.59
398	6.7	8.40	0.9804	6	390	2.59
398	6.8	8.40	0.9755	6	388	2.59
398	6.9	8.40	0.9693	6	386	2.59
398	7.0	8.40	0.9617	6	383	2.58
398	7.1	8.40	0.9523	6	379	2.58
398	7.2	8.40	0.9406	6	375	2.57
398	7.3	8.40	0.9264	6	369	2.57
398	7.4	8.40	0.9091	6	362	2.56
398	7.5	8.40	0.8882	6	354	2.55
398	7.6	8.40	0.8632	6	344	2.54
398	7.7	8.40	0.8337	6	333	2.52
398	7.8	8.40	0.7992	6	319	2.50
398	7.9	8.40	0.7597	6	304	2.48
398	8.0	8.40	0.7153	6	286	2.46



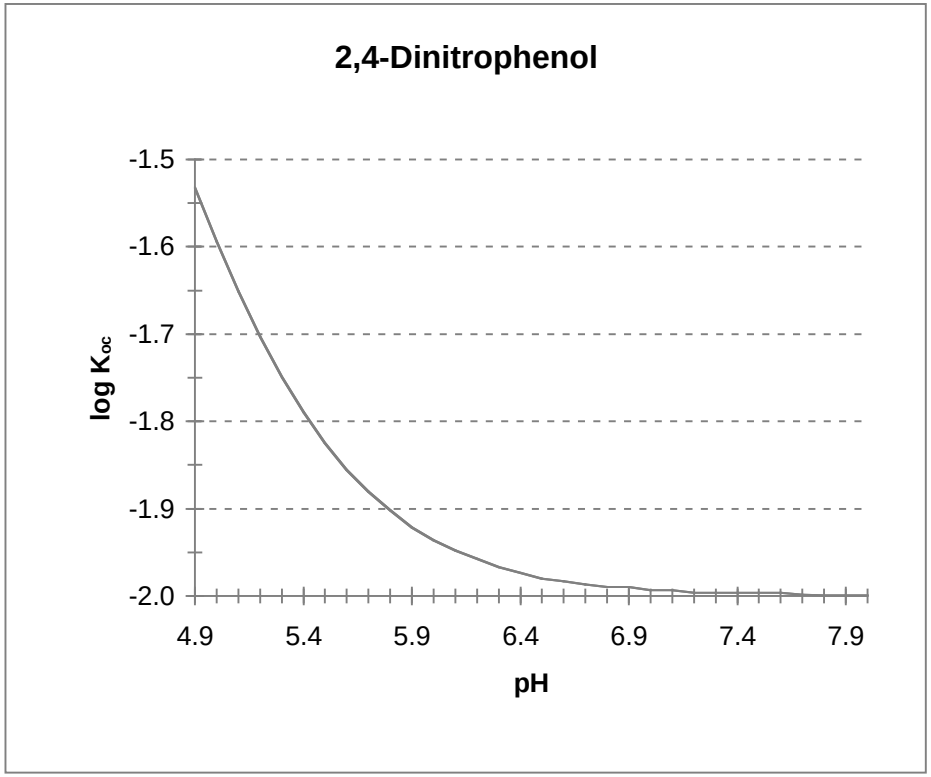
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
159	4.9	7.90	0.9990	2.4	159	2.20
159	5.0	7.90	0.9987	2.4	159	2.20
159	5.1	7.90	0.9984	2.4	159	2.20
159	5.2	7.90	0.9980	2.4	159	2.20
159	5.3	7.90	0.9975	2.4	159	2.20
159	5.4	7.90	0.9968	2.4	158	2.20
159	5.5	7.90	0.9960	2.4	158	2.20
159	5.6	7.90	0.9950	2.4	158	2.20
159	5.7	7.90	0.9937	2.4	158	2.20
159	5.8	7.90	0.9921	2.4	158	2.20
159	5.9	7.90	0.9901	2.4	157	2.20
159	6.0	7.90	0.9876	2.4	157	2.20
159	6.1	7.90	0.9844	2.4	157	2.19
159	6.2	7.90	0.9804	2.4	156	2.19
159	6.3	7.90	0.9755	2.4	155	2.19
159	6.4	7.90	0.9693	2.4	154	2.19
159	6.5	7.90	0.9617	2.4	153	2.18
159	6.6	7.90	0.9523	2.4	152	2.18
159	6.7	7.90	0.9406	2.4	150	2.18
159	6.8	7.90	0.9264	2.4	147	2.17
159	6.9	7.90	0.9091	2.4	145	2.16
159	7.0	7.90	0.8882	2.4	141	2.15
159	7.1	7.90	0.8632	2.4	138	2.14
159	7.2	7.90	0.8337	2.4	133	2.12
159	7.3	7.90	0.7992	2.4	128	2.11
159	7.4	7.90	0.7597	2.4	121	2.08
159	7.5	7.90	0.7153	2.4	114	2.06
159	7.6	7.90	0.6661	2.4	107	2.03
159	7.7	7.90	0.6131	2.4	98	1.99
159	7.8	7.90	0.5573	2.4	90	1.95
159	7.9	7.90	0.5000	2.4	81	1.91
159	8.0	7.90	0.4427	2.4	72	1.86



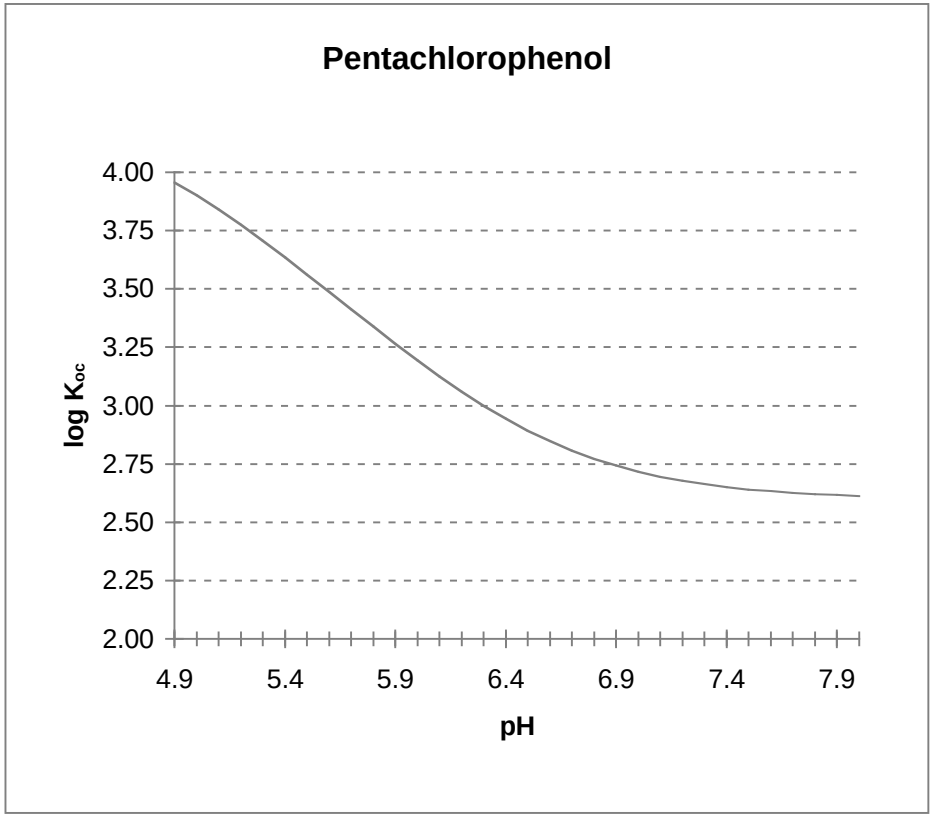
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
0.8	4.9	3.30	0.0245	0.01	0.03	-1.53
0.8	5.0	3.30	0.0196	0.01	0.03	-1.59
0.8	5.1	3.30	0.0156	0.01	0.02	-1.65
0.8	5.2	3.30	0.0124	0.01	0.02	-1.70
0.8	5.3	3.30	0.0099	0.01	0.02	-1.75
0.8	5.4	3.30	0.0079	0.01	0.02	-1.79
0.8	5.5	3.30	0.0063	0.01	0.01	-1.82
0.8	5.6	3.30	0.0050	0.01	0.01	-1.86
0.8	5.7	3.30	0.0040	0.01	0.01	-1.88
0.8	5.8	3.30	0.0032	0.01	0.01	-1.90
0.8	5.9	3.30	0.0025	0.01	0.01	-1.92
0.8	6.0	3.30	0.0020	0.01	0.01	-1.94
0.8	6.1	3.30	0.0016	0.01	0.01	-1.95
0.8	6.2	3.30	0.0013	0.01	0.01	-1.96
0.8	6.3	3.30	0.0010	0.01	0.01	-1.97
0.8	6.4	3.30	0.0008	0.01	0.01	-1.97
0.8	6.5	3.30	0.0006	0.01	0.01	-1.98
0.8	6.6	3.30	0.0005	0.01	0.01	-1.98
0.8	6.7	3.30	0.0004	0.01	0.01	-1.99
0.8	6.8	3.30	0.0003	0.01	0.01	-1.99
0.8	6.9	3.30	0.0003	0.01	0.01	-1.99
0.8	7.0	3.30	0.0002	0.01	0.01	-1.99
0.8	7.1	3.30	0.0002	0.01	0.01	-1.99
0.8	7.2	3.30	0.0001	0.01	0.01	-2.00
0.8	7.3	3.30	0.0001	0.01	0.01	-2.00
0.8	7.4	3.30	0.0001	0.01	0.01	-2.00
0.8	7.5	3.30	0.0001	0.01	0.01	-2.00
0.8	7.6	3.30	0.0001	0.01	0.01	-2.00
0.8	7.7	3.30	0.00004	0.01	0.01	-2.00
0.8	7.8	3.30	0.00003	0.01	0.01	-2.00
0.8	7.9	3.30	0.00003	0.01	0.01	-2.00
0.8	8.0	3.30	0.00002	0.01	0.01	-2.00



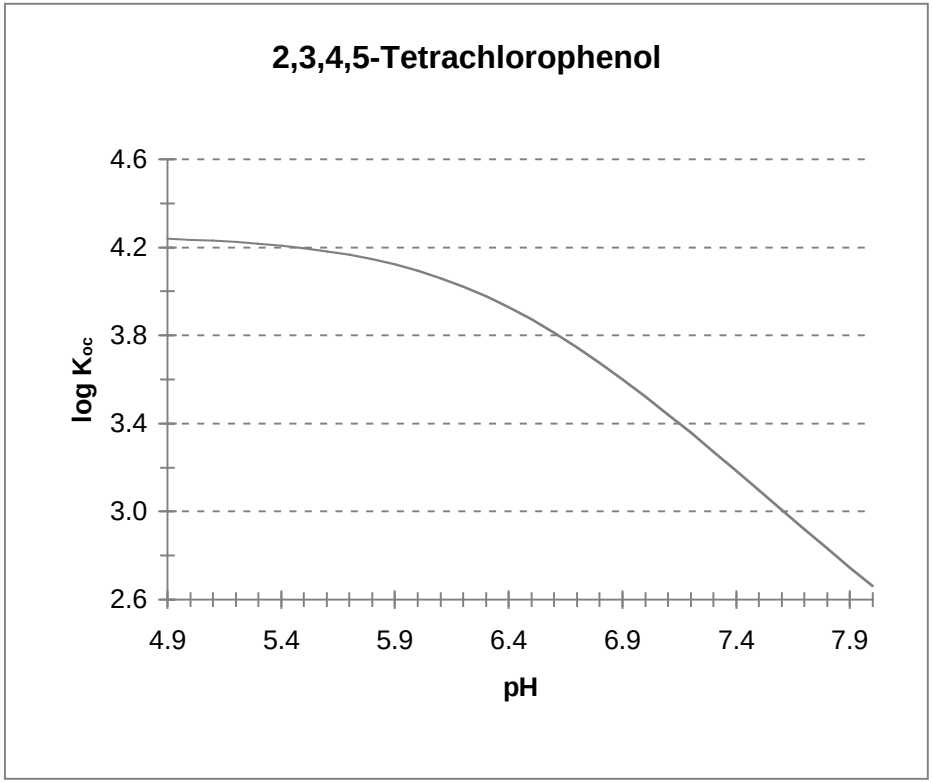
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
19953	4.9	4.80	0.4427	398	9055	3.96
19953	5.0	4.80	0.3869	398	7964	3.90
19953	5.1	4.80	0.3339	398	6927	3.84
19953	5.2	4.80	0.2847	398	5965	3.78
19953	5.3	4.80	0.2403	398	5097	3.71
19953	5.4	4.80	0.2008	398	4325	3.64
19953	5.5	4.80	0.1663	398	3650	3.56
19953	5.6	4.80	0.1368	398	3073	3.49
19953	5.7	4.80	0.1118	398	2584	3.41
19953	5.8	4.80	0.0909	398	2176	3.34
19953	5.9	4.80	0.0736	398	1837	3.26
19953	6.0	4.80	0.0594	398	1560	3.19
19953	6.1	4.80	0.0477	398	1331	3.12
19953	6.2	4.80	0.0383	398	1147	3.06
19953	6.3	4.80	0.0307	398	998	3.00
19953	6.4	4.80	0.0245	398	877	2.94
19953	6.5	4.80	0.0196	398	781	2.89
19953	6.6	4.80	0.0156	398	703	2.85
19953	6.7	4.80	0.0124	398	640	2.81
19953	6.8	4.80	0.0099	398	592	2.77
19953	6.9	4.80	0.0079	398	552	2.74
19953	7.0	4.80	0.0063	398	521	2.72
19953	7.1	4.80	0.0050	398	496	2.70
19953	7.2	4.80	0.0040	398	476	2.68
19953	7.3	4.80	0.0032	398	461	2.66
19953	7.4	4.80	0.0025	398	447	2.65
19953	7.5	4.80	0.0020	398	437	2.64
19953	7.6	4.80	0.0016	398	429	2.63
19953	7.7	4.80	0.0013	398	423	2.63
19953	7.8	4.80	0.0010	398	418	2.62
19953	7.9	4.80	0.0008	398	414	2.62
19953	8.0	4.80	0.0006	398	410	2.61



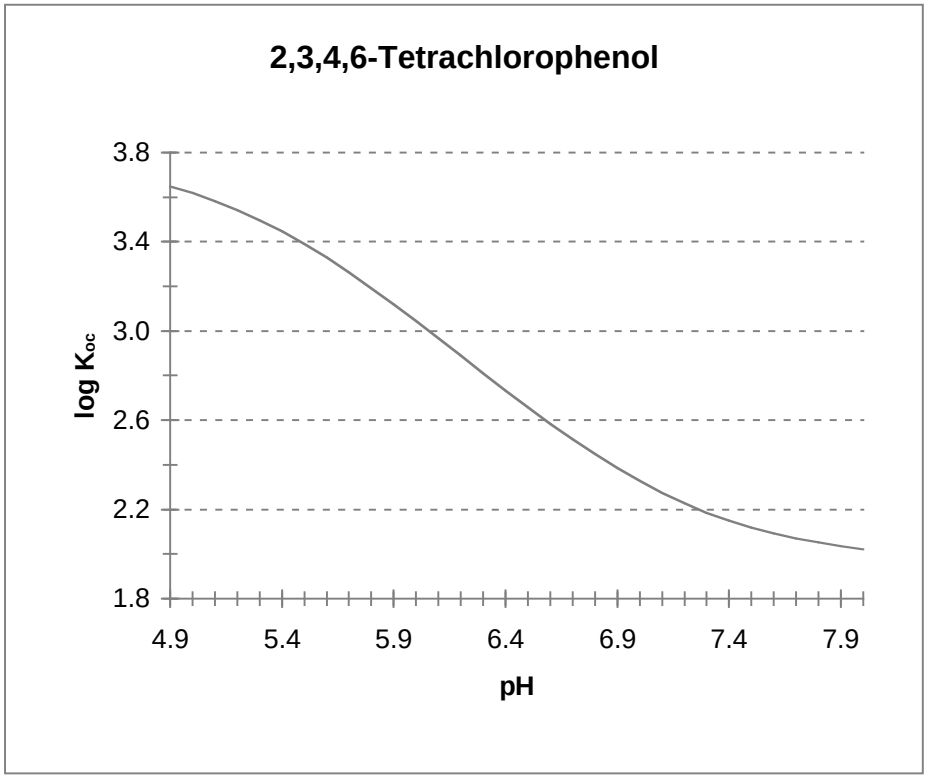
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
17916	4.9	6.35	0.9657	67	17304	4.24
17916	5.0	6.35	0.9572	67	17152	4.23
17916	5.1	6.35	0.9468	67	16966	4.23
17916	5.2	6.35	0.9339	67	16736	4.22
17916	5.3	6.35	0.9182	67	16456	4.22
17916	5.4	6.35	0.8991	67	16115	4.21
17916	5.5	6.35	0.8762	67	15706	4.20
17916	5.6	6.35	0.8490	67	15221	4.18
17916	5.7	6.35	0.8171	67	14651	4.17
17916	5.8	6.35	0.7801	67	13991	4.15
17916	5.9	6.35	0.7381	67	13241	4.12
17916	6.0	6.35	0.6912	67	12404	4.09
17916	6.1	6.35	0.6401	67	11492	4.06
17916	6.2	6.35	0.5855	67	10518	4.02
17916	6.3	6.35	0.5288	67	9506	3.98
17916	6.4	6.35	0.4712	67	8477	3.93
17916	6.5	6.35	0.4145	67	7465	3.87
17916	6.6	6.35	0.3599	67	6491	3.81
17916	6.7	6.35	0.3088	67	5579	3.75
17916	6.8	6.35	0.2619	67	4742	3.68
17916	6.9	6.35	0.2199	67	3992	3.60
17916	7.0	6.35	0.1829	67	3332	3.52
17916	7.1	6.35	0.1510	67	2762	3.44
17916	7.2	6.35	0.1238	67	2277	3.36
17916	7.3	6.35	0.1009	67	1868	3.27
17916	7.4	6.35	0.0818	67	1527	3.18
17916	7.5	6.35	0.0661	67	1247	3.10
17916	7.6	6.35	0.0532	67	1017	3.01
17916	7.7	6.35	0.0428	67	831	2.92
17916	7.8	6.35	0.0343	67	679	2.83
17916	7.9	6.35	0.0274	67	556	2.75
17916	8.0	6.35	0.0219	67	458	2.66



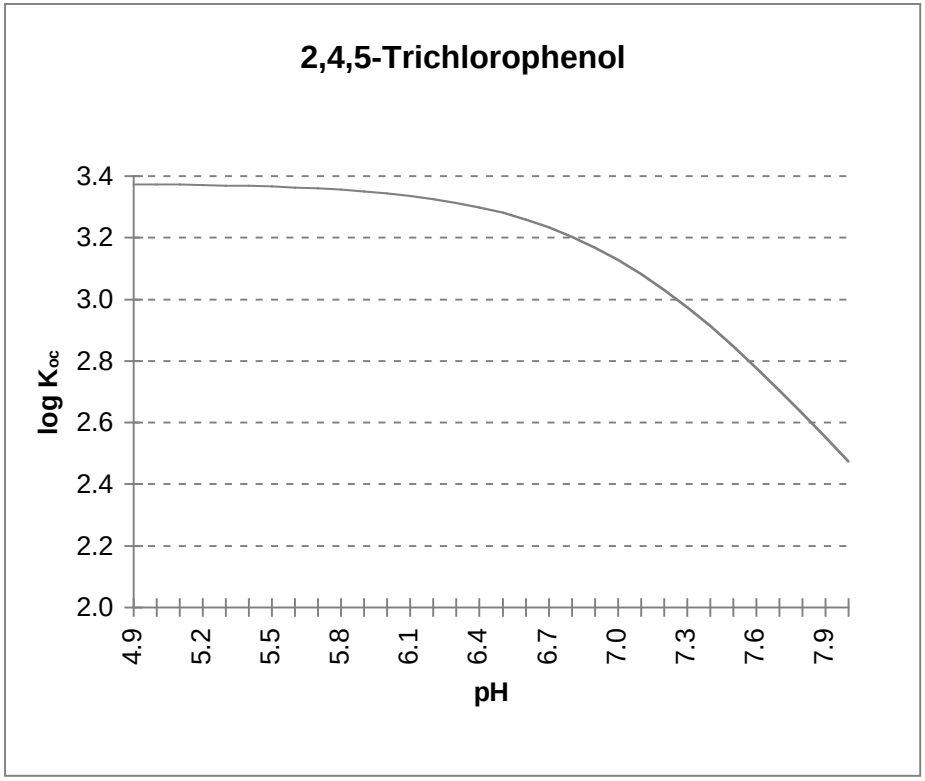
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
6190	4.9	5.30	0.7153	93	4454	3.65
6190	5.0	5.30	0.6661	93	4154	3.62
6190	5.1	5.30	0.6131	93	3831	3.58
6190	5.2	5.30	0.5573	93	3491	3.54
6190	5.3	5.30	0.5000	93	3142	3.50
6190	5.4	5.30	0.4427	93	2792	3.45
6190	5.5	5.30	0.3869	93	2452	3.39
6190	5.6	5.30	0.3339	93	2129	3.33
6190	5.7	5.30	0.2847	93	1829	3.26
6190	5.8	5.30	0.2403	93	1558	3.19
6190	5.9	5.30	0.2008	93	1317	3.12
6190	6.0	5.30	0.1663	93	1107	3.04
6190	6.1	5.30	0.1368	93	927	2.97
6190	6.2	5.30	0.1118	93	775	2.89
6190	6.3	5.30	0.0909	93	647	2.81
6190	6.4	5.30	0.0736	93	542	2.73
6190	6.5	5.30	0.0594	93	455	2.66
6190	6.6	5.30	0.0477	93	384	2.58
6190	6.7	5.30	0.0383	93	327	2.51
6190	6.8	5.30	0.0307	93	280	2.45
6190	6.9	5.30	0.0245	93	242	2.38
6190	7.0	5.30	0.0196	93	213	2.33
6190	7.1	5.30	0.0156	93	188	2.27
6190	7.2	5.30	0.0124	93	169	2.23
6190	7.3	5.30	0.0099	93	153	2.19
6190	7.4	5.30	0.0079	93	141	2.15
6190	7.5	5.30	0.0063	93	131	2.12
6190	7.6	5.30	0.0050	93	123	2.09
6190	7.7	5.30	0.0040	93	117	2.07
6190	7.8	5.30	0.0032	93	113	2.05
6190	7.9	5.30	0.0025	93	108	2.03
6190	8.0	5.30	0.0020	93	105	2.02



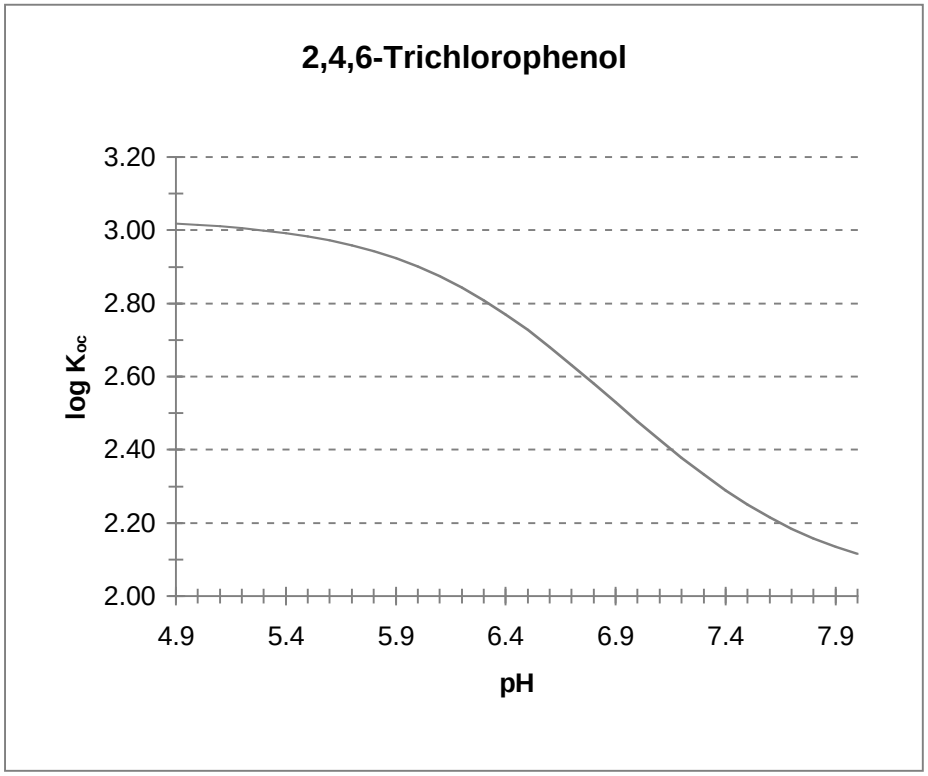
Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
2380	4.9	7.10	0.9937	36	2365	3.37
2380	5.0	7.10	0.9921	36	2361	3.37
2380	5.1	7.10	0.9901	36	2357	3.37
2380	5.2	7.10	0.9876	36	2351	3.37
2380	5.3	7.10	0.9844	36	2343	3.37
2380	5.4	7.10	0.9804	36	2334	3.37
2380	5.5	7.10	0.9755	36	2323	3.37
2380	5.6	7.10	0.9693	36	2308	3.36
2380	5.7	7.10	0.9617	36	2290	3.36
2380	5.8	7.10	0.9523	36	2268	3.36
2380	5.9	7.10	0.9406	36	2241	3.35
2380	6.0	7.10	0.9264	36	2207	3.34
2380	6.1	7.10	0.9091	36	2167	3.34
2380	6.2	7.10	0.8882	36	2118	3.33
2380	6.3	7.10	0.8632	36	2059	3.31
2380	6.4	7.10	0.8337	36	1990	3.30
2380	6.5	7.10	0.7992	36	1909	3.28
2380	6.6	7.10	0.7597	36	1817	3.26
2380	6.7	7.10	0.7153	36	1713	3.23
2380	6.8	7.10	0.6661	36	1597	3.20
2380	6.9	7.10	0.6131	36	1473	3.17
2380	7.0	7.10	0.5573	36	1342	3.13
2380	7.1	7.10	0.5000	36	1208	3.08
2380	7.2	7.10	0.4427	36	1074	3.03
2380	7.3	7.10	0.3869	36	943	2.97
2380	7.4	7.10	0.3339	36	819	2.91
2380	7.5	7.10	0.2847	36	703	2.85
2380	7.6	7.10	0.2403	36	599	2.78
2380	7.7	7.10	0.2008	36	507	2.70
2380	7.8	7.10	0.1663	36	426	2.63
2380	7.9	7.10	0.1368	36	357	2.55
2380	8.0	7.10	0.1118	36	298	2.47



Appendix L. K_{oc} Values for Ionizing Organics as a Function of pH

$K_{oc,n}$	pH	pKa	Φ	$K_{oc,i}$	K_{oc}	log K_{oc}
1070	4.9	6.40	0.9693	107	1040	3.02
1070	5.0	6.40	0.9617	107	1033	3.01
1070	5.1	6.40	0.9523	107	1024	3.01
1070	5.2	6.40	0.9406	107	1013	3.01
1070	5.3	6.40	0.9264	107	999	3.00
1070	5.4	6.40	0.9091	107	982	2.99
1070	5.5	6.40	0.8882	107	962	2.98
1070	5.6	6.40	0.8632	107	938	2.97
1070	5.7	6.40	0.8337	107	910	2.96
1070	5.8	6.40	0.7992	107	877	2.94
1070	5.9	6.40	0.7597	107	839	2.92
1070	6.0	6.40	0.7153	107	796	2.90
1070	6.1	6.40	0.6661	107	748	2.87
1070	6.2	6.40	0.6131	107	697	2.84
1070	6.3	6.40	0.5573	107	644	2.81
1070	6.4	6.40	0.5000	107	589	2.77
1070	6.5	6.40	0.4427	107	533	2.73
1070	6.6	6.40	0.3869	107	480	2.68
1070	6.7	6.40	0.3339	107	429	2.63
1070	6.8	6.40	0.2847	107	381	2.58
1070	6.9	6.40	0.2403	107	338	2.53
1070	7.0	6.40	0.2008	107	300	2.48
1070	7.1	6.40	0.1663	107	267	2.43
1070	7.2	6.40	0.1368	107	239	2.38
1070	7.3	6.40	0.1118	107	215	2.33
1070	7.4	6.40	0.0909	107	195	2.29
1070	7.5	6.40	0.0736	107	178	2.25
1070	7.6	6.40	0.0594	107	164	2.22
1070	7.7	6.40	0.0477	107	153	2.18
1070	7.8	6.40	0.0383	107	144	2.16
1070	7.9	6.40	0.0307	107	137	2.14
1070	8.0	6.40	0.0245	107	131	2.12



APPENDIX M

Response to Peer-Review Comments on MINTEQA2 Model Results

APPENDIX M

Response to Peer-Review Comments on MINTEQA2 Model Results

Peer review of the SSL MINTEQA2 model results identified several issues of concern, including

- The charge balance exceeds an acceptable margin of difference (5 percent) in most of the simulations. A variance in excess of 5 percent may indicate that the model problem is not correctly chemically poised and therefore the results may not be chemically meaningful.

- The model should not allow sulfate to adsorb to the iron oxide. Sulfate is a weakly outer-sphere adsorbing species and by including the adsorption reaction, sulfate is removed from the aqueous phase at pH values less than 7 and is prevented from participating in precipitation reaction at these pH values.

- Modeled K_d values for barium and zinc could not be reproduced for all studied conditions.

The remainder of this Appendix addresses each of these issues.

Charge balance in the MINTEQA2 model runs

Although the charge imbalances (e.g., 6.8% at pH 8.0 and 54.9% at pH 4.9) are present especially at high and low pH conditions, the conclusion that the charge imbalance makes the model results not chemically meaningful is not warranted.

MINTEQA2 uses two primary equations to solve chemical equilibrium problems: the mass action equation (also called the mass law equation) and the mass balance equation. MINTEQA2 does not use the charge balance equation to obtain the mathematical solution of the equilibrium problem. This does not mean that the charge balance equation has no meaning in MINTEQA2 calculations.

The reviewer's concern is understandable. It is logical that any chemical system whose charges are not in balance must be incomplete or have erroneous concentrations for one or more components. However, the systems being modeled here are not "real" systems in the sense that they physically exist somewhere so that measurements can be made on them. Rather, they are generic, representative systems for ground water with variable (high, medium, low) concentrations of those parameters that most significantly impact K_d.

The modeled groundwater consists of national median concentrations of those major cations and anions that are most likely to impact the chemistry of the trace metal of interest by: (1) their complexation with the trace metal, (2) their competition with the trace metal for sorption sites, and/or (3) their effect on the ionic strength of the solution and thus, the activity coefficients of all species in solution including the trace metal. The settings of the three components of this representative system that have the greatest impact on the calculated K_d for various trace metals are systematically varied. The three "master variable" components are pH, iron hydroxide sorption site concentration, and concentration of natural organic matter (particulate and dissolved).

No attempt was made to reconcile charge balances at the different settings of the three master variables. If reconciling charge balance had been attempted, it would have been accomplished by adjusting the concentrations of relatively inert anions and cations (e.g., NO_3^-, Na^+) as needed to balance the charge at equilibrium. It would be unwise to adjust the concentrations of more reactive components (e.g., CO_3^{2-}, Ca^{2+}). To do so would be inconsistent with the initial assumption that those constituents could be adequately represented by median concentrations observed in ground water and that variability in the system could be captured by varying the three master components.

Table M-1 shows the result if the concentrations of the less reactive components NO_3^- and Na^+ are adjusted in the high and low pH model runs so as to give a charge imbalance of <5% at equilibrium. The results shown pertain to the medium iron hydroxide and medium natural organic matter settings for zinc at the pH values listed. As shown in the table, the K_d values computed differ little from those presented in this report. The expected degree of error in the K_d values due to the many simplifications and assumptions involved in generic modeling must surely exceed the variance due to charge imbalance.

Table M-1. K_d values with and without counter ions (Na^+ or NO_3^-) added to balance charge.

pH	K_d[1] (L/kg) No Counter Ion Added	K_d[1] (L/kg) With Na^+ or NO_3^- Added
4.9	1.61	1.51
8.0	16,161	16,135

[1] K_d values shown correspond to the medium iron hydroxide, medium natural organic matter settings. Counter ions were added to reduce charge imbalance to <5% at equilibrium.

Sulfate adsorption in MINTEQA2 model runs

The peer reviewer states that sulfate should not be allowed to adsorb to the iron oxide. The reviewer concludes that by including the adsorption reactions "sulfate is removed from the aqueous phase at pH values less than 7 and is prevented from participating in precipitation reactions at these pH values".

The sulfate adsorption reactions on iron oxide included in the MINTEQA2 model runs were taken from a database of adsorption reactions that has been shown to give reliable results in predicting sulfate adsorption on pure phase iron oxide (Dzombak, 1986). The reviewer is correct in that free sulfate concentration is enhanced at low pH in runs without sulfate adsorption relative to runs with sulfate adsorption. However, for runs with low contaminant trace metal concentrations from which the SSL K_d's were taken, metal-sulfate precipitates do not form regardless of whether sulfate adsorption is included or not. Also, the K_d values over the entire range of trace metal concentrations modeled do not differ significantly when sulfate adsorption is included versus excluded.

Test runs were conducted on barium, zinc and cadmium at various settings of the three master variables (pH, natural organic matter (NOM) concentration, and iron oxide (FeOX) sorption site concentration). Table M-2 shows the K_d values for the lowest and highest trace metal concentration for model runs with and without sulfate adsorption. Results are shown for barium, zinc and cadmium at the indicated settings of the master variables. Where results differ for the "with" and "without"

sulfate adsorption cases, it is most frequently due to the formation of aqueous complexes between the trace metal and sulfate that compete with trace metal adsorption reactions, especially at low metal concentrations.

Table M-2. K_d values calculated with and without sulfate adsorption reactions.

Metal (settings)	K_d[1] (L/kg) with SO_4 adsorption	K_d[1] (L/kg) without SO_4 adsorption
Ba (MMH)	2.01 - 0.10	2.01 - 0.10
Ba (MMM)	1.37 - 0.04	1.37 - 0.04
Ba (LMM)	0.59 - 0.04	0.59 - 0.04
Ba (LLM)	0.12 - 0.01	0.12 - 0.01
Ba (LLL)	0.12 - 0.01	0.12 - 0.01
Zn (MMH)	1537 - 863	1478 - 830
Zn (LMM)	1.61 - 0.42	1.57 - 0.41
Zn (LML)	1.46 - 0.26	1.43 - 0.25
Cd (LMM)	0.94 - 0.01	0.91 - 0.01

[1] K_d range shown corresponds to the lowest and highest trace metal concentrations. Master variable settings are indicated by a three letter code for each model run: the leftmost letter indicates pH, the middle letter represents the NOM concentration, and the rightmost letter indicates the concentration of FeOX adsorption sites (eg., HLM indicates high pH, low natural organic matter, medium and iron oxide site concentration).

Reproducing RTI results for barium and zinc

The peer reviewer had difficulty reproducing the K_d values computed for barium and zinc. The reviewer included two sample input files for MINTEQA2 that had failed to produce results similar to the SSL calculations.

The SSL results can be reproduced for all metals using the current version of MINTEQA2 (v3.11) distributed by EPA. As indicated in the 1994 Technical Background Document, a modified version of this model was used to calculate SSL K_ds. The current version can be used to calculate the same results by performing the following steps:

1) Edit the v3.11 component database file COMP.DBS to insert a component to represent particulate organic matter (POM). Use the 3-digit identifying number 251, a charge of -2.8, and a molar mass of zero.
2) Edit the v3.11 file THERMO.DBS to add the metal POM reactions shown in Appendix H of the RTI draft report. The file DATABASE.DOC included with MINTEQA2 v3.11 gives detailed instructions for modifying the database file. After all reactions are added, del or rename the current THERMO.UNF and TYPE6.UNF files and execute program UNFRMT (included with v3.11) to create new *.UNF files.

3) Observe that there were two modifications to v3.11 that make calculation of K_d in L/kg easier in the version used by RTI. Since those modifications are not present in v3.11 itself, the user must take care in computing K_d. The procedure is to first obtain the calculated concentration of the metal of interest (say, barium) bound with POM from PART 3 of the output file. If you have set the solid precipitation flag to print a report each time a solid precipitates or dissolves, there will be a series of PART 3 outputs each corresponding to a precipitation or dissolution event. You must be sure that the PART 3 output from which you obtain the metal-POM concentration is the equilibrium output (i.e., it occurs prior to the PART 5 EQUILIBRATED MASS DISTRIBUTION with no intervening PROVISIONAL MASS DISTRIBUTION). After obtaining the metal-POM concentration, locate the line corresponding to the trace metal of interest, say barium in the PART 5 EQUILIBRATED MASS DISTRIBUTION section. Obtain the total sorbed concentration value and to this value add the concentration of metal-POM species. This is necessary because v3.11 recognizes only components with number 811 through 859 as sorption components. The metal-POM concentration will not have been added in the sorbed column. It will instead have been included in the dissolved column, so subtract the metal-POM concentration from the dissolved total. Finally, to compute K_d, take the ratio of sorbed over dissolved (after the adjustment for metal-POM). The resulting K_d must be divided by 3.1778 kg/L (the mass of soil that one liter of solution is equilibrated with) to express the result in L/kg.

If the above three steps are followed, the v3.11 MINTEQA2 will give the same result as in the 1994 Technical Background Document provided the data in the input file is correct. The two input files sent designed by the reviewer did not give correct results even when these steps were followed because of faulty values in the input file. The files supplied by the reviewer (SSLBA.INP and SSLZN.INP) were correct in all respects except two:

1) The site concentration for the POM component at the medium setting was entered as 1.930×10^3 mg/L. This value was evidently obtained from the table on page 33 of the EPA report (US EPA, 1992) after converting to mg/L. This is not the correct value for this the POM component. The correct value is 9.31×10^{-4} mol/l and is found in the table on page 38 of EPA report.

2) The iron oxide adsorbent is represented by two site types (components 811 and 812). The high population site has a lower affinity for the iron oxide surface for metals (expressed in a smaller log K in the adsorption reactions involving metals). For a particular metal, say, zinc, it will be noted that there are two reactions in the database of 42 iron oxide adsorption reactions (FEW-DLM.DBS). This three-digit component number associated with the reaction having the smaller log K of the two is the number to that must be used for the high population site. That is, component 812 should be entered at the higher site concentration and 811 at the lower site concentration. The set of site concentrations is given on page 44 of the EPA report. In the sample input files, component 811 was associated with the high site concentration and 812 with the lower.

After correcting these two errors and observing the special requirements of using of v3.11 as indicated above, the K_d values obtained using MINTEQA2 v3.11 with the peer reviewer's files were virtually identical to the SSL results.

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MANAGING RISKS AND UNCERTAINTIES

DOE/EH/(CERCLA)-002

Uncertainty Management: Expediting Cleanup Through Contingency Planning

Office of Environmental Management
Office of Environment, Safety & Health

February 1997

This guide is primarily intended for personnel with line management responsibility for Department of Energy (DOE) environmental restoration projects conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). It describes techniques for managing project uncertainty, including decision rules and contingency planning as outlined in the DOE/EPA "Principles of Environmental Restoration" workshop. Additional written guidance is available in DOE's *Remedial Investigation/Feasibility Study (RI/FS) Process, Elements, and Techniques Guidance* (DOE/EH-9400, December 1993) and DOE's *Phased Response/Early Action Guidance* (DOE/EH-0256, November 1995).

Introduction

Some degree of uncertainty in environmental restoration projects always exists. This inherent uncertainty may result from incomplete knowledge of the nature and extent of contamination, an inability to predict a technology's performance under site-specific conditions, or new or changing regulatory requirements. Although these inherent uncertainties present a significant challenge to effective project management, recognizing and planning for them helps to ensure that projects stay on schedule and within budget.

In order to effectively reduce and manage uncertainty prior to or during a response action, the project team must first determine which uncertainties are significant (i.e., can impact the implementation of the response action(s) under consideration). Once significant uncertainties are identified, the DOE, EPA and State project managers (i.e., the core team), must decide whether to reduce the uncertainty through data collection, or reach consensus on how best to "manage" the uncertainty through contingency planning. In short, this decision will require a balance between the cost of data collection (and decisional benefits gained) against the cost of planning for a potential deviation (i.e., uncertainty), and the cost / schedule impacts of modifying the design if the deviation occurs.

Outlined below are steps to follow once the core team decides to pursue managing an uncertainty through contingency planning.

Step One: Identify Expected Conditions and Potential Deviations

The core team should use their conceptual model developed for the site (or "problem") being addressed as a basis for identifying and evaluating expected conditions and potential deviations. An expected condition is any physical, chemical, technical, or regulatory condition that is expected to be encountered during implementation of the response action. For example, based on all available information [e.g., process history, preliminary assessment / site investigation (PA/SI)], the core team expects that contamination of Pu-238 greater than 75 pCi/g is confined to the soil and sediment from zero to four feet deep in the bed of an old, abandoned canal. However, given the possible releases of Pu-238 that could have occurred over a twenty year period, the core team identifies the potential presence of Pu-238 greater than 75 pCi/g below four feet, as a deviation that has a realistic probability of occurrence.

Step Two: Evaluate Deviations

Once potential deviations have been identified, the core team should determine what level of "pre-response" planning is appropriate by evaluating each deviation as to its possible impact on the implementation of the likely response(s), and its ability to negate achievement of response objectives.

Typically, a qualitative evaluation of the factors discussed below is sufficient to determine how best to proceed:

- Probability deviation will occur: The core team should rank deviations based on their likelihood of occurrence (e.g., high, medium, low).[1] Using the example from above, the core team may determine there is a low probability that contamination of Pu-238 above 75 pCi/g extends below four feet since the two PA/SI samples taken did not exceed this level.

- Potential impacts of the deviation: The core team should evaluate each deviation in terms of its potential impacts on the response action(s) cost, schedule, and implementation requirements (e.g., site preparation / mobilization, material handling, transportation). Typically, this requires bounding the range of impacts and comparing this range to a tolerable threshold[2] around which the base design is being constructed. For example, should contamination of Pu-238 above 75 pCi/g extend below four feet, soil volumes requiring excavation will increase significantly. If the site's temporary storage facility can only absorb a 25% increase (the threshold) in soil volume before capacity is exceeded, termination of field activities may be necessary until additional temporary storage is made available.

- Time to respond: The core team should estimate the "lead" time to respond between occurrence of the deviation and the impact to the project. As before, this may be done qualitatively or quantitatively, depending on the significance of the potential impact of the deviation. The shorter the lead time to respond, the less time available to implement the contingent response if a deviation is detected. Consequently, a greater level of contingency plan development / design is usually required to modify the base design in a timely manner (e.g., special equipment is procured and brought out to the site in case deviation occurs).

  Alternatively, if a long lead time is expected, then a less detailed contingency plan may be appropriate.

Step Three: Develop Appropriate Contingency Plans

Once the core team determines the appropriate level of "pre-response" contingency plan for each specified deviation, development of contingency plans can begin. Based on the required level of detail, a contingency plan should include a strategy for what needs to be accomplished to effectively manage and respond to a deviation. Specifically, the core team should define the necessary design modifications and / or actions required in the field to manage the deviation (e.g., modify excavation approach, provide higher level of personnel protection equipment (PPE), construct short-term storage area). Ultimately, the objective is to ensure the required scope of the contingency plan can be documented for procurement purposes and preplanning is sufficient to allow rapid, effective responses to deviations.

Additional considerations in developing contingency plans are discussed below[3]:

- Implementability: Based on the evaluation in step two, the core team should determine the necessary level of development / design to ensure the contingency plan can be easily implemented and will reliably address the deviation. As the probability that a deviation may occur increases, or as a shorter lead time to respond is required, a more developed contingency plan may be necessary to ensure rapid implementation. [NOTE: In some cases, the design of the contingency plan may need to be integrated into the base design.] Likewise, the greater the potential impacts of the deviation (e.g., occurrence of the deviation will require termination of field activities), the higher degree of confidence required that the contingency plan is implementable.

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[1] The core team needs to carefully consider whether a deviation having a high probability of occurrence is better characterized as an expected condition rather than a potential deviation.

[2] This threshold is the maximum change in the expected conditions that the base design (for the response action) can accommodate before a contingent response(s) is required.

[3] These same factors are useful to determine the most suitable contingency plan in the case where several contingency options exist.

- Effectiveness: The contingency plan should provide a similar level of protectiveness as the selected response (i.e., achieves the established response objectives) and any applicable or relevant and appropriate environmental standards (ARARs). For example, monitoring[4] may indicate that in addition to Pu-238, metals regulated under RCRA's Land Disposal Restriction (LDR) are present. Should LDR Toxicity Characteristic metal waste be encountered during excavation, a contingency plan for treatment (e.g., immobilization) to achieve regulatory levels required for disposal needs to be in place.

- Cost: Once expected conditions and deviations are identified, the impacts and likelihood of occurrence of a deviation should be evaluated against the costs of implementing a contingency plan. Again, as the probability that a deviation will occur increases, the cost of incorporating the contingency plan into the base design may be less than incurring the additional cost impacts of modifying the design later when the deviation occurs. For example, if Pu-238 concentrations exceed waste acceptance criteria (WAC) for the proposed disposal facility, downtime costs incurred until additional storage and an alternative disposal site are found could well exceed the costs of ensuring these contingent responses are in place before the excavation begins.

Step Four: Develop Associated Monitoring Plan

A monitoring plan should be developed for each deviation in order to determine when the deviation has occurred and when to implement the corresponding contingency plan. Decision rules (see Highlight 1) are an effective tool to specify monitoring requirements (how much and what type of data to collect) to detect specific deviations and link those monitoring requirements to specified contingency plans.

Decision rules define the criteria necessary for triggering action and therefore the core team must precisely define these criteria in order to clearly define the boundaries for taking action.

[4] As used here, monitoring refers to any sampling performed during the response action to determine when a deviation has occurred.

HIGHLIGHT 1: Example Decision Rules

If the concentration of radon in air exceeds *x* pCi/L at any monitoring station along the working fence line during remediation, then a mechanical ventilator will be used until the concentration decreases below *x* pCi/L.

If a alpha/beta/gamma surface scan during scabbling indicates radiological contamination above established criteria exceeds a depth of 2 inches in more than 25% of the area decontaminated, then decontamination will cease and the building will be demolished and disposed as low-level radioactive waste.

Of particular importance in decision rule development is ensuring data quality and quantity are acceptable to the core team for making a decision of whether a deviation has occurred and the necessity of implementing a contingency plan. Similarly, the core team should determine an acceptable level of uncertainty associated with a decision to terminate the response (i.e., the error that is acceptable in analytical methods to verify remediation goals have been met in order to close the site). A table is useful in linking the expected condition to the evaluation of deviations and development of contingency plans (see Highlight 2).

Please refer any questions concerning this material to:

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HIGHLIGHT 2: EXAMPLE UNCERTAINTY ANALYSIS TO DEFINE CONTINGENCY PLAN						
EXPECTED CONDITION	REASONABLE DEVIATION	EVALUATION			MONITORING PLAN	CONTINGENCY PLAN
		PROBABILITY OF OCCURRENCE	TIME TO RESPOND	IMPACT		
Pu-238 contamination in the soil does not reach the existing sanitary sewer line under the north canal.	Contamination extends to within 5 feet of sewer lines requiring excavation of soil around sewer pipe, causing structural instability in the pipe.	Low. Existing information does not suggest contaminants have migrated to this depth.	Long. Excavation can move to other areas but deviation must eventually be resolved to prevent schedule delays.	Medium. Excavation cannot continue around the sewer line.	Screen selected samples 5 feet above the sewer line using an on-site lab to determine if 25 pCi/g cleanup goal is met.	•Reroute sewer •Shore pipeline •Excavate in area adjacent to the pipeline until additional logistics are in place
During excavation, fugitive dust will not exceed air quality control standards.	Fugitive dust exceeds air quality control standards.	Medium. Area experiences variable weather conditions (i.e., strong winds) during this time of year. Cobbly, sand-like soil has low moisture content.	Short. Must be resolved quickly to prevent schedule delay.	High. Excavation cannot continue if fugitive dust standards are exceeded.	Tenax tubes will be placed around the perimeter of the excavation site.	•Provide spray tanks and hoses at the excavation site •Spray excavation site
Excavation will not exceed a depth of 20 feet and slopes will remain stable.	Slopes of excavation site become unstable and begin to sluff off.	Medium. Site has been disturbed (previously backfilled to a depth of 10 feet) and therefore may not be stable.	Short. Excavation slope must be modified quickly due to health and safety risks.	High. Will impact cost and schedule, depending on severity of sluffing, due to additional soil requiring removal.	Visual inspection will indicate unstable soil conditions. Geologist will log the soil type and compare it to the expected geological conditions.	• Modify excavation slope • Shore excavation
Pu-238 concentrations in canal do not exceed waste acceptance criteria (WAC) for disposal site.	Pu-238 concentrations in the canal exceeds WAC.	Low. Limited Field Investigation (LFI) information does not suggest contaminants exceed WAC.	Short. Must be resolved quickly to prevent schedule delay.	High. Depending on volume exceeding WAC, project cost and schedule may exceed the project baseline if the necessary disposal is not available.	Use field screening to identify Pu-238 levels above 300 pCi/g. Collect 5 grab samples from a 50ft^2 area for lab analysis to determine if WAC have been exceeded.	•Segregate and store separately •Provide additional storage • Have alternative disposal site identified and available
Th-232 concentrations do not necessitate personnel protection equipment (PPE) above Level B.	Th-232 concentrations require Level A PPE.	Low. Recent readings with field instrumentation do not suggest Th-232 concentrations will require PPE higher than Level B.	Short. If the response action is to continue, appropriate PPE must be provided.	High. Excavation cannot continue until PPE is upgraded.	Use field instrumentation to determine if Th-232 concentrations exceed Level B PPE requirements.	•Have higher PPE protection levels available at the excavation site
No Land Disposal Restricted (LDR) waste is encountered during excavation.	LDR waste is encountered during excavation.	Medium. Previous sampling did not indicate LDR waste, but based on process history this is a possibility.	Short. Waste must be separated immediately.	Medium. Excavation can continue but appropriate material handling and treatment before disposal is needed.	XRF scan of every 5 x 5 lift section will indicate metals above LDR trigger levels.	•Remove and segregate LDR waste •Ensure adequate storage capacity exists •Ensure treatment capacity exists

RCRA RISK ASSESSORS

April 13, 1998

This is it!

"The List" of RCRA Risk Assessors

Remember that survey someone from Region 8 sent you several months ago...and possibly again... and again since then? Alas, you will find enclosed the "list" of RCRA risk assessors that resulted from that survey.

ıe survey was designed to provide Regional RCRA risk assessors with a "network" of contacts who have experience working on RCRA corrective action facilities and expertise in dealing with risk-related issues within the context of the Resources Conservation and Recovery Act. It is hoped that this "network" will (1) help regional risk assessors with problem-solving, (2) facilitate information sharing, and (3) provide a mechanism by which to build national consistency in performing risk assessments for RCRA facilities.

In addition, the list includes those OSW staff who either do risk assessment for RCRA rule-making or deal with other areas of RCRA ·vhich incorporate risk assessment issues.

List Format

The first two pages of the list are a quick reference guide to risk experts, arranged by Region and HQ Office. These pages indicate the name, phone number, field(s) of expertise, approximate proportion of the individuals workload that is devoted to RCRA risk assessments. Also indicated is whether the individual also works on CERCLA sites and/or combustion facilities. Finally, the quick reference pages indicate whether the risk assessors experience includes primarily human health or ecological risk assessments, or both.

The remaining pages provide a more detailed description of each of the risk assessors, including their mailing address, fax number, areas of expertise and facility experiences. These pages were intended to help Regional risk assessors identify individual(s) in other regions who have expertise and/or experience that may be helpful in resolving issues or problems you may be facing at your facilities.

Ecological Risk Assessors...FYI

Are you aware of the National Ecological Risk Assessment Forum (ERAF)? This group, formerly known as the National BTAG, adopted a new vision statement, group charter and operating guidelines in June 1997. The new vision statement states, "The Ecological Risk Assessment Forum (ERAF) is the national group providing technical assistance for ecological risk assessments to support risk management decisions at hazardous waste sites". The group charter defines, "membership shall consist of EPA employees with an interest in OSWER ecological risk assessment issues (e.g., Regional BTAG coordinators, OERR, ERT, OSW, and ORD representatives)". The Vision Statement and Group Charter are attached for your review.

As outlined in the new charter, RCRA ecological risk assessors are welcome to participate. The ERAF holds monthly conference calls to discuss eco-risk issues and holds an annual meeting to provide policy updates and technical training to participants. The current ERAF tri-

chairs are Clarence Callahan (R9), David Charters (ERT), and Bruce Duncan (R10). If you are interested in participating, please contact one of the tri-chairs or the BTAG coordinator in your region:

Region 1:	Susan Svirsky
Region 2:	Mike Clemetson
Region 3:	Barbara Okorn
Region 4:	Lynn Wellman
Region 5:	Brenda Jones
Region 6:	Susan Roddy
Region 7:	Steve Wharton
Region 8:	Dale Hoff
	Gerry Henningsen
Region 9:	Clarence Callahan
	Ned Black
Region 10:	Bruce Duncan

Farewell

It is with mixed feelings that I inform you that I will be leaving the RCRA risk assessor ranks at the end of May. I will be leaving Region 8 to take a research toxicologist position within ORD at the Mid-Continent Ecology Division in Duluth, MN. I must say, I have enjoyed my tenure as a RCRA risk assessor and have gained a great appreciation for the work you all do. Probably the most astounding thing I learned is how much hazardous waste is out there, how little data exists on many of these wastes and thus, how important the risk assessor's role is in accomplishing corrective action. I know that my experience as a risk assessor will give me a unique perspective as I move back into research. I am planning on staying in touch and working with you to do what I can to ensure ORD's research programs are relevant for risk assessments of hazardous wastes.

I've had the pleasure to meet many of you and, in the process of compiling the survey, I have talked with nearly all of you. It's been a pleasure and thanks for your help!

Sincerely,

Tala Henry

Final Note

If anyone would like to volunteer to take on the task of updating the RCRA risk assessors list periodically, please let me know, ASAP. To reach me, just look me up on the quick reference page of the list!

RCRA RISK ASSESSMENT CONTACTS

REGION	LAST NAME	FIRST NAME	RA ROLE	FIELD(S) of EXPERTISE	PHONE #	RCRA	CERCL	Human	Eco	Incinerato	NOTES
1	BALLEW	Mary	Risk Assessor	Public Health/Epidemiology	617-573-5718	X		X		No	100% RCRA
1	HSIEH	Jui-Yu	Risk Assessor	Toxicology/Biology	617-565-3501	X		X	x	Yes	100% RCRA
1	TYLER	Patti	Risk Assessor	Aquatic Biology/Toxicology	781-860-4342	x	X		X	No	15% RCRA/ WAM for RCRA ERA contract
2	No EPA RCRA	Risk Assessors									Use Contractor Support
3	PRINCE	Ruth	Risk Assessor	Toxicology	215-566-3118	X		x	x	No	100% RCRA
3	QUINN	Elizabeth	Risk Assessor	Toxicology	215-566-3388	X		X	x	No	100% RCRA
3	ROTENBERG	Sam	Risk Assessor	Chem/Biochem/Toxicology	215-566-3396	X		X		Yes	100% RCRA
4	ADAMS	Glenn	Risk Assessor	Toxicology	404-562-8667	x	X	X		No	10% RCRA
4	AKIN	Elmer	Risk Assessor	Toxicology	404-562-8634	x	X				
4	KOPOREC	Kevin	Risk Assessor	Toxicology	404-562-8644	x	X	X		Yes	40% RCRA
4	SIMON	Ted	Risk Assessor	Toxicology	404-562-8642	x	x	X	x	Yes	50% RCRA
4	WELLMAN	Lynn	Risk Assessor	Plant Ecology/Env. Science	404-562-8647	x	X		X	No	20% RCRA
5	CAPRON	Lisa	Risk Assessor	Ecology	312-886-0878	X			X	No	100% RCRA
5	MANGINO	Mario	Risk Assessor	Toxicology/Chemistry	312-886-2589	X		X		Yes	100% RCRA
5	MAZUR	Daniel	Risk Assessor	Aquatic Ecology	312-353-7997	X			X	Yes	100% RCRA
5	OLSBERG	Colleen	Risk Assessor	Toxicology	312-353-4686	X		X		Yes	100% RCRA
5	SHARROW	Diane	Reviewer	Ecology	312-886-6199	X			X	No	10% RCRA
6	KIM	Youngm	Risk Assessor	Toxicology	214-665-6788	X		X	x	Yes	100% RCRA
6	MARTINEZ	Marial	Risk Assessor	Toxicology	214-665-2230	X		x	x	No	100% RCRA/Primarily BRAC Facilities
6	MORTON	Michael	Risk Assessor	Toxicology/Aquatic Biology	214-665-8329	X		X	x	No	100% RCRA
6	YURK	Jeff	Risk Assessor	Ecology/Toxicology	214-665-8309	X		x	x	Yes	100%RCRA
7	MONROE	David	Risk Assessor	Toxicology	913-551-7184	x	X	X	x	Yes	10% RCRA
7	WHARTON	Steve	Risk Assessor	Aquatic Biology/Ecology	913-551-7819	x	X		X	No	5% RCRA
8	BENSON	Bob	Risk Assessor	Toxicology	303-312-7070	x		X		No	15% RCRA
8	HENRY	Tala	Risk Assessor	Toxicology	218-529-5159	X		x	x	Yes	5% RCRA; moved to ORD/NHEERL/MED-Duluth
9	BLEVINS	Mary	Risk Assessor	Ecology	415-744-2069	X			X	Yes	100% RCRA
9	DOWNEY	Jennifer	Risk Assessor	Ecology/Biology	415-744-2062	X			X	Yes	100% RCRA
9	WILSON	Patrick	Risk Assessor	Toxicology	415-744-2038	X		X	x	Yes	100% RCRA
10	BAILEY	Marcia	Risk Assessor	Toxicology	206-553-0684	x	x	X		Yes	50% RCRA
10	DUNCAN	Bruce	Risk Assessor	Ecology/Marine Biology	206-553-8086	x	X		X	No	5% RCRA
10	GOULET	Joe	Risk Assessor	Toxicology/Biology/Ecology	206-553-6692	x	X		X	No	10% RCRA
10	NWOSU	Julius	Risk Assessor	Toxicology	206-553-7121	x	X	x	x	Yes	10% RCRA

RCRA RISK ASSESSMENT CONTACTS

	LAST NAME	FIRST NAME	RA ROLE	FIELD(S) of EXPERTISE	PHONE #	RCRA	CERCL	Human	Eco	Incinerato	NOTES
	OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE										
HQ	GREVATT	Peter	Science Advisor	Toxicology	202-260-3100	x	x	X	x	Yes	Formerly Region 2 RCRA Toxicologist
	PSPD/CAPB: Permits and State Programs Division/Corrective Action Program Branch										
HQ	LAGO	Carlos	Reg. Imp. Ana	Engineering/Ecology	703-308-8642	X		x	X	No	100% RCRA
HQ	MERCER	Mark	Risk Assessor	Environmental Engineering	703-308-8652	X		X	x	Yes	100% RCRA
HQ	SCHUVER	Henry	Env. Scientist	Corr. Action Env. Indicators	703-308-8656	X		X			RCRA, since '86 NJDEP, Consulting, R2
	EMRAD: Economics, Methods & Risk Assessment Division										
HQ	BERTRAND	Charlotte	Risk Assessor	Safety/Industrial Engineering	703-308-9053	X		X		No	100% RCRA
HQ	COLTON-BRA	Virginia	Risk Assessor	Geochemistry	703-308-8613	X		X		No	100% RCRA
HQ	COZZIE	David	Risk Assessor	Environmental Science/Biology	703-308-0479	X		x	x	Yes	100% RCRA/ OSW ERAF Member
HQ	CUTHBERTSO	Becky	Env. Engineer	Environmental Engineering	703-308-8447	X		X	x	No	100% RCRA
HQ	FARBER	Glenn	Reg. Imp. Ana	Economics/Policy Analysis	703-308-0491	X		X	x	Yes	100% RCRA
HQ	JOHNSON	Ann	Env. Scientist	Hydrogeology/Env. Engineerin	703-308-0498	X		X	x	No	100% RCRA
HQ	KRONER	Stephen	Risk Assessor		703-308-0468	X		X	x	No	100% RCRA/ OSW ERAF Member
HQ	MCBRIDE	Alexander			703-308-0466	X				Yes	100% RCRA
HQ	POLLARD	Karen	Risk Assessor	Environmental Science	703-308-3948	X		x	x	Yes	100% RCRA
HQ	SALEEM	Zubair	Risk Assessor	Hydrology	703-308-0467	X		X	x	No	100% RCRA
HQ	WITTNER	Andrew	Risk Assessor	Economics	703-308-0496	X		x	x	Yes	100% RCRA
						KEY:	X =	primary		x =	secondary or equal

NATIONAL ECOLOGICAL RISK ASSESSMENT FORUM
VISION STATEMENT

The Ecological Risk Assessment Forum (ERAF) is the national group providing technical assistance for ecological risk assessments to support risk management decisions at hazardous waste sites. The ERAF serves to promote scientifically defensible and nationally consistent methods for conducting ecological risk assessments (ERAs) that provide risk managers with information needed to make and communicate transparent, reasonable, risk-based decisions.

The ERAF will support the following principles:

1. Provide a national forum for transfer of technical methods for environmental assessment and biological monitoring;

2. Enhance coordination between EPA regions and headquarters offices in technical matters of ecological risk assessment and convey consensus opinions on their application in policy decisions;

3. Obtain and dispense technical information for members through various sources, such as literature reviews, professional meetings and forums, agency documents and personal contacts.

4. Collaborate with and provide support as necessary to other EPA programs, federal and state agencies, and tribes.

NATIONAL ECOLOGICAL RISK ASSESSMENT FORUM
GROUP CHARTER AND OPERATING GUIDELINES

The ERAF has adopted a vision statement that forms the basis for its activities and further adopts the following operating guidelines.

I. MEMBERSHIP

A. Membership will consist of EPA employees with an interest in OSWER ecological risk assessment issues at hazardous waste sites (e.g., Regional BTAG Coordinators, OERR, ERT, OSW, and ORD representatives).

B. Non-EPA employees may be invited to participate as *ex officio* members in ERAF meetings, calls, or other activities with the consensus of the forum.

II. MEMBER RESPONSIBILITIES

A. Members will regularly participate in periodic conference calls, national meetings, and other forum-wide activities.

B. Members will join and actively participate in workgroups formed to address issues and generate work products.

C. Members will solicit input from and provide information to risk managers charged with the responsibility of making ecologically based risk management decisions at hazardous waste sites.

III. LEADERSHIP

A. Leadership will consist of three Co-chairs, two of which must be from Regional Offices. Terms will be two years, with one co-chair term beginning in even numbered years, and two co-chair terms beginning in odd numbered years. The term beginning in even numbered years will be held by a Regional Office representative. No successive terms will be allowed, and service will be voluntary.

B. Selection of Co-chairs will be through an election process. Incumbent Co-chairs will solicit nominations and prepare the ballot for Co-chair election. Voting will be based on simple majority, with each of the Regional Offices, OERR, ERT, OSW, and ORD having three votes. The nominee(s) receiving the greatest number of votes during the current election cycle will serve as the Co-chair(s) for the terms under consideration. The nominee receiving the next greatest number of votes following the Co-chair(s) will be the first alternate Co-chair, who would serve if a Co-chair is unable to complete his/her term. Elections will be held at the summer meeting (generally, the third quarter of the fiscal year).

IV. LEADER RESPONSIBILITIES

A. Co-chairs will develop agendas for, coordinate, and memorialize proceedings of conference calls and national meetings.

B. Co-chairs will maintain a Technical Issues Docket, which includes those scientific issues on which the ERAF will provide a consensus opinion.

C. Co-chairs will monitor progress of workgroups in resolving technical issues, schedule work among workgroups, and ensure timely completion of work products.

D. Co-chairs will serve as points of contact for communication to and from the ERAF. This role will include serving as a conduit for funding for the ERAF.

V. DECISION MAKING PROCESS

A. Consensus will form the basis for ERAF decision making. A quorum of ten members is required to establish consensus.

B. Consensus will proceed as follows:

1. Tier I: The ERAF will strive to achieve the broadest possible consensus amongst all members; failing this,

2. Tier II: Consensus building will revert to one voice per organization by designated representatives for a total of 14 entities participating (i.e., the 10 Regions at one voice each, plus OERR, ERT, OSW, and ORD all at one voice each).

C. Prenotification of a consensus building event is required: a two week notice is preferred.

VI. COMMUNICATIONS

A. Conference calls will occur monthly on the third Tuesday of the month for a maximum of two hours. Co-chairs will assure an adequate agenda for each call and will cancel any call absent such an agenda.

B. ERAF national meetings will occur twice per year, one of which will be held in the Washington, D.C. area. Meetings will occur generally in the first and third quarters of the fiscal year; one meeting will occur concurrently with the human health risk assessors, if possible.

C. Co-chairs will archive in the designated repository all proceedings from national meetings and conference calls and all workgroup work products.

References for Managing Risks and Uncertainties

- OSWER Directive 9355.7-04, "Land Use in the CERCLA Remedy Selection Process;" May 25, 1995 (www.epa.gov/superfund/resources)

- OSWER Directive 9610.17, Use of Risk-Based Decision Making in UST Corrective Action Programs, March 1,1996, (www.epa.gov/swerust1/rbdm)

- "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments," Interim Final, U.S. EPA, June 5, 1997 (Available to order via NCEPI, Order Number: EPA 540-R-97-006. FAX order to: 703/321-8547).

- EPA Risk Characterization Program, memorandum from Carol Browner, March 21, 1995.

- "Guidance for Data Useability in Risk Assessment," Final, April, 1992, Publication 9285.7-09FS.

- Exposure Factors Handbook: EPA/600/8-89/043, August, 1996.

- OSWER Directive 9355.0-30, "Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions," April 22, 1991.

- Recommendations of the Technical Review Workgroup for Lead of an Interim Approach for Assessing Risks Associated With Adult Exposures to Lead in Soil (www.epa.gov/superfund/resources)

- OSWER Directive 9200.4-27, "Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities," August 1998 (www.epa.gov/)

- "Use of Data Quality Objectives Process in Risk Assessment," EH-231-023/0794, July 1994.

- Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Advanced Notice for Proposed Rulemaking (ANPR) May 1, 1996 (61 FR 19432): (Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm)

- "Policy for Risk Characterization at the US Environmental Protection Agency", Docket No. S0051, March 1995. (Available from the RCRA Docket Information Center).

- OSWER Directive 9610.17: Use of Risk-Based Decision Making in UST Corrective Action Programs, March, 1996. (Available to download from the Internet: http://www.epa.gov/swerust1/directiv/od961017.htm#Whereused)

- Guidance on Risk Characterization for Risk Managers and Risk Assessors, February 26, 1992.

- Risk Assessment and Risk Management in Regulatory Decision-Making, The Presidential/ Congressional Commission on Risk Assessment and Risk Management, Final Report, 1997.

- Risk Assessment Guidance for Superfund, Volumes I and II, interim final EPA/540/1-89/001, December 1989. (Available from NSCEP, call 800 490-9198, FAX request to 513 489-8695, ncepi.mail@epa.gov)

- Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Interim

References for Managing Risks and Uncertainties

Final, EPA/540/1-89/002 & 003 & 004, March 1989.) (Available from NSCEP, call 800 490-9198, FAX request to 513 489-8695, ncepi.mail@epa.gov)

- Risk Assessment, U.S. EPA, EPA/600/M-91/034, 1991.
- Risk Assessment Guidelines of 1986, U.S. EPA, EPA/600/88-7/045, 1986. (Available to download from the Internet: http:www.epa.gov/clhtml/pubalpha.html)
- Risk Assessment Review, U.S. EPA, EPA/600/N-94/002, December 1993. (Available to download from the Internet: http:www.epa.gov/clhtml/pubalpha.html)
- Risk Assessment Review, U.S. EPA, EPA/600/N-94/006, April 1994. (Available to download from the Internet: http:www.epa.gov/clhtml/pubalpha.html)
- Risk Management Plan Data Elements, U.S. EPA, EPA550/B-96/012, May 1996. (Available to download from the Internet: http:www.epa.gov/clhtml/pubalpha.html)
- Risk Assessment and Risk Management, ORD, June 1998. (http://www.epa.gov/ordntrnt/ORD/Risk.htm)
- RCRA Corrective Action: Human Health Assessment. Department of Energy, May 1994. (DOE Environmental Policy and Guidance Documents: http://www.homer.hsr.ornl.gov/oepa/risk/)
- Guidance for Risk Characterization. U.S. EPA, Science Policy Council, February, 1995.
- Peer Review Workshop Report on a Framework for Ecological Risk Assessment, U.S. EPA, February, 1992. (Available from NSCEP, call 800 490-9198, FAX request to 513 489-8695, ncepi.mail@epa.gov)
- Ecological Risk Assessment Planning and Problem Formulation: Middle Snake River Watershed, U.S. EPA, June 17, 1996 (Draft) (Available over the Internet: http://www.epa.gov/cgi-bin/claritgw/oepa)

*does not work OSW Waste Cleanup Website: http://www.epa.gov/epaoswer/osw/cleanup.htp

- RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction
- Integrated Risk Information System (IRIS): http://www.epa.gov/iris/
- Elements to Consider When Drafting EPA Risk Characterizations, March 1995: http://www.epa.gov/ORD/spc/rcelemen.htm
- Risk Assessment and Comparative Risk Analysis: http://www.epa.gov/opperspd/history7/setprior/sect2.htm
- Risk Management and Priority Setting, Environmental Management 1995, Department of Energy: http://www.em.doe.gov/em95/riskmgmt.html

References for Managing Risks and Uncertainties

- Environmental Risk: Your Guide to Analyzing And Reducing Risk: http://www.epa.gov/reg5rcra/wptdiv/risk.htm

- Policy for Risk Characterization at the U.S. EPA, March 1995: http://www.epa.gov/ORD/spc/rcpolicy.htm

- Risk-Based Decision Making Index: OUST: http://www.epa.gov/swerust1/rbdm/index.htm

- American Society for Testing and Materials Risk-Based Corrective Action: http://www.ucop.edu/facil/eps/astm.html

- Risk Assessment, Management, and Communication: A Guide to Selected Sources (www.epa.gov/cgi-bin/claritgw)

- Risk Assessment, EPA/600/M-91/034, 1991 (www.epa.govclhtml/pubalapha.html)

"OPEN-WINDOW" COMMUNICATION

Effective Group Participation Skills

Communication Tool for a RCRA Corrective Action Project Manager

As a Project Manger, your success achieving a Corrective Action depends, in part, on your level of skill development in working with other people. Educational systems often fail to provide skill development in this subject area. As an aid to you as a Project Manager, this Communication Tool offers a summary of some group participation skills along with a self-assessment to help you determine your areas of strength and further development.

As a RCRA Corrective Action Project Manager, **your ability to work effectively with others** such as the facility, the public, colleagues/managers/employees in your agency, or other regulatory agencies greatly influences the ease and success of your Corrective Action projects. Effective group participation skills can be learned or developed over time. The first step is determining your current skill level. The following table is a tool to help you assess your current group participation skills:

1) The left column lists the specific "Group Participation Skills," behavior you might use in a discussion, meeting, phone call, or interaction with the facility, the public, the other regulatory agency, or your own agency.
2) In the next column, place a check mark in one of the three boxes in the middle to indicate the extent to which you have developed and apply this skill in RCRA Corrective Action projects.
3) When you complete this self-assessment, circle those group participation skills for which you have checked the accompanying boxes "Not at all" or "Partially." Then, review the right-hand column to see how you can practice this skill and apply it in the future.

Effective Group Participation Skills

Communication Tool for a RCRA Corrective Action Project Manager

Group Participation Skills	Extent to which I have developed and apply this skill in RCRA Corrective Action			To practice this skill . . .
	Not at all	Partially	Totally	
Paraphrasing				Verbally summarize what you hear another say, and ask if it is accurate.
Information or opinion-seeking				Assess what information is relevant to the discussion, and ask others for that information or for their opinion.
Clarifying				State your ideas clearly and directly. Offer examples or illustrations.
Summarizing				In two sentences or less, identify the main point(s) of what you just said.
Testing ideas				Pose a question such as, "What if we (insert idea)? What would be the benefits? The obstacles?"
Integrating ideas				Combine the suggestions and ideas presented into a new idea.
Information or opinion-giving				Assess what information is relevant to the discussion, then provide helpful information or a helpful opinion.
Compromising				Offer a solution that may be acceptable to all parties.
Reducing tension				Offer some levity or humor in discussion. Lighten up the situation by telling a "light" story.
Setting standards				Suggest guidelines or minimum criteria against which the group might evaluate potential solutions.

Effective Meetings with the Facility

Communication tool for a RCRA Corrective Action Project Manager

Meetings can be productive means of accelerating a Corrective Action or a waste of time. Whether a meeting is productive or nonproductive depends, in part, on you as a Project Manager. You can improve the likelihood of a productive meeting(s) with tangible outcomes by applying some of the ideas and practices provided below.

As a RCRA Corrective Action Project Manager, you may meet routinely with the representatives of a facility undergoing a Corrective Action. A productive working relationship with the facility may make your job easier, more enjoyable and may help the facility achieve Corrective Action Results more quickly and successfully. A productive working relationship is often created through shared successes, and effective meetings can be one way to help create shared successes. Meetings are a productive means to share ideas, educate the facility, obtain information first-hand, and provide information first-hand. Meetings are an opportunity to conduct a site walk of the facility; to meet with key facility personnel, especially those with past history of the facility, and those who will be involved in implementing a Corrective Action; to review the facility's Conceptual Site Model, or to share yours; to openly and informally discuss future land use options; and to share and informally discuss other ideas.

This communication tool will assist you in helping promote or build productive meetings between the regulatory agencies and the facility to achieve a RCRA Corrective Action Result.

Key actions you can take to help create productive meetings include:

- ***Focus discussions on Something Tangible, Specific, and in Common.*** Discussions between a facility and a regulatory agency can be very general, non-specific, and highly theoretical. You may find yourself frustrated when what you thought you heard does not correlate with the actions or activities following a "meeting of the minds". In meetings, by focusing the facility's and your attention on something very tangible, specific, and in common, you increase the likelihood that meeting outcomes produce more tangible results. Environmental Indicators (EIs), a Conceptual Site Model (CSM), or groundwater models are some examples of topics that are very tangible, specific, and ideally in common. Some Regional Environmental Protection Agency (EPA) offices request the facility complete EI forms so that the EPA office and the facility then compare forms and better define areas of agreement and disagreement. These offices find this focuses the discussions on the more technical versus conceptual topics, and a Corrective Action proceeds more readily.
- ***Get the 'Right' People to Participate.*** Much work goes into making effective Corrective Action decisions. The process can often take months or years. The discussions, the selection of assumptions, the choice of risk assessment scenarios - all these lead over time to Corrective Action decisions. A method to streamline decision-making is to involve the 'right' people throughout the process, even during early stages of information gathering and decision-making. The 'right' people are those in the position to make Corrective Action decisions. This may often include a facility representative who is empowered to make Corrective Action decisions. It will also likely include their consultants. Find out who these people are, and meet with them to make best use of your time.
- ***Clarify Roles and Responsibilities.*** It is important to maintain your role as a representative of a regulatory agency. The facility will benefit by your clarifying your role in these meetings and in the RCRA Corrective Action process. You will benefit from hearing the facility verbalize what they view as their role and their responsibilities in the Corrective Action process. You more easily can

correct any misunderstandings when you are aware of areas of misperception. Clarifying roles and responsibilities is especially important in the area of public participation, where you and the facility have joint responsibilities.

- ***Maintain Regular Meetings.*** A RCRA Corrective Action, like all successful endeavors, requires a continuous focus of attention and energy over time. Quarterly meetings, for example, are one means to keep the attention and energy of the facility and regulatory agency focused on achieving the same Corrective Action Results. You can help monitor regular meetings an by creating an ongoing schedule agreed to by all participants. Scheduling the time on everyone's calendar can often be difficult, and you can avoid the hassles of scheduling these meetings by setting up a regular date, for example "the Tuesday of the first full week of each quarter."
- ***Create a "Roadmap."*** A "Roadmap" is a plan with milestones, an approach to achieving an end result, in this case Corrective Action Results. By working with the facility to outline a "Roadmap" to achieve a Corrective Action, you can provide your input and suggestions and also have an idea of how the facility plans to proceed and what progress you can expect. Creating a plan with milestones helps reduce unwanted surprises or misunderstandings, and it creates a common tool that you and the facility can use to move toward a Corrective Action Result.
- ***Clarify Important Decisions.*** Meetings are important opportunities to not only exchange information, but also to clarify past decisions, suggest tentative future decisions, and clarify a present course of action. With the 'right' people present, this is an opportunity to discuss and get as close as possible to clarifying a decision or the "next steps." Summarize decisions at the meeting, and check to ensure you and everyone have a correct understanding. Together, create a feedback mechanism or a means for everyone to obtain the same information arising out of the meeting. One method is to write your summary of decisions or 'next steps' on flip chart paper during the meeting and obtain everyone's feedback as to the accuracy of your understanding. These can be converted to notes and distributed to all participants after the meeting. Meeting notes might be taken by a designated note-taker, with an agreement to finalize or agree to the content of the notes in a conference call 2 weeks after the meeting.
- ***Acknowledge the Shared Successes.*** Success breeds more success. Recognize and build on successes, such as the ability of your agency and the facility to agree on the fundamental aspects of a conceptual site model, or the success a facility has achieved in accomplishing an Interim Action. Mention the successes, ask the representatives at the meetings what helped create these successes, and encourage the group to continue building on these activities and behaviors that resulted in a success.

Working with Resistance

Communication Tool for a RCRA Corrective Action Project Manager

As a Project Manager, achieving your goals may require a change in another's attitudes, behaviors, or actions. Often, a person or an organization's first response to change appears in the form of resistance. Therefore, at times you encounter resistance from the facility, the public, your colleagues, or other regulatory agencies. Unknowingly, some of your automatic responses may actually increase another's resistance and thereby impact a Corrective Action. This Communication Tool can help you both understand and reduce this natural resistance through increasing your knowledge and developing some specific skills.

In a RCRA Corrective Action project, you may often face resistance and challenges when working with the facility, the public, colleagues within your own organization, and colleagues in other regulatory agencies. This is normal and natural, as you are working with people and organizations with different beliefs, values, and priorities. For example, a facility may fail to meet your expectations. A public group or representative may continue to press for change or expediency in a particular Corrective Action. Members within your own agency may place higher priority on aspects of a Corrective Action you view as less urgent and important. Or, another regulatory agency may disagree with your approach in handling a particular Corrective Action.

You can more easily and directly achieve a RCRA Corrective Action Result by reducing the resistance between yourself, the facility, the public, and colleagues in your and other regulatory agencies. The first step is educating yourself on just what is resistance, what increases it, and what you can do to decrease the resistance.

What is resistance?

- **Resistance is often a person or an organization's first response to making a change.** It is a natural response to help maintain one's current beliefs, values, and priorities. As a RCRA Corrective Action Project Manager, you are often asking a person or an organization to modify in part their beliefs, values, or priorities to more highly regard environmental cleanup.

What increases resistance?

- **Resistance often increases when people feel they are 'not fully heard' or are disregarded.** For example, if a local resident at a public meeting expresses a concern to the facility or regulatory agency and that concern is disregarded, the resident's resistance to changing a belief, value, or priority may increase.
- **Resistance often increases if you put up "roadblocks" to communication.** These may include: threatening, preaching, arguing, criticizing, blaming, ridiculing, shaming, or being overly directive. As a RCRA Corrective Action Program Manager, you may choose or need to use these behaviors in certain circumstances. You can benefit by recognizing these will likely create "roadblocks" to communication and make it difficult to return to a more collaborative, consensus-building approach with a facility, the public, or regulatory agencies.

How can I reduce resistance?

It is helpful to recognize that resistance, rather than being a tug of war, represents an opportunity to learn, to grow, and to discover new ideas and solutions. Rather than being a game in which someone is right and someone is wrong, you can develop or enhance your skills to reduce resistance and create a bridge of communication between yourself, the facility, the public, and colleagues in regulatory agencies.

- **Listening Skills.** The first step in dealing with resistance is to truly ***understand, not necessarily agree with, but at a minimum, understand another's point of view***. Some practical suggestions for developing your listening skills include:

  — Stop talking.

  — Empathize.

  — Recognize your own judgements, prejudices, and biases.

  — Demonstrate you are listening with maintaining good eye contact, appropriate facial gestures, frequent nods to assure that you hear what they are saying, and occasional "uh huh" or "I hear you."

  — Get their main concerns.

  — Avoid jumping to conclusions.

- **Acknowledgment Skills.** The next step in dealing with resistance is to ***openly acknowledge or communicate another's point of view.*** It is helpful, where a person expresses a great deal of emotion, to ***openly acknowledge the person's emotion***. This requires effectively listening not only for what is said (the content) but also for the feeling or emotion behind the content. Some ways to openly acknowledge another's emotions include phrases such as the following:

  — I sense you might feel ....

  — You sound as though you are anxious (or worried, or afraid) about ....

  — It seems you are very upset about ...

  — You look worried about ...

  — You appear confused/frustrated about ...

  — This seems unfair to you that ...

  Only after the other person feels their point of view and emotions (if there is emotion behind the communication) will the person be open and receptive to options, suggestions, and problem-solving. Attempting to provide options and suggestions, or to problem-solve, before they feel heard and understood actually increases the resistance.

- **Flexibility Skills.** Flexibility is the skill of being adaptable, responsive to change, resilient. As a RCRA Corrective Action Project Manager, you may find this skill most valuable as you work to bring together the different ideas and perspectives of yourself, the facility, the public, and other regulatory agencies. You may find it useful to offer or consider different possible alternatives. You may find it beneficial to more openly consider another's point of view, such as the facility's assumptions that form the basis of their conceptual site model, a community's future land use ideas, or your technical expert's opinions.

Once I reduce the resistance, what next?

After you reduce the resistance through effectively listening, openly acknowledging another's point of view, and demonstrating openness to new ideas and options, you can ***help create a bridge*** of understanding between yourself, the facility, the public, or colleagues in the regulatory organizations. You do this by ***building on areas of agreement.*** Sometimes you must "peel the onion" to discover the areas of agreement. "Peeling the onion" involves asking questions, listening, and discovering those areas of agreement. Bring these to the surface, and work with others to start building on even small areas of disagreement. A small success can lead to a larger success. Enough of these successes leads to RCRA Corrective Action Results.

RCRA Public Participation Manual

1996 Edition

United States Environmental Protection Agency
Office of Solid Waste, Permits Branch
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Statement

This manual reviews regulatory requirements and provides policy guidance to help implement the RCRA program. The policies set forth in the attached manual are not final agency action, but are intended solely as guidance. They are not intended, nor can they be relied on, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided, or to act at variance with the guidance, based on an analysis of specific site circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

This manual replaces and supersedes the 1993 RCRA Public Involvement Manual *(EPA 530-R-93-006). This manual is designed for use by agency staff, public interest organizations, private citizens, and owners/operators of hazardous waste management facilities.*

Acknowledgments

The RCRA Public Participation Manual was developed by the Office of Solid Waste with the invaluable help of a task group comprised of EPA and State regulators, industry representatives, and representatives of public interest groups. EPA would like to thank the members of the task group who provided their able services to this effort. For a full listing of participants, please refer to Appendix Q.

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What This Manual Can Do For You

A Handbook for All Stakeholders

This document is a user's manual for public participation activities in the permitting process. In the same way that a user's manual explains how a car or an appliance works, this manual explains how public participation works in the RCRA permitting process and how citizens, regulators, and industry can cooperate to make it work better.

EPA teamed up with a diverse group of stakeholders from the environmental community, industry, and government agencies to produce this manual. The manual emphasizes the importance of cooperation and communication, and highlights the public's role in providing valuable input during the permitting process. The manual also furthers EPA's commitments to early and meaningful involvement for communities, open access to information, and the important role of public participation in addressing environmental justice concerns.

EPA wrote this manual to help all stakeholders in the permitting process. Here is how the manual can help you:

If you are a citizen...
This manual provides a clear description of the many public participation activities that are required by federal regulations. The manual also points out steps that agencies, company owners, and public interest groups can take to provide more public input into the process. In this manual, you will also find a list of people and organizations that you can contact to learn more about the permitting process and about community organizing.

If you are a government regulator...
This manual provides specific details about public participation requirements and outlines EPA's current policies. The manual also explains activities that you can conduct to provide better information to the public and to invite more public input into your RCRA permitting work. By reading this manual, you will learn how to open a dialogue with other stakeholders, how to assess communities and be sensitive to their concerns, how to plan for public participation, how to fulfill all the regulatory requirements, and how to go beyond the requirements.

If you are a member of a public interest or environmental group...
Reading this manual will let you know what public participation events are required under federal regulations, and how your organization can get involved. It provides useful tips, based on the experience of public participation practitioners, on how to interact with other stakeholders and

how to conduct public participation activities. The manual also provides contacts and publications that you can tap into for more information.

If you own or operate a hazardous waste management facility...
This manual describes when and how to conduct the pubic participation events involved in the permitting process. It points out the events you are responsible for and lets you know how the permitting agency will conduct other activities. By reading the manual, you will find out how to interact with the community around your facility, and how to be sensitive to their concerns, and how to cooperate and communicate with all stakeholders. The manual also describes public participation opportunities you can provide that go beyond the requirements.

Other Sources of Information

EPA is compiling a reference list of public participation and risk communication literature. For this list, EPA is interested in the following subjects areas: community organizing, community involvement and participation, environmental justice, risk communication, creative problem-solving, alternative dispute resolutions, participatory activities, environmental activism, and information-sharing. EPA is not interested in technical documents or data related to permitting. To initially solicit items for the reference list, EPA published a notice in the Federal Register (61 FR 15942). EPA intends to update the list periodically; any additional items people wish to propose for inclusion in the reference list may be submitted to the attention of the RCRA Permits Branch, Office of Solid Waste (5303W), U.S. Environmental Protection Agency, 401 M Street SW, Washington, DC 20460. Please do not send the original document. Include the full names of all authors, full titles, publisher, date of publication, city where the work was published, an abstract, and an address and/or phone number where one can write or call to obtain the publication (if applicable).

An initial draft of this reference list is available through the RCRA Hotline, or through the RCRA Information Center, in Docket Number F-95-PPCF-FFFFF, (see Appendix A for the appropriate telephone numbers).

If you are not trying to find out about public participation in the permitting process for facilities that store, treat, or dispose of hazardous wastes, then this manual will not be the best one for you. The following are suggestions of places to look for related information:

- If you are trying to learn more about public participation in the Superfund program, refer to *Community Relations in Superfund: A Handbook* (USEPA, EPA/540/R-92/009, OSWER Directive 9230.0-3C, January 1992).

- If you are trying to learn more about the siting of hazardous waste management facilities prior to permitting, you will most likely need to contact your local or state officials. See Appendix B for a list of state agency contacts. EPA is planning to issue guidance on this

topic during 1996. Contact the RCRA Hotline (see Appendix A for the number) for more information.

- If you are trying to learn about hazardous substances (other than wastes) stored by facilities or amounts of toxic substances released to the environment, you will want to find out more about the Emergency Planning and Community Right-to-Know Act (EPCRA), or and the Toxics Release Inventory (TRI). Call EPA HQ, your Regional Office, or the RCRA/Superfund Hotline (see Appendix A for phone numbers) for more information. Information on accessing EPA data is available in Appendix R.

- If you are trying to find out about how the public can participate in siting municipal waste landfills, refer to *Sites for Our Solid Waste: A Guidebook for Effective Public Involvement* (USEPA, EPA/530-SW-90-019, March 1990).

If you are unsure about whether a facility in your area will need a RCRA permit, you can contact your State agency or your Regional EPA office (see the Appendices A and B for numbers).

Chapter 1
Introduction

Overview of this Manual

This manual covers federal public participation requirements. States may have additional requirements.

This manual is a guide to improving cooperation and communication among all participants in the RCRA permitting process. Like the September 1993 RCRA Public Involvement Manual (EPA530-R-93-006), this manual outlines public participation procedures and what staff in EPA and RCRA-authorized state programs can do to ensure that the public has an early and meaningful role in the process. However, this new manual goes beyond the scope of past manuals by providing public participation guidance to regulated industries and the communities that interact with them.

The broader scope of today's manual reflects EPA's belief that all stakeholders have a role in providing for meaningful public participation. Permitting agencies, public interest organizations, community members, and regulated facilities are all stakeholders in RCRA permitting actions. Each group has an interest in the permitting process and, moreover, can take steps to increase public participation and improve communication. This manual provides guidance for all RCRA stakeholders who seek to achieve these goals. Of course, the Federal and State agencies still administer RCRA and its public participation activities, but EPA acknowledges that members of communities and owners and operators of hazardous waste management facilities also play an integral role in the permitting process .

One reason for the broader scope of this guidance document is that facility owners and operators have more formal responsibilities than ever in RCRA public participation. This trend in EPA’s approach, demonstrated through regulations such as the permit modifications procedures in 40 CFR 270.42 (52 FR 35838, September 23, 1987) and the part 124 changes in the "RCRA Expanded Public Participation" rule (60 FR 63417-34, December 11, 1995), has made facility owners and operators responsible for a number of public participation activities -- from public notices to meetings and information repositories. These new regulations underscore EPA's support for strengthening the link between facilities and their host communities.

This manual will also be helpful to many private companies that have adopted, or are establishing, public participation programs as part of their commitment to good corporate citizenship. While these activities often take place outside of the official RCRA permitting process, EPA supports

facilities in their efforts to inform and involve the public. This manual will guide facility owners and operators as they implement the public participation requirements of the RCRA program, especially those in the RCRA Expanded Public Participation rule. The manual will help facility owners and operators go beyond the regulatory requirements, expand their public participation activities, and build lasting relationships with surrounding communities.

Citizens are an essential component of the RCRA permitting process. The formal public participation activities, required by regulation, aim to provide citizens with both access to information and opportunities to participate in the process. Some citizens and other groups have expressed concerns about barriers to involvement in RCRA permitting. EPA was also concerned -- as are many members of the public -- that formal public participation begins too late in the permitting process and that RCRA permitting information is not always accessible to people. In response to these concerns and others, EPA promulgated the RCRA Expanded Public Participation rule. We hope that this rule and its accompanying policy statement will improve access to permitting information and enhance public participation.

Some of the most meaningful involvement for citizens may occur outside of the official process.

EPA recognizes that valuable public participation can take place outside of the formal procedures mandated by regulation. Through informal channels, citizens communicate and interact with other citizens, public interest groups, regulated facilities, and permitting agencies. EPA supports communities in their efforts to carry out informal means of participation that go beyond regulatory standards. Some of the most meaningful and informative involvement for citizens may come through activities not organized by permitting agencies or regulated facilities. We hope that this manual will be a valuable resource for communities and public interest groups that are concerned about RCRA facilities in their area.

Following this introductory chapter, the manual is organized as follows:

Chapter 2, “Guidelines for a Successful Public Participation Program,” introduces some basic public participation concepts and points out principles of public participation that we encourage all RCRA stakeholders to follow.

Chapter 3, “Public Participation in RCRA Permitting,” covers the basic steps in the RCRA permitting process and the public participation activities that accompany them. After reviewing the requirements, the chapter provides a list of additional participation activities to supplement the requirements.

Chapter 4, “Public Participation for RCRA Corrective Action Under Permits and §3008(h) Orders,” details EPA’s public participation guidelines for the corrective action program. This chapter reflects the

current agency position on these issues as the corrective action program continues to evolve.

Chapter 5, “Public Participation Activities: How to do Them,” provides detailed descriptions for dozens of public participation techniques -- required and optional, formal and informal. The chapter explains all of the public participation methods mentioned in the previous chapters and provides information on additional methods.

The Appendices provide resources that will help any participant in the RCRA permitting or corrective action programs. Included in the Appendices are: phone numbers and addresses for contact persons at all state agencies, the 10 EPA Regional offices, and EPA Headquarters; current permitting fact sheets; example notices and press releases; and EPA policy memoranda.

If you already have a general knowledge of the RCRA permitting program, you may want to skip ahead to Chapter 2 at this point.

The Big Picture

The RCRA program involves many people and organizations with roles that vary greatly. Congress writes or amends the Act which, when signed by the President, becomes law. After the Office of Solid Waste and Emergency Response (OSWER) at EPA develops the regulations that more specifically define and explain how the law will be implemented, the RCRA program is implemented by both EPA Headquarters (OSWER) and staff in EPA regional offices. The states may, in turn, apply to EPA for the authority to run all or part of the RCRA program. In doing so, a state may adopt the federal program outright or develop its own program, as long as it is at least as stringent and as broad in scope as the federal program. The regulated community is involved with the RCRA program because it must comply with the law and its regulations. Finally, the general public participates by providing input and comments at almost every stage of the program's development and implementation.

RCRA and its 1984 Amendments

The Resource Conservation and Recovery Act, an amendment to the Solid Waste Disposal Act, was enacted by Congress in 1976 to address a problem of enormous magnitude -- how to safely manage and dispose of the huge volumes of municipal and industrial solid waste generated nationwide. The goals set by RCRA were:

- To protect human health and the environment;
- To reduce waste and conserve energy and natural resources; and

RCRA GOALS

- To protect human health and the environment
- To reduce waste and conserve energy and natural resources
- To reduce or eliminate the generation of hazardous waste as expeditiously as possible

- To reduce or eliminate the generation of hazardous waste as expeditiously as possible (also referred to as waste minimization and pollution prevention).

The Act continues to evolve as Congress amends it to reflect changing needs. It has been amended several times since 1976, most significantly on November 8, 1984. The 1984 amendments, called the Hazardous and Solid Waste Amendments (HSWA), significantly expand the scope and requirements of RCRA. The HSWA provisions related to corrective action at RCRA facilities are described later in this chapter.

The program outlined under Subtitle C of the Act is the one most people think about when RCRA is mentioned. Subtitle C establishes a program to manage hazardous wastes from cradle to grave. The objective of the Subtitle C program is to ensure that hazardous waste is handled in a manner that protects human health and the environment. To this end, EPA established regulations under Subtitle C regarding the generation; transportation; and treatment, storage, and disposal of hazardous waste. These regulations are found in Title 40 of the Code of Federal Regulations (CFR), in Parts 261-266 and Parts 268-270. [Note: The CFR contains all the general and permanent rules published by the Executive departments and agencies of the Federal Government.]

The Subtitle C program has resulted in perhaps the most comprehensive regulatory program EPA has ever developed. The Subtitle C regulations first identify those solid wastes that are "hazardous" and then establish various administrative requirements for the three categories of hazardous waste handlers: (1) generators; (2) transporters; and (3) owners or operators of treatment, storage, and disposal (TSD) facilities. This manual applies only to the TSD facilities, and the term "facilities" in this manual refers only to TSD facilities. The Subtitle C regulations set technical standards for the design and safe operation of hazardous waste facilities. These standards are designed to minimize the release of hazardous waste into the environment. Furthermore, the regulations for RCRA facilities serve as the basis for developing and issuing (or denying) permits to each facility. Issuing permits is essential to the Subtitle C regulatory program because it is through the permitting process that the regulatory agency actually applies the technical standards to facilities.

RCRA Facility Permitting

Owners or operators of TSD facilities are required to submit a comprehensive permit application covering all aspects of the design, operation, maintenance, and closure of the facility. Owners and operators are also required to certify annually that they have a waste minimization program in place. Many companies have found waste minimization is often a cost-effective alternative or supplement to waste management. Facilities in existence on November 19, 1980, operate under interim status until a final permit decision is made. Similarly, facilities that are in

existence when new regulations are promulgated that subject them to RCRA Subtitle C may also operate under interim status while they proceed through the permitting process. New facilities are ineligible for interim status and must receive a RCRA permit before construction can commence.

The permit application is divided into two parts: A and B. Part A is a short, standard form that collects general information about a facility. Part B is much more detailed and requires the owner or operator to supply detailed and highly technical information about facility operations. Because there is no standard form for Part B, the owner or operator must rely on the regulations to determine what to include in this part of the application. Existing facilities that received hazardous waste on or after November 19, 1980, or subsequently fell under Subtitle C due to new regulations, submitted their Part As when applying for interim status. Their Part B applications can be either submitted voluntarily or called in by the regulatory agency. Owners or operators of new facilities must submit Parts A and B simultaneously at least 180 days prior to the date on which they expect to begin physical construction; however, construction cannot begin until the agency has issued the permit. Permit applications are processed according to the procedures found in 40 CFR Part 124.

The RCRA Corrective Action Program

RCRA requires owners and operators of RCRA facilities to clean up contamination resulting from present and past practices, including those practices of previous owners of the facility. These clean up activities are known as corrective action. HSWA added three provisions for corrective action, thus significantly expanding EPA's authority to initiate corrective action at both permitted RCRA facilities and facilities operating under interim status. Section 3004(u) of HSWA requires that any permit issued under RCRA §3005(c) to a facility after November 8, 1984 address corrective action for releases of hazardous wastes or hazardous constituents from any solid waste management unit (SWMU) at the facility. If all corrective action activities cannot be completed prior to permit issuance, then the permit must include a “schedule of compliance” establishing deadlines and financial assurances for completing the required corrective actions. Section 3004(v) authorizes EPA to require corrective action beyond the facility boundary, if necessary. Finally, §3008(h) authorizes EPA to issue administrative (i.e., enforcement) orders or bring court action to require corrective action or other measures, as appropriate, when there is, or has been, release of hazardous waste or hazardous constituents from a RCRA facility operating under interim status.

Corrective action is typically carried out by the facility owner or operator under the requirements or conditions stated in the RCRA permit or administrative order. In some cases, the owner or operator is required, through an order, to begin corrective action prior to permit issuance. If the regulatory agency issues a permit to the facility prior to completion of all activities specified in the order, then the agency may require the owner or

operator to continue all or some of the activities under the order, or may incorporate the requirements of the order into the RCRA permit schedule of compliance.

Public Participation in the RCRA Program

Section 7004(b) of RCRA gives EPA broad authority to provide for, encourage, and assist public participation in the development, revision, implementation, and enforcement of any regulation, guideline, or program under RCRA. In addition, the statute specifies certain public notices (radio, newspaper, and a letter to relevant agencies) that EPA must provide before issuing any RCRA permit. The statute also establishes a process by which the public can dispute a permit and request a public hearing to discuss it.

In fulfilling its statutory mandate, EPA has written regulations to implement the RCRA program. To carry out its public participation responsibilities under the Act, EPA has used its authority to develop specific public participation activities in the RCRA permitting program. As we explain in more detail in the following chapters, EPA's RCRA regulations provide for public participation at all hazardous waste management facilities -- from before permit application, through the permitting process, and during the permit life.

Chapter 2
Guidelines for a Successful Public Participation Program

What is Public Participation?

The RCRA permitting process brings government, private industry, public interest groups, and citizens together to make important decisions about hazardous waste management facilities. These groups and individuals have a stake in the facility under consideration, its operations, corrective action, or changes in its design or administration. As "stakeholders" they will communicate and interact throughout the permitting process and possibly throughout the life of the facility.

Public participation plays an integral role in the RCRA permitting process. Officially speaking, EPA uses the term "public participation" to denote the activities where permitting agencies and permittees encourage public input and feedback, conduct a dialogue with the public, provide access to decision-makers, assimilate public viewpoints and preferences, and demonstrate that those viewpoints and preferences have been considered by the decision-makers (see 40 CFR 25.3(b)). "The public" in this case refers not only to private citizens, but also representatives of consumer, environmental, and minority associations; trade, industrial, agricultural, and labor organizations; public health, scientific, and professional societies; civic associations; public officials; and governmental and educational associations (see 40 CFR 25.3(a)). When one considers "the public" in this broad sense, public participation can mean any stakeholder activity carried out to increase public's ability to understand and influence the RCRA permitting process.

Public participation increases the public's ability to understand and influence the process.

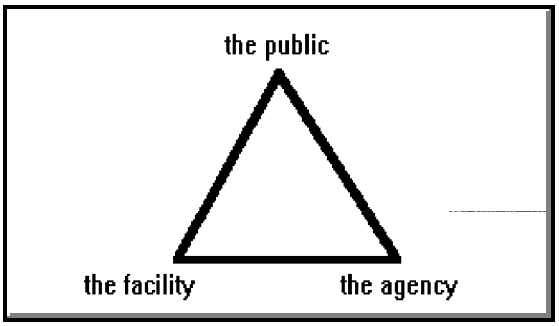

Figure 1 -- The Public Participation Triangle

We can represent the relations between these stakeholders as a triangle with the regulators, the facility owner/operator, and the interested public each forming a corner. Out of each corner runs a

line that represents each group's communication with the other participants in the process.

Public participation is a dialogue.

In the best case, the stakeholders interact well, the lines of communication are strong between all the parties, and information flows in both directions around the triangle. This last point is important: *public participation is a dialogue.* You will read more about this dialogue later in this chapter.

Why Bother With Public Participation?

There are a number of reasons why agencies, facilities, and interest groups should provide for RCRA public participation and why citizens should make an effort to participate in RCRA decision-making. The first, and most obvious reason, is that facilities and permitting agencies are required to conduct public participation activities under the Act and its implementing regulations. Additional activities provided by facilities, agencies, and other organizations in the community can complement the required activities.

The second reason to bother with public participation is "good government." Permitting agencies are charged with making many controversial decisions, which should not be made by technical expertise alone. Public participation in controversial decision-making is an essential element of the good government philosophy. Community members have a right to be heard and to expect government agencies to be open and responsive.

Public input can help the agency and the permittee make better technical decisions.

In addition to providing good government, the third reason for encouraging public input is that it can help agencies reach better technical solutions and, thus, make better policy decisions. Public input can also help permittees or prospective applicants make better business and technical decisions. A community is most qualified to tell you about its own needs, and people who live with a facility every day will have the familiarity to provide useful insights. Experience has shown that RCRA actions often benefit from public participation. With public input, permitting decisions can gain a breadth and an appreciation of local circumstances that technical staff alone could not provide.

The fourth reason to bother with public participation is that RCRA actions are more likely to be accepted and supported by community members who can see that they have had an active role in shaping the decision. Showing community members that the regulatory agency or the facility is willing to address community concerns will establish the foundation for improved understanding and community involvement in the process, even if members of the community do not always agree with the outcome of that process. By promoting public participation, permitting agencies can reduce the potential for concern over less consequential risks and dedicate more

resources to addressing serious risks and issues. Many companies have also found that promoting early and meaningful public participation can save resources in the long run by avoiding delays and lawsuits based on public opposition.

What Makes A Successful Public Participation Program?

A successful public participation program is inclusive. It allows members of the community to have an active voice in the RCRA decision-making process. Agency staff, facility personnel, and citizens will be able to talk openly and frankly with one another about RCRA-related issues, and search for mutually-agreeable solutions to differences.

In addition to the paragraph above, a successful public participation program will meet the targets set out in the subsections that make up the remainder of this chapter. The principles in these following subsections are applicable to all public participation activities.

Dialogue and Feedback

A vital and successful public participation program requires a dialogue, not a monologue . In other words, information must flow in loops between any two stakeholder groups. For example, the regulators should not just release information to the facility owner/operator, who passes it to the community, who then contacts the regulators. The regulator should make the information available to everyone and ask for feedback. Each corner of the triangle must keep the two-way conversation going with the two remaining corners.

The address and phone number of a contact person should appear on fact sheets, notices and other outreach materials.

Open communication lines require participants to be accessible to the other stakeholders. An effective way to make your group accessible is to designate a **contact person** for every permitting activity. The contact person should make his or her address and phone number available to the other stakeholders by printing it on any fact sheets or other informational materials produced by the organization. The contact person will field all inquiries on the permitting activity at hand. Other people involved in the process will appreciate this single and accessible point of contact.

Public participation should encourage “feedback loops.”

Without an active two-way communications process, no party will benefit from the "feedback loop" that public participation should provide. For example, if the regulatory agency sends out a fact sheet about an upcoming permit action, that fact sheet alone does not constitute public participation. Missing is the "feedback loop," or a way for the agency to hear from those who read the fact sheet. To get feedback, the agency might name a contact person in the fact sheet and encourage telephone or written comments, place calls to civic or neighborhood associations, visit a community group, or hold a meeting or workshop to discuss material in the fact sheet. Feedback loops enable the agency to monitor public interest or concern,

adjust public participation activities, and respond quickly and effectively to changing needs. The feedback loop is a useful tool for all stakeholders in the process.

> Members of the public have valid concerns and can often improve the quality of permits and agency decisions.

Even if a feedback loop operates successfully, public participation cannot be successful if the permitting agency or the facility is reluctant or unable to consider changes to a proposed activity or permit action based on public comment or other input. While the decision-makers at the agency or the facility need not incorporate every change recommended by the public, they should give serious consideration to these suggestions and respond by explaining why they agree or disagree. Members of the public, like other stakeholders in the process, have valid concerns and can often contribute information and ideas that improve the quality of permits and agency decisions. Regulators and facility owner/operators should take special notice of this point and make available more opportunities for public participation.

Honesty and Openness

As we emphasized in the section above, participants in the RCRA permitting process should make all efforts to establish open paths of communication. Being honest and open is the best way to earn trust and credibility with the other stakeholders in the process. Making information available to the community and providing for community input can improve public perception of the permitting agency or the facility and lead to greater trust and credibility. Trust and credibility, in turn, can lead to better communication and cooperation and can focus the public debate on issues of environmental and economic impacts.

Establishing trust should be the cornerstone of your public participation activities. The following is a list of things to remember when establishing your credibility:

1. Remember the factors that are necessary for establishing trust -- consistency, competence, care, and honor.
2. Encourage meaningful involvement by other stakeholders.
3. Pay attention to process.
4. Explain the process and eliminate any mystery.
5. Be forthcoming with information and involve the public from the outset.
6. Focus on building trust as well as generating good data.
7. Follow up. Get back to people. Fulfill your obligations.
8. Make only promises that you can keep.
9. Provide information that meets people’s needs.
10. Get the facts straight.
11. Coordinate within your organization.
12. Don’t give mixed messages.
13. Listen to what other stakeholders are telling you.

14. Enlist the help of organizations that have credibility with communities.
15. Avoid secret meetings.

This list was adapted from the manual *Improving Dialogue With Communities* (New Jersey Department of Environmental Protection, 1988). This manual and a number of other sources produced by states, EPA, trade groups, and public interest groups are available for more information on trust and credibility factors.

A Commitment to the Public

Public officials have ethical obligations to the public that have a practical value in building the foundation necessary for successful communication:

* informing the public of the consequences of taking, or not taking, a proposed action;

* showing people how to participate so that interested people can;

* keeping the public informed about significant issues and proposed project changes;

* providing all segments of the public with equal access to information and to decision-makers;

* assuring that the public has the opportunity to understand official programs and proposed actions, and that the government fully considers the public's concerns; and

* seeking the full spectrum of opinion within the community, not only from the business community and other agencies, but also from neighborhood and community groups, environmental organizations, and interests with other points of view.

(Adapted from *Sites for our Solid Waste* , Environmental Protection Agency, EPA/530-SW-90-019, March 1990 and 40 CFR 25.3(c)).

An Informed and Active Citizenry

If you are a citizen who is interested in a permitting issue, the regulations provide a number of opportunities to access information and get involved. The following activities are some things citizens can do to be influential and well-informed participants.

- Contact the permitting agency early. Identify the designated contact person for the project (the name should be on fact sheets and notices, or available by calling the agency).

- Do background research by talking to local officials, contacting

research or industrial organizations, reading permitting agency material, and interacting with interested groups in the community.

- Perform an assessment. Request background information from the permitting agency, local officials, and the facility ownership. Ask about day-to-day activities, the decision-making structure, and current policies and procedures; inquire about how the proposed project fits into larger political issues, local planning, and the facility's business plans. Request special information that may open up additional solutions, including pollution prevention approaches that may reduce or recycle the amount of waste that is managed in the facility.

- Ask to have your name put on the facility mailing list for notices, fact sheets, and other documents distributed by the agency. Add your name to mailing lists maintained by involved environmental groups, public interest and civic organizations.

- Tell the permitting agency, the facility owner/operator, and other involved groups what types of public participation activities will be most useful for you and your community. Inform them about the communication pathways in your area (e.g., what newspapers people read most, what radio stations are popular), the best locations for information repositories and meetings, and other information needs in the community (e.g., multilingual publications).

- Submit written comments that are clear, concise, and well-documented. Remember that, by law, permitting agencies must consider all significant written comments submitted during a formal comment period.

- Participate in public hearings and other meetings; provide oral testimony that supports your position. Remember that a public hearing is not required unless someone specifically requests one in writing.

- If any material needs further explanation, if you need to clear up some details about the facility or the permitting process, or you would like to express specific concerns, then request an informational meeting with the permitting agency or the appropriate organization, such as the State's pollution prevention technical assistance office.

- Follow the process closely. Watch for permitting agency decisions and review its responses to public comments. Be aware that you have an opportunity to appeal agency decisions.

- Remember that your interest and input are important to the agency

and other concerned stakeholders.

- To get tips about community organizing, information about how to participate in the regulatory process, or possible referrals to other involved groups in your area, you can contact the local League of Women Voters chapter. If you cannot contact a local chapter, or one does not exist, you can contact the state chapter. Phone numbers and addresses are provided in Appendix C.

EPA encourages citizens to consider these recommendations and follow them where applicable. At the same time, EPA recognizes that the best way to participate will be different in every situation. Citizens should contact other concerned persons, community organizations, and environmental groups to determine how citizens can best influence the permitting process.

Starting Early

A good public participation effort involves the public early in the process, encourages feedback, and addresses public concerns before initial decisions. The permitting agency, the facility owner/operator, and public interest organizations involved in the RCRA permitting process should make all reasonable efforts to provide for early stakeholder participation and open access to information. These efforts should include informing and seeking feedback from impacted communities before any significant actions. You should avoid the appearance of making decisions before public input. Even in cases where the facility and the agency meet privately in the early stages of the process, they should keep up the lines of communication with the public. One State agency has found success by making a meeting summary available to the public in an information repository whenever the regulators meet with facility staff. Such gestures can increase public faith while reassuring people that the agency will seek public input before making major permitting decisions.

EPA encourages public participation activities throughout the RCRA permitting process, especially when the activities foster an early, open dialogue with potentially affected parties. This can be particularly effective in exploring alternatives to treatment or that go beyond compliance, including for example, pollution prevention.

Early outreach and straightforward information can establish trust among the other stakeholders while reducing misinformation and rumors. Key contacts in the community should always know about planned activities that will be visible to members of the community, such as construction work or excavation related to facility expansions or corrective action. Interested people or groups in the community can use early participation activities to

make their concerns and suggestions known before major decisions take place. Since early participation activities may be the first word that people hear about a permitting activity, EPA is requiring expanded notice efforts before the facility submits a permit application (see "Notice of the Pre-Application Meeting" in Chapter 3). All stakeholders should use their knowledge of individual communities and local communication channels (e.g., contacts in the community, the media, civic and religious organizations) to foster effective information-sharing.

RCRA regulations require facilities and agencies to start public participation activities prior to application submittal, and continue them through the entire life of the permit. In essence, the facility owner or operator cannot put off public participation. EPA encourages permit applicants and permit holders to take early public participation activities seriously -- early activities can set the tone for the permitting process and even the entire life of the facility.

Start early and plan ahead: public interest in a facility can grow rapidly and unexpectedly.

Setting up an effective public participation program is a valuable use of time and resources. External pressure to start public participation work may not be present at the outset of a project, because members of the public may be unaware of the facility's operations and the regulatory agency's activities. However, public interest in a facility can grow rapidly and unexpectedly. Participants can best prepare for such situations by assessing their communities, taking proactive steps, and preparing for contingencies.

Getting the news out early gives people time to react. Other stakeholders can offer better information and suggestions when they have some time to think about it. For example, a facility can better incorporate community concerns into its permit application if it hears public concerns well before application submittal. Agencies and facilities owe the public the same courtesy, allowing citizens adequate time to review, evaluate, and comment on important information. By the same token, citizen participants should do their best to make their interests known early. If a citizen is invited to participate early, but decides not to and raises issues at the end of a process, then that citizen risks losing credibility with other stakeholders in the process.

Finally, extensive early outreach (as we point out in the following section) will make the permitting process or the corrective action smoother over the long run. Early outreach brings issues to the surface before stakeholders have invested great amounts of time and resources in a project; these issues are easier to address at an early stage. Moreover, early outreach minimizes the possibility that the public will feel like the agency or the facility is surprising them with an undesirable project. By providing early notice, agencies and facilities can avoid the public reactions that have "blind-sided" some projects in the past.

Assessing the Situation

Community assessments are an important step to take before preparing or revising a public participation strategy. Assessments are essential tools for facility owners who are applying for a RCRA permit (including interim status facilities), seeking a major permit modification, or undertaking significant corrective action. Permitting agencies should focus their assessments on communities where a major new facility is seeking a permit, or in other cases where permitting activity or corrective action has the potential to evoke public interest. Additionally, assessments may be appropriate at any stage during the life of a facility, especially in situations where the level of public interest seems to be changing.

Every community is different. What works in one community may not work in another.

Community assessments allow agencies, facility owners, and public interest groups to tailor regulatory requirements and additional activities to fit the needs of particular communities. Each community is different and has its own way of spreading information and getting people interested. Important institutions and groups will also vary from place to place, as will socioeconomic status, culture and traditions, political and religious activity, and values. The facility owner, public interest groups, and the agency should make all reasonable efforts to learn the facts about the affected community. These data are essential to choosing public participation activities that will be useful and meaningful for the community.

Determining the Level of Public Interest

Some permitting activities do not generate much interest or concern among community members. Other activities will evoke strong interest and will require a much greater public participation effort. Although there are no hard and fast rules that make a facility a low- or high-profile facility, the level of interest will depend on a number of factors, such as (1) the type of RCRA action and its implications for public health and welfare; (2) the current relationships among the community, the facility, the regulatory agency or agencies, and other groups; and (3) the larger context in which the RCRA action is taking place, including the political situation, economics, and important community issues. Exhibit 2-1 (at the end of this Chapter) provides a guide for determining a facility's potential to be low-, medium-, or high-interest to the public.

Public participation activities should change over time to suit the level of interest in a facility.

While these guidelines can be useful as an early planning tool to predict public interest, agencies and facility owners should be flexible and prepared for rapid changes in the level of public interest in a permitting activity. The apparent level of public interest does not always reflect the potential for public interest. In some cases, the regulatory minimum will be sufficient. In other cases, the agency or facility should be prepared to provide additional input and information, as needed. Public participation activities should correspond to the level of community interest as it changes over

time.

Public interest, environmental, and civic organizations also assess their communities to determine the amount of interest in a permitting activity. These organizations can take steps to encourage public participation in the permitting process. Door-to-door canvassing, public information sessions, flyers, fact sheets, neighborhood bulletins, and mailings are all methods of sharing information with the public and encouraging citizen involvement. Organizations that are attempting to encourage public participation may find the rest of this section useful. In addition, more information for such groups is available by contacting the League of Women Voters (see Appendix C for contacts).

Community Assessment Methods

Facility owners should gather background information about the community before seeking a permit or a permit modification. Regulators should find out about community concerns at the outset of a major project or any project that seems likely to raise significant public interest. Public interest groups may want to perform similar background work. As emphasized in the previous section, understanding a community is essential to creating a successful public participation effort.

The facility owner is responsible for collecting his or her own information about a community before initiating any permitting activity (e.g., before requesting a permit modification or applying for a permit). Permitting agencies, on the other hand, should dedicate their resources, using their own judgment, to learning about concerns in the community and assessing communities where there is a high level of interest in a permitting activity. In some cases, permitting agencies and facility owners have cooperated to do joint outreach activities, and believe that the agency presence has made members of the community more comfortable during interviews or other activities. EPA does not recommend such cooperation as a rule (because, for example, other stakeholders could perceive this as “taking sides”). Permitting agencies should use their discretion and maintain the agency’s proper role during any such activities.

EPA recommends the following steps for gathering information about the community. Although facility owners may want to follow these steps before every major permitting activity (e.g., applying for a permit or a major modification), permitting agencies should focus on major activities at facilities that have the potential to raise significant public interest :

- Reviewing news clippings and other information that indicates how the community is reacting to the facility or the permitting activity.

- Talking to colleagues or anyone who has experience working with members of the particular community.

- Contacting companies, universities, local governments, civic groups, or public interest organizations that already have experience in the community. These groups may be able to provide useful information about community concerns, demographics, or reactions to other industry in the area. They may be able to point you towards other existing sources of community information.

If it seems like there is a low level of interest in the facility at this point, and things are not likely to change, the agency and the facility owner can begin planning the required public participation activities.

If, however, the facility shows indications of being a moderate- to high-interest level facility, a more detailed analysis of the community might be necessary, and additional public participation activities planned.

EPA recommends community interviews when there is a high level of public interest.

- To get a fuller picture, staff from the agency or the facility should consider contacting community leaders and representatives of major community groups to talk about the facility and the planned RCRA action. These interviews should represent a fair cross-section of viewpoints in the community. The community representatives may have a feel for how much community interest there is in a permitting activity. They also may be able to provide advice on how to handle the situation.

- If there are indications of likely high interest from the outset (e.g., a facility that is likely to be controversial is seeking a permit), the agency or the facility owner should consider conducting a broad range of **community interviews** with as many individuals as possible, including the facility's immediate neighbors, representatives from agencies that will participate in the RCRA action, community organizations, and individuals who have expressed interest in the facility (e.g., people on the agency's mailing list, newspaper reporters, local officials). A detailed discussion of how to conduct **community interviews** is provided in Chapter 5.

- After collecting the necessary information, the agency or the facility may wish to prepare a brief summary of major community concerns and issues (no more than five pages). The summary can be integrated into the public participation plan document or used as the basis for developing a "Question and Answer"-type **fact sheet** to distribute back to the community. See Chapter 5 for additional information on these activities.

Exhibit 2-2 at the end of this Chapter summarizes the steps to take in

determining the level of public interest in facilities and gathering background information.

Targeting Public Participation in Communities

The scope of the affected community will vary from facility to facility.

This initial assessment should provide a good idea about the scope and makeup of the "affected community." Pinpointing the affected community can be a difficult process; everyone has a different definition. EPA will not try to define the affected community here because its composition will vary with the particular characteristics of each facility and its surrounding community. *In some cases* , however, it may be appropriate to target a segment of the population that is broader than the "affected community." For instance, the appropriate target for early public notices and some other activities may go beyond people who are directly affected, to include citizens who are potentially interested or concerned about the facility. EPA recognizes that the distinction between "affected" and "concerned" or "interested" will not be completely clear in all cases. Permitting agencies should use their best judgment.

EPA realizes that resources will limit the breadth of any public participation program and that focus is necessary. It is clear that some people will have a more direct interest than others in a particular permitting activity. Given practical resource limitations, public participation activities should focus first on people with a more direct interest in a RCRA facility, while also realizing that "direct interest" is not always determined by physical proximity to a facility alone. It is impossible to point out all people who have a direct interest, but, as a general guideline, people with the most direct interests will live in the general vicinity of the facility, or have the potential to be affected by releases to groundwater, air, surface water or the local environment (e.g., through game, livestock, or agriculture or damage to natural areas). Direct interests may also include people who live on or near roads that will accept increased traffic of hazardous waste-carrying vehicles. EPA acknowledges that people residing a significant distance from the facility may have legitimate and important concerns, but EPA thinks it is reasonable to focus limited public participation resources on communities with direct interests. See the section on "The Mailing List" in Chapter 3 for a list of organizations that you should consider when thinking about the interested or affected community.

The Citizen's Role

Citizens in the community may want to assess the permitting situation, the agency (or agencies) involved, and the facility owner/operator. As we pointed out in the section above, citizens can get background on a permitting issue by talking to local officials, contacting research or industrial organizations, reading permitting agency material, and interacting

with interested groups in the community. Citizens may also want to find out about day-to-day activities at the facility or the agency, the decision-making structures they use, and their current policies and procedures. Citizens may want to get more information on the owner's/operator's involvement with other facilities or other activities. The contact persons for the facility and the agency are also good to know. Citizens can also talk to local officials, the agency, or the facility to find out how the proposed project fits into larger political issues, what local planning issues are involved, and what the facility's business plans are.

Individual community members can take part in the assessment process by providing input to other stakeholders through interviews, focus groups, or other methods used in community assessments (also see the section on "An Informed and Active Citizenry" earlier in this Chapter). This guidance manual gives an overview of the RCRA permitting process which individual community members may find helpful. The Appendices at the end of this manual provides other resources and contacts (the RCRA Hotline, agency phone numbers, and League of Women Voters' contacts) that citizens can access. EPA is also compiling a reference list of public participation and risk communication literature. The list is available through either the RCRA Information Center, in Docket Number F-95-PPCF-FFFFF, or through the RCRA Hotline (see Appendix A for appropriate telephone numbers). Members of the public can find out about permit activities in their area by contacting the permitting agency, talking to environmental groups or public interest organizations, reading state, federal, and private environmental publications in the library, looking for zoning signs or other announcements, attending public meetings and hearings, watching the legal notice section of the newspaper or checking display advertisements, listening to local talk shows, or keeping up with local events through town bulletins, associations, or council meetings.

Valuable public interaction can take place outside of the formal permitting process.

In addition, members of the community can contact the permitting agency or the facility -- outside of any formal activity -- to give early input and to share their concerns. Community members should suggest public participation activities, meeting locations, or means of communication that will work well in their community. This sort of informal communication, via letter or interview, can be very helpful, especially in terms of establishing a public participation plan (see Chapter 5 for a description of public participation plans). EPA also recognizes that valuable public interaction takes place outside of the formal permitting process. Citizens may choose to contact other groups in the community that have an interest in the permitting activity. Environmental, public interest, and civic organizations often play a role in the RCRA permitting process. These groups can provide interested citizens the opportunity to participate in efforts to influence the permitting process through collective action.

Alternatively, citizens may see fit to create new organizations to discuss issues related to the permitting process or to provide input into the process.

Planning for Participation

A good public participation program avoids misunderstandings by anticipating the needs of the participants. It provides activities and informational materials that meet the needs of, and communicate clearly to, specific community members and groups. The public participation plan is the agency's schedule and strategy for public participation during the initial permitting process, significant corrective actions, and other permitting activities at facilities receiving high levels of public interest.

After assessing the situation, the agency should have an approximate idea of how interested the public is in the facility. Based on the information from the community assessment, the agency should draft a plan addressing public participation activities throughout the prospective permitting process and the life of the facility. For permitting activities and corrective actions that do not raise a high level of public interest in the community, the public participation plan will be a simple document, outlining the regulatory requirements. Major permitting activities and other high-interest activities will require a more detailed plan with participation opportunities that go beyond the requirements. Agency staff should keep in mind that community interest in a particular facility can change at any time; good plans will prepare for contingencies.

EPA recognizes that permitting agencies do not always have the resources they need to perform all the public participation activities they would like to perform. Agency staff must consider resources in all stages of the process, but particularly when developing a public participation plan. To make fewer resources go further, agencies should consider working with community groups, public interest organizations, and facility owners/operators to plan public participation events. Some relatively inexpensive activities can be very effective. More information on making use of additional resources is available in Appendix M. Information on the resources needed to perform specific public participation activities is available in Chapter 5.

The plan should create a structure for information to flow both to and from the public.

The goal of the public participation activities in the plan is to meet the specific needs of members of the community by creating a structure for information to flow both to and from the public. Anyone who plans public participation activities should strive for useful and timely exchange of information with the public. Again, EPA strongly encourages anyone conducting public participation activities to solicit public input on the types of communication and outreach activities that will work best in each

community. The agency, facility, civic and public interest groups should coordinate their public participation efforts, emphasizing two-way information exchange and avoiding unnecessary duplication in their activities.

To identify activities for the public participation program, the agency should go through the following steps:

1. list the major community issues and concerns;
2. list the community characteristics that will have a bearing on how you address these issues; and
3. list the activities that will address the community's concerns during the permitting process and, if applicable, corrective action.

Once the agency has outlined activities for the facility at hand, it should put together a strategy for implementing the activities. In general, the following are the areas of responsibility for public participation that the agency should consider:

- **Interacting with the media, especially on high-profile facilities.** If there is a high degree of interest in the facility, it will be important to have a media contact person who can get information out quickly, accurately, and consistently. The assistance of a public affairs office is often necessary (where applicable).

- **Interacting with elected officials.** For facilities receiving a moderate to high level of interest, it is often beneficial to work with elected officials to provide them with information they need to answer their constituents' questions. Put together a team of people who can fill the information needs of public officials. This team should include senior people who can answer policy questions when necessary.

- **Answering telephone and written inquiries.** It is important to follow up on all requests for information that you receive from stakeholders. Designate one person to be responsible for putting together the answers to questions in a form that is understandable to the public. This "contact person" should be named in all fact sheets and public notices. Remember the importance of two-way communication and the public participation triangle.

- **Coordinating public participation with other stakeholders.** It is crucial that all the people who are working on public participation be aware of what activities are being planned for the facility and any other facilities in the area, so that activities can complement each

other whenever possible. At the least, try to avoid conflicts between competing activities. Be sensitive to major events (e.g., celebrations, other meetings, religious revivals, fundraisers, elections) and important dates (e.g., local holidays, graduations) in the community.

- **Maintaining the mailing list and information repositories.** A mailing list is required under RCRA and the agency should update it to include new people or organizations who have expressed an interest in the facility. The facility and other organizations should refer to the agency any requests to be on the official facility mailing list. If public information repositories are established for the facility, they should be indexed and updated at least quarterly, or as required by the permitting agency. The facility may want to obtain a copy of the mailing list to use for distributing information.

- **Planning and conducting public meetings.** Set-up and coordination are critical to the success of public meetings. Public participation staff will need to choose a location for meetings based on public input and the need for comfort and accessibility. The public participation coordinator will need to schedule speakers, plan the agenda, and provide a mediator (if necessary) at the meeting. Chapter 5 provides more detail on public meetings, hearings, workshops, etc.

- **Handling production/distribution/placement of information, including fact sheets, public notices, news releases, meeting handouts and overheads, etc.** Much of your public participation time will be spent developing and producing information for interested stakeholders. Permitting agency staff may want to refer to Appendix M for a list of resources that can ease fact sheet and information production. Sometimes you may need to refer stakeholders to other agencies that have information readily available, such as the State pollution prevention technical assistance office, which often have fact sheets and technical experts available. A list of pollution prevention contacts is included in Appendix S.

Public participation activities should coincide with major steps in the permitting process.

The next step is to figure out a schedule of public participation activities. This schedule should include activities that are required by EPA regulations. In general, the timing of additional public participation activities should correspond to the completion of major steps in the technical process (e.g., application submittal, draft permit issuance, completion of the RFI). These are the times when members of the public may have new questions or concerns about the proposed action or the facility in light of new information, especially during corrective action. The regulators and the facility owner/operator should also be prepared to notify the public when any major activity will be taking place at the facility (e.g., start of construction for corrective action) or has taken place (e.g.,

emergency response to releases).

Permitting agencies should take the lead in writing and revising public participation plans, while allowing for input from other stakeholders and coordinating with activities held by the facility, public interest groups, and community organizations. The agency may want to involve other stakeholders in a group process to form a comprehensive plan. Depending on the amount of public interest in a facility, the plan could be an informal one- or two-page document or a formal public involvement plan that will be available to members of the community for comment. At a minimum, the plan should include a list of the specific public participation activities for the facility and a schedule for when they will occur. We encourage agencies to make these plans -- formal and informal -- available to the public.

Developing a written public participation plan will help staff account for all the necessary steps in the permitting or corrective action process. A formal plan will also let the public know what type of activities to expect during the process. EPA recommends that a formal plan contain the following sections:

- executive summary;
- introduction/overview;
- facility history;
- the RCRA action taking place;
- summary of community interviews, outlining concerns;
- a description of any early consultation (e.g., interviews with group leaders) that led to development of the plan;
- a list of the major issues likely to emerge during the process;
- an estimation of the level of public interest likely to be generated by the decision under consideration;
- public participation activities and schedule;
- a list of the agencies, groups, and key individuals most likely to be interested in the process;
- a list of key contacts; and
- information on meeting and repository locations, where applicable.

Communities can provide valuable advice on what public participation activities will work best.

EPA encourages permitting agencies to seek public input on the plans; final plans should be available for public review. This sort of input is important for getting the public involved early in the process. In addition, communities can provide useful advice on what channels of communication will work best in the area and what sort of activities will provide the most effective participation. Communities can provide practical solutions that improve communication and may even save resources. For example, in one community where rumors spread easily, citizens suggested that the agency put status reports on voicemail so that people could call in for

regular updates.

There are numerous ways that the community can contribute during the planning stage. Citizens can decide how interested they are in a particular activity by discussing issues with other stakeholders, accessing relevant documents, or calling hotlines or other experts. Those who would like to participate in the formal process can use this time to raise questions or develop their ideas. Some citizens may want to submit comments to the agency on the public participation plan. Moreover, EPA encourages interested citizens to meet together to discuss the potential impact of RCRA actions on their communities. Citizen groups may want to invite experts from the facility, the permitting agency, engineers, environmental contractors, scientists, health experts, and attorneys to speak at their meetings.

Understanding and Interaction Between Stakeholders

While each stakeholder shares the responsibility of providing open and two-way communication, the roles and responsibilities of the different stakeholders differ substantially. Participants in the RCRA permitting process should acknowledge these differences and account for them as they approach the process. We encourage participants to do their best to understand the interests and concerns of the other participants by following the principles below:

* Strive to respect other stakeholders and their opinions. Avoid personal attacks.

* Understand that people have different levels of understanding of RCRA. Not everyone is an expert, but everyone should have the chance to know all the facts.

* Realize that decisions made during the permitting process can have profound economic and social impacts. These decisions are very real and important; people will live and work with them every day.

* Acknowledge that statutory and regulatory requirements limit what can happen during the permitting process. Remember that everyone -- citizens, regulators, facility owners/operators, and public interest workers -- has resource and time constraints

* Recognize that people have concerns that go beyond the scientific or technical details. These concerns deserve respect.

* Build your credibility by being fair, open, and respectful.

* Try to understand the values and interests of other stakeholders before jumping to conclusions.

Promoting Environmental Justice

Environmental justice refers to the fair distribution of environmental risks across socioeconomic and racial groups. Some groups and individuals associated with environmental justice issues have raised the concern that EPA and some State environmental agencies do not provide equal protection under the nation's environmental laws. With regard to the RCRA permitting program, most of the concern surrounds the potential additional risk that hazardous waste facilities may pose when located near low-income or minority communities that already face an environmental burden from multiple sources.

On February 11, 1994, the President issued Executive Order 12898, directing federal agencies to identify and address the environmental concerns and issues of minority and low-income communities. EPA is committed to the principles in this Executive Order. Furthermore, in an effort to make environmental justice an integral part of the way we do business, the Agency issued a policy directive, in September 1994 (OSWER 9200.3-17), that requires all future OSWER policy and guidance documents to consider environmental justice issues.

EPA is committed to equal protection in the implementation and enforcement of the nation's environmental laws. Moreover, providing environmental justice for all U.S. residents is a major priority for EPA.

In the area of public participation, the Agency has made changes that will empower communities and potentially increase their voice in the permitting process. In the "RCRA Expanded Public Participation" rule (60 FR 63417-34, December 11, 1995), EPA created more opportunity for public involvement in the permitting process and increased access to permitting information. The rule gives all communities a greater voice in decision making and a clear opportunity to participate in permit decisions early in the process.

New EPA rules will empower communities by giving them a greater voice in the permitting process.

EPA strongly encourages facilities and permitting agencies to make all reasonable efforts to ensure that all segments of the population have an equal opportunity to participate in the permitting process and have equal access to information in the process. These efforts may include, but are not limited to:

- **Providing interpreters, if needed, for public meetings.** Communicating with the community in its language is essential for the two-way information flow required to ensure the public an equitable voice in RCRA public participation activities.

- **Providing multilingual fact sheets and other information.** Making sure that the materials presented to the public are written clearly in

the community's primary language.

- **Tailoring your public participation program to the specific needs of the community.** Developing a program that specifically addresses the community's needs will demonstrate to community members your interest in achieving environmental equity and fostering a sense of cooperation.

- **Identifying internal channels of communication that the community relies upon for its information, especially those channels that reach the community in its own language.** Examples of these "channels" are a particular radio show or station, a local television station, a non-English newspaper, or even influential religious leaders. By identifying and making use of these valuable communication channels, you can be sure that the information you want to publicize reaches its target audience.

- **Encouraging the formation of a citizens advisory group to serve as the voice of the community.** Such groups can provide meaningful participation and empowerment for the affected community (see Chapter 5 for more detail).

(Additional steps you can take to promote environmental justice are available in Appendix D).

Although EPA has taken steps on a national level to address environmental justice issues, many of these issues can be addressed more effectively at a local level and on a site-specific basis. Local agencies and leaders have an important role to play in addressing environmental justice concerns.

The RCRA permitting process is intended to ensure that facilities are operated in a manner that is protective of human health and the environment. Environmental justice concerns are often broader in scope, going beyond the technical design and operation of the facility to include socio-economic, ethnic, and racial factors for the surrounding community. Within the context of public participation in RCRA permitting, the best way to address environmental justice concerns is through active communication. Keeping open lines of communication among permitting agencies, facility owners, and community members is a good way to promote awareness and understanding of the permitting process, the facility operations, and the community’s concerns. Providing frequent opportunities for community participation empowers the community to play an important role throughout the process.

Permitting agencies should be forthright in explaining the scope and limitations of permitting regulations to the community. Agencies should

also make sure that citizens understand their rights within the permitting process (e.g., submitting comments, requesting a public hearing, appealing permit decisions). Facility owners should strive to establish good relations with the community and routinely interact with community members and organizations, seeking input and feedback when making significant decisions. Communities should gather information about other rights, outside of the permitting process, such as those afforded under Title VI of the Civil Rights Act.

Supporting Community-Based Environmental Protection

In its May, 1995 Action Plan, EPA's Office of Solid Waste and Emergency Response (OSWER) endorses community-based environmental protection (CBEP). CBEP is a method of solving environmental problems in the context of the community in which they occur. OSWER's plan points to CBEP as a method that "brings the government closer to the people it is meant to serve." It also heralds CBEP as "a new way of accomplishing traditional tasks in a more effective, more responsive manner."

Stakeholder involvement is one of the keys to CBEP. OSWER's plan points to CBEP efforts as ones that "must empower and equip the community to participate in environmental decisions, taking into account not only the human but also the ecological and socioeconomic health of a place." Thus, the involvement and cooperation of the community, facility owners and operators, and agency personnel in the permitting process will fuel CBEP efforts. Moreover, increased access to information and opportunities for participation in the permitting process (like those in the RCRA Expanded Public Participation Rule) will empower communities and enable them to practice CBEP.

We encourage permitting agencies, facility owners and operators, public interest groups, and members of the community to carry out the spirit of this manual. As we emphasized in the section on “Promoting Environmental Justice” above, the best solutions to many environmental challenges are available at the local community level, and no problem can be solved without input from local stakeholders. Only by cooperating, communicating, and providing feedback and equal opportunities can community-based programs reach their potential for solving environmental problems.

> The best solutions to many environmental challenges are available at the community level.

Permitting agencies can take a lead role in promoting a CBEP approach by discussing RCRA issues in coordination with other environmental concerns in a given area. Program distinctions between water, air, waste, and toxics are less important to stakeholders outside of the agency. Agency staff should be prepared to address RCRA concerns in the context of air and water issues that may reach beyond a particular facility. Many companies are particularly interested in finding opportunities to reduce process wastes

through pollution prevention and recycling that affect air, water, and waste permit requirements. Several states are embarking on "whole facility" approaches to permitting to take advantage of this approach. Permitting agencies should consider using **fact sheets** and **availability sessions** to explain RCRA's relationship to other programs. Combining public meetings across program lines could also make the entire environmental picture more clear to stakeholders.

Re-evaluating and Adjusting the Public Participation Program

As RCRA activity increases at a facility and becomes more visible, public interest in a site can increase dramatically. Interest can also fade away without warning. Participants in the permitting process should anticipate and plan for sudden changes in the level of interest in a facility. Periodic communication with key community contacts can help to anticipate changes in the attitude or interest of other stakeholders. All participants should make sure to keep their key contacts informed of all planned activities -- especially activities that are highly visible and tend to raise a lot of interest, such as construction work or excavation related to cleanups.

In addition, at facilities that are receiving high levels of public interest, the agency or the facility may want to conduct follow-up community interviews at a key point (or points) in the decision-making process. These interviews will help predict major shifts in public interest or concern. The agency should also encourage members of the community to submit comments throughout the process and especially during formal comment periods. Agency staff should make clear to the public (e.g., through fact sheets) how the comment and response process works.

Permitting agencies, facility owners, and other involved organizations should evaluate the effectiveness of public participation programs regularly through the process. The permitting process is complex and the best way to measure the success of a public participation plan is not always clear. The following are indicators that a public participation program is working:

- stakeholders are not asking the same questions over and over again;
- stakeholders are not raising concerns about a lack of information;
- the appropriate contact person is handling inquiries in a timely manner;
- most of the public participation time is not devoted to correcting breakdowns in the information-sharing triangle (see above) between the community, the agency, and the facility;
- the channels of communication are well-defined and open;
- interested parties are providing informed comments on the project; and

- members of the public are bringing their concerns to stakeholders that are actively involved in the process, rather than taking them directly to the press or elected officials.
- Creative, more flexible, technical solutions, including pollution prevention solutions, are being explored.

The best way to evaluate the success of a public participation program is to ask other stakeholders what is and isn't working.

If the program is not achieving these objectives, then the agency, facility, and involved groups need to assess their techniques and determine what changes will improve the program. If members of the community are dissatisfied, then public participation activities may not be reaching the right target audiences. The community may not have adequate access to information or may not be understanding it because it is too complex. In some cases, the public may need more detailed information. The community may feel uncomfortable in relations with the facility or the agency, or the agency or the facility may be uncomfortable relating to the community. The facility may not understand its role in the process in relation to the agency's role. All of these difficulties can reduce the effectiveness of the public participation program. The best way to find out what is going wrong is to talk to the community and the other stakeholders. Ask them what is working and where improvements are needed. Modify public participation activities based on their suggestions and your own time and resource limitations.

Members of the community should have a chance to evaluate the public participation activities that the agency, the facility, and public interest or other groups are employing. EPA encourages participants to solicit feedback from the public, going beyond the regulatory requirements where necessary. **Surveys**, **interviews**, or **informal meetings** are all effective ways to gather feedback. In addition, the agency, facility, and involved groups should explain the permitting process to the community, update the community on significant activities, and provide information that community members can access and understand. If these standards are not being met, then the community should communicate its concerns to the appropriate contact person. Citizen input is the feedback that makes two-way communication work. All involved organizations should create a means for citizens to let them know if public participation activities are not working (e.g., use of a contact person, suggestion boxes, hotlines, surveys, etc.). Once these organizations know where the breakdown is occurring, they can adjust their programs to address community concerns.

Chapter Summary

Public participation, defined broadly, is any stakeholder activity carried out to increase public input or understanding of the RCRA permitting process.

The public participation triangle represents the communication between the public, regulators, and the facility.

Public participation is based on a dialogue.

Public participation is required, it can lead to better technical decisions, and it can engender public support for a project.

A successful public participation program allows members of the community to have an active voice in the process and to have free access to important information. Participants in a successful program will also pursue the following benchmarks:

- Creating a dialogue that provides for feedback;
- Establishing trust and credibility in the community through honesty and openness;
- Fostering an informed and active citizenry that follows the process, gives input to other stakeholders, and discusses issues with other concerned groups and people;
- Ensuring that public officials meet their obligations to the public;
- Involving the public early in the process, receiving feedback, and addressing public concerns before making decisions;
- Assessing the community to find out from citizens what types of activities would best allow them to participate;
- Planning your public participation activities ahead of time, allowing flexibility for changing interest levels in the community;
- Understanding and respecting the values and limitations of other stakeholders;
- Taking steps, such as issuing multilingual fact sheets or encouraging the formation of citizen advisory groups, to ensure that all segments of the interested community have an equal opportunity to receive information and participate in the process;
- Supporting efforts to respond to environmental challenges on a community level; and
- Periodically evaluating the effectiveness of your program in the community and adjusting as community attitudes and interest levels evolve.

Exhibit 2-1
Determining the Likely Level of Public Interest in a RCRA Facility

Level of Interest	Type of RCRA Action	Community Members' Relationships With Facility/Regulatory Agency	Larger Context
Low Level of Public Interest in a Facility	C The RCRA activity is unlikely to be controversial (e.g., a routine modification) C There is no contamination at the facility that could come into direct contact with the public	C People do not live near the facility C There is a history of good relations between the facility and members of the community C Members of the community have expressed confidence in the regulatory agency and/or the facility	C The facility receives very little media attention and is not a political issue C Community members have not shown any past interest in hazardous waste issues
Moderate Level of Public Interest in a Facility	C The RCRA action may involve activities, such as §3008(h) corrective action activities, that contribute to a public perception that the facility is not operating safely C Examples may include permits for storage and on-site activities and routine corrective actions. C Highly toxic and/or carcinogenic wastes may be involved (e.g., dioxins)	C A relatively large number of people live near the facility C There is a history of mediocre relations between the facility and members of the community C The facility is important to the community economically, and the action may affect facility operations C Members of the community have had little or poor contact with the regulatory agency C Local elected officials have expressed concern about the facility	C Community members have shown concern about hazardous waste issues in the past C The facility receives some media attention and there are organized environmental groups interested in the action C There are other RCRA facilities or CERCLA sites in the area that have raised interest or concern
High Level of Public Interest in a Facility	C The RCRA action includes a controversial technology or is high-profile for other reasons (e.g., media attention) C Highly toxic and/or highly carcinogenic wastes are involved (e.g., dioxins) C There is potential for release of hazardous substances or constituents that poses potential harm to the community and the environment C There is direct or potential community contact with contamination from the facility (e.g., contaminated drinking water wells or recreation lake)	C The nearest residential population is within a one-mile radius C A relatively large number of people live near the facility C There is a history of poor relations between the facility and the community C The facility has violated regulations and community members have little confidence in the regulatory agency to prevent future violations C There is organized community opposition to the facility's hazardous waste management practices or to the action C Outside groups, such as national environmental organizations, or state or federal elected officials have expressed concern about the facility or action C The economy of the area is tied to the facility's operations	C Community members have shown concern about hazardous waste issues in the past C Facility activities are an issue covered widely in the media C There is interest in the facility as a political issue, at the local, state, or federal level (e.g., statewide and/or national environmental groups are interested in the regulatory action) C There are other issues of importance to members of the community that could affect the RCRA action (e.g., concern over a cancer cluster near an area where a facility is applying for a permit to operate an incinerator) C There are other RCRA facilities or CERCLA sites nearby that have been controversial

Exhibit 2-2
Steps in Evaluating Facilities and Gathering Information

Step 1: Review the RCRA Action

Is it:

☐ Likely to be a controversial action (e.g., permitting a commercial waste management facility)
☐ Unlikely to be a controversial action

Step 2: Talk to colleagues who have worked in this community about their interactions with members of the public

C Has there been a large degree of public interest or concern about other projects?
C Have members of the public shown confidence in the regulatory agency?

Step 3: Review regulatory agency (or any other) files on the facility

Are there:

☐ A lot of inquiries from members of the public
Major concern(s) _____
Any organized groups? _____
☐ Few inquiries from members of the public
☐ Clippings from newspapers or other media coverage

Step 4: Formulate your preliminary impression of the community based on the above information

Step 5: Talk with several key community leaders to confirm your impression

People to interview:

1. _____
2. _____
3. _____

Step 6: Determine the anticipated level of community interest based on the above information

☐ Low (go to Step 7)
☐ Moderate (next step: conduct additional community interviews with one member of each community subgroup)
☐ High (next step: conduct a full set of community assessment interviews)

Step 7: Write a brief summary of any major community concerns/issues

Chapter 3
Public Participation During the RCRA Permitting Process

Introduction

The previous chapter examined the importance of public participation and the information-sharing triangle, while reviewing the critical components for building a successful public participation program. Chapter 3 describes the specific public participation activities that EPA requires or recommends during each phase of the RCRA permitting process, beginning before submission of the RCRA part B permit application, continuing through the preparation of draft and final permit decision, and throughout the life of the RCRA permit.

States may have their own public participation requirements in addition to the federal

Section 7004(b) of RCRA and EPA's permitting regulations, found in 40 CFR Parts 124 and 270, form the foundation for mandatory public participation activities during the permitting process for both operating and post-closure permits. The reader should note that the corrective action schedule of compliance and other corrective action provisions are typically part of the RCRA permit under 40 CFR Part 270 (unless carried out under an enforcement order). Changes to these sections of the permit must follow the permit modifications procedures of 40 CFR Part 270.41 or 270.42. We review the corrective action public participation procedures in Chapter 4.

RCRA permitting regulations require an array of public participation procedures during the permitting process and the life of the permit. However, situations often occur where the facility and the agency will need to go beyond the requirements in 40 CFR Parts 124 and 270. Following the assessment and planning guidance we provided in Chapter 2, participants in the permitting process will discover whether a certain permitting activity deserves greater public participation. Regulators, facility staff, or community groups may want to consider expanded public participation activities (described in this chapter and in Chapter 5) -- if resources allow -- at priority facilities, controversial facilities, or at facilities where the affected community has a particular need for greater involvement or access to information . Participants in the process should seek input from other stakeholders to determine if the public participation activities are adequate. The permitting agency may suggest that the facility or public interest

groups conduct additional activities to supplement required activities and strengthen communication and trust among stakeholders. In addition, EPA encourages the community to suggest additional public participation activities to the permitting agency, the facility, or community and public interest groups.

In December 1995, EPA expanded the public participation requirements in the RCRA program by promulgating new regulations. The new regulations, known as the "RCRA Expanded Public Participation" rule (60 FR 63417, December 11, 1995), require earlier public involvement in the permitting process, expand public notice for significant events, and enhance the exchange of permitting information. The new requirements, which we describe more fully in this chapter, include: (1) a public meeting held by the facility prior to submitting the part B RCRA permit application; (2) expanded notice requirements, including use of a posted sign, a broadcast notice, and a newspaper display advertisement to publicize the meeting; (3) notification of the public when the agency receives a permit application and makes it available for public review; (4) permitting agency discretion to establish an information repository, which will be supplied and maintained by the applicant or permit holder; and, (5) additional notices during the trial burn period for combustion facilities.

In addition to the new regulatory requirements, EPA is taking steps to ensure equitable public participation in the RCRA permitting process. On December 20, 1995 EPA Office of Solid Waste and Emergency Response (OSWER) Assistant Administrator Elliot Laws issued a memorandum to the EPA Regional Administrators stating the Agency's policy to ensure equal access to permitting information and provide an equal opportunity for all citizens to be involved in the RCRA permitting process (see Appendix N). In this manual, we are strongly encouraging facilities to meet the same standard of equitable public participation. EPA is committed to equal protection of our citizens under the nation's environmental laws and urges all participants in the RCRA permitting process to strive for environmental justice, equal opportunity to participate in permitting, and equal access to information.

Public participation activities should fit the diversity, character, and culture of the affected community.

To meet this standard, EPA (when it is the permitting agency) will issue multilingual notices and fact sheets and use translators, where necessary, in areas where the affected community contains significant numbers of people who do not speak English as a first language. In addition, the Agency recommends that facilities make efforts to tailor public participation activities to fit the diversity, character, and culture of the affected community. When communicating with a community, participants in the permitting process should take into account the particular pathways and methods of information transfer that are used by that community. These principles are applicable to all public participation activities, and EPA

encourages their adoption by all participants in the RCRA permitting process. See the section entitled "Promoting Environmental Justice" in Chapter 2 for more information.

Public Participation During the Permit Decision Process

The permit decision process is composed of a number of steps. Each step is accompanied by public participation requirements. As we have mentioned, the regulatory minimum for public participation may not be sufficient in all cases. Permitting agencies and facilities should consider going beyond the regulatory requirements, where necessary, to provide for meaningful and equitable public participation.

For the sake of simplicity, in this manual we will divide the permit decision process into four steps:

- the pre-application stage;
- application submittal, agency notice and review;
- preparation of the draft permit, public comment period, and the public hearing; and
- response to public comments and the final permit decision.

Stakeholders should keep in mind that the permit decision process is lengthy and can be complex and confusing. Keeping the lines of communication open during the process takes effort on the part of all participants. This effort is especially critical during the long periods of time while the agency is reviewing the permit or the facility may be responding to a Notice of Deficiency (which we describe later in this Chapter). The agency, the applicant, and other interested groups should take steps to keep the community involved and informed during these "down" times.

We also encourage stakeholders to learn about the process, ask questions, and discuss it with the other participants. Permitting agencies in particular, should make efforts to disseminate fact sheets and information packages about the permitting process. Agencies, public interest groups, or facilities may want to perform other public information tasks (see chapter 5 for descriptions) to ensure that all stakeholders understand, and are comfortable with, the permitting process.

Step One: The Pre-Application Stage

Required Activities

The RCRA Expanded Public Participation rule requires a new permit applicant (or a facility that is applying to renew a permit while making significant changes) to hold a public meeting prior to submitting the part B RCRA permit application. This meeting is the earliest formal step in the

RCRA permitting process.

Early public input can improve the quality of any permitting activity; the public can contribute information and recommendations that will be helpful to agencies as they make permitting decisions and to facilities as they develop their applications and proposals.

The Pre-Application Meeting

The most important goal EPA hopes to achieve from the pre-application meeting requirement is the opening of a dialogue between the permit applicant and the community. We believe that the applicant should open this dialogue at the beginning of the process. The meeting will give the public direct input to facility personnel; at the same time, facility personnel can gain an understanding of public expectations and attempt to address public concerns before submitting a permit application. We hope that this requirement will help address the public concern that public participation occurs too late in the RCRA permitting process.

Conducting the Meeting

> The pre-application meeting will allow the facility to hear and respond to public concerns.

The pre-application meeting should provide an open, flexible, and informal occasion for the applicant and the public to discuss the various aspects of a hazardous waste management facility's operations. Discussion at the pre-application meeting need not concern the technical aspects of the permit application in extensive detail; such technical examination is more suited to the draft permit stage (which we describe later in this Chapter). We anticipate that the applicant and the public will use this meeting to share information, learn about each other's concerns, and start building the framework for a solid working relationship. The pre-application stage is also an excellent time to explore the facility's level of expertise in waste minimization and pollution prevention, and the potential for involving the facility's waste minimization experts in the public participation process.

While a formal meeting style (i.e., like a public hearing) may suit some permitting situations, EPA realizes that it will not fit in all cases. With this idea in mind, EPA has written the regulations to allow flexibility in the type of "meeting" held by the permit applicant. For instance, an applicant may decide to hold an availability session or open house (see Chapter 5) in place of a traditional meeting. As long as this approach meets the requirements and the spirit of § 124.31 (as presented in this section), EPA will not preclude applicants from tailoring meeting styles to fit particular situations.

Regardless of the type of meeting that the applicant decides to hold, the applicant (as well as the other participants in the process) should strive for equitable participation and access to information during the pre-application meeting and the notice of the meeting (see "Promoting Environmental

Justice" in Chapter 2 and the Introduction to this Chapter).

At the meeting, permit applicants should address, at the level of detail that is practical (based on available information), the following topics: what type of facility the company will operate; the location of the facility; the general processes involved and the types of wastes to be generated and managed at the facility; and the extent to which waste minimization and pollution prevention may supplement or replace waste treatment needs. The discussions should also include the transportation routes to be used by waste transporters and planned procedures and equipment for preventing or responding to accidents or releases.

Addressing community concerns at the start of a project can prevent misunderstanding and opposition in the long run.

These are examples of the types of issues that might be of particular concern to a community and about which the community might be able to provide useful suggestions to the applicant. The applicant might then be able to incorporate that information into the proposed facility design or operations, either as part of the initial application, if time allows, or at subsequent stages in the process (e.g., in submitting revisions to its application, or in responding to a Notice of Deficiency issued by the permitting agency). By learning about and addressing public concerns up front, the applicant may be able to prevent misunderstanding from escalating into community opposition. Moreover, the public will have a clear and open opportunity to interact and communicate with the potential applicant.

The applicant should make a good faith effort to provide the public with sufficient information about the proposed facility operations. While we do not expect applicants to go into extensive detail at the pre-application stage, they should provide the public with enough information to understand the facility operations and the potential impacts on human health and the environment. We encourage applicants to provide **fact sheets**, information packets, or other materials (see Chapter 5) that explain the proposed operations, company policies, waste minimization proposals, or other information that is relevant to the proposed facility.

The permitting agency may choose to make permitting and pollution prevention fact sheets available at the meeting. One such fact sheet is included as Appendix J of this manual. EPA recommends that permit applicants distribute this fact sheet (or a similar one produced by the state agency) at the pre-application meeting, especially in cases where a representative of the permitting agency does not attend. EPA does not expect permit applicants to answer questions about the RCRA permitting process at the pre-application meeting -- particularly where the applicant is not sure of the answer. We advise the applicant to let a representative of the permitting agency answer such questions. If an agency representative is not available at the meeting, then the applicant should provide the name of

an agency contact person and the number of the RCRA Hotline (available in Appendix A) or an applicable State information line.

Some applicants may want to consider inviting or hiring a moderator to conduct the pre-application meeting. The moderator should be a neutral third party (e.g., a civic organization, non-profit community group, or a consultant) that is not a stakeholder in the permitting decision process. A moderator can lend objectivity to the proceedings and help to keep the discussions fair, under control, and on track. Regardless of whether a third party conducts the meeting, facility representatives should be present to answer questions and interact with the community.

EPA regulations are flexible with regard to conducting the pre-application meeting. One of the few requirements is for the applicant to post a sign-in sheet, or a similar mechanism, to allow participants to volunteer their names and addresses for inclusion on the facility mailing list (see § 124.31(b)) . The applicant should understand that attendees may not want to put their names on a mailing list; the sign-in sheet always should be voluntary. The applicant should make clear at the meeting that people can contact the permitting agency directly to add their names to the facility mailing list at any time.

The applicant must submit the list of attendees, along with a "summary" of the pre-application meeting, as a component of the part B permit application. We do not intend for the meeting summary to be a verbatim account of the meeting. EPA recognizes how difficult it is to keep a word-for-word record of a public meeting. Applicants should make a good faith effort to provide an accurate summary of the meeting. While the regulations do not indicate a particular format for the meeting summary, we recommend a type-written document that identifies major issues, points made in support of those issues, and any response made by the applicant or other attendees.

As mentioned above, the applicant must submit the summary as a component of the part B application. This component should be a typewritten hard-copy. Since the part B application is available for review by the public, attaching the summary as part of the application assures that people who are unable to attend the meeting will have an opportunity to find out what happened. We encourage applicants to make the summary available in other formats where a community has special needs (e.g., on audio tape for visually impaired residents).

The facility must conduct the pre-application meeting.

The RCRA Expanded Public Participation rule requires the facility to conduct the pre-application meeting. We believe that the applicant should conduct the meeting in an effort to establish a dialogue with the community. EPA encourages permitting agencies to attend pre-application

meetings, in appropriate circumstances, but *the facility must conduct the pre-application meeting* . Agency attendance may, at times, be useful in gaining a better understanding of public perceptions and issues for a particular facility, and for clarifying issues related to the permitting process. However, agency staff should ensure that their attendance does not detract from the main purposes of the meeting, such as opening a dialogue between the facility and the community, and clarifying for the public the role of the applicant in the permitting process.

The regulations do not preclude State agencies and permit applicants from working together to combine State siting meetings with pre-application meetings. EPA encourages them to do so, provided that the combined meetings fulfill the requirements in § 124.31. If meetings are combined, the portion of the meeting that is dedicated to the RCRA facility permit must be run by the applicant; the regulatory agency must give the applicant the floor for a sufficient time period. In notifying the public of the meeting, under § 124.31(d), the applicant must make clear that the RCRA portion of the meeting is separate from the general siting discussion.

The pre-application meeting will provide the community with a clear entry point for participation at an early stage in the permitting process. We encourage members of the community to become involved at the pre-application stage. Public comments and suggestions are easier for the facility to address at this early stage than later on in the process. For this reason, public input can have a greater impact at this stage. Interested citizens should attend the meeting and participate in the informal dialogue.

The public can learn more about the facility and the company seeking a permit before attending the meeting by contacting the facility, or by contacting other stakeholders in the community. Some community members may want to research to learn more about the planned (or already existing) facility. If you are interested in obtaining more information on the facility or the permitting process, you may want to contact the permitting agency or the corporation that owns the facility. Additional information about past and present owners, past waste spills and releases, complaints, and the status of other state, local, and federal permits may be available from the following: the planning board, City Hall or the town council, the county health department, local newspapers, the library, and local fire and rescue departments. These sources will give you access to information such as deeds and environmental testing results.

Meeting attendees can become part of the facility mailing list by adding their names and addresses to the sign-up sheet at the meeting or by sending their names directly to the permitting agency. People on this list will receive any significant information sent out by the agency or the facility regarding the facility.

Citizens should note that not all aspects of the permit application will be clear at the pre-application stage, in part, because EPA is encouraging facilities to meet with the public before making all final decisions on their permit applications. This way, the facility owner/operator will be more flexible and can react more effectively to suggestions and concerns raised in the meeting. Participants at the meeting should note that the facility owner/operator will not know the answer to all questions about the permitting process. The permitting agency and the RCRA/Superfund Hotline will be available to answer questions about the permitting process and other RCRA requirements (remember that States may have different procedures than EPA)..

Date, Time, and Location of the Meeting

The timing of the meeting is flexible. EPA believes that flexibility is necessary because the optimal timing for the meeting will vary depending on a number of factors, including the nature of the facility and the public's familiarity with the proposed project and its owner/operator. The applicant should choose a time for the meeting while considering the following factors: (1) the community must receive adequate notice before the facility submits a permit application; (2) the facility's plans for construction or operation need to be flexible enough to react to significant public concerns and to make changes to the application, if necessary; (3) the meeting should not take place so long before submittal of the application that the community will forget the facility. We encourage applicants to make a good faith effort to choose the best date for the pre-application meeting.

While the final rule requires the facility to hold *only one pre-application meeting*, cases may arise where more than one meeting is preferable. For instance, if a facility holds one public meeting and takes several months to a year to submit the application, then the facility owner/operator should consider holding a second meeting. In other cases, the facility may want to hold a few meetings of different types (e.g., a **public meeting** as well as an **availability session**). Of course, permitting agencies or other stakeholder groups may decide to hold additional public meetings where appropriate.

The applicant should avoid scheduling the meeting at a time that conflicts with other important community activities.

The permit applicant should encourage full and equitable public participation by holding the pre-application meeting at a time and place that is convenient to the public. The applicant should schedule the meeting at a time when the community is most likely to be available. Many communities, for instance, may prefer a meeting held after normal business hours. Meeting schedulers should avoid holding the meeting at a time that will conflict with important community activities (e.g., social, religious, or political events, other meetings, school activities, or local occasions). The applicant should also make sure that the meeting place has adequate space and is conducive to the type of meeting that the applicant will conduct.

Finally, the meeting location should have suitable access for all persons; if such a location cannot be procured, then the applicant should make all reasonable efforts to provide for equitable participation in the meeting (e.g., by responding to written comments).

Some members of the affected community may not feel comfortable with meetings held on facility property. Applicants should address community concerns in this area. EPA encourages applicants to hold the pre-application meeting on neutral public ground, such as a local library, a community center, a fire station, town hall, or school.

Notice of the Pre-Application Meeting

EPA developed the pre-application meeting notice requirements with the goal of encouraging facilities to reach as many members of the public as possible, within reasonable means. The expanded notice requirements are intended to reach a broad audience and to encourage as many people as possible to attend the meeting. Attendance at the meeting may also provide an indication of the level of public interest in the facility, although low attendance does not necessarily equal low interest. Using the list of attendees from the meeting will allow agencies to develop larger mailing lists; these lists, in turn, will help the facility and the agency to update more people more often about the permitting process.

The new rule requires the applicant to provide notice of the pre-application meeting to the public in three ways:

- *A newspaper display advertisement.* The applicant must print a display advertisement in a newspaper of general circulation in the community. The display ad should be located at a spot in the paper calculated to give effective notice to the general public (see the example in Appendix H). The ad should be large enough to be seen easily by the reader. In addition to the display ad, we also encourage facilities to place advertisements in free newspapers, community bulletins, newsletters, and other low-cost or free publications. In some cases, potential interest in the facility may extend beyond the host community. Under these circumstances, we encourage the applicant either to publish the display ad so that it reaches neighboring communities or to place additional ads in the newspapers of those communities.

- *A visible and accessible sign.* The applicant must provide notice on a clearly-marked sign at or near the facility (or the proposed facility site). If the applicant places the sign on the facility property, then the sign must be large enough to be readable from the nearest point where the public would pass -- on foot or by vehicle -- by the site. EPA anticipates that the signs will be similar in size to zoning notice signs required by local zoning boards (of course, this size will vary according to the prerogative of the

zoning board). If a sign on the facility grounds is not practical or useful -- for instance, if the facility is in a remote area -- then the applicant should choose a suitable alternative, such as placing the sign at a nearby point of significant vehicular or pedestrian traffic (e.g., the closest major intersection). In the case that local zoning restrictions prohibit the use of such a sign in the immediate vicinity of the facility, the facility should pursue other available options, such as placing notices on a community bulletin board or a sign at the town hall or community center. EPA intends the requirement that the sign be posted "at or near" the facility to be interpreted flexibly, in view of local circumstances and our intent to inform the public about the meeting. In addition to the requirements of § 124.31, we encourage the applicant to place additional signs or flyers in nearby commercial, residential, or downtown areas. Supermarkets, hardware or department stores, malls, libraries, or local gathering places may have bulletin boards for posting notices and flyers. EPA encourages facilities to keep track of posted signs and remove them after the meeting.

- *A broadcast media announcement* . The applicant must broadcast the notice at least once on at least one local radio or television station. EPA expects that the applicant will broadcast the notice at a time and on a station that will effectively disseminate the notice. The applicant may employ another medium, aside from television or radio, with prior approval of the permitting agency. Many communities run their own cable channels for local news and activities; this medium may be used to target a local audience, often at no charge. Television spots may be advantageous for delivering pertinent information about a hazardous waste management facility directly to the people at home.

Choose notice methods that will spread the word over all segments of the affected community.

Sample notices are provided in Appendix H and more may be available by contacting the permitting agency.

EPA encourages facilities to pick a mixture of public notice tools that meets the regulations and will allow the affected community to receive equitable, timely, and effective notice of the pre-application meeting. Such a mixture may include a number of different and specialized notices that target specific groups within each community. One example of such a targeted notice would be the use of a translated advertisement on Chinese-speaking local access television station to reach a Chinese-American enclave in an area where the community members are affected by the permitting activity. Specific segments of the affected community can be targeted by strategic placement of the newspaper display ad, the timing and station of a radio spot, the geographic location of signs, use of free newspapers, and multi-lingual notices. EPA does not require that the applicant try to reach the largest audience with each method of public notice (e.g., the radio spot need not be placed on the most popular station). Instead, the applicant should use a combination of methods (including

translations) to spread the word over all segments of the affected community, taking into account the channels of information that are most useful in reaching diverse groups.

EPA encourages applicants to go beyond the minimum requirements in the regulations when providing notice of the pre-application meeting. The following suggestions will help in providing an effective broadcast notice. In some rural areas, community members may listen to or watch predominantly one radio or television station; in this case, the applicant should use this station as the vehicle for the notice. Some areas are part of a radio market (i.e., defined by services such as Arbitron's Radio Market Definitions) or television market and have competing radio and television stations. Where there is more than one station, the facility owner or operator should consider carefully the likely audience of the station in order to ensure that a substantial number of people will see or hear the ad. Areas with many competing stations are more likely to have audiences that may be delineated, for instance, by age, ethnicity, or income. In these situations, broadcasting the notice on several stations, or in more than one language, may be beneficial. In all cases, EPA suggests that the announcement occur at listening or viewing hours with a substantial audience -- hours that will vary for each community as well as for specific groups. The facility may consult with broadcast stations and community members to determine the best times to broadcast the notice.

The regulations also require the applicant to send a copy of the notice to the permitting agency. Applicants must follow this provision, but we encourage facilities to contact the appropriate agencies before this stage. *Applicants should consider informing the agency of their intent to seek a permit before planning the pre-application meeting.* Like other stakeholders in the permitting process, the permitting agency can benefit from receiving information as early as possible in the process. In addition, the permitting agency may be able to provide guidance about how to run the pre-application meeting or what types of public notice work best in a particular community.

EPA also encourages the applicant to send a copy of the notice to all members of the facility mailing list, if one exists. This suggestion applies especially to facility owners who are applying for a permit renewal and must comply with § 124.31 because they are seeking to make a change on the level of a class 3 permit modification. At these facilities, the mailing list will already exist and people on the list will be interested in learning about the most recent activity at the facility. A mailing list will most likely not exist for new applicants.

Getting the word out at this early stage is essential to assuring adequate community participation during the entire permitting process. For this

Free papers, existing newsletters, press releases, and word-of-mouth are inexpensive ways to notify the public.

reason, we encourage the applicant to take additional steps, within reasonable means, to announce the meeting. We do not intend for applicants to spend large amounts of additional time and resources; on the contrary, there are many simple and inexpensive mechanisms for distributing information. Free announcements on television or radio, advertisements in free papers, town newsletters, flyers, small signs, and press releases are all ways to disseminate information at little or no cost. We also encourage facilities to pass information through local community groups and Local Emergency Planning Committees (established under section 301 of the Superfund Amendments and Re-Authorization Act (SARA)), professional and trade associations, planning commissions, civic leaders, school organizations, religious organizations, and special interest groups. Other stakeholders involved in the process are also good conduits for spreading news about the pre-application meeting.

The regulations require that the notice contain several pieces of information: (1) the date, time, and location of the meeting; (2) a brief description of the purpose of the meeting; (3) a brief description of the facility and proposed operations, including the address or a map (i.e., a sketched or copied street map) of the facility location; (4) a statement encouraging people to contact the facility at least 72 hours before the meeting if they need special access to participate in the meeting; and (5) the name, address, and telephone number of a contact person for the applicant.

The format of the notice is flexible as long as it communicates this information. The description of the purpose of the meeting should explain the facility's intent to submit a permit application and set out other objectives for the meeting. When describing the facility, the owner/operator should briefly cover what sort of facility it is or will be (e.g., a hazardous waste incinerator), what types of wastes it may handle, and what sort of operations will take place at the facility (e.g., types of manufacturing, commercial treatment of waste, etc.). For the facility map, the owner/operator should provide a photocopy of a street map or a sketched map, the purpose of which is to let the public know just where the facility is or will be. Finally, persons needing "special access" would include anyone who may have difficulty with stairs or some entrances, persons who are visually or hearing impaired, or any person who foresees some difficulty in attending the meeting without some help. EPA does not expect facilities to provide transportation to persons who cannot find other means of reaching the meeting.

The telephone contact provided by the applicant in the pre-application notice is an important addition to the public participation resources during this phase. EPA encourages members of the community to contact the facility, the permitting agency (see Appendices A and B for State and Federal contacts) or other interested groups in the community, as necessary,

to become acquainted with the permitting process and the facility plans.

EPA is not requiring the facility to submit proof of the public notice; however, we are requiring the facility to keep proof of the notice. The Agency is concerned that proof of the notices may be needed in the case of a lawsuit. The applicant should establish a simple file containing proofs for the notice. Acceptable forms of proof would include a receipt for the radio or TV broadcast, a photograph of the sign, and a photocopy of the newspaper advertisement or tear sheets.

The Facility Mailing List

The permitting agency is responsible for developing a representative mailing list for public notices under § 124.10. EPA is emphasizing the early development of a thorough mailing list as a critical step in the public participation process. If the mailing list allows the agency to keep important groups and individuals in the community up-to-date on activities at a facility, then the permitting agency and the facility will be better able to gauge community sentiment throughout the permitting process. See the section on "Mailing Lists" in Chapter 5 for additional information.

EPA anticipates that the meeting attendee list required under § 124.31(c) will help the agency generate the mailing list by identifying people or organizations who demonstrate an interest in the facility and the permit process.

> The permitting agency should develop the mailing list early.

In the past, mailing lists have not been fully developed, oftentimes, until the agency issued the draft permit or intent to deny the permit. EPA believes that the mailing list is an integral public participation tool which permitting agencies should create as early as possible in the process. Our intent in having the permit applicant submit the list of meeting attendees under § 124.31(c) was to allow the agency to formulate the mailing list at an earlier stage in the permitting process. Aside from the names identified by the permit applicant, we encourage permitting agencies to enhance the mailing list by contacting a wide variety of groups and individuals, such as: civic organizations, religious groups, public interest organizations, recreational groups, professional/trade associations, Local Emergency Planning Committees (LEPCs), emergency response and local health care personnel, environmental justice networks, educational and academic organizations, city hall and elected officials, planning and zoning boards, local development councils, involved State and Federal agencies, newspapers and reporters, immediate neighbors and property holders, other nearby companies or business groups, facility employees, and plant tour attendees. In addition, we encourage the agency to maintain and update the lists regularly. All commenters on permitting documents, attendees at any public meetings or persons using information repositories should be placed on the mailing list, or have the option of putting their names on the list.

Members of the community and other interested groups or individuals can contact the permitting agency to have their names put on the facility mailing list. Community and public interest organizations may want to provide the permitting agency with names for the mailing list. Refer to Appendices A and B if you would like to find the addresses and phone numbers of EPA's Regional offices and the state environmental agencies.

Additional Activities

Public participation activities should be geared to the potential level of community interest.

The level of public participation activities should correspond to the potential level of community interest in the permitting process. To determine the need for additional activities, participants should consider conducting a **community assessment** (see Chapters 2 and 5). If the level of interest is high, participants will want to do a more thorough needs assessment and prepare a formal **public participation plan** (see Chapters 2 and 5).

EPA encourages applicants to provide **fact sheets**, information packets, or other materials (see Chapter 5) at the pre-application meeting. The permitting agency may also choose to make permitting fact sheets available at the meeting. One such fact sheet is included as Appendix J of this manual. EPA recommends that permit applicants distribute this fact sheet at the pre-application meeting, especially in cases where a representative of the permitting agency does not attend.

To provide widespread notice of the pre-application meeting, the applicant may want to use notice methods that go beyond the requirements. Some of these methods, such as **public service announcements**, **existing newsletters and publications**, and **newspaper inserts** are described in Chapter 5.

In some cases, the agency, facility, or a community group may find it appropriate to hold an additional meeting during the pre-application stage. **Availability sessions** or **open houses** can provide the public with an opportunity to discuss issues face-to-face with officials or other interested people.

The "RCRA Expanded Public Participation" rule gives the permitting agency the authority to require the facility owner or operator to establish an **information repository** at any point in the permitting process or during the life of a facility. The agency should assess the need for the repository by considering a variety of factors, including: the level of public interest; the type of facility; the presence of an existing repository; and the proximity to the nearest copy of the administrative record. The information repository

An information repository makes information accessible to the public in a convenient location.

can improve the permitting process by making important information accessible to the public in a convenient location. (See Chapter 5 for more detail on information repositories). Of course, EPA encourages facilities or interested community groups to establish their own repositories for public access to information. Chapter 5 provides more guidance on how to establish a repository.

Some permitting information is quite technical and detailed. Members of the public and other stakeholders may find this information difficult to interpret. EPA encourages permitting agencies, facilities, and community groups to provide fact sheets and additional materials to make technical and complicated information more accessible to people who are not RCRA experts. **Workshops** or **availability sessions** may be useful for explaining technical information. Some citizens or community groups may want to consult other sources for help in interpreting scientific and technical data. If you are looking for such help, you may want to contact the permitting agency, facility staff, or other sources such as local colleges, universities, public interest groups, environmental and civic organizations. Additional contacts may be available in the local community. Interested citizens may be able to find out about these contacts by talking to local newspapers and other media who cover environmental issues. People who are interviewed for or quoted in news articles can be an additional source for information.

Getting as much input as possible from the community during these initial phases of the RCRA permitting process and before a draft permit is issued will be very useful during the draft permit stage. The draft permit will be more responsive to the needs and concerns of the community, and the community will be more likely to accept the permit conditions if it sees that its concerns have been heard.

Though the early meeting may reduce public concern that the agency and the facility are making important decisions before the public becomes involved, some concern may still remain. The agency and the facility are likely to have meetings that cannot, for practical purposes, be open to public participation. One State agency found that by making notes from these meetings available through an **information repository**, public trust in the agency increased.

Step Two: Application Submittal and Review

Required Activities

After the permit applicant has met with the public and considered recommendations and input from the community, he or she may choose to pursue a RCRA permit and then submit a RCRA part B permit application

to the permitting agency. Upon receiving the permit application, the permitting agency must, under § 124.32, issue a **public notice** to the facility mailing list and appropriate units of state and local government. The notice will inform recipients that the facility has submitted a permit application for agency review. In addition, the notice will inform the recipients of the location where the application is available for public review.

New EPA rules make permit applications available to the public during agency review.

Both of the provisions mentioned in the previous paragraph are the result of the RCRA Expanded Public Participation rule. EPA composed these regulations as a way to inform the public about the status of a facility's permit application early in the process .

Before issuing the notice at application submittal, the permitting agency should solicit community suggestions and input on the best place to put the application for public review (agency personnel may have gathered this information during an earlier stage in the process). We encourage the agency to issue the notice as soon as is practically possible after receiving the application. The notice must contain the following information: (1) the name and telephone number of the applicant's **contact person** ; (2) the name and telephone number of the permitting agency's contact office, and a mailing address to which information, opinions, and inquiries may be directed throughout the permit review process; (3) an address to which people can write in order to be put on the facility mailing list; (4) the location where copies of the permit application and any supporting documents can be viewed and copied; (5) a brief description of the facility and proposed operations, including the address or a map (i.e., a sketched or copied street map) of the facility location on the front page of the notice; and (6) the date that the application was submitted.

Permitting agencies must place the application and any supporting materials somewhere in the vicinity of the facility or at the permitting agency’s offices. The permitting agency should be sensitive to the burden on members of the affected community when determining where to place the application. Many communities do not have the resources or the time to travel several hours just to access permitting information. To make information available in these situations, the permitting agency should place the application in a place with public access in the general vicinity of the facility (e.g., a public library or community center). If such placement of the document is impractical, the agency should make sure that the public has other access to permitting information. For instance, the agency could require the facility to establish an information repository under § 124.31. If the community’s information needs are on a lower level, the agency may want to make a short summary of the permit application available to the affected community. In some cases, making information available in electronic form (e.g., via diskette or Internet) may be useful.

The application should be available for review in the vicinity of the facility.

We recommend that, where feasible, the agency place the application in a location where copying facilities are available and the public has adequate access to the documents. EPA also recommends that the application be in a locale where the documents will be secure and readily available. The application should go in the information repository, if one exists. If not, a public library or other building in the vicinity of the facility may provide a suitable choice. The permitting agency's headquarters or satellite office may be adequate if not too far from the facility.

Additional Activities

The permit application review process is often lengthy. It may take anywhere from one to five years to issue a permit, depending on the facility type and level of facility owner or operator cooperation. Permit applicants and regulators should recognize that members of the public have pointed out that they often feel "in the dark" during this phase. We encourage agencies and facilities to maintain a good flow of information during application review. If resources are available, permitting agencies and facilities should plan activities during this time period to keep citizens informed about the status of the process. Holding **workshops**, conducting **informal meetings**, and providing periodic **fact sheets** and **press releases** about the facility, opportunities for pollution prevention, and the RCRA permit process can spread information and keep the community involved. Identifying a **contact person** to accept comments and answer questions will also enhance communication. A (toll-free) **telephone hotline** with recorded status reports can reduce the potential for rumors.

EPA encourages permitting agencies to respond (e.g., in writing, by phone, by holding a meeting) to comments and requests from the public during the application review process. Agencies should make good faith efforts to address public concerns and issues.

In situations where a community wants more information about potential operations at a facility and the health and environmental risks of those operations, citizens or the agency can work with the facility to set up **facility tours** and **observation decks** during the public comment period. These activities will give the community a first-hand look at a facility and the operations and activities happening on-site. (Note that safety and liability issues need to be considered before a decision is made to include these activities.) These activities may be particularly useful for a new facility or when a facility proposes a new or different technology. Facility tours also may be particularly effective for explaining pollution prevention accomplishments and opportunities. Similarly, facility owners or operators may wish to coordinate with community leaders to tour the community. This may be useful for understanding potential community concerns.

Step Three: The Draft Permit, Public Comment Period, and Public Hearing

Required Activities

After the permitting agency reviews the permit application, it must notify the applicant in writing. If the application is incomplete, the permitting agency may request that the applicant submit the missing information. This request is known as a Notice of Deficiency (NOD). The permitting agency may issue several NODs before the application is finally complete.

Once an application is complete, the permitting agency will make a decision to issue a draft permit or a notice of intent to deny the permit application (which is a type of draft permit). In either case, the agency must notify the public about the draft permit. In the notice, the permitting agency must announce the opening of a minimum 45-day public comment period on the draft permit. The agency must print the notice in a local paper, broadcast the notice over a local radio station, and send a copy of the notice to the mailing list, relevant agencies, and applicable state and local governments. We encourage agencies to attempt to reach all segments of the affected community, within reasonable means, when issuing the notice of the draft permit (see "Step One: The Pre-Application Stage" above and Chapter 5 for more information on how to notify the public). Although the agency is not required to retain documentation of the notice, we recommend keeping a simple file with proof of the notices. Forms of proof might include a receipt for the radio ad and a photocopy of the newspaper add.

EPA regulations require the permitting agency to prepare a **fact sheet** or a **statement of basis** to accompany every draft permit. This fact sheet (or statement of basis) is required by regulation and is different than commonly used informational fact sheets. This fact sheet must explain the principal facts and the significant factual, legal, methodological and policy questions considered in preparing the draft permit. The fact sheet must also include, when applicable, the following (see § 124.8(b)):

- a brief description of the type of facility or activity which is the subject of the draft permit;
- the type and quantity of wastes that are proposed to be handled at the facility;
- a brief summary of the basis for the draft permit conditions;
- reasons why any requested variances or alternatives to required standards do or do not appear justified;
- a description of the procedures for reaching a final decision on the draft permit, including (1) the beginning and ending dates of the comment period and an address to which comments can be sent, (2) procedures for requesting a hearing and the nature of

the hearing, and (3) any other public participation procedures before the final permit decision; and

- the name and telephone number of a person to contact for additional information.

EPA recommends that the permitting agency include the fact sheet with the notice of the draft permit and make the fact sheet available to all interested parties.

Any person may request a **public hearing** during the public comment period. The agency must hold a public hearing if someone submits a written notice of opposition to a draft permit and a request for a hearing, or if the public demonstrates, by the number of requests for a public hearing, a significant degree of public interest in the draft permit. The Director also may hold public hearings at his or her discretion. The agency must notify the public about the hearing at least 30 days prior to the hearing. The agency may choose to combine the hearing notice with the draft permit notice. See Chapter 5 for information on holding a public hearing. Citizens may want to request a public hearing as a forum for airing community concerns. The hearing will be a standard meeting, attended by the agency and other interested parties.

There is more required public participation during the draft permit stage than at any other time during the permitting process. We strongly recommend that permitting agencies prepare public participation plans (see Chapter 5), even for the least controversial facilities, just to keep track of the activities during this stage.

By law, the agency must consider and respond to all significant comments received during the comment period.

The comment period on the draft permit allows anyone to submit their concerns and suggestions to the agency in writing. The permitting agency must, by law, consider all comments (see § 124.11) in making the final permit decision. In addition, the agency must briefly describe and respond to all significant comments raised during the comment period or during the public hearing. EPA encourages participants to submit comments during this period.

Additional Activities

You can use public participation activities to explain technical issues or the permitting process.

Permitting agencies can keep the process open by sharing all NOD information with the public, whether through the administrative record, an **information repository**, or another activity, such as a **workshop**. If the details of the NOD are too arcane or technical, the agency can provide a short **fact sheet**. The fact sheet should not gloss over any major omissions,

but, by the same token, it should point out when an omission is of a less serious nature.

Interested community groups or the permit applicant may decide to provide additional public participation activities during this stage. Some suggestions for useful activities would include explaining the NOD process and discussing technical issues in the application by holding **availability sessions**. Another option is for citizens or other stakeholders to request one-on-one or small **informal meetings** with the permitting agency, the permit applicant, or community groups. Stakeholder groups can improve their communication and interaction by meeting together in an informal forum. An informal meeting may also be more appealing to some participants, who may see activities like public hearings as overly confrontational.

The permitting agency may want to provide a **news release** when issuing the draft permit or intent to deny.

The agency, facility, or a public interest group may want to organize an **availability session**, **facility tours**, or some other activity prior to the comment period so that the public can be better informed about the facility. Some permitting agencies have held **public meetings** prior to a public hearing to provide a better forum to discuss issues. **Telephone hotlines** or voicemail recordings can supplement public notices to inform the community about the dates and locations of public participation events.

Step Four: Response to Comments and Final Permit Decision

Remember that State procedures may be different.

Required Activities

After the public comment period closes, the regulatory agency reviews and evaluates all written and oral comments and issues a final permit decision. The agency must send a **notice of decision** (not to be confused with a "notice of deficiency," see above) to the facility owner or operator and any persons who submitted public comments or requested notice of the final permit decision. The agency must also prepare a written response to comments that includes a summary of all significant comments submitted during the public comment period and an explanation of how, in making the final permit decision, the agency addressed or rejected the comments. This summary shows the community that the agency considered the community's concerns when making the final permit decisions. The agency must make the response to comments document available as part of the administrative record.

Additional Activities

If there was high interest during the comment period, the agency or the facility may want to issue a **news release** and **fact sheet** when the decision is finalized to inform a wide audience. The permitting agency may choose to update and release the fact sheet required in § 124.8.

Public Participation During the Life of a Facility

Interim Status Public Participation

When writing RCRA, Congress granted special status to facilities that existed when the statute went into effect and for facilities that would be brought under RCRA by new regulations. EPA refers to these facilities as having "interim status." According to RCRA, interim status facilities do not need a permit to operate; instead, while they are seeking permits, they follow a category of regulations created specifically for them by EPA. When EPA or a State issues a RCRA operating permit to one of these facilities, the facility loses its interim status.

Because interim status facilities can operate without a permit, many people are concerned that some of these facilities are not as safe as permitted facilities. Interim status facilities are not required to follow -- since they are not permitted -- any standardized public participation procedures or permit modification standards (that is, until the facility owner applies for a permit). Given all these conditions, interim status facilities often pose public participation challenges even though many such facilities have been operating for years.

Regulatory agencies may need to use innovative techniques to communicate with and provide information to communities around interim status facilities. EPA acknowledges that every situation will require a different type and level of community involvement. If interest grows in a certain facility, the agency should consider holding a **workshop** or an **availability session** . Information repositories are another available tool (see Chapter 5). The agency should take steps to explain the special situation of interim status facilities to citizens. Of course, if an interim status facility begins to attract public interest, permitting agencies should consider moving the facility towards getting a permit and undergoing the public participation steps in the permitting process.

Owners and operators of interim status facilities should involve the public even before they formally start to pursue a RCRA permit. One thing the facility owners could do to improve access to information is to make a draft part B application available to the public before submitting it to the

permitting agency. Facility owners who submitted part B applications in the past might make their applications available as well. (Note: any interim status facility that submits its part B application on or after June 11, 1996, will be subject to the standards of the RCRA Expanded Public Participation Rule and, thus, its application will be available for public review upon submission). The facility may also want to set up an **on-site information booth** or provide other background materials to the public. Establishing a **contact person** and making his or her name available to the public can improve communication between the facility and the community. Experience has shown that a good facility-community relationship during interim status will make for a more cooperative permitting process.

Members of the public will often have questions or concerns while a facility is in interim status. Citizens can contact the facility, the regulatory agency, or the RCRA/Superfund Hotline to ask questions or to inquire about other sources of information. Citizens may also want to contact public interest organizations, local government, or other involved citizens for more information. Interim status facilities will eventually need to enter the RCRA permitting process, which citizens can use as an opportunity to air concerns and to encourage the facility to make important changes.

Permit Modifications

Modifications can be initiated by either the agency or the facility.

Over time, a permitted facility may need to modify its permit. Just as public participation is a component of the initial permit process, it is also a part of the permit modification process. This section discusses different kinds of permit modifications and their corresponding public participation requirements. It is important to note that public participation responsibilities and activities vary depending on, first, who initiated the modification (i.e., the regulatory agency or the facility owner or operator) and, second, the degree to which the modification would change substantive provisions of the permit. No matter who initiates the modification, when a modification is proposed, only those permit conditions subject to modification are reopened for public comment.

State permitting agencies may have modifications processes that differ from the federal requirements . Contact your State agency (see Appendix B) for more details.

There are many reasons to modify a permit. In some cases, the regulatory agency may initiate a permit modification under 40 CFR 270.41. This section of the regulations identifies three causes for which the regulatory agency may require a permit modification: (1) alterations or additions to the permitted facility or activity; (2) new information received by the regulatory agency; or (3) new standards, regulations, or judicial decisions affecting the human health or environmental basis of a facility permit. In

addition, the regulatory agency may modify a compliance schedule for corrective action in the permit. Modifications initiated by the regulatory agency are subject to the full 40 CFR Part 124 permitting requirements, as described earlier in this chapter. Specifically, the permitting agency must

- Issue public notice of the draft modification;
- Prepare a fact sheet or statement of basis;
- Announce a 45-day public comment period;
- Hold a public hearing, if requested, with 30-day advance notice;
- Issue notice of the final modification decision; and
- Consider and respond to all significant comments.

More often, however, the facility owner or operator requests a permit modification to improve facility operations or make changes in response to new standards. Facility-initiated modifications are categorized under 40 CFR 270.42 as Class 1, 2, or 3 according to how substantively they change the original permit. Class 1 modifications require the least public involvement; Class 3, the most. Like agency-initiated modifications, a decision to grant or deny a Class 3 permit modification request is subject to the public participation procedures of 40 CFR Part 124.

Since facility owners or operators initiate modifications more often than the regulatory agency, the remainder of this chapter lays out the requirements for facility-initiated modifications. The permitting agency is also encouraged to follow these public participation activities, even if not required under an agency-initiated modification. Appendix L consists of an EPA fact sheet entitled "Modifying RCRA Permits," which provides more detail on permit modifications and associated public participation activities. Exhibit 3-1 at the end of this Chapter presents an easy-to-read synopsis of modification requirements and timelines.

When the Facility Owner or Operator Initiates a Modification

When a facility owner or operator wants to change a RCRA permit, he or she informs the regulatory agency and interested members of the public, either before making the change if it is substantive (Class 2 or 3), or soon after (with a few exceptions), if the change is minor (Class 1). In any case, this is relatively *early* notification for members of the public, who often perceive that RCRA actions are "done deals" by the time public comment is solicited.

> When a facility initiates a modification, it is responsible for some public participation activities.

The *facility owner or operator* is responsible for conducting most of the public participation for modifications he or she initiates. In addition, the facility, rather than the regulatory agency, bears the burden of explaining

and defending its actions to the public. To ensure that the facility's public participation efforts are successful, staff from the facility and the agency should discuss how to conduct the required activities; the agency should provide guidance and assistance where necessary. Moreover, EPA encourages facilities to consult with communities to determine what activities will best promote public participation.

Class 1 Modifications

Class 1 modifications address routine and administrative changes, including updating, replacing, or relocating emergency equipment; updating certain types of schedules identified in the permit; improving monitoring, inspection, recordkeeping, or reporting procedures; and updating sampling and analytical methods to conform with revised regulatory agency guidance or regulations. They do not substantively alter the conditions in the permit or reduce the facility's ability to protect human health and the environment. With a few exceptions, most Class 1 modifications do not require approval from the regulatory agency before they are implemented. (The exceptions are listed in Appendix I to 40 CFR 270.42.)

The only public involvement requirement for Class 1 modifications is that *within 90 days of implementing a change, a facility must send a* ***public notice*** *to all parties on the mailing list compiled by the permitting agency*. The facility is responsible for obtaining a complete facility mailing list from the agency. (For more information on **mailing lists** see Chapter 5.) Any member of the public may ask the agency to review a Class 1 modification.

Class 2 Modifications

Class 2 modifications address facility-initiated changes in the types and quantities of wastes managed, technological advances, and new regulatory requirements, where such changes can be implemented without substantively altering the facility's design or the management practices prescribed by the permit. Class 2 modifications do not reduce, and, in most cases should enhance, the facility's ability to protect human health and the environment. During a Class 2 modification, there may be good opportunities to explore “low tech” pollution prevention opportunities that reduce waste generation but do not require major process changes (e.g., segregating waste streams, modifying maintenance procedures, or installing closed loop recycling).

Class 2 modifications require a number of activities, including a public notice, comment period, and a public meeting.

Class 2 modifications require the facility to submit a modification request and supporting documentation to the regulatory agency. In addition, *the facility must notify the people on its mailing list about the modification*

request and publish this notice in a major local newspaper of general circulation. The facility must publish the notice and mail the letter within seven days before or after it submits the request to the regulatory agency. The newspaper notice marks the beginning of a **60-day public comment period** and announces the time and place of a public meeting. In addition, the notice must identify a **contact person** for both the facility and the regulatory agency and must contain the statement, "The permittee's compliance history during the life of the permit being modified is available from the regulatory agency contact person." The notice should state that public comments must be submitted to the permitting agency's contact person.

The public comment period provides an opportunity for the public to review the modification request at the same time as the permitting agency. The facility must place the request for modification and supporting documentation in a location accessible to the public in the vicinity of the facility (see guidance on **information repositories** in Chapter 5 for suitable locations). The *facility must conduct the* ***public meeting*** no earlier than 15 days after the start of the 60-day comment period and no later than 15 days before it ends. The meeting, which tends to be less formal than a public hearing held by the regulatory agency in the draft permit stage, provides for an exchange of views between the public and the owner or operator and a chance for them to resolve conflicts concerning the permit modification. The meeting must be held, to the extent practicable, in the vicinity of the permitted facility (*the guidance on the pre-application meeting, earlier in this chapter, is applicable to this public meeting*).

The requirements for this meeting, like the pre-application meeting, are flexible. The facility is not required to provide an official transcript of the meeting, though we encourage owners/operators to consult the community and find out if this information would be useful. The permitting agency is not required to attend the meeting or respond to comments made there; however, EPA recommends that agency staff attend the meeting to clarify questions about the permitting process and to find out about any public concerns and how the owner or operator plans to address them.

The permitting agency is required to consider all written comments submitted during the public comment period and must respond in writing to all significant comments in its decision. EPA expects that the meeting will provide information to the public and improve the written comments submitted to the permitting agency. EPA anticipates that community input at the meeting may also result in voluntary revisions in the facility's modification request.

As the following paragraphs explain, the Class 2 modification procedures were written to ensure quick action by the agency. However, when seen by

the public, these procedures can be very confusing. A simple solution that the permitting agency or the facility should consider is to provide a fact sheet or a time table to the public at the meeting.

The procedures for Class 2 modifications include a default provision to ensure that the permitting agency responds promptly to the facility's request. The agency must respond to Class 2 modification requests within 90 days or, if the agency notifies the facility of an extension, 120 days. At any time during this 120-day period, the agency can: (1) approve the request, with or without changes, and modify the permit accordingly; (2) approve the request, with or without changes, as a temporary authorization having a term of up to 180 days; or (3) deny the request. If the permitting agency does not reach a final decision on the request within this period, the facility is granted an automatic authorization that permits it to conduct the requested activities for 180 days. Activities performed under this authorization must comply with all applicable federal and state hazardous waste management regulations. If the agency still has not acted within 250 days of the receipt of the modification request, *the facility must notify persons on the facility mailing list within seven days, and make a reasonable effort to notify other persons who submitted written comments*, that the automatic authorization will become permanent unless the regulatory agency approves or denies the request by day 300. The public must always have a 50-day notice before an automatic authorization becomes permanent. The agency must notify persons on the facility mailing list within 10 days of any decision to grant or deny a Class 2 modification request. The agency must also notify persons on the facility mailing list within 10 days after an automatic authorization for a Class 2 modification goes into effect.

At any time during the Class 2 procedures the agency may also reclassify the request as a Class 3 modification if there is significant public concern about the proposed modification or if the agency determines that the facility's proposal is too complex for the Class 2 procedures. This reclassification would remove the possibility of a default decision.

As previously indicated, the permitting agency may approve a temporary authorization under 40 CFR 270.42(b) for 180 days for a Class 2 modification. In addition, the agency may grant a facility temporary authorization under 40 CFR 270.42(e), which would allow the facility, without prior public notice and comment, to conduct certain activities necessary to respond promptly to changing conditions. *The facility must notify all persons on the facility mailing list about the temporary authorization request within seven days of the request*. Temporary authorizations are useful for allowing a facility owner or operator to perform a one-time or short-term activity for which the full permit modification process is inappropriate, or for allowing a facility owner or operator to initiate a necessary activity while his or her permit modification

is undergoing the Class 2 review process. A temporary authorization is valid for up to 180 days, and the permitting agency may extend the authorization for an additional 180 days if the facility initiates the appropriate Class 2 modification process for the covered activity. In addition, any extension of the activity approved in the temporary authorization must take place under Class 2 procedures.

Class 3 modifications are more likely than other modifications to raise concern.

Class 3 Modifications

Class 3 modifications address changes that substantially alter a facility or its operations. For example, a request to manage new wastes that require different management practices is a Class 3 modification.

Class 3 modifications usually involve changes that are broader or more detailed than Class 1 or 2 modifications; they are also more likely to raise concern. Though the Class 3 modifications process allows significant opportunity for public participation, additional activities may be helpful in some situations. Permit holders, regulators, and community interest groups may want to consider taking steps to encourage earlier participation. Facilities, in particular, should recognize that some Class 3 modifications will significantly alter their operations. In such cases, and in all cases where public interest may be high, *permittees should consider providing information and public participation activities prior to submitting the modification request* .

When concern is high, it is critical for the facility to consult with the agency to make sure that the facility knows how to conduct the required public participation activities. In some cases, the permitting agency might encourage the facility to go beyond the requirements and hold **workshops** and publish **fact sheets** to explain the proposed change. Public participation activities held by the agency or public interest groups can supplement the regulatory requirements.

As with Class 2 modifications, Class 3 modifications require the facility to submit a modification request and supporting documentation to the permitting agency, and *notify persons on the facility mailing list about the modification request and publish notice in a major local newspaper of general circulation* . The facility must publish the notice and mail the letter within seven days before or after the submitting the modification request to the regulatory agency. The notice must contain the same information as the Class 2 notification (see above), including an announcement of a ***public meeting*** *to be held by the facility* at least 15 days after the notice and at least 15 days before the end of the comment period. The newspaper notice marks the beginning of a **60-day public comment period.**

In holding a public meeting during the comment period, the facility owner or operator should follow the guidance for the pre-application meeting above. The requirements for this meeting are flexible. The facility is not required to provide an official transcript, though we encourage owners/operators to consult the community and find out if this information would be useful. As with Class 2 modifications, the agency is not required to attend the meeting or to respond to comments made at the meeting. However, it is important that the permitting agency attend the facility's public meeting in order to gauge concern about the proposed change and prepare appropriately for a public hearing, if one is requested. By attending the public meeting, the agency may learn whether it needs to conduct additional public participation activities (e.g., hold a **workshop** or **informal meetings**) after preparing the draft modification. The agency can also clarify questions about the permitting process. The agency should consider responding to issues raised at the meeting as part of the response to comments for the 60-day comment period. Of course, people who attend the meeting have the opportunity to submit formal comments to the permitting agency during the comment period.

At the conclusion of the 60-day comment period, the agency must consider and *respond to all significant written comments received during the comment period*. The agency must then either grant or deny the Class 3 permit modification request according to the permit modification procedures of 40 CFR Part 124.

Class 3 modifications are subject to the same public participation procedures as permit applications.

Class 3 modifications are subject to the same review and public participation procedures as permit applications, as specified in 40 CFR 270.42(c). The agency is required to perform the following tasks:

- Preparation of draft permit modification conditions or notice of intent to deny the modification;
- Publication of a **notice** of the agency's draft permit decision, which establishes a 45-day **public comment period** on the draft permit modification;
- Development of a **fact sheet** or **statement of basis**;
- Holding a **public hearing**, if requested, with **30-day advance notice**;
- Issuance of the **notice of decision** to grant or deny the permit modification; and
- Consideration and response to all significant written and oral comments received during the 45-day public comment period.

With Class 3 permit modifications, the public has 60 days to comment on the facility's requested modification and another 45 days to comment on the agency's draft permit modification or proposed notice of intent to deny the modification. And, in addition to the public meeting held by the facility owner or operator, the public may also request a **public hearing** with the

agency.

The permitting agency must notify persons on the facility mailing list within 10 days of any decision to grant or deny a Class 3 modification request. As with Class 2 modifications, the regulatory agency may grant a facility a temporary authorization to perform certain activities requested in the Class 3 modification for up to 180 days without prior public notice and comment. For example, the agency may grant temporary authorizations to ensure that corrective action and closure activities can be undertaken quickly and that sudden changes in operations not covered under a facility's permit can be addressed promptly. Activities performed under a temporary authorization must comply with all applicable federal and state hazardous waste management regulations. *The facility must issue a public notice to all persons on the facility mailing list within seven days of submitting the temporary authorization request.* The agency may grant a temporary authorization without notifying the public. The permitting agency may reissue a temporary authorization for an additional 180 days provided that the facility has initiated the appropriate Class 3 modification process for the activity covered in the temporary authorization and the agency determines that the extension is warranted to allow the facility to continue the activity while Class 3 procedures are completed. See Appendix L for an EPA fact sheet on modifying RCRA permits.

Public Participation in Closure and Post-Closure

Facilities may discontinue operations at one or more units for a number of reasons. For example, units may have reached capacity, the facility owner or operator may no longer wish to accept wastes, or the facility may have lost interim status and be required to close by the permitting agency. During closure, facility owners or operators complete treatment, storage, and disposal operations; apply final covers or caps to landfills; and dispose of or decontaminate equipment, structures, and soil. Post-closure, which applies only to land disposal facilities that do not "clean close" (i.e., remove all contaminants from the unit), is normally a 30-year period after closure during which owners or operators of disposal facilities conduct monitoring and maintenance activities to preserve the integrity of the disposal system.

Closure and Post-Closure at Permitted Facilities

EPA regulations (40 CFR 264.112 and 264.118) require facilities seeking operating permits to submit closure and post-closure plans (if appropriate) with their Part B applications in accordance with 40 CFR 270.14(b)(13). Furthermore, land disposal facilities that leave wastes in place when they close must obtain a post-closure permit, which specifies the requirements for proper post-closure care. Consequently, *the public has the opportunity to comment on a facility's closure and post-closure plans and any amendments made to the plans as part of the permitting process and permit modification procedures* , as described earlier in this chapter.

Facilities seeking permits for post-closure are exempt from the pre-application meeting requirement (§ 124.31) in the RCRA Expanded Public Participation rule. The facility, permitting agency, or community group may decide to hold some type of meeting prior to issuance of the post-closure permit. Refer to Chapter 5 for information on **public meetings**, **availability sessions**, and **workshops**.

The permitting agency or other involved organizations should be aware of closure issues that may concern the public, and they should plan public participation activities accordingly. For example, if the public has reservations about how "clean" the facility will actually be after the facility closes, public interest groups, the agency, or the facility may want to provide **fact sheets** or conduct educational **workshops** and **informational meetings** about the closure plan and the conditions at the facility.

Public participation for the post-closure phase must address public concerns about corrective action.

If the facility owner or operator is leaving a facility, and possibly even the community, the public may be very concerned about whether the facility owner or operator will really be vigilant in monitoring the post-closure operations at the facility or will have enough financial resources to do so. Moreover, almost all post-closure permits will contain schedules of compliance for corrective action if a facility closes before all necessary corrective action activities are completed. As a result, public participation events in the post-closure phase need to address community concerns about corrective action. (See Chapter 4 for additional information on corrective action activities.) Note, however, that unless corrective action is required in the post-closure permit, public interest in closure plans is usually limited.

Closure and Post-Closure at Interim Status Facilities

Facilities may also close under interim status, often under enforcement orders. Facilities that are closing under interim status must submit closure and post-closure plans (if appropriate) under 40 CFR 265.112 and 265.118. Public participation activities for interim status facilities during the closure and post-closure processes are specified in 40 CFR 265.112(d)(4) and 265.118(f). The regulations require that *the permitting agency provide the public and the facility, through a* ***newspaper notice****, with the opportunity to submit written comments on the closure and post-closure plans and request modifications to the plans no later than 30 days from the date of the notice*. EPA encourages permitting agencies to use other methods of notice, as appropriate, to announce the meeting. In response to a request, or at its own discretion, the agency may hold a **public hearing** on the plan(s), if such a hearing might clarify one or more of the issues concerning the plan(s). The agency must provide **public notice** at least 30 days before the hearing. The agency will approve, modify, or disapprove the plan(s) within 90 days of their receipt.

The public can petition the permitting agency to extend or reduce the post-

closure care period applicable to an interim status facility or land disposal unit. Whenever the agency is considering a petition on a post-closure plan, it will *provide the public and the facility, through a* ***public notice in the newspaper****, with the opportunity to submit written comments within 30 days of the date of the notice* **.** Again, EPA encourages permitting agencies to go beyond the newspaper notice requirement, as appropriate, to disseminate the notice. In response to a request or at its own discretion, the agency may hold a **public hearing** on the post-closure plan, if such a hearing might clarify one or more of the issues concerning the plan. The agency must provide **public notice of the hearing** at least 30 days before it occurs. If the agency tentatively decides to modify the post-closure plan, 40 CFR 265.118(g)(2) requires that *the agency provide the public and the facility, through a* ***public notice in the newspaper****, with the opportunity to submit written comments within 30 days of the date of the notice*, as well as the opportunity for a public hearing. After considering the comments, the regulatory agency will issue a final decision.

An interim status facility may amend its closure plan at any time prior to the notification of partial or final closure, and its post-closure plan any time during the active life of the facility or during the post-closure care period. An owner or operator with an approved closure or post-closure plan must submit a written request to the permitting agency to authorize a change. In addition, the agency may request modifications to the closure and post-closure plans. If the amendment to the closure plan would be a Class 2 or Class 3 modification, according to the criteria specified in 40 CFR 270.42, then the modification to the plan will be approved according to the procedures in 40 CFR 265.112(d)(4) detailed above. Similarly, if the amendment to the post-closure plan would be a Class 2 or Class 3 modification, according to the criteria specified in 40 CFR 270.42, the modification will be approved according to the procedures in 40 CFR 265.118(f), also described above.

Chapter Summary

Some permitting situations will call for public participation that goes beyond the regulatory requirements

The "RCRA Expanded Public Participation" rule (60 FR 63417, December 11, 1995), provides for earlier public participation in the permitting process, expands public notice for significant events, and enhances the exchange of permitting information

EPA strongly encourages permitting agencies and facilities to ensure equal access to permitting information and provide an equal opportunity for all citizens to be involved in the RCRA permitting process

The permit decision process and the required public participation activities can be divided into four key steps :

1. The Pre-Application Stage

   - Facility gives public notice and holds an informal public meeting

- Agency develops a mailing list
- Additional activities that may apply include: community assessments, public participation plans, information repositories, and fact sheets

2. Application Submittal, Notice, and Review

- Agency issues a notice to the facility mailing list and state and local governments
- Agency makes application available for public review
- Additional activities that may apply include: observation decks, facility tours, community tours, workshops, and news conferences.

3. Preparation of Draft Permit, Public Comment Period, and the Public Hearing

- Agency issues public notice of draft permit (or intent to deny)
- Agency prepares a fact sheet or statement of basis
- Agency announces a 45-day public comment period
- Hold a public hearing, if requested or at the agency's discretion, with 30-day advance notice
- Additional activities that may apply include: information sessions, workshops, news releases, and fact sheets.

4. Response to Public Comments and the Final Permit Decision

- Agency responds to all significant comments raised during the public comment period, or during any hearing
- Agency issues notice of final permit decision

The regulatory agency can initiate a permit modification under 40 CFR 270.41 following the full permitting procedures of 40 CFR Part 124. A facility may also initiate a Class 1, 2, or 3 permit modification under 40 CFR 270.42. For facility-initiated modifications, public participation activities are required of both the facility and the regulatory agency, as described below:

1. Class 1

Facility Requirements :

- Notify mailing list within 90 days

2. Class 2

Facility Requirements :

- Notify mailing list and public newspaper notice
- Announce 60-day public comment period
- Place modification request and supporting documentation in an accessible location in the vicinity of the facility
- Hold public meeting
- If the regulatory agency does not act within 250 days of the modification request, notify mailing list that automatic authorization will become permanent in 50 days

Regulatory Agency Requirements :

- Allow 60 days for public comment on the modification request
- Consider all written comments and respond in writing to all significant comments
- Issue notice to the mailing list within 10 days of any decision to grant or deny a modification request
- Issue notice to the mailing list within 10 days after an automatic authorization goes into effect

3. Class 3

Facility Requirements :

- Notify mailing list and publish newspaper notice
- Announce 60-day public comment period
- Place modification request and supporting documentation in an accessible location in the vicinity of the facility
- Hold public meeting

Regulatory Agency Requirements :

- Allow 60 days for public comment on the modification request
- Issue public notice
- Prepare a fact sheet or statement of basis
- Announce a 45-day public comment period on draft permit decision
- Hold a public hearing, if requested, with 30-day advance notice
- Issue or deny the modification request
- Respond to written and oral comments from the 45-day comment period
- Consider and respond to all significant written comments received during the 60-day comment period

For Class 2 or 3 modifications, the permitting agency may grant a facility temporary authorization to perform certain activities for up to 180 days. The facility must notify the public within seven days of making the request. The agency may grant a temporary authorization without prior public notice and comment.

For facilities seeking permits, the public has the opportunity to comment on closure and post-closure plans and any amendments to the plans as part of the permitting process and permit modification procedures. The public can also comment and request hearings on closure and post-closure plans submitted by interim status facilities. The permitting agency can initiate, and the facility can request, modifications to interim status plans; these requests are also subject to public comment.

Post-closure permits and plans often mandate corrective action.

Exhibit 3-1
Public Participation Requirements for Class 1, 2, and 3 Permit Modifications

Class 1

Type of Changes -- Routine and administrative changes

Required Activities

Within 90 days of implementing a change, facility must notify all parties on mailing list.

Class 2

Type of Changes -- Improvements in technology and management techniques

Required Activities

Day 1: Regulatory agency receives modification request.
Day 7: Facility publishes newspaper notice, notifies mailing list, and places copy of permit modification request and supporting documents in accessible location.
Days 15-45: Facility holds public meeting.
Day 60: Written public comments due to regulatory agency.
Day 90: Regulatory agency response to modification request due, including response to written comments. Deadline may be extended 30 days.
Day 120: If regulatory agency has not responded, requested activity may begin for 180 days under an automatic authorization.
Day 250: If regulatory agency still has not responded, facility notifies public that authorization will become permanent unless regulatory agency responds within 50 days.
Day 300: If regulatory agency has not responded, activity is permanently authorized.

Regulatory agency must notify mailing list within 10 days of any decision to grant or deny modification request, or after an automatic authorization goes into effect.

Class 3

Type of Changes -- Major changes to a facility and its operations

Required Activities

Day 1: Regulatory agency receives modification request.
Day 7: Facility publishes newspaper notice, notifies mailing list, and places copy of the permit modification request and supporting documents in an accessible location.
Days 15-45: Facility holds public meeting.
Day 60: Written public comments due to regulatory agency.

After the conclusion of the 60-day comment period, the regulatory agency must grant or deny the permit modification request according to the permit modification procedures of 40 CFR Part 124. These include:

- Issuing public notice of the draft permit modification or intent to deny the modification;
- Preparing a fact sheet or statement of basis;
- Announcing a 45-day public comment period;
- Holding a public hearing, if requested, with a 30-day advance notice;
- Considering and responding to all significant written and oral comments received during the 45-day comment period; and
- Issuing notice of the final permit modification.

In addition, the regulatory agency must consider and respond to all significant written comments received during the 60-day comment period.

Chapter 4
Public Participation in RCRA Corrective Action Under Permits and §3008(h) Orders

Introduction

RCRA requires owners and operators of hazardous waste management facilities to clean up contamination resulting from current and past practices. These cleanups, known as corrective actions, reduce risks to human health and the environment.

As with the rest of the RCRA program, state environmental agencies can receive authorization from EPA to implement the corrective action program. The corrective action requirements in authorized states must be at least as stringent as the federal requirements and may be more stringent. Where states implement the program, EPA plays an oversight role; the Agency implements the program in non-authorized states.

This chapter lays out a framework for corrective action public participation that follows the typical approach to facility cleanup (e.g., site investigation, analysis of alternatives, remedy selection). However, alternative approaches may be used provided they achieve the goals of full, fair, and equitable public participation. More than 5,000 facilities are subject to RCRA corrective action. The degree of cleanup necessary to protect human health and the environment varies significantly across these facilities. Few cleanups will follow exactly the same course; therefore, program implementors and facility owners/operators must be allowed significant latitude to structure the corrective action process, develop cleanup objectives, and select remedies appropriate to facility-specific circumstances. Similar latitude must be allowed in determining the best approach to public participation, in order to provide opportunities appropriate for the level of interest and responsive to community concerns.

Corrective action may take place under a permit or an enforcement order.

At the federal level, corrective actions may take place under a RCRA permit or as an enforcement order under §3008 of RCRA. In authorized states, corrective action may take place under a state-issued RCRA permit, a state cleanup order, a state voluntary cleanup program, or another state cleanup authority. Since authorized states may use a variety or combination of state authorities to compel or oversee corrective actions, EPA encourages interested individuals to check with their state agency to gather information on the available public participation opportunities.

The RCRA corrective action program is the counterpart of EPA's other hazardous waste clean-up program, "Superfund," which is formally known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Unlike most Superfund clean-ups, RCRA corrective actions generally take place at facilities that continue to operate, and the current facility owner or operator is involved in the cleanup. Because cleanups under RCRA and Superfund often involve similar issues, EPA encourages equivalent public participation procedures in the two programs. Thus, parts of this chapter will refer you to the *Community Relations in Superfund* handbook (EPA/540/R-92/009, January 1992), which is available by calling the RCRA/Superfund Hotline at 1-800-424-9346.

Current Status of the Corrective Action Program

The ANPR emphasizes areas of flexibility in corrective action and describes how the program is improving.

Although Subpart S regulations are not final, much of the 1990 proposal is routinely used as guidance by permit writers.

On May 1, 1996, EPA published an Advance Notice of Proposed Rulemaking (ANPR) in the Federal Register (61 FR 19432). The Notice: (1) presents EPA's strategy for writing final corrective action regulations; (2) describes the current corrective action program and requests information to help EPA identify and implement improvements to the program; and (3) emphasizes areas of flexibility in the current program and describes program improvements already underway.

Public participation during corrective action derives from a combination of regulations and EPA guidance. The regulations set out requirements that facilities and agencies must meet when a permit is issued or modified, under 40 CFR parts 124 and 270, to incorporate corrective action provisions. EPA guidance, on the other hand, suggests additional provisions that the permitting agency may include in the permit. One example of such guidance for corrective action activities is the Proposed Subpart S rule (55 FR 30798, July 27, 1990). The Subpart S regulations are not final, but much of the 1990 proposal is routinely used as guidance by permit writers. [1]

Since there are no regulations requiring public participation under §3008(h) orders, any such activities are based on guidance. EPA policy states that the opportunities for public participation should be generally the same as those

[1] Two provisions of the 1990 proposal were promulgated in 1993: the final corrective action management unit (CAMU) and temporary unit regulations on February 16, 1993 (58 FR 8658). Under this final rule, CAMUs and temporary units may be designated by the regulatory agency in the permit prior to or during remedy selection according to the procedures in 40 CFR 270.41; these units may also be implemented through the use of Section 3008(h) orders or order modifications. Conversely, the facility may request a permit modification to implement a CAMU following the Class 3 permit modification process defined in 40 CFR 270.42. If approval of a temporary unit or time extension for a temporary unit is not requested under a Class 3 permit modification or obtained under a regulatory agency-initiated modification, the facility owner or operator may request approval for a temporary unit according to the procedures for a Class 2 permit modification. Chapter 3 (RCRA Permitting) discusses the public participation activities associated with each level of permit modification.

opportunities that accompany corrective action under a permit (see the section called "Special Considerations for Public Participation Activities Under §3008(h) Orders" below).

In the 1996 ANPR, the Agency reaffirmed using portions of the 1990 proposal as guidance.

The May 1, 1996 ANPR reaffirms the Agency's use of portions of the 1990 proposal as guidance, including many of the portions addressing public participation in corrective action. While much of the 1990 proposal will still be used as guidance, the ANPR emphasizes the need for flexibility in developing site-specific corrective action schedules and requirements, including public participation requirements tailored to meet the needs of the local community.

As described in the ANPR, EPA is actively looking for opportunities to identify and implement improvements to make the corrective action program faster, more efficient, more protective, and more focused on results. In the ANPR, the Agency emphasizes that revisions to the corrective action program should also enhance opportunities for timely and meaningful public participation.

This chapter outlines the public participation activities associated with the corrective action process under both permits and §3008(h) orders. It describes public participation activities currently required under federal regulations and policies, as well as additional activities that EPA recommends. If additional guidance is appropriate upon promulgation and re-proposal of corrective action regulations, EPA will update this chapter and make it available to the public.

The three paragraphs below provide a few guidelines for public participation, in the form of overarching principles, which should be considered throughout the corrective action process.

Early Participation

Public participation should come early in the corrective action process.

As we emphasized in Chapter 2, public participation should begin early in the permitting process. It should also begin early in the corrective action process. Many of the important decisions in a corrective action are made during the site investigation and characterization. Overseeing agencies and facilities should make all reasonable efforts to provide for early public participation during these phases.

Consistency with Superfund

A significant portion of the RCRA corrective action process is analogous to the Superfund process. Due to this similarity, EPA encourages permitting agencies and facilities to make public participation activities under the RCRA system consistent with those activities required under Superfund. For example, RCRA interim actions should provide opportunities for participation that are similar to, or go beyond, Superfund public

participation for removal actions, and similar opportunities for participation should be available under both corrective measures implementation and a Superfund remedial action.

Shared Responsibility for Public Participation Activities

The corrective action process may involve cleanup steps that are initiated by an overseeing agency or a facility owner/operator. Public participation activities will often be more useful for the public if the party who performed the latest cleanup step then conducts the public participation activity. For instance, if the facility owner/operator does a facility investigation, then it would usually be more appropriate for the facility owner/operator to run the public meeting or whatever activity follows the investigation. In addition, EPA recognizes that important forms of public participation take place outside of the formal corrective action process. The Agency encourages public interest, environmental, civic, and other organizations to provide such activities. The Agency also encourages citizens to discuss cleanup and permitting issues with knowledgeable stakeholders in the community.

Special Considerations for Public Participation Activities Under §3008(h) Orders

As we mentioned above, corrective action activities are conducted under an order issued under RCRA Section 3008(h). RCRA 3008(h) orders may be used to get corrective action started in advance of facility permitting or when a facility is closing under interim status. RCRA 3008(h) orders may be issued either on consent or unilaterally. A consent order is issued when the facility and the regulatory agency have come to an agreement about the corrective action; a unilateral order is issued when the regulatory agency and the facility have been unable to agree about the need for, or the scope of, corrective action.

As a matter of EPA policy, the substantive corrective action requirements and public participation requirements imposed under an order are generally the same as those that would occur if corrective action were taking place under a permit (61 FR 19432, May 1, 1996); however, because orders have significant administrative differences from permits there are some special considerations. For example: under a §3008(h) order, there may be limitations on the permitting agency's ability to release or discuss certain information; no public participation activities are statutorily *required* under §3008(h), though EPA policy is that public participation under corrective action orders be generally the same as under permits; and, while facility owner/operators may agree to conduct public participation activities under a consent order, under a unilateral order public participation responsibilities will likely fall to the permitting agency.

> Under EPA policy, public participation requirements during corrective action are generally the same under orders and permits.

In addition to ensuring that appropriate public participation activities occur during implementation of a corrective action order, in some cases, it may

be useful to begin public participation prior to the issuance of the order by assessing the community's concerns and identifying the most appropriate means of addressing those concerns. (Assessing a community's concerns and planning for public participation is discussed in greater detail in Chapter 2.) When corrective action will take place under a consent order, care should be taken to explain to the community that corrective action orders on consent are not traditional enforcement actions in that they are simply means to expedite initiation of corrective action activities; they are not typically issued in response to a violation at the facility.

Limitations on Releasing Information: When the agency is negotiating an order with the facility, confidentiality of certain information must be maintained. The aim of these negotiations is to encourage frank discussion of all issues and to resolve differences, thereby allowing the agency to issue an order on consent rather than unilaterally. Agency staff should take notice: public disclosure of some information may be in violation of state and federal statutes, and could jeopardize the success of the negotiations, so be sure to coordinate any public notices with enforcement staff before releasing information.

Not being able to fully disclose information to the public can pose problems, particularly in a community where interest is high and citizens are requesting information. If interest in the facility is high, the project manager, project staff, and the Public Involvement Coordinator should discuss how to address citizens' concerns without breaching confidentiality. At the very least, the public deserves to know why these limitations are necessary and when and if they will be lifted.

Further constraints may be placed upon public participation if discussions with the facility break down, and the case is referred to the Department of Justice (DOJ) to initiate litigation. In this situation, public participation planning should be coordinated with the lead DOJ attorney as well.

Strongly Suggested Versus Required Activities: As discussed earlier in this Chapter, EPA's policy is that the substantive corrective action requirements and public participation requirements imposed under an order should be generally the same as those that would occur if corrective action were taking place under a permit. U.S. EPA's Office of Solid Waste and Emergency Response has issued two directives addressing public participation in §3008(h) orders: Directive 9901.3, *Guidance for Public Involvement in RCRA Section 3008(h) Actions* (May 5, 1987) and Directive 9902.6, *RCRA Corrective Action Decision Documents: The Statement of Basis and Response to Comments* (April 29, 1991). These directives suggest public participation activities in orders, even though such activities are not required by statute. The directives suggest the following activities **after** a proposed remedy has been selected:

- Writing a **statement of basis** discussing the proposed remedy;

- Providing **public notice** that a proposed remedy has been selected and the statement of basis is available;
- Providing a **public comment period** (30-45 days) on the proposed remedy;
- Holding a **public hearing** if requested; and
- Writing a **final decision** and **response to comments** .

The remainder of this Chapter reflects EPA's support for having equivalent public participation steps under both permits and orders. While there are no requirements for public participation under orders, EPA strongly suggests the activities reviewed in this Chapter. In our review of the corrective action elements (initial site assessment, site characterization, etc.) in the following pages, we discuss public participation activities that are required or additional. Because EPA strongly suggests public participation activities under orders, we present them under the "Required Activities" headings for each corrective action element.

Consent Versus Unilateral Orders: If the agency is issuing a consent order, the agency should consider negotiating with the facility to have it write a **public participation plan** (if community interest in the facility is high), or at least conduct some activities as terms of the order. If the agency is issuing a unilateral order, however, circumstances may be such that it is necessary and/or appropriate for the agency to assume all or most public participation responsibilities. Care must be used regarding the disclosure of information prior to the issuance of a unilateral order. Premature disclosure may place additional strain on the facility-agency relationship.

Public Participation In Corrective Action

Because corrective action activities involve investigation of releases and potential releases of hazardous waste, the community is likely to take an active interest. Corrective action investigations and remedial activities may be very visible to the public. Experts visit the facility to conduct investigations, trucks and equipment travel back and forth to the facility, and government agencies oversee activities. Delays in the cleanup or long "down times" between permitting activities are not uncommon. All of these factors can heighten the anxiety and concern of the community. Accordingly, the community may require more information on issues related to current or potential contamination, including levels of contamination, the extent of health and environmental risks, and the potential for future risks. The public may also seek additional opportunities to give input to the overseeing agency or the facility.

The regulatory requirements provide a baseline for adequate public participation while leaving a great deal of flexibility in the program. Some situations will call for public participation opportunities that go beyond the regulatory baseline. Where regulations do not specify public participation during corrective action, overseeing agencies and facility owners/operators

should develop site-specific public participation strategies that are consistent with existing requirements and provide for full, fair, and equitable public participation.

The scope and complexity of corrective actions will vary significantly across facilities. For this reason, EPA has created a flexible program that allows regulatory agencies to tailor corrective action requirements to facility-specific conditions and circumstances. While EPA's public participation regulations establish a baseline of requirements, some situations will call for public participation opportunities that go beyond the regulatory baseline. This is particularly true in the corrective action program because many of the specific corrective action regulations, including regulations for public participation, are not yet final and because corrective action activities often occur outside the permitting process (e.g., under a federal or state order). In this chapter, we will discuss times during the process when additional public participation can be critical. We encourage stakeholders to follow the guidance in this chapter and Chapter 2 when planning for public participation in the corrective action process.

Corrective actions, like most site cleanup activities, usually involve several key elements. These elements are:

- Initial Site Assessment (RCRA Facility Assessment (RFA));
- Site Characterization (RCRA Facility Investigation (RFI);
- Interim Actions;
- Evaluation of Remedial Alternatives (Corrective Measures Study (CMS);
- Remedy Selection;
- Remedy Implementation (Corrective Measures Implementation (CMI)); and
- Completion of the Remedy.

A successful corrective action program must be procedurally flexible; no one approach will be appropriate for all facilities.

The corrective action process is not linear. The elements above should not be viewed as prescribed steps on a path, but as evaluations that are necessary to support good cleanup decisions. Because these elements may not occur in the same order (or at all) at every facility, we encourage planners to use them as general guidelines, while leaving flexibility for changes. A successful corrective action program must be procedurally flexible; no one approach to implementing these cleanup elements will be appropriate for all facilities. The seven elements, and the public participation activities associated with them, are described in the sections below.

Refer to Chapter 3 for additional information on permitting, including permit modifications, and Chapter 5 for specific details on public participation activities described in this chapter.

The corrective action process usually begins with an initial site assessment,

Initial Site Assessment (RFA)

called a RCRA Facility Assessment or RFA. The RFA is conducted either by the overseeing agency or by the facility with subsequent agency approval. The purpose of an RFA is to gather data about a site, including releases and potential releases of hazardous waste and hazardous constituents, to determine whether a cleanup may be necessary. RFAs usually include (1) a file review of available information on the facility; (2) a visual site inspection to confirm available information on solid waste management units (SWMUs) at the facility and to note any visual evidence of releases; and (3) in some cases, a sampling visit to confirm or disprove suspected releases.

The results of an RFA are recorded in an RFA report. The RFA report will describe the facility and the waste management units present at the facility and note any releases or potential releases. It will also describe releases and potential releases from other, non-waste-management-associated sources (e.g., a spill from a product storage tank). Interested individuals may request copies of RFA reports from the appropriate EPA regional office or state agency.

In addition to the information recorded in RFA reports, if corrective action is taking place in the context of a RCRA permit, the permit application will also describe the physical condition of the facility including its subsurface geology, the waste management units present at the facility, and any releases and potential releases.

The RFA report usually serves as the basis for future corrective actions at a facility. If, after completion of the RFA, it appears likely that a release exists, then the overseeing agency will typically develop facility-specific corrective action requirements in a schedule of compliance, which will be included in the facility's permit or in a RCRA Section 3008(h) corrective action order.

In the case of corrective action implemented through a permit, the public may comment on the schedule of compliance for corrective action during permit issuance and subsequent permit modification (see Chapter 3 for more information on the permitting process and permit modifications).

When corrective action is implemented though a 3008(h) order, the public should be given an opportunity to comment on the schedule of compliance when the order is issued; however, it may take many months of discussions between the facility owner/operator and the overseeing agency before an order is issued. In the meantime, the facility owner/operator may develop a **mailing list** , modeled after the mailing list developed under the permitting process, and a **public participation plan** .

On the day the order is issued, the administrative record, containing all information considered by the agency in developing the order, is made available for inspection by the public. The agency may also want to place a copy of the administrative record at a local library close to the facility.

The overseeing agency or facility owner/operator should consider writing a **fact sheet** that gives details of the order and the corrective action process. If there is a high level of interest in the facility, an **open house** or **workshop** should be considered.

Site Characterization (RFI)

A RCRA Facility Investigation or RFI is necessary when a release or potential release is identified and additional information is necessary to determine the nature and scope of corrective action, if any, that is needed. The purpose of an RFI is to characterize the nature and extent of contamination at the facility and to support selection and implementation of a remedy or remedies or, if necessary, interim measures.

Required Activities

If corrective action is being conducted in the context of a RCRA permit, the public has the opportunity to review and comment on the scope of the RFI and RFI schedules and conditions during permit issuance. The RFI is usually conducted by following an agency-approved RFI plan. If the RFI plan is incorporated into a permit by a permit modification, then the public will have an opportunity to comment on the scope and schedule of the RFI during the modification process. See Chapter 3 for more information on public participation during permit modifications.

If corrective action is being conducted under a 3008(h) order, the public should be given the opportunity to review and comment on the scope of the RFI and RFI conditions when the order is issued and/or when the RFI workplan is approved.

RFIs can often involve numerous rounds of field investigation and can take months or even years to complete. During the RFI process, it may be necessary to change the RFI requirements or modify the RFI schedule to react to new information. When corrective action is being conducted in the context of a RCRA permit, the public has an opportunity to comment on changes to RFI conditions and schedules during the permit modification process. Significant changes to the scope of RFI requirements are typically Class 3 permit modifications, changes to RFI schedules or investigatory details (e.g., a change in the number of samples to be collected in a given sampling area) are typically considered either Class 1 or Class 2 modifications, depending on their significance. When corrective action is being conducted under an order, the public's opportunities to review changes to RFI conditions and schedules should be consistent with the opportunities that are available under a permit. The **facility mailing list,** developed during the initial stages of the permitting process, or a mailing list developed during preparation of the corrective action order, should be used and updated throughout the corrective action process in order to keep members of the community informed. (See Chapters 3 and 5 for more information on facility mailing lists.)

In some cases (e.g., where there is a high level of public interest in corrective action activities), the overseeing agency will determine that an **information repository** is needed to ensure adequate public involvement. When corrective action is being conducted under a RCRA permit the agency can require the facility to establish a repository under § 270.30(m). A repository at the RFI stage will provide access to information from an early stage in the process, though the agency has the discretion to use this provision at any stage in the permitting process or at any stage during the corrective action. If the agency decides to require a repository, it will direct the facility to notify the public of the existence of the repository, including the name and phone number of a **contact person**. See Chapter 5 for more detail on information repositories.

Additional Activities

The start of the RFI usually marks the beginning of highly visible, on-going corrective action activities at a facility. Because RFI activities are highly visible and because many of the important decisions regarding the scope of potential corrective actions may be made during the RFI, it will generally be appropriate to reevaluate community concerns and the level of public participation and to revise the **public participation plan** accordingly (see Chapter 5) when RFIs begin. Such efforts early in the process, before community concerns and issues become overwhelming, will be beneficial in the long run.

Developing and distributing **fact sheets** throughout the RFI process is an excellent way to keep in touch with the community. It is a good idea to issue a fact sheet before the RFI begins to explain the investigation's purpose and scope. Another fact sheet should be issued after the RFI is completed to report the investigation results.

EPA encourages all facilities to make the results of the RFI readily available to interested stakeholders. One means of providing access to the information is to send a **summary of the RFI report** to the **facility mailing list**, as proposed in the 1990 Subpart S proposal. The facility may choose other means of distributing the information, such as through a **fact sheet or project newsletter**. The full report should be made available for review in an **information repository**, if one exists, or through some other method that is convenient for the interested public.

The facility owner/operator should provide notice to all adjacent landowners and other persons who may have been affected by releases of contamination, via air or ground water, from the facility. EPA recommends that the owner/operator follow the provisions in the 1990 proposal (proposed § 264.560(a) and (b)) for **notifications for discoveries of contamination** (see 55 FR 30882).

Informal meetings or **workshops** held by the facility, the permitting agency, or public interest groups can provide valuable forums for discussing community concerns.

Interim Actions

Interim actions are activities used to control or abate ongoing risks to human health or the environment in advance of final remedy selection. For example, interim actions may be required in situations where contamination poses an immediate threat to human health or the environment. They also may be required to prevent further environmental degradation or contaminant migration prior to implementing the final remedy. Interim actions may occur at any point in the corrective action process; however, they are often implemented during the RFI or CMS.

Required Activities

When corrective action is proceeding under a RCRA permit, the permit may identify specific interim measures and/or stabilization measures (if they are known at the time of permit issuance) or may have general conditions that govern when interim measures might be required during the course of the corrective action. In either case, the public can comment on the interim measures strategy in the draft permit as part of the permitting process.

When corrective action is proceeding under a 3008(h) order, the public should have the opportunity to comment on specific interim measures or general interim measure conditions when the order is issued, or otherwise in a manner that is consistent with the opportunities available when corrective action takes place under a permit.

Additional Activities

In recent years EPA has increasingly emphasized the importance of interim measures and site stabilization in the corrective action program. In the ANPR, EPA notes that an overriding goal in our management of the corrective action program is to help reduce risks by emphasizing early use of interim actions (while staying consistent with the environmental objectives at the facility). If a facility owner/operator or the permitting agency anticipates that an early interim action will be the only cleanup step taken over a significant period of time, then the facility or the agency should inform the public of such a plan and receive feedback, unless the immediacy of the situation will not allow for feedback. The facility and the agency should both announce a **contact person** to provide information and respond to inquiries about the action. Agencies and facilities may find Superfund guidance on removal actions useful in the RCRA context (see *Community Relations in Superfund: A Handbook*, Chapter 5).

It is a good idea to keep the public informed of such activities by issuing **fact sheets** or holding **informal meetings** . Because interim measures can be conducted at any stage in the corrective action process, you should incorporate activities related to interim measures into the rest of your public involvement program.

Evaluation of Remedial Alternatives (CMS)

When the need for corrective measures is verified, the facility may be required to perform a Corrective Measures Study (CMS) to identify and evaluate potential remedial alternatives. In cases where EPA or a state is using performance standards or a similar approach and in cases where the preferred remedial alternative is obvious (e.g., where EPA has issued a presumptive remedy that is appropriate to site-specific conditions), submission of a formal CMS may not be necessary.

Required Activities

When corrective action is proceeding under a permit, the permit schedule of compliance may already include conditions that specify when a CMS is warranted; the public can comment on these draft permit conditions at the time of permit issuance. However, because the RFI and CMS phases may last several years, depending on the complexity of the facility, the community may be frustrated by the length of time involved and the lack of information on results or findings. Significant changes to the scope of CMS requirements, as specified in the permit, may be considered Class 3 permit modifications requiring significant public involvement. Changes to the CMS schedule, or CMS details are typically considered class 1 or 2 permit modifications, as appropriate.

Public participation during corrective action under a 3008(h) order should be consistent with public participation under a permit. The public should have the opportunity to review and comment on the scope of the CMS and CMS conditions when the order is issued and/or when the CMS workplan is approved.

Additional Activities

In the 1996 ANPR, EPA emphasizes that it expects facility owners/operators to recommend a preferred remedy as part of the CMS. While there is no formal requirement for public participation at this time, EPA strongly encourages the facility to present its preferred remedy to the community before formally submitting it to the agency. The facility should seek community input through an **informal meeting** , **availability session** , or another method that encourages dialogue. This early input is likely to improve many preferred remedies and make them more agreeable to communities. Moreover, it will make the facility and the overseeing agency aware of community concerns and ways to address them.

Holding **workshops** and **informal public meetings** about the CMS process, the remedies being considered, and the activities being conducted at the facility will keep the community involved and informed. **Fact sheets** distributed at significant milestones during the CMS can keep the community abreast of the progress that has been made.

The agency and the facility should provide the name and number of a **contact person** . A contact person will accept comments and answer questions from the community, disseminate information, demonstrate the agency's and facility's willingness to talk with the community, and give the facility or the agency an opportunity to respond to public concerns. The agency or the facility may even consider establishing a **hotline** if a large number of people call with questions. The mailing list and local newspapers are good ways to advertise availability of the hotline.

Remedy Selection

Following receipt of a recommendation of a preferred remedy from the facility owner/operator, the overseeing agency will review the preferred remedy and other remedial alternatives and decide to tentatively approve the preferred remedy, tentatively select a different remedy or require additional analysis of remedial alternatives. The tentatively selected remedy will then undergo public review and comment, usually in the form of a proposed modification to the facility's permit or corrective action order. Following public review, the agency will respond to public comments and then modify the facility permit or corrective action order to incorporate the remedy.

Required Activities

When corrective action is proceeding under a permit, public review and comment on the tentatively selected remedy is generally conducted using the procedures of 40 CFR 270.41 for agency-initiated permit modifications. For such a modification, 40 CFR 270.41 requires the same level of public participation as is required for a draft permit. The agency must release the proposed modification for public review and issue a **public notice** announcing that the proposed modification is available for review. The agency must publish this notice in a major local newspaper, broadcast it over local radio stations, and send it to all persons on the mailing list.

In addition, agency staff must prepare a **fact sheet** or **statement of basis** to explain the proposed modification and the significant factual and legal reasons for proposing the remedy. The statement of basis describes the proposed remedy, but does not select the final remedy for a facility. This approach allows for consideration of additional information during the **public comment period** . Following the comment period, public comment and/or additional data may result in changes to the remedy or in another choice of remedy. After the agency has considered all comments from the public, the final decision -- selecting the remedy or determining the need to

develop another option -- is documented in the response to comments. (For more information on statements of basis, refer to OSWER Directive 9902.6, *RCRA Corrective Action Decision Documents: The Statement of Basis and Response to Comments* (April 29, 1991)).

A **45-day public comment period** on the draft permit modification follows publication of the public notice. The comment period provides the public with an opportunity to comment, in writing, on conditions contained in the draft permit modification. If information submitted during the initial comment period appears to raise substantial new questions concerning the draft permit modification, the agency must re-open or extend the comment period.

The members of the public may request a **public hearing** on the draft permit modification. If a hearing is requested, the agency must give a **30-day advance notice** to the community that states the time and place of the hearing. The agency Director has the discretion to schedule a public meeting or hearing even if the community does not request one. In some cases, scheduling a public hearing before the public requests one may save valuable time in the modification process and demonstrate a willingness to meet with the community to hear its questions and concerns.

After the public comment period closes, the agency must review and evaluate all written and oral comments and issue a final decision on the permit modification. Then the agency must send a **notice of decision** to the facility owner or operator and any persons who submitted public comments or requested notice of the final decision and prepare a written **response to comments**. This document must include a summary of all significant comments received during the public comment period and an explanation of how they were addressed in the final permit modification or why they were rejected. The response to comments must be made available through the Administrative Record and the **information repository**, if one was established, and must be sent to the facility and all persons who submitted comments or requested a copy of your response.

When corrective action is proceeding under a 3008(h) order, the Agency's longstanding policy is that the public's opportunity to review and comment on tentatively-selected remedies should be commensurate with the opportunity that would be available if the corrective action were conducted under a permit. At a minimum, this opportunity should include: publishing a notice and a brief analysis of the tentatively-selected remedy (this is typically referred to as a statement of basis) and making supporting information available; providing a reasonable opportunity for submission of written comments; holding a public hearing or public meeting, if requested by the public or determined necessary by the overseeing agency; preparing and publishing responses to comments; and, publishing the final remedy decision and making supporting information available. Additional guidance is available in OSWER Directives 9901.3, *Guidance for Public*

Involvement in RCRA Section 3008(h) Actions (May 5, 1987) and 9902.6 *RCRA Corrective Action Decision Documents: The Statement of Basis and response to Comments* (April 29, 1991).

Additional Activities

The agency, public interest groups, or the facility should consider holding **workshops** or **informal meetings** during the public comment period to inform the public about the proposed remedy. These discussion sessions can be especially useful when information about corrective measures in a draft permit modification is quite technical or the level of community concern is high.

Remedy Implementation (CMI)

Once the overseeing agency modifies the permit or corrective action order to include the selected remedy, the facility must begin to implement the remedy. Remedy implementation typically involves detailed remedy design, remedy construction, and remedy operation and maintenance; it is called Corrective Measures Implementation or CMI. Corrective measures implementation is generally conducted in accordance with a CMI plan, approved by the overseeing agency.

Required Activities

When corrective action is proceeding under a permit, the public will have an opportunity to comment on CMI conditions and schedules during the permit modification for remedy selection or when the permit is modified to incorporate the CMI plan. Significant changes to the scope of CMI may be considered Class 3 permit modifications. Changes to the CMI schedule are typically considered either Class 1 or Class 2 permit modifications, as appropriate.

When corrective action is proceeding under a 3008(h) order, the public's opportunity to comment on CMI conditions and schedules should be consistent with the opportunities that would be available if corrective action were taking place under a permit.

Additional Activities

Remedy implementation will often involve highly visible activities, such as construction of new on-site treatment and containment systems, and staging and transportation of large volumes of materials. These activities may result in increased levels of public interest, which may already be high due to the public's participation in remedy selection.

EPA recommends that the facility notify all individuals on the facility **mailing list** when the construction plans and specifications are available for public review. If the facility has established an **information repository** ,

then the plans should go in the repository; otherwise, the facility should place the plans in a convenient location with public access.

As mentioned earlier, the corrective action process can take years to complete. Additional public participation activities may be appropriate during corrective measures implementation to inform the community of the progress of the remedial action, especially if the public shows concern over the pace and scope of the cleanup operations. In particular, it may be useful to release periodic **fact sheets** to the community that report on progress of the cleanup operations. It may also be helpful to hold an **availability session/open house** near or on the site of the facility to demonstrate or explain the activities involved in the remedy.

Completion of Remedy

Once corrective measures are complete the overseeing agency will either terminate the corrective action order or modify the permit to remove the corrective action schedule of compliance. Decisions regarding completion of corrective measures can be made for an entire facility, for a portion of a facility, or for a specified unit or release. EPA policy is for the public to be given an opportunity to review and comment on all proposals to complete corrective action.

Required Activities

When corrective action is proceeding under a permit, proposals to complete corrective measures should follow the procedures for Class 3 permit modifications. See the section on Class 3 modifications in Chapter 3 for details.

When corrective action is proceeding under a 3008(h) order and a proposal to complete corrective measures is issued, the public should have notice and comment opportunities that are consistent with the opportunities available under the Class 3 permit modification procedures.

Additional Activities

In some cases, hazardous wastes or hazardous constituents will remain in or on the land after completion of corrective measures. When this occurs, the overseeing agency may require the facility to record a notation in the deed to the facility property regarding the types, concentrations, and locations of such waste or constituents.

Chapter Summary

At the federal level, corrective actions may take place under a RCRA permit or as an enforcement order under §3008 of RCRA.

In authorized states, corrective action may take place under a state-issued RCRA permit, a state cleanup order, a state voluntary cleanup program, or another state cleanup authority. Authorized states may use a variety or combination of state authorities to compel or oversee corrective actions.

EPA's recent Advance Notice of Proposed Rulemaking (ANPR) (61 FR 19432, May 1, 1996) for the corrective action program does three things: (1) it presents EPA's strategy for writing final corrective action regulations; (2) it includes a description of the current corrective action program and requests information to help EPA identify and implement improvements to the program; and (3) it emphasizes areas of flexibility in the current program and describes program improvements already underway.

The ANPR also affirmed EPA's use of the 1990 proposal as guidance and emphasized the Agency's commitment to enhanced public participation.

As a matter of EPA policy, the type and timing of public participation activities for §3008(h) orders are generally the same as those for corrective action in permitting.

There are three important distinctions between conducting public participation in corrective action under a §3008(h) order and through permitting:

1. Under a §3008(h) order, there may be limitations on the release or discussion of certain information;

2. No public participation activities are <u>required</u> under §3008(h) but they are strongly encouraged in guidance. In addition, the agency may require the facility to conduct additional activities as a term in the order; and

3. Facilities may agree to conduct public participation activities under a consent order, however, under a unilateral order, the responsibility will likely fall to the agency.

While being flexible, the corrective actions should provide for early public participation, seek consistency with Superfund community involvement standards, and allow facility owner/operators to perform public participation activities where appropriate.

The corrective action process is composed of seven basic elements which are not prescribed steps, but evaluations that are necessary to make good cleanup decisions. Because these elements may not occur in the same order (or at all) in every situation, we encourage planners to use them as general guidelines, while leaving flexibility for changes. A successful corrective action program must be procedurally flexible

The basic elements (with corresponding public participation activities that are currently required or suggested):

1. Initial Site Assessment (RCRA Facility Assessment)

   - Schedule of compliance will go into permit, where public can comment
   - For enforcement orders, the agency will release administrative record and make it available for public review. The agency may provide a fact sheet and hold an open house or workshop.

2. Site Characterization (RCRA Facility Investigation)

   - Update mailing list, if necessary
   - Establish information repository, if required
   - Revise public participation plan
   - Modify permit, if necessary, to reflect changes to schedule of compliance
   - Under an order, provide notice and comment on the planned RFI
   - Develop fact sheets on the investigations
   - Mail summary of RFI Report to facility mailing list and make available to the public
   - Hold informal meetings or workshops
   - Issue notifications for discovery of contamination

3. Interim Actions -- May occur at any time during the process

- Provide for public input and feedback , as appropriate given time constraints, and announce a contact person
- Use fact sheets and informal meetings, if appropriate

4. Evaluation of Remedial Alternatives (Corrective Measures Study)

- Hold informal meetings or workshops when facility presents preferred remedy
- Identify a contact person
- Develop fact sheets on the study
- Establish a hotline

5. Remedy Selection

- Agency-initiated permit modifications follow 40 CFR 124 procedures, including public notice, public comment period, and a hearing (if requested)
- For corrective action under an order, the agency should: publish a notice and a statement of basis; take public comment; holding a public hearing or public meeting, if requested by the public or determined necessary by the overseeing agency; prepare and publish responses to comments; and, publish the final remedy decision while making supporting information available.
- Hold workshop on proposed remedy
- Once final remedy is selected, send out notice of decision
- Issue response to comments
- Hold informal meetings or workshops on the final remedy

6. Corrective Measures Implementation

- Notify public when plans and specifications are available for review
- Develop fact sheets on remedy implementation
- Coordinate availability session/open house

7. Completion of Remedy

- Agency may remove schedule of compliance from the permit or terminate the order by following the Class 3 modifications procedures for a permit or a similar process for an order.

Chapter 5
Public Participation Activities: How to Do Them

Introduction

This chapter presents a "how-to" for a broad range of activities that permititng agencies, public interest groups, and facility owners/operators can use to promote public participation. The variety of activities in this chapter should fit any situation: from the formal regulatory process that EPA follows, to community-based discussions of RCRA issues, to events held by the facility owner or operator.

Some of the activities in this chapter (for instance, public hearings) will be more appropriately led by a permitting agency; however, all stakeholders can learn more about the different kinds of activities by reviewing this chapter. Moreover, EPA would like to emphasize that this list is not exhaustive. You should consult with other stakeholders to determine if these or any other public participation activities will best suit your particular situation. Several of the appendices provide contact lists for various stakeholder groups.

As we emphasized in the preceding chapters, public participation is a dialogue. It involves both getting information out to other stakeholders and getting feedback in the form of ideas, issues, and concerns. We have divided this chapter's activities to reflect the dual role of public participation. The first group of activities involves techniques that disseminate information. The second group involves techniques that are useful for gathering and exchanging information. Note that some of these activities, such as informal meetings, are useful both for disseminating and collecting information. On the other hand, some activities, such as public notices, provide one-way communication. *EPA encourages stakeholders to combine public participation techniques so that they provide two-way communication.* For instance, if an agency issues a public notice, it should create a feedback loop by including the name and number of a contact person in the notice. Similarly, a facility or a public interest group could provide for feedback in an information repository by asking users to complete surveys or by assigning a staff person to answer questions at the repository.

The following pages contain summaries of numerous public participation activities, information on how and when to conduct them, an estimate of how much effort they require, and their advantages and limitations. Each summary includes a checklist to help in conducting the activity. Examples of public notices and fact sheets are also included.

Use this directory to locate specific activities:

Public Participation Plans 5-4

Disseminating Information

Public Notices 5-8
Newspaper Advertisements 5-9
Newspaper Inserts 5-9
Free Publications and Existing Newsletters 5-9
Public Service Announcements 5-10
Broadcast Announcements and Advertisements 5-10
Signs and Bulletin Boards 5-10
Telephone Networks or Phone Trees 5-11
Translations 5-16
Mailing Lists 5-19
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Information Repositories 5-40
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Briefings 5-50
Presentations 5-53
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Observation Decks 5-59
News Releases and Press Kits 5-62
News Conferences 5-67

Gathering and Exchanging Information

Community Interviews 5-70
Focus Groups 5-77
Door-to-Door Canvassing 5-80
Public Comment Periods 5-84
Unsolicited Information and Office Visits 5-87
Surveys and Telephone Polls 5-90
Contact Persons 5-94
Telephone Contacts 5-97
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Question and Answer Sessions 5-106
Information Tables 5-109
Informal Meetings with Other Stakeholders 5-112
Public Meetings 5-117
Public Hearings 5-123
Availability Sessions/Open Houses 5-130

Workshops 5-134
Attending Other Stakeholder Meetings and Functions 5-139
Citizen Advisory Groups 5-141

Public Participation Plans

Regulatory Requirements

None.

Description of Activity

A public participation plan provides a community-specific plan for interacting with a community regarding the permitting or corrective action activities taking place at a RCRA facility. The plan, typically prepared by the permitting agency, assesses the level of community interest as well as the types of concerns identified through a variety of sources (e.g., **community interviews**) and, based on this information, recommends specific activities for involving the community in the RCRA process. See the section on "Planning for Participation" in Chapter 2 and the detailed sample plan in Appendix I for more information. Chapter 3 of *Community Relations in Superfund* also provides useful guidance.

The level of detail in the plan will vary according to the probable level of public interest, the type of permitting activity, the location of the facility, and other applicable factors. The steps described in this section are not all necessary in every plan. Depending on the situation, the public participation plan may vary from a two-page schedule of activities to a comprehensive study of the population, an itinerary of permitting activities, and an analysis of community concerns.

Level of Effort

A Public Participation Plan may take several days to two weeks to complete. Revision of a plan could take a few days to a week. The range of effort depends on the priority of the site and the complexity of the activities performed at that site.

How to Conduct the Activity

A Public Participation Plan should be based on information collected during community interviews (if conducted) and information obtained from other sources, such file searches, reviews of past media coverage, and community assessments done by third parties (see the section entitled "Planning for Participation" in Chapter 2). This information is analyzed and organized into a community-specific plan. Typical sections of a public participation plan are:

- Introduction -- several paragraphs clearly explaining the purpose of the document.

- Facility History -- several paragraphs to several pages providing an overview of the facility, its technical and regulatory history, and a history of past community concerns and involvement in activities at

the facility. Short cut: attach the facility fact sheet if one already exists.

- Community Concerns -- several paragraphs to several pages summarizing the concerns identified during the community interviews.

- Objectives of the Plan -- several paragraphs to several pages, depending on the objectives, providing a narrative of the major objectives of the plan. Objectives typically relate to the specific concerns outlined in the previous section.

- Public Participation Activities -- several paragraphs to several pages, depending on the plan, describing the specific activities that will be conducted to meet the objectives outlined in the previous section (e.g., meetings, fact sheets, briefings for local officials, etc.) and a schedule for conducting these activities.

- Appendices -- Appendices can be included to provide the mailing list, media contacts, and public meeting and information repository locations.

The activities in a public participation plan should be tailored to address community concerns and needs. The plan should include the kinds of activities that are discussed in this manual.

The plan should be presented in a public document that serves to demonstrate to the community that the agency (and public interest groups and the facility owner, if involved) listened to specific community concerns and developed a specific program around those concerns. EPA encourages permitting agencies to seek input from other stakeholders during development of the plan. The facility owner and public interest groups can provide information about their planned activities and the community representatives can suggest the types of activities, information channels, and logistics that will work best in the area.

Revisions of all or parts of the public participation plan for a facility may be done in order to incorporate new information, reflect changes in community concern, and adjust public participation activities to meet these changes. A revision ensures that the plan remains sensitive to citizens' concerns through the final phases of a permit determination or a corrective action. It can also evaluate which public participation activities were effective and which were not.

When to Use

Public participation plans may be prepared:

- At the beginning of the RCRA process (e.g., for facilities seeking a permit or facilities beginning corrective action) to schedule activities

and assign responsibilities;

- After community interviews (if conducted).

Public participation plans should be revised:

- When a significant change in community concerns or activities at the facility occurs (e.g., after a remedy is selected or the facility proposes a significant permit modification); and

- At least every two years for longer-term projects.

Accompanying Activities

Although they are not necessary in every case, **community interviews** can be very helpful when writing a plan. The plan typically includes the **mailing list** and provides the locations of the **information repositories** and **public hearings** .

Advantages and Limitations

Public participation plans establish a record of community concerns and needs and a set of activities to meet those needs. Because the plans are community-specific, they ensure that the community gets the information they need in a fashion that is most useful and they assist the project staff in making the most efficient use of their time when interacting with the public.

The plan represents the agency's commitment to dedicate significant resources to the activities specified; thus, agency staff should make certain that resources are available to implement all activities identified in the plan. The plan should not schedule activities that the agency will not be able to conduct.

Community concerns can change significantly and may require that the public participation plan be revised periodically. The plans should be seen as "evolving" documents. The agency may need to revise the plan often, conducting new community interviews each time. At the least, the agency should be prepared to revise activities or expand activities as the project proceeds.

Revising the plan will help to ensure that the agency continues to respond to citizens' concerns during long-term projects. Minor changes also can help a public participation planner; for example, the contacts list can incorporate changes in addresses, new telephone numbers, and the names of new officials.

Checklist for Public Participation Plans

As applicable:

- __ Review facility background file and other information sources
- __ Review comments gathered during the community interviews
- __ Coordinate with other key stakeholders to discuss the plan
- __ Write draft plan
  - __ Introduction -- explains the purpose of the document
  - __ Project History -- provides an overview of the project, its technical and regulatory history, and a history of past community concerns and involvement in the project (if available)
  - __ Community Concerns -- summary of the concerns identified during the community interviews
  - __ Objectives of the Plan -- explains the major objectives relating to specific concerns outlined in the previous section of the document
  - __ Public Participation Activities -- describes the specific activities to be conducted to meet the objectives of the plan and schedule
  - __ Appendices -- provide information on key contacts, media, public meeting and information repository locations.
- __ Coordinate internal review of plan
- __ Solicit community input on the plan
- __ Prepare final plan based on comments
- __ Distribute plan to information repositories if they exist, or make the plan available to the public in a convenient place

Public Notices

Regulatory Requirements

The permitting agency must give official public notice when issuing the draft permit (§ 124.10(c)), holding a public hearing under § 124.12, or when an appeal is granted under § 124.19. This notice must be sent by the agency to all relevant units of federal and local government, the applicant, and all parties on the facility mailing list. In addition, the notice must be broadcast over local radio stations and published in a daily or weekly major local newspaper of general circulation.

A prospective permit applicant must issue a similar, but broader, public notice to announce the pre-application meeting (§ 124.31). This notice must be published as a display advertisement in a paper of general circulation and must be sent to the permitting agency and appropriate units of local government. The applicant must also post the notice as a sign at or near the facility, and as a broadcast media announcement. The notice must include the name, address, and telephone number of a contact person for the applicant.

The facility owner/operator must provide public notice for permit modfications (including modifications to incorporate corrective action provisions) under § 270.42. For a class 1 modification, the facility must notify the facility mailing list. For a class 2 modification, the facility must notify the mailing list and publish a newspaper notice when requesting the modification. The permitting agency must notify the mailing list within 10 days of granting or denying a modification request. For a class 3 modification, the facility must publish a newspaper notice and notify the mailing list when requesting a modfication. The permitting agency must follow the procedures for modifications in part 124 when granting or denying the class 3 permit modification. The permitting agency will also notify people on the mailing list and State and local government within 10 days of any decision to grant or deny a Class 2 or 3 modification request. The Director also must notify such people within 10 days of an automatic Class 2 modification goes into effect under § 270.42(b)(6)(iii) or (v).

If the permitting agency initiates the permit modification, under § 270.41, then the agency must follow the notice requirements for a draft permit in § 124.10(c) (see above in this section). Agency-initiated modifications may include modifications during the corrective action process.

If the permitting agency requires a facility to establish an information repository under § 124.33 or § 270.30(m), the agency Director will specify notice requirements. At the least, the facility will provide written notice to the people on the mailing list.

Permitting agencies must also provide provide public notice during the trial burn stage at permitted and interim status combustion facilities (§ 270.62(b)

and (d); 270.66(d)(3) and (g)) and when an interim status facility undergoes closure or post-closure (see §§ 265.112(d)(4) and 265.118(f)).

Description of Activity

Public notices provide an official announcement of proposed agency decisions or facility activities. Notices often provide the public with the opportunity to comment on a proposed action.

Most RCRA notices contain essentially the same types of information. Where they differ is in how they are distributed by the agency or the facility. Some go to members of the mailing list, some as legal advertisements in the newspaper, and some others as signs or radio advertisements. In all cases, EPA encourages facilities and permitting agencies to make a good faith effort to reach all segments of the affected community with these notices. As we mention earlier in this manual, any organization that wants to provide public notice has a number of inexpensive and simple options available to it, including: free circulars; existing newsletters or organzation bulletins; flyers; bulletin boards; or storefront signs.

There are many effective ways to spread information. However, the job of anyone giving notice is to find out what information pathways will be most effective in a particular community. Public interest groups, the facility, and the permitting agency should seek community input on this topic. The citizens of that community are the most qualified people to explain what methods will work best in their community. **Community interviews** are one way to learn more about how the citizens communicate.

The following are the most common ways to give public notice:

- Newspaper Advertisements . Traditionally, public notices have often appeared as legal advertisements in the classified section of a newspaper. While this method provides a standard location for the ads, display advertisements (located along with other commercial advertisements) are more likely to reach a larger audience. Display advertisements offer an advantage over legal classified ads since they are larger, easier to read, and are more likely to be seen by the casual reader. A sample is available in Appendix H of this manual.
- Newspaper Inserts . Inserts stand out from other newspaper advertisements since they come as a “loose” section of the newspaper (a format often used for glossy advertisements or other solicitations). They provide a way to reach beyond the most-involved citizens to inform a broader segment of the community.
- Free Publications and Existing Newsletters . Placing a notice in a newsletter distributed by a local government, a civic or community organization, or in a free publication (e.g., a paper that highlights local or community activities) is a generally inexpensive way to target a specific audience or segment of the community. Some publications may not be appropriate for communicating information from your

organization. By publishing information through a group that has a specific political interest or bias, your organization may be perceived as endorsing these views. Permitting agencies may want to avoid associations with groups that appear to represent the agency's interests. In any case, the relationship between your organization and the newsletter or publication should be clear to the public.

You may want to consider some of the following options. Local governments sometimes send newsletters or bulletins to their entire population; such newsletters can reach an entire affected community. Planning commissions, zoning boards, or utilities often distribute regular newsletters; they may be willing to include information about permitting activities. Newsletters distributed by civic, trade, agricultural, religious, or community organizations can also disseminate information to interested readers at low cost. Some segments of the affected community may rely on a free local flyer, magazine, independent or commercial newspaper to share information.

- Public Service Announcements . Radio and television stations often broadcast, without charge, a certain number of announcements on behalf of charities, government agencies, and community groups. In particular, they are likely to run announcements of public meetings, events, or other opportunities for the public to participate. One drawback with a public service announcement is that you have no guarantee that it will go on the air. If it does go on the air, it may come at odd hours when relatively few people are listening.
- Broadcast Announcements and Advertisements . A number of RCRA notices must be broadcast over radio or another medium. Beyond these requirements (which are further explained below and in the section on “Notice of the Pre-Application Meeting” in Chapter 3), you may consider providing notice via a paid TV advertisement or over a local cable TV station. Paid advertisements can be expensive and may be seen by the public as taking a side. You can avoid this drawback by limiting information to the facts (e.g., time, date, location of the meeting). Some local access cable TV stations run a text-based community bulletin board, which may provide a useful way to distribute information.
- Signs and Bulletin Boards . The notice requirements for the pre-application meeting (§ 124.31) require posting of a visible and accessible sign. Signs can be a useful means of public notice, especially for residents and neighbors of the facility or planned facility. A sign on the site should be large enough so that passers-by, whether by foot or by vehicle, can read it. If few people are likely to pass by the site, consider posting the sign at the nearest major intersection. Another option is to place posters or bulletins on community bulletin boards (in community centers, town halls, grocery stores, on heavily-travelled streets) where people are likely to see them. The signs should contain the same information as a written or broadcast notice.

- Telephone Networks or Phone Trees . This method provides an inexpensive, yet personal, manner of spreading information. The lead agency, facility, or organization calls the first list of people, who, in turn, are responsible for calling an additional number of interested people. Phone trees are a good way to provide back up plans or reminders while reducing the number of calls made by individual staff members. As an alternative to calling the first tier, the lead agency, facility, or organization may want to distribute a short written notice.

Level of Effort

Preparing a public notice and arranging for its publication takes a day or two, depending on the need for review. Producing a television or radio ad, or building a sign will take longer, depending on the situation.

How to Conduct the Activity

To prepare a public notice:

1. **Identify the major media contacts.** While there may be many daily newspapers serving a particular area, use only one or two for the public notice. In general, use the newspaper with the widest circulation and greatest visibility in order to reach the most people and elicit the greatest response. In some cases, you may want to choose specific newspapers to reach target audiences; find out what papers the affected community reads and place your notices there. Use a similar strategy for notices in the broadcast media. If you are giving notice via more than one media, you have more flexibility for reaching specific audiences. See the section on "Notice of the Pre-Application Meeting" in Chapter 3 for more information.

2. **Take into account publication schedules.** Many local or community newspapers are published on a weekly or bi-weekly basis. This may make it difficult to coordinate the publication of the notice with the event. In such a case, consider using a city-wide newspaper that is published more frequently. If the city-wide paper is not likely to reach all segments of the affected community, you should make efforts to supplement the newspaper notice with other means of notice (e.g., signs or broadcast media).

3. **Include the following information in the public notice:**

   - Name and address of the facility owner/operator;
   - A brief description of the business conducted at the facility and the activity that is the subject of the notice;
   - Name, address and telephone number of an individual who can be contacted for further information on the activity;
   - A brief description of the comment procedures and the date, time, and place of any hearing;

- If the permit is issued by EPA, the location of the administrative record and the times when it is open for public inspection; and
- Any additional information considered appropriate.

Also, try to format the notice so that it is eye-catching. A logo can help.

4. **Announce dates, times, and locations clearly in the public notice.** When announcing an event such as a hearing, make sure that the date and time do not conflict with other public meetings, religious or non-religious holidays, or other important community events.

5. **Provide ample notice.** For RCRA permits, the public notice must allow at least 45 days for public comment. Public notice of a public hearing must be given at least 30 days prior to the hearing. Be sure to state the opening and closing dates for comment periods.

6. **If possible, review a typeset version of the notice before it is published to ensure accuracy.**

7. **Keep proof of the notice for your files.** Newspapers often can provide "tear sheets" as a record of the notice. Similar proofs are available from radio or television stations. You should consider keeping photgraphs of posted signs.

When to Use

The "Regulatory Requirements" section above reviews the mandatory public notices. In addition, agency personnel can use informal public notices to announce other major milestones or events in the permit review or corrective action process. Permitting agencies may also want to use public notices when they are establishing mailing lists. The facility must issue notices when it requests a permit modification, holds a pre-application meeting, or establishes an information repository.

Public notices can be useful for any organization involved in the RCRA permitting process. Whenever a public interest organization is planning an activity, or would like to supplement notices given by the facility or the agency, you may want to consider using one of the public notice methods in this manual. Notices can also help build your mailing lists.

Accompanying Activities

Public notices are used to announce **public comment periods** and **public hearings**. They can also be used to announce other meetings and milestones, opportunities to join the **mailing list**, as well as the availability of an **information repository**, **fact sheets**, or other permitting information.

Advantages and Limitations

Public notices are an efficient, simple means of alerting the public to important events. However, public notices should never substitute for other activities that involve direct communication with the public.

Public notices can be more effective, and provide more of a feedback loop, when they are combined with a means of gathering information from the public. Every notice should contain a **contact person** so that the public can direct comments or questions to the agency, the facility, or other stakeholder groups.

See "Description of Activity" above in this section for advantages and limitations of specific notice methods.

Checklist for Public Notices

__ Compile information to be included in the public notice:

- __ Name of agency overseeing the permit or corrective action
- __ Name, address, and phone number of contact person
- __ Facility owner/operator and description of facility activities
- __ Purpose of public notice
- __ If applicable provide the date, time, and location of public hearing (or meeting)
- __ Description of the procedures governing the public's participation in the process

__ Draft the public notice, announcement, or advertisement

__ Coordinate review of the draft public notice

__ Prepare final public notice

__ Receive final approval of public notice

__ Coordinate placement of the public notice in the local newspaper(s), coordinate distribution of the public notice to the facility mailing list, submission to radio/television stations or other publications (as applicable)

For publication in local newspaper(s):

Name of Newspaper	Publication Days	Advertising Deadline

__ Prepare procurement request or advertising voucher for public notice publication

__ Obtain price quotes (i.e., cost per column inch)

__ Determine size of public notice _____

__ Determine deadlines for publication of the public notice

__ Submit for publication

__ Request proof of publication; file proof in facility file

Checklist for Public Notices (continued)

For distribution to the mailing list:

__ Verify that facility mailing list is up-to-date

__ Produce mailing labels

__ Distribute to the mailing list

For broadcast on local radio/television stations:

___ Verify media list

___ Prepare procurement request or advertising voucher for public notice spots

___ Obtain price quotes

___ Distribute to stations

___ Request proof of airing and file in facility file

Translations

Regulatory Requirements

None. EPA strongly recommends using multilingual fact sheets, notices, and other information (as appropriate) to provide equal access to information in the permitting process.

Description of Activity

Translations provide written or oral information in a foreign language to a community with a significant number of residents who do not speak English as a first language. There are two types of translations:

- A written translation of materials originally written in English;
- A simultaneous verbal translation (i.e., word by word) of a public meeting or news conference, usually with small headsets and a radio transmitter.

Translations ensure that **all** community members are informed about activities at a facility and have the opportunity to participate in the decision-making process.

Level of Effort

The amount of time needed to translate a document depends on the length of the document and the complexity of the information in the document. You should allow at least several days for translation.

How to Conduct the Activity

To develop a successful translation:

1. **Evaluate the need** for a translation. Evaluate the demographic characteristics of the community as well as the type of public participation activities being planned. Consider whether citizens' ability to take part in an activity is limited by their inability to speak or understand English.

2. **Identify and evaluate translation services** . A successful translation depends on the skill of the translator. More problems may be created than solved if inaccurate or imprecise information is given. Many translators will not be familiar with the technical terms associated with hazardous materials and few, if any, will be familiar with the RCRA permitting and corrective action processes. This problem may be further compounded in the case of oral translations (especially simultaneous translations) as there is no time for review or quality control. Thus, it is necessary to contract someone with experience in translating technical information and check the translator's work to ensure that the content and tone are in keeping with the intent. You also need to ensure that the translator uses the same dialect as those in your intended audience.

3. **Avoid the use of jargon or highly technical terms** . As a matter of standard practice, a staff member should go over in advance all technical and RCRA terms that may cause problems with the translator.

4. **For verbal presentations, public meetings, and news conferences, plan what to say ahead of time** . If the translator has a prepared written speech to work with in advance, there is more time to work out any vocabulary "bugs" and thereby reduce the chances of faltering over unfamiliar material or making inaccurate word choices. If possible, practice with the translator before the actual meeting or presentation date.

5. **Anticipate questions from the audience and reporters** , and have at least the technical aspects (e.g., chemical names, statistics) of the answers translated in advance.

When to Use

A translation can be used:

- When a signficant portion of the community does not speak English as a first language. A written translation should be provided for fact sheets or letters, unless a presentation or public meeting would be more appropriate (e.g., the literacy rate among the foreign-speaking community is low).
- Verbal translations are recommended where there is considerable concern over the facility, extreme hostility, or suspicion of the agency's efforts to communicate with community members.

Accompanying Activities

The need for translations is often determined during the community assessment and **community interviews** . Translations are generally used for **fact sheets** , **public notices** , **presentations** , **public meetings** , **public hearings** , and **news conferences** .

Advantages and Limitations

Written translations and use of translators ensure that a greater number of community members can participate effectively in the process and, therefore, provide input to decisions concerning the RCRA-regulated process. This effort assures the community of your organization’s sincerity in providing opportunity for public participation.

Translations are very costly, especially simultaneous translations of public meetings. Sentence-by-sentence oral translations frequently double the length of public meetings, and may make information more difficult to present effectively and smoothly. In addition, very few translators are familiar with the RCRA permitting and corrective action processes. For facilities having highly volatile or sensitive problems, it may be difficult to communicate your organization’s position and involve community

members in a constructive dialogue.

Checklist for Translations

- __ Determine need for translations
- __ Identify translation service or identify staff to provide translating services
- __ Fact sheet translations
  - __ Provide English text (including text for graphics, headlines, fact sheet flag)
- __ Meeting translations
  - __ Determine if translation will be simultaneous or if translations will occur following statements.
  - __ If simultaneous, provide audio equipment for translator/participants
  - __ Prepare list of technical and RCRA terms that will need to be translated
  - __ Prepare, in advance with the translator, presentations, responses to questions

Mailing Lists

Regulatory Requirements

The permitting agency must establish and maintain the facility mailing list in accordance with § 124.10(c)(1)(ix). The agency must develop the list by: (a) including people who request in writing to be on the list; (b) soliciting persons for "area lists" from participants in past permit proceedings in that area; and (c) notifying the public of the opportunity to be put on the mailing list through periodic publication in the public press and in such publications as Regional- and State-funded newsletters, environmental bulletins, or State law journals.

Description of Activity

Mailing lists are both important databases and essential communication tools. Mailing lists ensure that concerned community members receive relevant information. They allow messages to reach broad or targeted audiences. The better the mailing list, the better the public outreach and delivery of information. Mailing lists typically include concerned residents, elected officials, appropriate federal, state, and local government contacts, local media, organized environmental groups, civic, religious and community organizations, facility employees, and local businesses.

It is recommended that you develop an internal distribution list at the same time you prepare your external mailing list. The distribution list for permitting agencies should include all technical project staff, public involvement staff, legal staff, and staff from other affected programs (Air, Water, etc.), as appropriate. This list will help ensure that all relevant project staff receive the same information about all phases of the project. Facilities and community organizations should follow similar procedures to keep their staffs and members informed.

Level of Effort

A mailing list can be developed in conjunction with other public participation activities. Depending on the size of the list, inputting information into a data base can take several days. Updating will require approximately half a day per quarter.

How to Conduct the Activity

To develop and update a mailing list, consider the following:

1. **Solicit names, addresses, and phone numbers of individuals** to be included on the list. This should include individuals who put their names and addresses on the sign-in sheet at the pre-application meeting, if applicable. Telephone numbers are useful to have so that you can contact these individuals for community interviews and to aid you when you update your list.

   Individuals to include in your mailing list:

- The people interviewed during community interviews, as well as other names these people recommend;
- All nearby residents and owners of land adjacent to the facility;
- Representatives of organizations with a potential interest in an agency program or action (e.g., outdoor recreation organizations, commerce and business groups, professional/trade associations, environmental and community organizations, environmental justice networks, health organizations, religious groups, civic and educational organizations, state organizations, universities, local development and planning boards, emergency planning committees and response personnel, facility employees);
- Any individual who attends a public meeting, workshop, or informal meeting related to the facility, or who contacts the agency regarding the facility;
- Media representatives;
- City and county officials;
- State and Federal agencies with jurisdiction over wildlife resources;
- Key agency officials; and
- The facility owner/operator.

2. **Review background files** to ensure all interested individuals are included on the mailing list.

3. **Input information into a computer system** so that it can be categorized and sorted and printed on mailing labels.

4. **Send a letter or fact sheet to the preliminary mailing list developed using 1) and 2) above.** Inform key Federal, State, and local officials, citizens, and other potentially interested parties of your activities and the status of upcoming permit applications or corrective actions. Ask whether they wish to receive information about this facility. Ask them for accurate addresses and phone numbers of other people who might be interested in the project.

5. **Update your mailing list** at least annually to ensure its correctness. Mailing lists can be updated by telephoning each individual on the list, and by using local telephone and city directories as references. The permitting agency can update the official mailing list from time to time by requesting written indication of continued interest from those listed. The agency can then delete any people who do not

respond (see § 124.10(c)(1)(ix)(C)).

See the section on "The Facility Mailing List" in Chapter 3 for more information.

When to Use

A mailing list is a required public participation activity for permitting. Additional people may want to join the list if corrective action will take place at a facility. Public interest groups or other involved organizations often have mailing lists.

- Develop a mailing list as soon as possible during the permit application phase, or as soon as the need for a RCRA Facility Investigation is identified.
- Update the mailing list regularly.

Develop a distribution at the same time you develop a mailing list.

Accompanying Activities

Mailing lists are useful in identifying individuals to contact for community interviews. They are also needed to distribute **fact sheets** and other materials on the facility. **Public notices** and sign-up sheets at **public meetings** or **information repositories** can help you build mailing lists.

Advantages and Limitations

Mailing lists provide the names of individuals and groups interested in activities at RCRA facilities. However, lists can be expensive and time-consuming to develop, and they require constant maintenance.

Checklist for Mailing Lists

Mailing List Development:

__ Verify the list format (i.e., name, title, company, address, phone number)

__ Consider issuing a public notice to solicit names for the mailing list

__ Identify people to be included on the list:

- __ People who signed the attendance sheet at the pre-application meeting (if applicable)
- __ City elected officials (mayor and council)
- __ City staff and appointees (city manager, planning director, committees)
- __ County elected officials (supervisors)
- __ County staff and appointees (administrator, planning director, health director, committees)
- __ State elected officials (senators, representatives, governor)
- __ State officials (health and environment officials)
- __ Federal elected officials (U.S. Senators, U.S. Representatives)
- __ Federal agency officials (EPA)
- __ Residents living adjacent to facility
- __ Other interested residents
- __ Media
- __ Business groups of associations
- __ Businesses possibly affected by the facility (i.e., located down-wind of facility)
- __ The facility owner/operator
- __ Consultants working on the project or related projects
- __ Local environmental groups
- __ Other civic, religious, community, and educational groups (e.g., League of Women Voters, government associations, churches, homeowners and renters associations)
- __ State and Federal Fish and Wildlife Agencies

Checklist for Mailing Lists (continued)

__ Have list typed

__ Prepare mailing list

__ Store on computer data base

Mailing List Updates:

__ Verify names/addresses by searching telephone directory

__ Verify names/addresses by searching city directory

__ Verify names/addresses by calling each individual

__ Consider issuing a notice asking for written indication of continued interest (§ 124.10(c)(1)(ix)(C))

Notices of Decision

Regulatory Requirements

RCRA requires the permitting agency to issue a notice of decision to accompany the final permit decision (under § 124.15 procedures). The agency must send the notice to the permit applicant and to any person who submitted written comments or requested notice of the final permit decision (§ 124.15). Note that Class 3 modifications and the corrective action final remedy selection also follow § 124.15 procedures and require a Notice of Decision.

Description of Activity

A notice of decision presents the agency's decision regarding permit issuance or denial or modification of the permit to incorporate changes such as the corrective action remedy.

Level of Effort

A notice of decision may take several days to write and review, depending on the complexity. Allow time for several rounds of revisions. If you need to develop graphics, such as site maps, allow time to produce the graphics.

How to Conduct the Activity

The notice should briefly specify the agency's final decision and the basis for that decision. The notice must also refer to the procedures for appealing a decision. Notices of decision must be sent to the facility owner/operator (permit applicant) and each person who submitted written comments or requested notice of the final permit decision. You may want to send the notice to other interested parties as well. Final permits generally become effective 30 days after the notice of decision.

When to Use

- When a permit decision has been finalized following the 45-day public comment period;
- When the permitting agency makes its final decision regarding a permit modification.

Accompanying Activities

A **response to comments** document must be issued at the same time the final permit decision is issued.

Advantages and Limitations

The notice of decision provides a clear, concise public record of the decision. However, the notice of decision should not be a substitute for other activities that involve direct two-way communication with the public.

Checklist for Notices of Decision

- __ Determine contents of the notice of decision
  - __ Decision made and basis for that decision
  - ___ Information on appeal procedures
- __ Coordinate writing the notice with technical and legal staff
  - __ Technically accurate
  - __ Satisfies statutory requirements
  - __ Provides the public with all necessary information in a clear and concise manner
- __ Coordinate internal review of notice of decision
- __ Prepare final notice of decision based on internal review comments
- ___ Notify the facility owner/operator and anyone who submitted written comments or requested notice of the final decision
- __ Notify other interested parties of the decision
- __ Place copy of the notice of decision in the administrative record and the information repository (if one exists)

Introductory Notices

Regulatory Requirements

While EPA regulations do not specifically require an introductory notice, § 124.32 provides for an agency notice at the time of application submittal. Permitting agencies may want to consider the guidance in this section (in addition to the § 124.32 requirements) when preparing the notice at application submittal. Chapter 3 provides guidance specifically for the notice at application submittal.

Description of Activity

An introductory notice explains the agency's permit application review process or the corrective action process and the opportunities for public participation in that process.

Level of Effort

The amount of time needed to prepare an introductory notice is based on whether the notice is prepared as a public notice or a fact sheet. If prepared as a public notice, allow a day or two for writing, review, and placement in newspapers and other media. If prepared as a fact sheet, allow several days to a week to write and review, depending on the layout and graphics used, and several days for printing.

How to Conduct the Activity

To prepare an introductory notice:

1. **Determine the best method to explain the permit application review or corrective action process.** An introductory notice can be presented as a public notice, a fact sheet, or a flier distributed to the facility mailing list.

2. **Prepare and distribute the notice.** Coordinate the writing and distribution of the notice with technical project staff. Take care to write the notice avoiding technical terms and jargon.

3. **Include an information contact.** Provide the name, address, and phone number of a contact person who the public can call if they have questions or need additional information about the facility. You might add a return slip to the notice for people to complete and return to your organization if they would like additional information or to be placed on a mailing list.

When to Use

An Introductory Notice can be used:

- When you find the community knows little or nothing about the RCRA process; and

- When you need to notify the public of how they can become involved in the RCRA process.

Accompanying Activities

Informal meetings , **availability sessions/open houses** , or **workshops** may be conducted following release of the notice.

Advantages and Disadvantages

An introductory notice informs the public about the agency's permit application review process and how they can be involved in the process. However, the notice is a one-way communication tool. A **contact person** should be identified in the notice so that interested members of the community can call this person if they have questions.

Checklist for Introductory Notices

- __ Determine how you will distribute the notice.
  - __ Public notice in newspaper
  - __ Fact sheet or flier sent to the mailing list
- __ Prepare draft introductory notice
- __ Include name and phone number of a contact person
- __ Coordinate internal review of introductory notice
- __ Write final introductory notice based on comments received during the internal review
- __ Verify facility mailing list is up-to-date
- __ Request mailing labels
- __ Distribute introductory notice

Fact Sheets/ Statements of Basis

Regulatory Requirements

EPA's regulations require the agency to develop a fact sheet or a statement of basis to accompany the draft permit. The agency will develop a fact sheet for any major hazardous waste management facility or facility that raises significant public interest (§ 124.8). The agency must prepare a statement of basis for every draft permit for which a fact sheet is not prepared (§ 124.7). Note that these requirements also apply to Class 3 modifications and agency-initiated modifications (such as the agency may use at remedy selection), which must follow the part 124 procedures. Specific requirements for these activities are described below under "How to Conduct the Activity."

Description of Activity

RCRA-required fact sheets and statements of basis summarize the current status of a permit application or corrective action. This required fact sheet (or statement of basis) is probably different than the commonly-used informational fact sheets that most people recognize. The required fact sheet must explain the principal facts and the significant factual, legal, methodological and policy questions considered in preparing the draft permit. They can vary in length and complexity from simple two-page documents to 12-page documents complete with graphic illustrations and glossaries.

The agency and other stakeholder groups may find it useful to develop other fact sheets to be used in public participation activities. These informal/informational fact sheets can explain difficult aspects of the permitting process or provide technical information in language that an ordinary person can understand. These fact sheets may come in many different varieties and levels of detail.

Fact sheets are useful for informing all interested parties about the basis for the permitting agency's decision regarding a facility permit or proposed corrective action activities. They ensure that information is distributed in a consistent fashion and that citizens understand the issues associated with RCRA programs.

Statements of basis are generally shorter than fact sheets and summarize the basis for the Agency's decision. Statements of basis are often used in the corrective action program to summarize the information contained in the RFI/CMS reports and the administrative record. They are designed to facilitate public participation in the remedy selection process by:

- Identifying the proposed remedy for a corrective action at a facility and explaining the reasons for the proposal.

- Describing other remedies that were considered in detail in the RFI and CMS reports.
- Soliciting public review and comment on all possible remedies considered in the RFI and CMS reports, and on any other plausible remedies.
- Providing information on how the public can be involved in the remedy selection process.

In emphasizing that the proposed remedy is only an initial recommendation, the statement of basis should clearly state that changes to the proposed remedy, or a change from the proposed remedy to another alternative, may be made if public comments or additional data indicate that such a change would result in a more appropriate solution. The final decision regarding the selected remedy(ies) should be documented in the final permit modification (if applicable) with the accompanying response to comments after the permitting agency has taken into consideration all comments from the public.

Level of Effort

Fact sheets and statements of basis may take from two days to two weeks to write, depending on their length and complexity. Allow time for several rounds of revisions. Allow three days for printing. (Short Cut: Use already developed RCRA templates with graphics that are on file at your agency).

How to Conduct the Activity

The first step in preparing a fact sheet is to determine the information to be presented. EPA decisionmaking regulations require that RCRA permit fact sheets contain the following types of information:

- A brief description of the type of facility or activity which is the subject of the draft permit;
- The type and quantity of wastes covered by the permit;
- A brief summary of the basis for the draft permit conditions and the reasons why any variances or alternatives to the proposed standards do or do not appear justified;
- A description of the procedures for reaching a final decision, including the beginning and ending dates of the public comment period and the address where comments can be sent, and procedures for requesting a public hearing; and
- Name and telephone number of a person to contact for additional information.

A statement of basis is prepared the same way as a fact sheet. The statement of basis summarizes essential information from the RFI and

CMS reports and the administrative record. The RFI and CMS reports should be referenced in the statement of basis. The statement of basis should:

- Briefly summarize the environmental conditions at the facility as determined during the RFI.
- Identify the proposed remedy.
- Describe the remedial alternatives evaluated in sufficient detail to provide a reasonable explanation of each remedy.
- Provide a brief analysis that supports the proposed remedy, discussed in terms of the evaluation criteria.

Select a simple format for presenting the information. Avoid using bureaucratic jargon, acronyms, or technical language in the text, and be concise.

Use formatting techniques to make the fact sheet or statement of basis more interesting and easy-to-read. People are less likely to read a fact sheet or statement of basis consisting of a solid sheet of typed text than one with clear, informative illustrations. Moreover, a well-designed document suggests that the permitting agency takes its public participation program seriously.

Coordinate the production of these documents with technical project staff. Technical staff should review them to ensure that the information conveyed is accurate and complete. Outreach staff should review them to ensure that the communication goals are being met.

Arrange for printing and distribute copies of the fact sheet or statements of basis to the mailing list, place extra copies at the information repository, and distribute additional copies at public meetings and hearings.

When to Use

While fact sheets/statements of basis are required for draft permits, they can also be helpful at other times in the permitting and corrective action processes:

- During technical review of the permit application;
- At the beginning of a RCRA facility investigation;
- When findings of the RCRA facility investigation are available;
- When the corrective action is completed; and
- When the Notice of Decision is released.

In addition, fact sheets can be written to explain a facility inspection or

emergency action, a new technology, or a community-based activity.

Fact sheets and statements of basis can be particularly useful in providing background information prior to a public meeting or public hearing.

Accompanying Activities

Fact sheets and statements of basis are generally used in conjunction with the **mailing list**, **public notices**, **public comment periods**, and **public meetings** and **hearings**. However, as stated above, they can be helpful at almost any stage in the permitting or corrective action processes.

Advantages and Limitations

Fact sheets and statements of basis are effective in summarizing facts and issues involved in permitting and corrective action processes. They communicate a consistent message to the public and the media. Produced throughout the permitting or corrective actions processes, they serve to inform the public about the regulatory process as well as the technical RCRA issues and can aid in creating a general community understanding of the project. They are relatively inexpensive and can be distributed easily and directly to the mailing list. In addition, fact sheets and statements of basis can be tailored to meet specific information needs identified during community assessments.

However, a poorly written fact sheet or statement of basis can be misleading or confusing. Documents of this type that are not written in an objective style can be perceived as being too "persuasive" and considered "propaganda" by mistrusting communities. Remember that fact sheets and statements of basis are a one-way communication tool, and therefore should always provide the name and telephone number of a contact person to encourage comments and questions.

Checklist for Fact Sheets/Statements of Basis

- __ Determine purpose and focus of fact sheet or statement of basis
- __ Develop outline
  - __ Organize contents in a logical manner
  - __ Determine appropriate graphics
- __ Verify mailing list is up-to-date
- __ Request mailing labels
- __ Coordinate preparation of fact sheet or statement of basis with technical staff as appropriate
  - __ Draft text
  - __ Draft graphics
  - __ Draft layout
  - __ Place mailing coupon on reverse side of mailing label
- __ Coordinate internal review of fact sheet or statement of basis
- __ Incorporate revisions into final fact sheet or statement of basis
- __ Proofread final fact sheet or statement of basis
- __ Arrange printing of fact sheet or statement of basis
  - __ Select paper weight, ink color, and color paper
- __ Print fact sheet or statement of basis
- __ Distribute fact sheet or statement of basis to the mailing list and place additional copies in the repository

Project Newsletters and Reports

Regulatory Requirements

None.

Description of Activity

Project newsletters and reports are means of direct communication that keep interested people informed about corrective action and permitting activities. Both publications provide a level of project detail that is not usually available from the news media. A project newsletter uses a reader-friendly, news-based format to provide regular updates on activities in the permitting process and actions taking place at the facility. Project reports may include official technical reports or other environmental documents and studies related to a particular facility. Sending these reports directly to key stakeholders can spread information more effectively than simply placing the documents in an information repository.

Level of Effort

Newsletters can require significant amounts of staff time and resources to write, copy, and distribute. Direct transmission of reports will require less staff time, but may cost more to copy and distribute.

How to Conduct the Activity

To provide a project newsletter or project reports:

1. **Assign a staff person to produce the newsletter.** Instruct project staff to direct relevant information and reports to this person.

2. **Decide on a format and style for the newsletter.** Evaluate the resources you have available for the newsletter and decide what type of newsletter you will produce. Keep in mind that a visually-attractive newsletter with plenty of graphics and simple language is more likely to be read. Avoid bureaucratic or technical jargon. The newsletter should contain real news that is useful to people. Since people who are not familiar with the project may pick up the newsletter, write it so that first-time readers can understand it.

3. **Provide for review.** Permitting agencies, in particular, will want to ensure the credibility of their newsletters by making sure that they are objective. In such cases, you may consider asking a **citizen advisory group**, a consultant, or a non-partisan civic group (e.g., the League of Women Voters), to review the document. If the public has concerns over the credibility of your organization, it may be beneficial for the citizens advisory group or a neutral body to produce the newsletter. An objective newsletter should candidly report all developments at the facility.

4. **Summarize detailed reports.** If you are distributing a technical report, you should consider including a summary. Another option is to include findings in the project newsletter and allow people to send in a clip-out request form or contact your staff for copies of the full report.

5. **Check your mailing list.** Make sure that your mailing list is up to date and includes all interested stakeholders and media contacts (see the section on **Mailing Lists** above).

6. **Update your mailing list.** Project newsletters may continue for a number of years. You should consider updating your mailing list by including an "address-currency" card in the newsletter on a regular basis (e.g., once a year). By sending in this card, people will continue to receive the newsletter.

When to Use

Project newsletters and reports can provide detailed information about a facility that is not usually available in the media. These methods may be most useful when:

- there is a high level of public interest in a facility;
- when many citizens do not have access to an information repository, or a repository has not been established;
- you would like to maintain project visibility during extended technical studies; or
- presenting the results of detailed studies through a newsletter will better inform the public.

Accompanying Activities

A **mailing list** is essential for distribution of reports and newsletters. You should consider **availability sessions** , **open houses** , or **informal meetings** to explain the results of detailed reports and studies. Always include a **contact person** in the newsletter or report.

Advantages and Limitations

Newsletters and project reports are useful ways to disseminate important information to stakeholders. Making reports widely available can enhance their credibility.

Newsletters may require significant amounts of staff time and resources. Direct distribution of technical reports may create confusion if they are not accompanied by a summary.

Checklist for Project Newsletters and Reports

- __ Assign a staff person to be in charge of producing the newsletter or reports
- __ Direct the project staff (e.g., through a memo) to forward all relevant project information to the newsletter director
- __ Decide on format, style, and frequency of distribution
- __ Draft the newsletter
- __ Review the newsletter for content, style, simple language, and visual appeal
- __ (If applicable) Send the newsletter to an assigned neutral party for review
- __ If you produce detailed project studies or reports, write a summary in simple language and attach to the report or include the summary in the newsletter
- __ Distribute the newsletter to the mailing list
- __ Update the mailing list on a regular basis

Response to Comments

Regulatory Requirements

According to § 124.17, the permitting agency must prepare a response to comments at the time that it issues a final permit decision. The agency will also issue a response to comments when making final decisions on requested Class 2 and 3 permit modifications under § 270.42 and agency-initiated modifications under § 270.41.

Description of Activity

A response to comments identifies all provisions of the draft permit or modification that were changed and the reasons for those changes. It also briefly describes and responds to all significant comments on the draft permit that were received during the public comment period.

The response to comments should be written in a clear and understandable style so that it is easy for the community to understand the reasons for the final decision and how public comments were considered.

Level of Effort

A response to comments can be a time-intensive activity because of the large amount of organization, coordination, and review needed. On average, allow several hours per comment for completion, as some questions may take only a few minutes to answer while others may involve in-depth technical and legal responses. In general, preparing response to comments documents can take from several days for low-interest facilities to several weeks for high-interest facilities.

How to Conduct the Activity

There is no required format for preparing response to comments documents. However, several EPA Regions have adopted a two part approach:

- Part I is a summary of commenters' major issues and concerns and expressly acknowledges and responds to those issues raised by the local community. "Local community" means those individuals who have identified themselves as living in the immediate vicinity of a facility. These may include local homeowners, businesses, the municipality, and facility employees. Part I should be presented by subject and should be written in a clear, concise, easy to understand manner suitable for the public.

- Part II provides detailed responses to all significant and other comments. It includes the specific legal and technical questions and, if necessary, will elaborate with technical detail on answers covered in Part I. It also should be organized by subject.

Think of Part I as a type of fact sheet for the detailed responses provided in

Part II. Because both parts deal with similar or overlapping issues, the response to comments should state clearly that any points of conflict or ambiguity between the two parts shall be resolved in favor of the detailed technical and legal presentation in the second part.

In order to effectively address all public comments, closely coordinate the preparation of responses with appropriate legal and technical staff. Also, it is important to be certain that all comments are addressed. A system of numbering all comments as they are received and referring to these numbers in all internal drafts of the response document may help keep track of them. Computer databases are a good way to keep track of and arrange the comments.

In addition, the Response to Comments should include a summary that discusses the following:

- The number of meetings, mailings, public notices, and hearings at which the public was informed or consulted about the project;
- The extent to which citizen's views were taken into account in decision-making; and
- The specific changes, if any, in the project design or scope that occurred as a result of citizen input.

Response to comments documents must be sent to the facility owner/operator and each person who submitted written comments or requested notice of the final permit decision.

When to Use

A response to comments is required for all final permit decisions and decisions on class 2 and 3 modifications..

Accompanying Activities

A response to comments usually accompanies the **notice of decision** .

Advantages and Limitations

A response to comments provides a clear record of community concerns. It provides the public with evidence that their input was considered in the decision process. The summary also is an aid in evaluating past public participation efforts and planning for subsequent activities.

Comments may be difficult to respond to at times, like when the public raises new issues, questions, or technical evidence during the public comment period. The permitting agency may need to develop new materials to respond to these questions.

Checklist for Response to Comments

- __ After reviewing comments, determine organization of document
  - __ Determine groups, subgroups of comments
  - __ Where applicable, paraphrase and summarize comments
- __ Write a response for each comment, group or subgroup of comments
- __ Prepare an introductory statement including:
  - __ A summary of the number and effectiveness of meetings, mailing, public notices, and hearings at which the public was informed or consulted about the project
  - __ The numbers and kinds of diverse interests which were involved in the project
- __ Prepare a summary statement including:
  - __ The extent to which citizen's views were taken into account in decision-making
  - __ The specific changes, if any, in the project design or scope that occurred as a result of citizen input.
- __ Coordinate internal review of the Response to Comments with all necessary departments (public affairs, technical, legal)
- __ Prepare final Response to Comments
- __ Distribute Response to Comments to:
  - __ Information Repository
  - __ Facility owner/operator
  - __ Each individual who makes written or oral comments
  - __ Individuals who asked to receive the Response to Comments
  - __ Appropriate agency officials
  - __ Administrative Record

Information Repositories

Regulatory Requirements

EPA regulations authorize the permitting agency to require a facility to establish an information repository during the permitting process (§ 124.33) or during the active life of a facility (§ 270.30).

Description of Activity

An information repository is a collection of documents related to a permitting activity or corrective action. A repository can make information readily available to people who are interested in learning about, or keeping abreast of, RCRA activities in or near their community.

Information repositories are not mandatory activities in every situation. As mentioned above, RCRA regulations give the permitting agency the authority to require a facility to set up and maintain an information repository. The agency does not have to require a repository in every case; it should use its discretion. Additionally, a facility or an environmental group may voluntarily set up a repository to make it easier for people in the community to access information.

The size and location of the repository will depend on the type of permitting activity. The regulations allow the permit applicant or permittee to select the location for the repository, as long as it is in a location that is convenient and accessible to the public. If the place chosen by the facility does not have suitable access, then the permitting agency can choose a more suitable location. EPA encourages the facility and the agency to *involve the public when suggesting a location for the repository -- the potential users of the facility are best qualified to tell you if it's suitable.* See #1 under "How to Conduct the Activity" below.

The information that actually goes in the repository can differ from case to case, depending on why the repository was established. If the agency requires a facility to establish the repository, then the agency will set out the documents and other information that the facility must include in the repository. The agency will decide what information will be most useful according to the specifics of the case at hand. For instance, multi-lingual fact sheets and other documents will be most appropriate in situations where there are many non-English-speakers in an affected community. Similarly, if the community needs assistance in understanding a very technical permitting situation, then the agency and the facility should provide fact sheets and other forms of information that are more accessible to the non-technical reader. See #2 under "How to Conduct the Activity" below.

The permitting agency should assess the need, on a case-by-case basis, for an information repository at a facility. When doing so, the agency has to

consider a variety of factors, including: the level of public interest; the type of facility; the presence of an existing repository; and the proximity to the nearest copy of the administrative record. Since any of these other factors may indicate that the community already has adequate access to information, and since repositories can be resource-intensive, permitting agencies should use this authority only in cases where the community has a true need for additional access to information.

For example, in determining levels of public interest the agency staff will want to consider: What kind of turnout has there been at public meetings? What kind of responses during community interviews? What level of media attention? How many inquiries have been coming in? What levels of community involvement have there been in previous facility and/or local environmental matters? If another repository already exists, can it be augmented with materials to meet the information needs of the permit or corrective action at hand? Is it located in a convenient and accessible place? [Note: If a facility has an existing repository that does not completely satisfy the need that the agency identifies, then the agency may specify additional steps that the facility must take to make the repository meet the public need.]

Is the nearest copy of the administrative record "close enough"? The answer to this question could depend on a few things. Ask yourself some other questions first. For example: Can people get there by public transportation or only by a personal vehicle (i.e, by car or taxi)? Do most people in the community rely on public transportation, or do most people have and use their own cars? Apart from whether it is accessible by public transportation or personal vehicle, how long is the trip? Is the administrative record available for review on weekends or after business hours?

Level of Effort

Depending on the amount of available documentation, the information repository may take a week to establish, including compiling and indexing documents and arranging for placement in a library or other location. Updating may take a day or two every quarter. A public notice announcing the availability of the information repository may take between a day to write, review, and place in newspapers or send to the mailing list.

How to Conduct the Activity

To establish an information repository:

1. **Determine a suitable location.** For repositories established under §§ 124.33 or 270.30, the initial choice of location is made by the facility. If the agency decides that the facility-proposed location is not suitable, then the agency will suggest another location.

   Whether required or established voluntarily, the repository should be be convenient and accessible for people in the community. Whoever establishes the repository should consider, in particular, locations

suggested by community residents. Typical locations include local public libraries, town halls, or public health offices.

A facility may choose to set up the repository at its own offices. Before doing so, the facility owner or operator should discuss his or her intent with community representatives and/or the agency. It is important to confirm that people are comfortable about coming onto facility property and trust that you will properly maintain the information in the repository.

Facility owners and operators should be sensitive to the concern that some citizens have about repositories that are on facility property. Some people do not feel comfortable when they need to attend a meeting or a function on the facility grounds. If the members of your community may feel uncomfortable at the facility, then you should make all efforts to establish the repository at a suitable off-site location. All repositories should be in a location where its users will feel comfortable when accessing information.

In evaluating potential sites for the repository, there are several factors to consider. The location should have adequate access for disabled users, should be accessible to users of public transportation (where applicable), and should be open after normal working hours at least one night a week or on one weekend day. Repositories should be well lit and secure.

A facility should also ensure that someone in its company and someone at the repository location are identified as the information repository contacts -- to make sure that the information is kept up-to-date, orderly and accessible.

Depending on the level of community concern, or the location of the facility relative to the surrounding communities, more than one repository may be desirable. For example, if a county seat is several miles from the RCRA-regulated facility, and county officials have expressed a strong interest in the facility, two repositories may be advisable: one in the community closest to the facility, and the other in the county seat.

2. **Select and deposit the materials to be included in the repository.** For repositories established under EPA's regulations, the permitting agency will decide, on a case-by-case basis, what documents, reports, data, and information are necessary to help the repository fulfill its intended purposes, and to ensure that people in the community are provided with adequate information. The agency will provide a list of the materials to the facility. The agency has the discretion to limit the contents of repositories established under §§ 124.33 and 270.30. While there is no outright ban on materials, EPA encourages regulators to ensure that repository materials are relevant and

appropriate.

Facilities, permitting agencies, and public interest groups may decide to establish repositories aside from those required by regulation. Whoever establishes a repository should consult the public regarding what materials would be most useful to members of the surrounding community. EPA encourages parties to place substantive and appropriate materials in the repository.

If you are establishing an information repository, you should consider including the following documents:

- Background information on the company or facility;
- Fact sheets on the permitting or corrective action process;
- Meeting summary from the pre-application meeting (if one was conducted);
- Public involvement plan (if developed);
- The draft permit;
- Reports prepared as part of the corrective action investigations, including the RCRA Facility Assessment (RFA), the RCRA Facility Investigation (RFI), and the Corrective Measures Study (CMS);
- Fact sheets prepared on the draft permit or corrective action plan;
- Notice of decision;
- Response to comments;
- Copies of relevant RCRA guidance and regulations;
- A copy of the Cooperative Agreement, if the state is the lead agency for the project;
- Documentation of site sampling results;
- Brochures, fact sheets, and other information about the specific facility (including past enforcement history);
- Copies of news releases and clippings referring to the site;
- Names and phone numbers of a contact person at the facility and at the permitting agency who would be available to answer questions people may have on the materials in the repository; and
- Any other relevant material (e.g., published studies on the potential risks associated with specific chemicals that have been found stored at the facility).

You should organize the documents in binders that are easy to use and convenient for the on-site repository host. For projects that involve a large number of documents, separate file boxes should be provided as a convenience to the repository host to ensure that the documents remain organized.

3. **Publicize the existence of the repository.** For repositories required under RCRA regulations, the permitting agency will direct the facility, at a minimum, to announce the repository to all members of

facility mailing list. If you establish a repository aside from EPA's regulations, you should be sure to notify local government officials, citizen groups, and the local media of the location of the project file and hours of availability. Newsletters of local community organizations and church groups are another means of notifying the public.

4. **Keep the repository up-to-date by sending new documents to it as they are generated.** If the permitting activity is controversial or raises a lot of community interest, you should consider providing several copies of key documents so that community members can check them out for circulation. For repositories required under RCRA regulations, the facility is responsible for updating the repository with new documents and maintaining the documents in the repository.

When to Use

An information repository is recommended:

- When the agency requires the facility to establish an information repository. In making its determination, the agency will consider relevant factors, including: the level of public interest; the type of facility; the presence of an existing repository; and the proximity to the nearest copy of the administrative record; and

- When interest in the facility is high and the public needs convenient access to relevant facility documents.

Accompanying Activities

The contact person(s) should be responsible for making sure that all relevant materials have been filed in the repository.

If you establish a repository, you may want to consider setting aside time at the repository to periodically staff a "walk-up" **information table** . An information table would entail having a representative from your organization, the permitting agency, or both, available to answer questions that repository visitors may have. You may decide to establish the information table on a routine basis (for example, once a month) or at key milestones in the permitting or corrective action process (for example, after a draft permit decision or completion of the RFI).

Advantages and Limitations

An information repository provides local officials, citizens, and the media with easy access to accurate, detailed, and current data about the facility. It demonstrates that your organization is responsive to citizens' needs for comprehensive information on the facility.

An information repository is a one-way communication tool and does not allow for interaction between citizens and your organization (unless used in

conjunction with a “walk-up” information table). The information repository may also include technical documents, which may be difficult for citizens to understand.

Checklist for Information Repositories

[Note: this checklist contains all the steps for information repositories required under §§ 124.33 and 270.30. Anyone who is establishing a repository apart from these requirements should check above in this section to find out which steps apply].

__ Determine location of Information Repository; check with agency

__ Establish contact with the director of the location determined above

__ Mail a letter to the permitting agency confirming the location of the Information Repository

__ Agency will mail a list of required documents to the facility

__ Collect and compile the documents to include in the Information Repository

- __ Documents sequentially numbered
- __ Index prepared
- __ Documents placed in notebooks

__ Deliver documents to location determined above

- __ Have location director sign a letter/memo acknowledging receipt of the documents

__ Send a notice to the facility mailing list indicating the availability of the Information Repository; provide additional means of notice (e.g., newspaper, broadcast media) as appropriate

__ Update the Information Repository as key public documents are available and at key technical milestones

Exhibits

Regulatory Requirements

None.

Description of Activity

Exhibits are visual displays such as maps, charts, diagrams, photographs, or computer displays. These may be accompanied by a brief text explaining the displays and the purpose of the exhibit. Exhibits provide a creative and informative way to explain issues such as health risks or proposed corrective actions. They make technical information more accessible and understandable.

Level of Effort

Exhibits may take from one day to one week to write, design and produce depending on the complexity of the exhibit. Computer software production will take longer. Allow time for review of the exhibit's design and concept.

How to Conduct the Activity

To develop and display an exhibit:

1. **Identify the target audience.** Possible audiences include:

   - General public;
   - Concerned citizens;
   - Environmental/Public Interest groups;
   - Media representatives; and
   - Public officials.

2. **Clarify the subject.** Possible subjects include:

   - The RCRA program or the permit or corrective action process;
   - Historical background on the facility;
   - Public participation activities;
   - Corrective action or waste management technologies; and
   - Health and safety issues associated with the facility.

3. **Determine where the exhibit will be set up.** If the general public is the target audience, for example, assemble the exhibit in a highly visible location, such as a public library, convention hall, or a shopping center. If concerned citizens are the target audience, set up a temporary exhibit at a **public meeting**, **availability session/open house**, or **an informal meeting**. An exhibit could even be as simple as a bulletin board at the site or staff trailer.

4. **Design the exhibit and its scale according to the message to be transmitted.** Include photos or illustrations. Use text sparingly.

When to Use

Exhibits can be used:

- When level of interest in the facility is moderate to high;
- When information to be conveyed can be explained graphically;
- When staff time is limited and the audience is large;
- When a display can enhance other information being distributed; and
- When displays will be useful over long periods of time and at different facilities (e.g., generic posterboards on RCRA process).

Accompanying Activities

Exhibits are useful at **public meetings** , **public hearings** , and **availability sessions/open houses** . If an **observation deck** is installed at a site, a nearby exhibit could explain corrective action or compliance activities under way.

Advantages and Limitations

Exhibits tend to stimulate public interest and understanding. While a news clipping may be glanced at and easily forgotten, exhibits have a visual impact and leave a lasting impression. Exhibits also can convey information to a lot of people with a low level of effort.

Although exhibits inform the public, they are, for the most part, a one-way communication tool. One solution to this drawback is to attach blank postcards (**surveys**) to the exhibit, encouraging viewers to comment or submit inquiries by mail to the agency. Another approach is to leave the phone number of the **contact person** who can answer questions during working hours. However, these requests must be answered or citizens may perceive the agency as unresponsive to their concerns. Finally, computer touch screens can provide some feedback by answering common questions about an exhibit.

Checklist for Exhibits

- __ Determine purpose, use of exhibit
  - __ Identify the audience
  - __ Clarify the message
  - __ Determine where and how the exhibit will be displayed
    - __ Free-standing
    - __ Table-top display
    - __ Will the exhibit need to be easily transported?
- __ Coordinate design and construction with public involvement coordinator (and contractors, if available)
  - __ Write copy
  - __ Determine graphics
  - __ Design the exhibit
  - __ Coordinate review of the design, text, and graphics
  - __ Complete the exhibit based on review comments

Briefings

Regulatory Requirements

None.

Description of Activity

Briefings are useful for sharing information with key stakeholders, whether they are involved regulators, elected officials, or members of involved public interest or environmental groups. You can use briefings to inform other stakeholders about the status of a permit application or corrective action; to provide them with materials such as technical studies; results of the technical field and community assessments; and engineering designs. These sessions are conducted in person, and the briefings usually precede release of information to the media or occur before a public meeting. Briefing key stakeholders is particularly important if an upcoming action might result in political controversy.

Level of Effort

Briefings will usually take a day to plan and conduct.

How to Conduct the Activity

To schedule and hold briefings:

1. **Inform your audience** far in advance of the date of the briefing. It is usually best to hold the initial briefing in a small public room, such as a hotel meeting room, conference room, or at the stakeholders' offices. Where relationships might be antagonistic, it may be best to hold the briefing in a neutral location.

2. **Present a short, official statement** explaining the information in the context of the RCRA process and announcing future steps in the process.

3. **Answer questions about the statement.** Anticipate questions and be prepared to answer them simply and directly.

   If the briefing has been requested, find out in advance the information that the stakeholders seek and prepare to answer these and related questions.

When to Use

Briefings are appropriate:

- When key stakeholders have expressed a moderate to high level of concern about the facility or the process;

- Before the release of new information to the media and the public;

- When unexpected events or delays occur; and
- At any point during the permit or corrective action processes. If local officials have expressed concern during the preliminary assessment of the facility, a briefing may be appropriate to explain the RCRA permitting or corrective action program and the technical actions that are scheduled for the facility.

Accompanying Activities

Briefings usually precede **news conferences** , **news releases** , **informal meetings** , or **public meetings** .

Advantages and Limitations

Briefings allow key stakeholders to question you directly about any action prior to public release of information regarding that action. By providing a "heads up," you can prepare other key stakeholders to answer questions from their constituents when the information becomes public. Briefings also allow for the exchange of information and concerns.

Because briefings are normally offered to a small select group, they are not considered to be general information dissemination to the public. Care must be taken to provide the public with ample opportunity to receive information. At briefing sessions, include the appropriate officials, taking care not to exclude people key to the public participation process. Avoid the perception that you are trying to bury facts or favor special interest groups.

Although briefings can be an effective tool for updating key stakeholders (e.g., state and local officials, community leaders, involved regulators) they always should be complemented by activities to inform the general public, such as **informal meetings** with small groups, **public meetings** , or **news conferences** .

Checklist for Briefings

__ Determine date, time, and location of briefing.

Date: _____

Time: _____

Location: _____

__ Notify key state and local officials, citizens, and other interested parties of the briefing

__ Prepare presentation

__ Prepare any handout materials

__ Conduct briefing

__ Follow-up on any questions you are unable to answer during the briefing

Presentations

Regulatory Requirements

None.

Description of Activity

Presentations are speeches, panel discussions, video tapes or slide shows held for local clubs, civic or church organizations, school classes, or concerned groups of citizens to provide a description of current RCRA activities. They help improve public understanding of the issues associated with a permitting or corrective action.

Level of Effort

One to two days may be needed to set up and schedule the presentation, prepare for it, give the presentation, and follow up on any issues raised. Add more time if you need to prepare visual equipment.

How to Conduct the Activity

Develop procedures that can be changed easily to suit different audiences. To conduct presentations:

1. **Contact groups that may be interested in learning about your work.** Announce the program through the media and in your publications. Adjust the tone and technical complexity of any presentation to suit the audience's needs.

2. **Select a standard format** such as the following:

   - Introduce yourself, your organization, the RCRA permitting or corrective action process, and the facility;
   - Describe the issues that affect your audience;
   - Discuss what is being currently done; and
   - Discuss how citizens can play a part in making decisions about the facility.

3. **Set a time limit of 20 minutes.** Consider having several staff members deliver short segments of the presentation. Allow time for a **question-and-answer session** .

4. **Schedule presentations at convenient times,** possibly evenings or weekends, or during regularly-scheduled meetings of other groups. Consult with members of your target audience to find out what time is best for them.

5. **Select supporting materials** (slides, graphics, exhibits, etc.) that will

hold the audience's attention but not distract from the speaker's message. Conduct a trial run in front of colleagues and rehearse the presentation as much as possible.

6. **If substantive issues or technical details cannot be handled in the time allowed for the presentation, name a contact for further information.**

When to Use

Presentations may be held:

- When there is moderate to high interest in a facility;
- When it is practical to integrate short RCRA presentations into meetings on other subjects; and
- When a major milestone in the RCRA process is reached.

Accompanying Activities

Fact sheets or handouts should be distributed so that participants have something to refer to after the presentation. Incorporating **exhibits** into your presentation will hold the audience's attention and aid in their understanding of the material. **Question and answer sessions** will help clear up any misunderstanding about the presentation and allow you to address complex issues in more detail

Advantages and Limitations

Because the presentation is delivered in person, the audience has a chance to ask questions, and the presenter can gauge citizens' concerns. Also, many people can be reached at one time, reducing individual inquiries. Making project staff available for community speeches and presentations will signal your organization’s interest in the community.

Presentations require substantial effort to be effective. A poorly planned presentation can distort residents' views of the situation.

Because the presentation is rehearsed, accommodating different or unanticipated concerns of the audience can be difficult. Handle these concerns during a **question-and-answer session** after the presentation.

Checklist for Presentations

- __ Contact groups that may be interested in a presentation
- __ Determine message(s) to be presented based on stated community interests/concerns
- __ Prepare presentation(s) based on responses from groups contacted
  - __ Prepare handout materials
  - __ Prepare exhibits or other visual materials
- __ Determine what staff are available for presentations
- __ Schedule presentations
- __ Conduct rehearsals
- __ Conduct presentations
- __ Conduct follow-up question-and-answer session after presentations
  - __ Respond to questions you were unable to answer
  - __ Contact group regarding other presentation topics in which they may be interested

Facility Tours

Regulatory Requirements

None, though the tour will have to comply with facility safety plans.

Description of Activity

Facility tours are scheduled trips to the facility for media representatives, local officials, and citizens during which technical and public outreach staff answer questions. Facility tours increase understanding of the issues and operations at a facility and the RCRA-regulated process underway.

Level of Effort

Facility tours generally take a day to plan and conduct.

How to Conduct the Activity

To conduct facility tours:

1. **Plan the tour ahead of time.**

   The facility owner/operator may decide to conduct a tour, or the agency may set up a tour of the facility. If agency staff plan to lead the tour, they should coordinate with the facility owner/operator. Citizens groups should arrange tours with the facility owner/operator. If there is a Citizens Advisory Panel, the members could lead or participate in tours.

   Before the tour, you should:

   - Determine tour routes;
   - Check on availability of facility personnel, if needed; and
   - Ensure that the tour complies with the safety plan for the site.

   If it is not possible to arrange tours at the facility (e.g., the facility is under construction or not yet built), perhaps it would be possible to arrange a tour at one like it. Interested community members may benefit from touring a facility that has similar operations or where similar technologies have been applied. Touring a RCRA-regulated facility can give residents a clearer perception of what to expect at their own site.

2. **Develop a list of individuals that might be interested** in participating in a tour, including:

   - Individual citizens or nearby residents who have expressed concern about the site;

- Representatives of public interest or environmental groups that have expressed interest in the site;
- Interested local officials and regulators;
- Representatives of local citizen or service groups; and
- Representatives of local newspapers, TV, and radio stations.

3. **Determine the maximum number that can be taken through the facility safely.** Keep the group small so that all who wish to ask questions may do so. Schedule additional tours as needed.
4. **Think of ways to involve tour participants.** A "hands-on" demonstration of how to read monitoring devices is one example.
5. **Anticipate questions.** Have someone available to answer technical questions in non-technical terms.

When to Use

Tours may be conducted:

- When there is moderate to high interest in the facility, especially among elected officials;
- When it is useful to show activities at the facility to increase public understanding or decrease public concern;
- When it is practical and safe to have people on facility grounds; and
- During the remedial phase of corrective action.

Accompanying Activities

Fact sheets, **exhibits**, and **presentations** complement facility tours. An **observation deck** near the facility would allow them to watch the progress of activities on their own. An **on-scene information office** would allow for an agency official to be around and for less formal tours of the facility. An alternative to a facility tour would be a **videotape presentation** showing activity and operations at the facility. This would be effective in cases where tours cannot be conducted.

Advantages and Limitations

Facility tours familiarize the media, local officials, and citizens with the operations and the individuals involved in the permitting or corrective action. Unreasonable fears about the risks of the facility may be dispelled, as might suspicion of corrective action crews working at the facility. The result is often better understanding between stakeholders.

Facility tours require considerable staff time to arrange, prepare, and coordinate. Staff may have difficulty gaining site access for non-agency

people. Insurance regulations for the facility and liability, safety and injury considerations may make tours impossible.

Checklist for Facility Tours

- __ Determine need for facility tours
- __ Coordinate tours with the facility
  - __ Tour routes
  - __ Facility personnel
  - __ Tour dates
  - __ Compliance with health and safety
- __ Determine maximum number of people that can be taken on the tour
- __ Notify interested citizens on availability of facility tours
  - __ Call interested citizens
  - __ Distribute mailing to facility mailing list
  - __ Have citizens respond and reserve space on the tour
- __ Determine plant staff or agency staff to conduct tour
- __ Prepare responses to anticipated questions
- __ Conduct tours
- __ Follow-up on any requested information from interested citizens

Observation Decks

Regulatory Requirements

None.

Description of Activity

An observation deck is an elevated deck on the facility property, near the area where corrective or RCRA-regulated activities are in progress. The deck allows interested citizens to observe facility activities or corrective actions directly in order to remove some of the unfamiliarity, and hence fear, that may encompass RCRA-regulated activities.

Level of Effort

Maintaining an observation deck may be a time-intensive activity depending on the deck's hours of operation. Up to 40 hours a week may be necessary to staff the deck. Short Cut: Consider hiring a contractor to staff the deck, or limit the hours when it is open to the public.

How to Conduct the Activity

To use an observation deck, the agency and the facility should work together to:

1. **Decide whether or not an observation deck is needed or desirable.** Gauge community interest in the facility and whether or not there is a location for a deck that would facilitate observation.

2. **Coordinate deck construction.** Determine the best location for the observation deck keeping in mind safety and public access issues.

3. **Coordinate staffing of the observation deck.** Determine the hours of operation for the observation deck. Identify staff to supervise the observation deck and prepare staff to answer questions from the public.

4. **Announce the availability of the observation deck.** Notify the community that the deck is available through public notices, fact sheets, and a mailing to the facility mailing list.

When to Use

An observation deck may be used:

- When community interest or concern is high;
- When the community's understanding of facility operations will be enhanced by direct observation;
- When there will be sufficient activity at the site to promote the community's interest;

- When staff are available to supervise public use of the deck and answer questions;
- When it is physically possible to set up an observation deck in a place where there is no danger to the public;
- When a corrective action is being implemented; and
- When a new technology is being tested or implemented.

Accompanying Activities

An observation deck could complement periodic **facility tours** or an **on-scene information office** . Citizens can initially be informed about operations or corrective actions during the tours, then can monitor the progress of these activities at their convenience from the observation deck. **Fact sheets** or an informative **exhibit** placed near the deck also could further aid in explaining facility activities.

Advantages and Limitations

An observation deck allows citizens and media representatives to observe site activities without hindering the activities.

Constructing and occupying an observation deck is expensive and needs to be supplemented with an informational/interpretive program, so that citizens understand what they see. Further, health and safety issues must thoroughly be considered so that any visitor to the observation deck is not endangered by activities at the facility.

Checklist for Observation Decks

- __ Determine need for an observation deck
  - __ Coordinate with facility
- __ Identify staff available to supervise the observation deck and answer questions from interested citizens
- __ Coordinate deck construction
- __ Set hours of operation for the observation deck
- __ Notify interested citizens of availability of observation deck
  - __ Public notice
  - __ Fact sheet
  - __ Mailing to facility mailing list
- __ Maintain observation deck

News Releases and Press Kits

Regulatory Requirements

None.

Description of Activity

News releases are statements that you or your organization send to the news media. You can use them to publicize progress or key milestones in the RCRA process. News releases can effectively and quickly disseminate information to large numbers of people. They also may be used to announce public meetings, report the results of public meetings or studies, and describe how citizen concerns were considered in the permit decision or corrective action.

Press kits consist of a packet of relevant information that your organization distributes to reporters. The press kit should summarize key information about the permitting process or corrective action activities. Typically a press kit is a folder with pockets for short summaries of the permitting process, technical studies, newsletters, press releases, and other background materials.

If your organization has public affairs personnel, you should coordinate with them to take on media contact responsibilities.

Level of Effort

News releases generally take eight hours to write, review, and distribute to the media.

How to Conduct the Activity

To prepare news releases and press kits:

1. **Consult with external affairs personnel who regularly work with the local media.** External affairs personnel will assure that you adhere to organization policy on media relations. They will assist in drafting the news release and can provide other helpful suggestions about the release and the materials for the press kit.

2. **Identify the relevant regional and local newspapers and broadcast media, and learn their deadlines.** Get to know the editor and environmental reporter who might cover the issue. Determine what sorts of information will be useful to them.

3. **Contact related organizations to ensure coordination.** For instance, permitting agencies should contact other regulatory agencies on the federal, state, and local levels to ensure that all facts and procedures are coordinated and correct before releasing any statement

or other materials. If your organization is local, you should coordinate with national or state-wide chapters. You may want to consider discussing the news release with other interested stakeholders (e.g., through a **briefing**). However, draft news releases should not be shared -- they are internal documents.

4. **Select the information to be communicated.** For the press release, place the most important and newsworthy elements up front and present additional information in descending order of importance. Use supporting paragraphs to elaborate on other pertinent information. Mention opportunities for public participation (i.e., public meetings, etc.) and contact persons and cite factors that might contribute to earlier implementation or delays in the corrective action or permit processing. Note the location of the information repository (if applicable) or other sources for relevant documents. If you are presenting study findings or other technical information, present it in layman's terms along with any important qualifying information (e.g., reliability of numbers or risk factors).

   The press kit should contain materials that elaborate on the information in the press release. Basic summaries of the RCRA program, the permitting process, and public participation activities are helpful materials. Background reports or studies may also be useful. Enclose the name and phone number of a contact person and invite the reporter to call him or her with any questions.

5. **The news release should be brief.** Limit it to essential facts and issues.

6. **Use simple language.** Avoid the use of professional jargon, overly technical words, and acronyms.

7. **Identify who is issuing the news release.** The top of the sheet should include:

   - Name and address of your organization;
   - Release time ("For Immediate Release" or "Please Observe Embargo Until") and date;
   - Name and phone number of the contact person for further information; and
   - Headline summarizing the activity of interest.

8. **In some cases, send copies of the release and the press kit to other stakeholders** at the same time you give them to the news media. Coordinate with the public affairs office to determine appropriateness.

When to Use

The press kit and the news release can be complementary activities, though you may choose to use either one separately. Some of the occasions when you may want to issue a news release or a press kit include:

- When significant findings are made at the site, during the process, or after a study;
- When program milestones are reached or when schedules are delayed;
- In response to growing public or media interest or after your organization takes a new policy stance;
- When you are trying to increase public interest in a facility;
- Before a public meeting to announce subject, time, place; and
- A news release should not be issued at times when it may be difficult to get in touch with responsible officials (e.g., Friday afternoons, or the day before a holiday).

Accompanying Activities

The press kit is useful as a complement to a news release. News releases and press kits can accompany any formal **public hearings** or **public meetings**. They commonly accompany **news conferences**. They should provide the name of the **contact person** whom interested reporters can contact if they want more information.

Advantages and Limitations

A news release to the local media can reach a large audience quickly and inexpensively. Press kits allow reporters to put the issue in context. If a reporter is trying to meet a deadline and cannot contact you, he or she can turn to the press kit as an authoritative source of information. If the name, address, and phone number of a contact person are included, reporters and possibly interested community members can raise questions about the information in the release.

Because news releases must be brief, they often exclude details in which the public may be interested. A news release should therefore be used in conjunction with other methods of communication that permit more attention to detail. A news release is not an appropriate vehicle for transmitting sensitive information. In some cases, a news release can call unwarranted attention to a situation; a mailing to selected individuals should be considered instead. Frequent use of news releases to announce smaller actions may reduce the impact of news releases concerning larger activities.

One potential drawback of a press kit is that reporters may ignore it or use the information incorrectly when writing a story.

News releases and press kits cannot be used in lieu of a public notice. Certain activities, such as the preparation of a draft permit, are subject to public notice requirements. See the section on “Public Notices” earlier in this Chapter for more details.

Checklist for News Releases and Press Kits

- __ Coordinate with public affairs staff
- __ Determine purpose of news release and/or press kit
- __ Coordinate writing and distribution of release or press kit with the public affairs staff
  - __ Verify that media mailing list is up-to-date
  - __ Request mailing labels
- __ Write draft news release
  - __ Type and double space news release
  - __ Indicate the source of the news release (i.e., in the upper-left-hand corner, put the name and phone number of the person writing the release, along with the agency or department name and address)
  - __ Provide release instructions (i.e., "For Immediate Release")
  - __ Date the news release
  - __ Write concisely; avoid technical terms and jargon
  - __ Number pages; if more than one page is needed, put " -- more --" at the center bottom of the page that is to be continued; succeeding pages should be numbered and "slugged" with an identifying headline or reference (i.e., "EPA -- 2"); when you come to the end of the news release, indicate the end with one of the following: -- 30 --, ####, or -- END --.
- __ Prepare materials for the press kit
  - __ Collect short descriptions of the RCRA program, permitting, and public participation processes
  - __ Include other pertinent information, such as reports, studies, and fact sheets
- __ Coordinate internal review
- __ Prepare final matierals based on review comments
- __ Distribute news release and press kit to local media

News Conferences

Regulatory Requirements

None.

Description of Activity

News conferences are information sessions or briefings held for representatives of the news media and may be open to the general public. News conferences provide all interested local media and members of the public with accurate information concerning important developments during a RCRA-regulated process. If your organization has public outreach personnel, you will probably want to coordinate news conferences with them.

Level of Effort

Allow one to two days to prepare for, rehearse, and conduct a news conference.

How to Conduct the Activity

To conduct news conferences:

1. **Coordinate all media activity through your outreach staff.** Public outreach personnel will assure that you adhere to organization policy on news conferences. They will help arrange location and equipment, etc.

2. **Evaluate the need for a news conference.** Use this technique carefully because statements made during a news conference may be misinterpreted by the media. For reporting the results of site inspections, sampling, or other preliminary information other public involvement techniques (e.g., **fact sheets** , **news releases** , or **public meetings**) may be more appropriate. A news conference announcing preliminary results of technical studies may add unnecessarily to public concerns about the facility.

3. **Notify members of the local and regional media of the time, location, and topic of the news conference.** Local officials also may be invited to attend, either as observers or participants, depending upon their interest. Including local officials at a news conference will underscore your organization’s commitment to a community's interests and concerns.

4. **Anticipate reporters' questions and have your answers ready.**

5. **Present a short, official statement, both written and spoken, about developments and findings.** Explain your organization’s decisions by reviewing the situation and identifying the next steps. Use visual aids, if appropriate. Live conferences leave no room for

mistakes, so preparation and rehearsal is very important.

Open the conference to questions, to be answered by your staff, local officials, and any other experts present. Have technical staff on hand to answer any technical questions. Decide ahead of time who will answer certain types of questions.

When to Use

News conferences can be used:

- When time-sensitive information needs to reach the public, and a news release may not be able to address key issues for the community;
- When staff are well-prepared to answer questions; and
- During any phase of the permit application or corrective action.

Accompanying Activities

News conferences can be held before or after formal **public hearings** or **public meetings**. They are usually accompanied by **news releases**. **Exhibits**, **telephone contacts**, **briefings**, and **mailing lists** would contribute to the planning and effectiveness of a news conference.

Advantages and Limitations

News conferences provide a large public forum for announcing plans, findings, policies, and other developments. They also are an efficient way to reach a large audience. A written news release can help ensure that the facts are presented accurately to the media. During the question and answer period, your spokesperson(s) can demonstrate knowledge of the facility and may be able to improve media relations by providing thorough, informative answers to all questions.

A news conference can focus considerable attention on the situation, potentially causing unnecessary local concern. Residents may not welcome the increased attention that such media coverage is apt to bring. News releases or lower-profile means of disseminating information should be considered as alternatives.

A risk inherent in news conferences is that the media can take comments out of context and create false impressions. This risk is heightened when staff are unprepared or when the conference is not properly structured or unanticipated questions are asked.

Checklist for News Conferences

- __ Coordinate news conference with public affairs staff
- __ Determine purpose of news conference
- __ Identify staff to make presentations/answer questions at news conference
- __ Prepare visual materials (i.e., exhibits) and handout materials (i.e., fact sheets)
- __ Prepare responses to "anticipated" questions from the media
- __ Coordinate a rehearsal of all presenters
- __ Determine date, time, location, and equipment needs of news conference
  - __ Is the location large enough to accommodate the media?
- __ Notify local media of news conference in advance of news conference
- __ Call the local media the day before the news conference as a reminder
- __ Conduct the news conference
  - __ Set up room with a speakers table, chairs for the audience
  - __ Have handout materials available when media arrive

Community Interviews

Regulatory Requirements

None.

Description of Activity

Community interviews are informal, face-to-face or telephone interviews held with local residents, elected officials, community groups, and other individuals to acquire information on citizen concerns and attitudes about a facility. The interviews may be conducted by facility staff, the permitting agency, or public interest groups as part of the community assessment. Chapter 2 provides more information on community assessments in the section titled "Assessing the Situation."

Community interviews can play an important role in the community assessment, which usually takes place at the beginning of the permitting process, or before major modifications and significant corrective actions. Community interviews will not be necessary in every community. For instance, in routine or non-controversial situations, there may be no need for community interviews. However, if a facility is controversial or has the potential to receive high levels of public interest, then EPA recommends a broad range of community interviews. Permitting situations that fall between the preceding cases may require some interviews, beginning with a survey of community representatives and group leaders (see "Assessing the Situation" in Chapter 2).

Community interviews allow agencies, facility owners, and public interest groups to tailor regulatory requirements and additional activities to fit the needs of particular communities. Information obtained through these interviews is typically used to assess the community's concerns and information needs and to prepare a **public participation plan**, which outlines a community-specific strategy for responding to the concerns identified in the interview process.

Level of Effort

Community interviews are a time-intensive activity because of the large amount of organization required and time needed for interviews. While level of effort will vary, interviewers should schedule at least one hour per interview for research and preparation, the interview itself, and follow-up activities. If time and/or resources are limited, interviewers may want to conduct interviews by phone and focus on community leaders.

How to Conduct the Activity

Permitting agencies, facility owners, and public interest groups who plan to conduct community interviews should follow the steps below, adjusting them as necessary to suit the situation at hand:

1. **Identify potential people to interview.** If a mailing list is not available, begin by reviewing available files and other documents (e.g., newspaper articles) to identify local residents, key state and local officials, and citizen organizations that have been involved with or expressed concern about the facility. Agency staff or other groups in the community (e.g., existing facility owners and operators, public interest organizations, civic groups, local government agencies) may also be able to suggest individuals or groups to interview. Develop a list of individuals and groups that provides the greatest variety of perspectives. Make sure to include individuals who tend to be less vocal to balance the views of those who are more outspoken. Your contact list may include:

   - state agency staff, such as officials from health, environmental, or natural resources departments;
   - local agency staff and elected officials, such as county health department officials, county commissioners, mayor or township administrator, and officials on environmental commissions, advisory committees, and planning boards;
   - representatives of citizens' groups organized to address issues at the facility or in the area;
   - non-affiliated area residents and individuals;
   - local business representatives (e.g., from the Chamber of Commerce or Council of Governments);
   - local civic groups, neighborhood associations, educational and religious organizations;
   - local chapters of public interest groups (e.g., environmental organizations); and
   - nearby landowners and businesses.

2. **Determine how many interviews to conduct.** Conduct interviews with the goal of obtaining a broad range of perspectives and gathering sufficient information to develop an effective public participation plan. However, the actual number of interviews is likely to depend on available time and resources as well as the community's level of interest and concern about the facility. It is generally desirable to conduct more extensive interviews in communities where the level of concern is high. Alternatively, where the level of interest is low or there has already been significant interaction with community, fewer interviews may be appropriate.

3. **Prepare for the interviews.** Before conducting the interviews, learn as much as possible about the community and community concerns

regarding the facility. Review any available news clippings, documents, letters, and other sources of information relevant to the facility. Determine whether the community has any particular language, geographic, or economic characteristics that should be addressed. Prepare a list of questions that can serve as a general guide when speaking with residents and local officials. Questions should be asked in a way that stimulates discussion on a variety of topics, including:

- General knowledge of the facility. Find out what sort of information the community has received about the facility and if what level of involvement the community has had with the facility.

- Specific concerns about the technical and regulatory aspects of activities at the facility. Determine what the community's concerns are and what types of information would be most appropriate to address these concerns.

- Recommended methods of communicating with the community and receiving community input. Determine which communications tools are likely to be most effective -- e.g., mailings, meetings, broadcast media -- and what public participation events could best serve the community. Learn about special information needs that the community may have (e.g., the level of literacy, the percentage of non-English speakers).

- The best public meeting facilities, most relied-upon media outlets, and the best times to schedule activities.

- Other groups or individuals to contact for more information.

4. **Arrange the interviews.** Telephone prospective interviewees and arrange a convenient time and place to meet. Ideally, the meeting place should promote candid discussions. While government and media representatives are likely to prefer meeting in their offices during business hours, local residents and community groups may be available only in non-business hours. Meetings at their homes may be most convenient.

During the interviews:

1. **Provide background information.** Briefly describe the permitting activity or corrective action at hand.

2. **Assure interviewees that their specific comments will remain confidential.** At the beginning of each interview, explain the purpose of the interviews -- to gather information to assess community concerns and develop an appropriate public participation strategy.

Explain that while the public participation plan will be part of the administrative record, the plan will not attribute specific statements or information to any individual. Ask interviewees if they would like their names, addresses, and phone numbers on the mailing list.

3. **If community members do not feel comfortable with interviewers from your organization, consider using a third-party.** Some citizens may not be entirely forthcoming with their concerns or issues if they are uncomfortable with the interview. If sufficient resources are available, inciter hiring a contractor to perform interviews. Some civic or community organizations may be willing to help in the interview process. If these options are not available, then consider distributing anonymous **surveys** or convening **focus groups** , where a number of citizens can give their input together.

4. **Identify other potential contacts** . During the discussions, ask for names and telephone numbers of other persons who are interested in activities at the facility.

5. **Gather information on past citizen participation activities** . Determine the interviewee's perceptions of past outreach activities by your organization.

6. **Identify citizens' concerns about the facility** . When identifying concerns, consider the following factors:

   - Threat to health -- Do community residents believe their health is or has been affected by activities at the facility?

   - Economic concerns -- How does the facility affect the local economy and the economic well-being of community residents?

   - Agency/Facility/Interest Group credibility -- Does the public have confidence in the capabilities of the agency? What are the public's opinions of the facility owner/operator and involved environmental/public interest organizations

   - Involvement -- What groups or organizations in the community have shown an interest in the facility? Is there a leader who has gained substantial local following? How have interested groups worked with the agency or facility in the past? Have community concerns been considered in the past?

   - Media -- Have events at the facility received substantial coverage by local, state, or national media? Do local residents believe that media coverage accurately reflects the nature and intensity of their concerns?

   - Number affected -- How many households or businesses perceive themselves as affected by the facility (adversely or

positively)?

7. **Assess how citizens would like to be involved in the RCRA permitting or corrective action process** . Briefly explain the RCRA public participation process and ask the interviewees how they would like to be involved and informed of progress made and future developments at the facility. Ask what is the best way to stay in contact with the interviewee. Ask the interviewee to recommend convenient locations for setting up the information repository or holding public meetings. Keep a list of those who wish to be kept informed.

When to Use

Community interviews should be conducted:

- As part of a community assessment by facility owners who are applying for a permit, seeking a major permit modification, or beginning significant corrective action.
- By the permitting agency to find out about community concerns at the outset of a major permitting or corrective action process.
- Before revising a public participation strategy, because months, or perhaps years, may have elapsed since the first round of interviews, and community concerns may have changed.

As the level of community concern increases, so does the need to conduct more extensive assessments. If there has been a lot of interaction with the community and interested parties, information on citizen concerns may be current and active. In such situations, it may be acceptable to conduct only a few informal discussions in person or by telephone with selected, informed individuals who clearly represent the community to verify, update, or round out the information already available.

Accompanying Activities

As stated above, community interviews are conducted to gather information to develop an appropriate **public participation plan** for the facility. A **mailing list** may or may not be in place at the time interviews are conducted. If there is one, it can be used to identify individuals to interview. If one has not yet been established, the interviews themselves can provide the basis for the list.

Advantages and Limitations

Community interviews can be a valuable source of opinions, expectations, and concerns regarding RCRA facilities and often provide insights and views that are not presented in the media. In addition, these interviews may lead to additional information sources. The one-on-one dialogue that takes place during community interviews provides the basis for building a good working relationship, based on mutual trust, between the community and other stakeholders. Therefore, although its primary purpose is to gather

information, the community interview also serves as an important public outreach technique.

The major disadvantages of community interviews are that they may be time-consuming and resource-intensive for your staff; they could cause unnecessary fear of the situation among the public; and, they are not very useful if you do not talk with the right people -- the people who have not identified themselves as well as the more vocal ones who have.

Checklist for Community Interviews

__ Determine number of interviews to be conducted: _____

__ Determine dates for interviews: _____

__ Identify team to conduct interviews:

_____

_____

__ Identify individuals to interview

- __ Review facility background files for names of people who have expressed interest
- __ Identify community leaders to contact
- __ Identify city/state/county officials to contact

__ Prepare interview questions

__ Review background information available about the facility and community

__ Set up interviews

- __ Confirm interviews by mail or phone

__ Conduct interviews

- __ Ask for additional people to contact
- __ Gather information using prepared interview questions

__ Follow-Up

- __ Follow-up interview with a thank you letter
- __ Notify the interviewee when the public participation strategy is available in the repository

Focus Groups

Regulatory Requirements

None.

Description of Activity

Some organizations use focus groups as a way of gathering information on community opinion. The advertizing industry developed focus groups as an alternative to expensive market research (which relies heavily on polling). Focus groups are small discussion groups selected either to be random or to approximate the demographics of the community. The group is usually led by a trained moderator who draws out people's reactions to an issue.

Facility owners may want to consider focus groups as a complement to interviews during the community assessment or at important activities during the life of a facility. The permitting agency may want to consider focus groups to gauge public opinion before controversial permitting activities or corrective actions.

Level of Effort

Focus groups can be resource-intensive, depending on the number of groups you convene. This method will be more expensive if you need to provide for a moderator, meeting space, or transportation.

How to Conduct the Activity

To prepare for focus groups:

1. **Determine whether or not a focus group can help the process.** Community interviews serve much the same purpose as focus groups. Will gathering members of the community together provide more comfort? Will it be a more effective means of gauging public opinion?

2. **Select your focus groups.** Contact other stakeholders and community leaders to get input on who to include in your focus groups.

3. **Use community interview techniques to get input from the focus group.** You can follow the guidance in "Community Interviews" above in this Chapter to learn about the types of questions to ask your focus groups.

4. **Use the information in forming a public participation plan.**

When to Use

Facility owners may want to use focus groups as a complement to community interviews; permitting agencies may want to consider focus groups in situations where there is a high degree of public interest in a

permitting activity. Focus groups provide a quick means of feedback from a representative group and can be a good supplementary activity, especially if such group discussions will make some members of the public feel more comfortable.

Accompanying Activities

Use focus groups as a complement to **community interviews** . You may want to hold a **presentation** or provide the groups with information such as **fact sheets** .

Advantages and Limitations

Focus groups allow you to get an in-depth reaction to permitting issues. They can help to outline a public participation plan and give an indication of how the public will react to certain issues.

The reactions of a focus group cannot, in all cases, be counted on to represent the greater community. Some people may perceive focus groups as an effort to manipulate the public.

Checklist for Focus Groups

__ Determine number of focus groups to be conducted: _____

__ Determine dates for focus groups: _____

__ Identify moderator to conduct focus groups:

_____

__ Identify individuals for focus groups

- __ Review facility background files for names of people who have expressed interest
- __ Identify community leaders to contact
- __ Identify city/state/county officials to contact

__ Prepare discussion questions

__ Review background information available about the facility and community

__ Set up focus groups

- __ Confirm participation by mail or phone

__ Conduct focus groups

- __ Ask for additional people to contact
- __ Gather information using prepared interview questions

__ Follow-Up

- __ Follow-up interview with a thank you letter
- __ Notify the interviewee when the public participation plan is available

Door-to-Door Canvassing

Regulatory Requirements

None.

Description of Activity

Door-to-door canvassing is a way to collect and distribute information by calling on community members individually and directly. Public interest groups have long used such techniques, and they may also be useful for facility owners as a way to gauge public interest during the community assessment stage. The permitting agency may consider using this technique to interact with the community in situations where public interest is very high, such as emergency cleanups, or in other situations where direct contact with citizens is essential. See the section on "When to Use" below for more details.

During these interactions, canvassers can field questions about the permitting activity, discuss concerns, and provide fact sheets or other materials. Some citizens may want to find out more about the activity by signing up for mailing lists or by attending an upcoming event.

Level of Effort

Door-to-door canvassing is a very time-intensive activity because of the number of staff needed to conduct the canvassing and the amount of time you will need to plan for the canvassing. Canvassers should travel in pairs in areas where there may be a lot of contention or in high crime areas. Planning for the door-to-door canvassing will require at least a day. This includes identifying the area to be canvassed, determining the amount of staff needed, and notifying area residents. The amount of time spent canvassing will depend on the size of the area to be canvassed.

How to Conduct the Activity

A door-to-door canvass involves training staff to gather information, answer questions, and to communicate with a possibly irate or suspicious public.

Procedures to follow in preparing a door-to-door canvass include:

1. **Identify the area where canvassing is necessary or desirable.** Determine the area where special information must be given or collected. This area may range from just a few streets to several neighborhoods. Determine if there is a need for a translator or materials in languages other than English. Also determine when it is likely that people will be at home; the canvassing may have to be conducted in the evening.

2. **If time permits, notify residents** (e.g., by distributing a flyer) that canvassers will be calling door-to-door in the area. Tell residents what time the canvassers will be in the neighborhood and explain the purpose of the canvassing program. Advance notice will reduce the suspicions of residents and encourage their cooperation. Also, notify local officials so they are aware of the door-to-door canvassing.

3. **Provide canvassers with the information they will need** to respond to questions. Residents will want to know what is happening at the facility and may have questions about possible health effects associated with various activities. If appropriate, you should distinguish between the types of questions that a canvasser may answer (i.e., questions concerning the schedule of activity) and the types of questions that should be referred to technical staff (e.g., highly technical questions concerning hazardous waste or agency policies). Provide canvassers with fact sheets or other written materials for distribution.

4. **Canvass the designated area.** Note the name, address, and telephone number of residents requesting more information. Note also the names of those who were especially helpful in giving information. Be prepared to tell residents when they will next be contacted and how (i.e., by telephone, by letter, or in person). All canvassers should have an official badge to identify themselves to residents.

5. **Send a thank-you letter** after the canvass to all residents in the canvassed area. If possible, provide information concerning recent developments and any results or pertinent information gathered by the canvass. Respond to special requests for information either in the thank-you letter or by telephone.

When to Use

Door-to-door canvassing may be used:

- When there is a high level of concern about the site, but meetings cannot be scheduled;
- When there is a need to notify citizens about a certain event or an upcoming permitting issue;
- When you need to reach a specific group of people for a specific purpose, such as getting signatures to allow access to properties adjacent to the facility;
- When the community has a low literacy rate and written materials aren't useful;

- When the area consists of a population whose primary language is not English, but it is important to pass information to the area; and

- When there is an emergency situation that the community needs to know about.

Accompanying Activities

Telephone contacts and **community interviews** may help to identify appropriate areas for canvassing efforts. Canvassers should add to the **mailing list** names of individuals who either requested additional information or provided particularly useful information.

Advantages and Limitations

This activity involves face-to-face contact, thereby ensuring that citizens' questions can be directly and individually answered. Canvassing demonstrates a commitment to public participation, and is a very effective means of gathering accurate, detailed information, while determining the level of public concern.

This technique is very time-consuming and costly, even in a small area. Furthermore, trained people that can answer questions at the necessary level of detail are often not available for this activity. This activity is not recommended for the dissemination of information except in an emergency. This high level of direct contact can raise more concerns rather than allay them.

The safety and security of the canvassers also should be taken into account when planning this activity. Additional staff may be need so that people can work in teams to two or three; in extreme situations, security staff may be necessary .

Checklist for Door-to-Door Canvassing

- __ Identify area where canvassing will be conducted
  - __ Prepare maps for each team of canvassers
  - __ Send a letter to residents announcing canvassing
    - __ Prepare mailing list using the city directory (section listing residences by street address)
    - __ Prepare letter; coordinate internal review
  - __ Determine security needs of canvassing team
- __ Prepare any information (i.e., fact sheets) that canvassing team may provide to interested residents
- __ Identify staff to conduct canvassing and have official badges made to identify them
- __ Brief staff on canvassing effort
  - __ Provide staff with a copy of letter sent to residents
  - __ Tell staff what kinds of questions they may answer and provide them with information (i.e., questions concerning the schedule of activity)
  - __ Tell staff what kinds of questions they should refer to a specialist (i.e., technical questions)
  - __ Provide staff with prepared maps
- __ Canvass designated areas
  - __ Note the name, address, and telephone number of residents requesting more information
- __ Send thank you letter to all residents in the canvassed area

Public Comment Periods

Regulatory Requirements

Public comment periods are required whenever the permitting agency issues a draft permit or an intent to deny a permit (§ 124.10). Comment periods are also mandatory on requests for Class 2 and 3 permit modifications under § 270.42, for agency-initiated modifications under § 270.41, and during closure and post-closure for interim status facilities under §§ 265.112(d)(4) and 265.118(f).

Description of Activity

A public comment period is a designated time period in which citizens can formally review and comment on the agency's or facility's proposed course of action or decision. Comment periods for RCRA permits must be at least 45 days.

Level of Effort

There is no specific level of effort for a public comment period. Estimates of the time required to conduct activities associated with the public comment period (public notice, public hearing, etc.) are found elsewhere in this chapter. The time required to receive, organize, and determine how to respond to comments will vary depending on the number of comments received and the complexity of the proposed action (see the section on "Response to Comments" earlier in this chapter).

How to Conduct the Activity

Announce the public comment period in a local newspaper of general circulation and on local radio stations. Public notices must provide the beginning and ending dates of the public comment period and specify where interested parties should send their comments and/or requests for a public hearing. Refer to the section about "Public Notices" earlier in this chapter for further information.

When to Use

A minimum 45-day public comment period is required for RCRA permits, including modifications to permits initiated by the agency as well as Class 2 and 3 modifications requested by the facility.

Accompanying Activities

Public comment periods cannot begin until notice of the permitting activity is given. RCRA requires that the agency conduct a **public hearing** if requested by a member of the public during the public comment period. Announce the hearing through a public notice and through a fact sheet, if one is prepared in advance. Public comment periods cannot begin until notice is given.

Comments received during the public comment period must be discussed in a written **response to comments** .

Advantages and Limitations

Public comment periods allow citizens to comment on agency and facility proposals and to have their comments incorporated into the formal public record.

However, public comment periods provide only indirect communication between citizens and agency officials because, in some cases, the formal responses to the comments may not be prepared for some time. Also, in some cases, the agency may not individually respond to every comment. A public participation program should provide other activities that allow dialogue between agency officials and the community.

Checklist for Public Comment Periods

__ Determine dates of public comment period (minimum of 45 days)

Dates: _____

__ Determine contact person within the agency who will answer citizens' questions regarding the public comment period

__ Announce public comment period through a public notice

__ If requested by a member of the public during the comment period, schedule a public hearing

__ Document with a memo to the file any comments that were not received in written form

Unsolicited Information and Office Visits

Regulatory Requirements

None.

Description of Activity

EPA encourages permitting agencies, public interest groups, and facility owners/operators to seek input from interested citizens and other stakeholders. At times, this information may arrive in the form of phone calls, letters, and meetings. While this type of information is not always asked for, it can be helpful.

Citizens or stakeholders from other groups may want to visit the agency's office or the facility. In this situation, the visiting stakeholders will want to meet with the person who works most directly with their concerns.

Level of Effort

Depends entirely on the type of unsolicited information provided by the public. Office visits will also command varying amounts of time.

How to Conduct the Activity

Members of the public will come to the agency, the facility, or another organization with information and requests. Public outreach staff should be available for discussion and information when visitors come.

Unsolicited information can be very helpful. First, it can provide an idea of the level of public concern over a facility. Second, members of the public often provide information that is essential to making good technical, economic, and policy decisions. Local citizens often have the most knowledge and insight about the conditions of the land and the people surrounding a facility.

If interested people come to the office, they should be received by a staff member who can relate well with the public and knows the overall mission of your organization. If feasible, he or she should introduce the visitors to members of the staff who can discuss specific issues. Staff people should listen to the citizens' concerns and provide feedback where possible. They should be candid when they do not know the answer to a question. They should also be cordial, avoid jargon and overly technical language, and try to solve the visitor's problem. (See the section on "Informal Meetings With Other Stakeholders" in this Chapter for more information).

If citizens send a letter or call by phone, the receiving organization should respond as soon as possible. If the response will be delayed, a representative of the organization should write a letter or call to explain.

The receiving organization should consider all relevant comments as informal input into the permitting process and let citizens know how they can submit formal comments.

When to Use

Unsolicited information is a constant in community participation. You can improve (or maintain) the credibility of your organization by giving due weight to citizens' concerns and by replying promptly to citizen input.

Accompanying Activities

Fact sheets , **project reports** , and other mailings can answer questions or reply to citizen inquiries. Offer to put concerned citizens on the **mailing list**. Consider holding an **availability session** , **open house** , or **informal meetings** if you detect a high level of public interest.

Advantages and Limitations

A good outreach program can increase your organization's credibility. Unsolicited information can alert you to issues of high public concern and allow you to identify involved groups in the community. Visitors to your organization can get to know the staff, while the staff gains a better understanding of the visitors' concerns.

Unsolicited information is, at best, a supplement to more formal information-gathering. It may be misleading since it does not always reflect the overall level of public concern. Good handling of unsolicited information takes good communication and cooperation within your organization.

Checklist for Unsolicited Information and Office Visits

For office visits:

__ Appoint a member of your staff to act as a liaison for public visits

__ The liaison should answer questions and introduce stakeholders to members of your organization who are involved in the issue

__ Invite visitors to put their names on your mailing list

__ Follow up quickly on any questions that you could not answer during the visit

For phone calls and written requests:

__ Keep a log of calls and letters from other stakeholders

__ Respond quickly to questions; inform the questioner if your response will not be timely

Surveys and Telephone Polls

Regulatory Requirements

None.

Description of Activity

If public participation is to be a dialogue, citizens need ways to provide feedback to facilities, public interest organizations, and permitting agencies. Surveys and polls are designed to solicit specific types of feedback from a targeted audience, such as public opinion about a permitting activity, the effectiveness of public participation activities, or what could be done to improve distributed materials. Surveys may be either oral or written; used in person or by mail; and distributed either to specific segments of the community or to representative samples. We discuss telephone polls in this section, but you may want to consider door-to-door polling or other methods.

Facility owners may want to consider using surveys and polls during the community assessment to gauge public sentiment about constructing or expanding a facility, or as a complement to direct community interviews. The permitting agency can use surveys and polls in a similar fashion, especially during major projects and at facilities that raise controversy. The agency, public interest groups, and the facility owner may also want to use surveys and polls to find out if citizens are receiving enough information about the RCRA activity and are being reached by public notices or other outreach methods.

Level of Effort

On-paper surveys distributed at meetings or by mail are relatively easy and inexpensive, aside from postage. Surveys done in person or by telephone can be very time-consuming.

How to Conduct the Activity

To prepare for surveys or telephone polls:

1. **Specify the information that you need to gather.** Construct specific questions to include in the survey or poll. For written surveys, consider which questions should be multiple choice or "check one box" -- formats that people are more likely to answer. Ensure that oral questions are not too long or confusing and be wary of the factors that can bias your surveying method (e.g., the wording of the question).

   Survey questions do not have to be highly detailed in every case. You may use surveys to allow people to submit general impressions after a meeting or a hearing.

2. **Design the survey or poll.** For written surveys, you should leave plenty of room for people to write. Give clear instructions and explain how you will be using the information. Always include the name and number of a contact person. Provide multi-lingual surveys where appropriate. Follow these same guidelines for oral surveys and polls. For oral surveys, you may want to provide a business card to the interviewee when your discussion is over

3. **Distribute the surveys and questionnaires.** As we mentioned earlier, you may distribute written surveys in person or via mail. You may also leave them for people to pick up after a meeting; or you may decide to distribute them by hand to peoples' homes. If people will need to mail the survey, consider including pre-stamped, pre-addressed envelopes.

   If you are seeking out specific information, you may want to distribute the surveys to a representative sample of the community. In some cases, you may want to do a "blanket" distribution to all homes and businesses within a certain distance of the facility.

   If you choose to do an oral survey, follow the information in the section on "Community Interviews" earlier in this Chapter.

   For telephone polls, you will have to decide whom to call and whether you will address the poll to a random sample, a representative sample, or a targeted segment of the community. If you are attempting one of the latter two options, you may want to contact community leaders and local officials to determine the demographics of the area.

When to Use

Use surveys and telephone polls when:

- you are seeking specific information from a targeted community or audience; or
- you are trying to provide people with a means of giving anonymous feedback during the permitting process.

Accompanying Activities

Always include the name and number of a **contact person** on a survey or a questionnaire. Surveys and questionnaires can be useful for gathering general impressions about specific permitting activities or public participation events, such as **availability sessions** or **public hearings** . They may also complement **community interviews** by allowing people, who may have been uncomfortable or pressured during the interview, to submit anonymous thoughts and comments.

Advantages and Limitations

Written surveys and questionnaires are relatively inexpensive and simple ways to solicit information. They can provide feedback loops for many permitting activities and some people may be more comfortable with the

anonymity that written surveys can ensure. Oral surveys and polls allow you to interact directly with members of the public and to solicit their immediate feedback on permitting issues.

Surveys conducted in-person can be very time-consuming and expensive. Written surveys may not present viewpoints that are representative of the community because people who fill out the surveys tend to have stronger feelings in favor, or against, the proposed activity. Surveys conducted by mail have the additional weaknesses of undependable response rates and questionable response quality.

Checklist for Surveys and Telephone Polls

__ Determine what type of information is needed

__ Determine what format will work best for gathering the information

Written surveys:

__ Determine if you will need to provide the survey in a multilingual format or you will need to provide for other special communication needs in the community (e.g., persons who are illiterate)

__ Prepare interview questions

__ Design the survey sheet; leave adequate writing room and make sure the instructions are clear and easy to understand

__ Provide the name of a contact person on the survey

__ Decide how you will distribute the survey, based on the public participation plan, community interviews, and background information on the facility and the community

Telephone polls or an oral surveys:

__ Identify a team to conduct the survey or the telephone poll

_____

_____

__ Identify how you will target the polling group

__ Consult a polling firm or a consultant if you are conducting your survey with a representative sample

__ Determine if you need to conduct a multilingual poll or survey and whether there are other special communication needs in the community (e.g., persons who are hearing impaired)

__ Prepare the questions for the poll or survey

__ Write a script you can use to give background information to people before the questions

__ When you conduct the survey, provide the name of a contact person, either over the phone, or by handing out business cards in person

Contact Persons/Offices

Regulatory Requirements

EPA regulations require the permitting agency to designate a contact office in most public notices. This requirement applies to draft permits, notices of intent to deny a permit, and modifications initiated by the permitting agency (§§ 124.10(d) and 270.41), as well as to the notice of application submittal (§ 124.32(b)). In these cases, the permitting agency will also provide a contact for the permit applicant. When a permit applicant holds a pre-application meeting under § 124.31, the applicant must provide public notice that includes a contact person for the facility. Similarly, the facility must provide public notice, including a contact at the agency and the facility, when requesting a Class 2 or 3 permit modification (§ 270.42 (b) and (c)). Permitting agencies must also provide contacts and telephone numbers (for the facility and the agency) during the trial burn stage at permitted and interim status combustion facilities (§ 270.62(b) and (d); 270.66(d)(3) and (g)).

Description of Activity

The contact person is a designated staff member who is responsible for responding to questions and inquiries from the public and the media. Some organizations may want to consider distributing lists of contact persons who are responsible for answering questions in certain topic areas.

Level of Effort

The amount of time that the contact person spends responding to citizen concerns and questions will depend on the level of community interest in a facility's permit or corrective action activities. A contact person may spend a few hours a day responding to citizen inquiries if there is high to moderate interest in the facility's RCRA activities.

How to Conduct the Activity

For each permit or corrective action, designate a contact who will respond to citizens' requests for information, answer their questions, and address their concerns on any aspect of the permit or cleanup process. Although permitting agencies are only required to designate a contact office, specifying a person and keeping the same person as the contact throughout the process may engender more public trust and confidence.

When a contact person is assigned:

1. **Send out a news release** announcing the contact person to all local newspapers, radio stations, and television stations. Include the contact person's telephone number and mailing address in all news releases, fact sheets, and mailings. Include in publications a self-mailer, which can be a separate flyer or a designated cut-a-way section of the fact sheet that is addressed to the contact person and leaves room for interested people to request more information or

write their comments.

2. **Give the name, address, and phone number of the contact person to all involved staff in your organization and other stakeholders.** Let staff members know that the contact person may be approached for information and that your staff should coordinate the release of information with the contact person. Inform other stakeholders that the contact person will be available for questions and information-sharing.

3. **Keep a log book** of all citizen requests and comments received by the contact person, and how each one was handled. This will help to assure that incoming requests are not filed and forgotten. This log book also provides another record of issues and concerns.

When to Use

A contact person should be designated for every facility at the outset of the RCRA process.

Accompanying Activities

Designation of the contact person should be announced in **news releases** and **fact sheets**, and **public notices**. The contact person also should be responsible for making sure that the facility's **information repository**, if required, is kept up-to-date.

Advantages and Limitations

A contact person can assure citizens that your organization is actively listening to their concerns and can provide the community with consistent information from a reliable source.

The contact person may not have the authority to resolve all of the concerns raised by citizens and other stakeholders; his or her role may be limited to providing information and facilitating communication between your staff, citizens, and other stakeholders. If, for any reason, the identity of the contact person changes, it is important to inform the community, media contacts, and other stakeholders about this change quickly. You should designate a replacement as soon as possible.

Checklist for Contact Persons

__ Designate a contact person for the facility:

_____

__ Notify media of the name, mailing address, and phone number of the contact person

__ Inform your staff and other stakeholders who are involved with the facility

__ Have contact person maintain a log book of all stakeholder requests and comments received

Telephone Contacts

Regulatory Requirements

None.

Description of Activity

Telephone contacts can be used to gather information about the community and to update State and local officials and other interested parties on the status of permitting or corrective action activities. See the section on "Surveys and Telephone Polls" earlier in this Chapter for related activities.

Level of Effort

Telephone contacts can be a time-intensive activity, depending on the nature of the call. Allow several hours per call when gathering information.

How to Conduct the Activity

In making telephone contacts:

1. **Know exactly what information to request or give out.** Plan carefully what you want to say or what information you would like to obtain from these individuals. Refer to the section on "Community Interviews" earlier in this chapter for information on how to conduct these interviews.

2. **Conduct telephone calls and take notes for your files.**

When to Use

Telephone contacts may be used:

- In the early stages of the RCRA actions to identify key officials, citizens, and other stakeholders who have a high interest in the facility;
- To gather information when face-to-face community interviews are not possible;
- When new and time-sensitive material becomes available; and
- When there is a high level of community interest in the facility, and it is important to keep key players informed.

Accompanying Activities

Telephone contacts are usually made to arrange or conduct community interviews, develop **mailing lists** and arrange for other public participation activities such as **news briefings** , **informal meetings** , and **presentations** .

Advantages and

Telephone calls can be an inexpensive and expedient method of acquiring

Limitations

initial information about the facility. Once the initial information has been gathered, telephone contacts are a quick means of informing key people about facility activities and for monitoring any shifts in community concerns.

Residents initially may feel uncomfortable discussing their concerns and perceptions over the telephone with a stranger. Once residents have met your staff in person, however, they may be more open and willing to discuss their concerns during follow-up telephone calls.

Checklist for Telephone Contacts

Initial telephone contacts:

__ Identify individuals to contact:

- __ State officials
- __ Local officials
- __ Regulatory agency officials
- __ Concerned citizens
- __ Media
- __ Environmental groups, civic organizations, public interest groups

__ Prepare information to discuss on telephone

- __ Prepare questions for individuals to answer
- __ Prepare information that you can give them

__ Keep a log book of information received/given

On-going contacts:

__ Maintain up-to-date telephone contact list

__ Prepare information to discuss on telephone before each set of calls

Telephone Hotlines

Regulatory Requirements

None.

Description of Activity

A hotline is a toll-free (or local) telephone number people can call to ask questions and obtain information promptly about RCRA activities. Some hotlines allow people to order documents.

Level of Effort

The amount of time spent on the telephone hotline responding to citizen concerns and questions will depend on the level of concern the community has regarding the facility's permit or corrective action activities. You may spend several hours a day responding to inquiries if there is high to moderate interest in the facility's RCRA activities.

How to Conduct the Activity

To install a telephone hotline, either as a semi-permanent fixture (available throughout the permit review or corrective action process) or as a temporary measure (installed at the time of major community feedback, such as the public comment period):

1. **Assign one or more staff members** to handle the hotline calls. Consider installing more than one line to minimize busy signals. If staff are not available throughout the day, install an answering machine directing people to leave their name, number, and brief statement of concern, and informing them that someone in your organization will return their call promptly. If a voice mail system is available, provide information on commonly requested information such as meeting dates and locations and the permit status. Check the answering machine for messages at least once a day. If the level of concern is high, check for messages more frequently.

2. **Announce the telephone hotline** in news releases to local newspapers, radio stations, and television stations, and in fact sheets, publications, and public notices.

3. **Keep a record of each question** , when it was received, from whom, and how and when it was answered. All questions and inquiries should be responded to promptly (within 24 hours) if an answer cannot be given immediately. Be diligent in following up requests for information and tracking down accurate, direct responses.

When to Use

A telephone hotline may be used:

- When community interest or concern is moderate to high;

- When emergencies or unexpected events occur, or when a situation is changing rapidly;
- When there is a high potential for complaints (e.g., about dust or noise);
- Where literacy rates are low and written information must be supplemented; and
- Where the community is isolated and has little opportunity for face-to-face contact with project staff (e.g., rural areas, areas far from Regional offices).

Accompanying Activities

The hotline can supplement all other public participation activities.

Advantages and Limitations

A hotline can provide interested people with a relatively quick means of expressing their concerns directly to your organization and getting their questions answered. This quick response can help reassure callers that their concerns are heard. A telephone hotline also can help monitor community concerns. A sudden increase in calls could indicate that additional public participation efforts may be warranted.

You must respond quickly to questions or concerns; otherwise callers may become frustrated. If the number of calls is large, responding quickly to each inquiry could prove burdensome to your staff. Furthermore, dialing a hotline number and receiving a recorded message could irritate or alienate some members of the public.

Checklist for Telephone Hotlines

- ___ Determine need for telephone hotline
- ___ Identify staff responsible for answering calls
  - ___ Have staff maintain a log of all calls and responses
- ___ Install telephone hotlines/answering machines
- ___ Notify interested people about the hotline
  - ___ Public notice
  - ___ Fact sheet
  - ___ Mailing to facility mailing list
- ___ Coordinate staffing of hotline
- ___ Follow-up on calls to hotline

On-Scene Information Offices

Regulatory Requirements

None.

Description of Activity

An on-scene information office is a trailer, small building, or office space on or near the facility site, depending on what is more convenient and accessible for the affected community. The office is staffed by a full-time or part-time person(s) who responds to inquiries and prepares information releases.

Level of Effort

An on-scene information office is a time-intensive activity. You may have staff in the office up to 40 hours a week. Short Cut: Hire a contractor to staff the office; however, always ensure that a representative is there for some specified period during the week.

How to Conduct the Activity

To provide an on-scene information office:

1. **Establish the office.** You may have to rent a trailer, arrange with the owner of the facility to designate space in the facility, or rent office space in a town to be used as an office and launching area. If you will be establishing the office off-site, then you should find an area in the vicinity of the facility or in the nearest town or village.

2. **Install a telephone** and an answering machine to respond to inquiries and publicize the number in local newspapers and your public participation publications.

3. **Assign someone to staff the office.** Establish **regular** hours, including some during the weekend and weekday evenings. Publicize the trailer's hours and the services it offers.

4. **Equip the office with the same materials normally contained in an information repository, if possible.** At a minimum, include key documents and summaries of other documents that are not available. Provide a copy machine so that the public can make copies of documents in the information repository.

When to Use

An on-scene information office may be used:

- When community interest or concern is high;

- During corrective actions;
- When cleanup involves complex technologies or processes;
- When the community perceives a high level of risk to health;
- When activities may disrupt the area surrounding the facility (e.g., traffic patterns); and
- When the area near the facility is densely populated.

Accompanying Activities

The on-scene staff person can conduct **meetings** and **question and answer sessions** to inform citizens about the status of the corrective actions or other facility operations. Staff may also prepare and distribute **fact sheets** and **newsletters** to local residents, conduct **facility tours**, and support the **telephone hotline**. With the **telephone contacts** they make, they can add to and update **mailing lists** and revise **public participation plans**. An on-scene information office may also be a good location for the **information repository**.

Individuals staffing an on-scene information office for an extended period of time will necessarily have a special role in the community. Involvement in other public participation activities may represent a large part of their function. In addition to distributing information to local residents, on-site staff may be responsible for maintaining data bases of residents' addresses, the status of access to property, and a daily log of inquiries. It is important that on-site staff monitor public perceptions and concerns daily. On-scene staff often can make useful recommendations regarding stakeholder concerns. Finally and perhaps most importantly, on-site staff members will frequently serve as a liaison with the public.

Advantages and Limitations

An on-scene information office can be an effective activity for ensuring that other stakeholders are adequately informed about permitting activities and that their concerns are addressed immediately.

An information office can be very expensive since it requires, at a minimum, a part-time staff person and a telephone. Hence, it should be used only when community concerns are currently high or may be high in the future.

Checklist for On-Scene Information Offices

- __ Determine need for an on-scene information office
- __ Identify staff to work in information office
- __ Rent a trailer or office space for the information office
- __ Equip the office with a telephone, office equipment (i.e., copier), and all materials contained in an information repository.
- __ Notify interested people of availability of on-scene information office
  - __ Public Notice
  - __ Fact sheet
  - __ Mailing to facility mailing list
- __ Maintain on-scene information office
  - __ Have staff conduct the following:
    - __ Maintain the mailing list
    - __ Review media coverage
    - __ Respond to calls from citizens and stakeholder groups

Question and Answer Sessions

Regulatory Requirements

None.

Description of Activity

A question and answer session makes knowledgeable staff available to stakeholders to discuss permitting and corrective action issues. Question and answer sessions typically accompany a presentation, briefing, or meeting. Anyone at the event who needs more information will have the opportunity to speak with officials after the event. These sessions can be informal or formal.

Level of Effort

Answering questions will add a small amount of staff time to other public participation activities.

How to Conduct the Activity

To conduct a question and answer session:

1. **Announce that someone will be available for questions after the event.** Pick an area where people can meet a knowledgeable staff person for questions and answers.

2. **Be responsive, candid, and clear.** Ensure that all questions are answered. If staff cannot answer the question on the spot, they should not be afraid to say "I don't know" and offer to answer the question after getting more information. The staffer should write down the question, discuss it with other staff, and respond -- as soon as possible -- by phone or letter. Try to avoid using jargon that people will not understand.

3. **Consider brainstorming ahead of time to develop potential questions and to prepare responses.**

When to Use

Question and answer sessions are appropriate whenever people at an event need more information or the presenting organization needs more feedback. Question and answer sessions are also appropriate when people may feel more comfortable asking questions in a one-on-one situation. If a particular issue, raised by one person at a meeting, is preventing other issues from making the floor at a meeting, you may want to offer to discuss the issue one-on-one after the meeting.

Accompanying Activities

Hold question and answer sessions after **exhibits**, **presentations**, **meetings**, **facility tours**, or on **observation decks**. Some events, such as **open**

houses, have built-in question and answer sessions. In responding to inquiries, you may want to provide written information, such as **fact sheets**, or refer the questioner to a **contact person**.

Advantages and Limitations

Question and answer sessions provide direct communication between your organization and citizens. They are a useful, easy, and inexpensive way of providing one-on-one explanations in an informal setting. One-on-one discussions may attract people who are intimidated from raising issues during a meeting. Such interactions may also increase public comfort and trust in your organization.

Citizens may not be pleased if you cannot answer a question on the spot; they will certainly not be pleased if your response is slow. Be sure to respond to all unanswered questions as soon as you can.

Checklist for Question and Answer Sessions

- ___ Brainstorm potential questions and prepare responses
- ___ If you are planning a Q&A session after a meeting or other event, let people know where it will be held by mentioning it during the meeting
- ___ Be candid and avoid jargon in your answers. If you cannot answer a question, take the questioner's phone number or address and respond to the question as soon as you can.

Information Tables

Regulatory Requirements

None.

Description of Activity

Information tables are simple public participation tools that you can use to interact with interested stakeholders. An information table consists of a table or booth set up at a meeting, hearing, or other event (e.g., a community fair or civic gathering). It is staffed by at least one member of your organization who is available to answer questions. Pamphlets, fact sheets, and brochures are available on the table, along with a sign-up sheet for interested people to add their names to the facility mailing list.

Level of Effort

This activity is time-intensive, with at least one staff person staying at the table during the entire event. The information table is less of a drain on other resources since the materials should already be available.

How to Conduct the Activity

To prepare for an information table:

1. **Learn from community interviews which local events are most frequented by citizens during the year.**

2. **Decide whether the table will be sufficient to address community concerns.** The information table may not be effective in highly-charged environments.

3. **Set up the table.** Include important fact sheets, answers to common questions, general descriptions of the RCRA program, contact names, and hotline numbers. Allow people to sign up for the facility mailing list. Use **exhibits** if appropriate.

When to Use

Use information tables when:

- You need to provide a feedback loop after a public event;
- The RCRA activity has raised significant public interest or technical issues may raise many questions among the public;
- You are gathering names for the facility mailing list;
- A local event, where tables are available, will attract a significant portion of the community.

Information tables may be useful in connection with a **public hearing** or

Accompanying Activities

meeting. EPA recommends using information tables as part of **availability sessions** and **open houses**. **Fact sheets**, **newsletters**, **project reports** and other information should be available at the table. People who come to the table should have the opportunity to sign up for the **mailing list**. **Exhibits** and diagrams can be helpful for explaining the process or technical issues. Provide the name of a **contact person** (or a list of contact people) for interested people to take with them. Information tables provide a good opportunity to distribute questionnaires and **surveys**.

Advantages and Limitations

An information table can provide a feedback loop that complements other events in the permitting process. Information tables at availability sessions and open houses can provide a comfortable way for people to approach project staff and ask questions. At county fairs or other events, they allow project staff to interact with the community and spread information about important permitting activities.

People who approach the information table may ask questions that staff cannot answer. To avoid any negative reactions, staff should record the question and contact the person with an answer by a certain date.

Checklist for Information Tables

(As appropriate):

__ Determine a location for the information table

- __ Facility name, location _____
- __ Contact person at location _____

__ Confirm availability of location for information tables

__ Discuss guidelines for information tables with the event planner

__ Assign staff to cover the information table

__ Collect materials for the information table

- __ Table and chairs
- __ Table skirt
- __ A sign that identifies your organization
- __ Exhibits, time-lines, surveys
- __ Mailing list sign-up sheet
- __ Name tags for your staff
- __ Pens and notepads
- __ Fact sheets, reports, pamphlets, and other documents that people can take
- __ Business cards with the name of a contact person at your organization
- __ Reference documents for your use

__ Keep a record of comments and questions for your files

Informal Meetings with Other Stakeholders

Regulatory Requirements

None. (This type of informal meeting is distinct from the pre-application meeting required under § 124.31 (and discussed under "Public Meetings" in this Chapter) which EPA has stated should be an informal discussion open to the public).

Description of Activity

Informal meetings are meetings your organization holds with individual stakeholder groups that have particular interest in a permitting activity. These meetings are held in an informal setting, such as a resident's home or a local meeting place. Informal meetings allow interested citizens and local officials to discuss issues and concerns. Staff responsible for the facility receive first-hand information from interested community members, special interest groups, and elected officials, while citizens have the opportunity to ask questions and explore topics of interest regarding the facility in question.

Public meetings , which are distinct from **public hearings** , are a special form of informal meetings where the entire community can participate. Public meetings allow all interested parties to discuss issues regarding the facility with each other as well as the regulatory agency. Public meetings can be especially useful for allowing discussion before a public hearing and can be scheduled immediately before the hearing. Comments made during a public meeting do not become part of the official administrative record as they do during a hearing. (See the sections on "Public Meetings" and "Public Hearings" in this Chapter for more details.)

Level of Effort

An informal meeting will take two to three days to plan and conduct. This includes about three hours to set up and schedule the meeting, five hours for preparation, four hours to conduct the meeting, and four hours to follow up on any issues raised during the meeting.

How to Conduct the Activity

To conduct informal meetings:

1. **Identify interested citizens and officials.** Contact each group and local agency that is directly affected by the facility, or contact individuals who have expressed concern regarding the facility. Interested citizen/public interest groups may also want to contact the agency or the facility to set up a meeting. Offer to discuss the permit or corrective action plans at a convenient time, taking into consideration the following elements that will affect levels of community interest and concern: for facilities at which emergency

actions are required, schedule the meeting after the agency has accurate information to share with the participants; for a corrective action, determine first when community concerns may be highest and schedule meetings accordingly. For instance, it may be appropriate to hold an informal meeting when the risk assessment report is released. Holding informal meetings early in the permit process can help prevent potentially volatile situations from developing by providing citizens with one-on-one attention.

2. **Limit attendance.** To increase effectiveness, restrict attendance to between five and 20 individuals or specify attendance by invitation only. The larger the group, the less likely it is that some people will candidly express their concerns. It is difficult to establish rapport with individuals in a large group. If a greater number of stakeholders are interested, you should schedule additional small meetings. If a greater number of participants appears than are expected at an informal meeting, divide the group into smaller groups to allow more one-on-one discussion to take place.

3. **Select a meeting date, time, and place convenient to attendants.** The meeting place should have chairs that can be arranged into a circle, or some other informal setting conducive to two-way communication. A private home, public library meeting room, community center, or church hall may be more likely to promote an exchange of ideas than a large or formal public hall. When scheduling the meeting, make sure that the date and time do not conflict with other public meetings that citizens may want to attend, such as town council meetings, or with holidays or other special occasions. Permitting agencies should be sure that the meeting location does not conflict with state "sunshine laws." In selecting a public meeting place, be attentive to the special needs of handicapped individuals (e.g., access ramps or elevators). Be aware that meetings will frequently have to be scheduled during evening hours to accommodate work schedules.

4. **Begin the meeting with a brief overview.** This short presentation should include a summary of the permit review schedule and how stakeholders can be involved in the decision. These opening remarks should be kept brief and informal (no more than a few minutes) to allow maximum opportunity for open discussion with meeting attenders. Cover whatever topics the public is interested in discussing, these may include:

   - Extent of the activity;
   - Safety and health implications;
   - Factors that might speed up or delay the regulatory and technical process; and

- How community concerns are considered in making decisions on permits and corrective actions.

5. **Identify the regulatory decision-makers** (major agencies and individuals responsible for enacting and enforcing RCRA regulations.) Citizens and other stakeholders will then know where to direct further questions or voice new ideas or suggestions.

6. **Gear the discussion to the audience.** Be sensitive to the level of familiarity that the citizens have with the more technical aspects of the activities discussed.

7. **Listen and take notes.** Find out what the meeting attendees want done. Some concerns may be addressed by making minor changes in a proposed action. Discuss the possibility for accommodating these concerns or explain the reasons why citizen requests appear to be unworkable or conflict with program or legal requirements.

8. **Promptly follow-up on any major concerns.** Stay in touch with the groups and contact any new groups that have formed, so that new or increasing concerns can be dealt with before problems develop.

9. **Write up brief minutes for your files.**

When to Use

Informal meetings can be used:

- When there is widely varying level of knowledge among community members;
- When the level of tension is high and large meetings may not be appropriate;
- When the community needs more personal contact to have trust in your organization or the process;
- When groups want to discuss specific issues in which the community as a whole isn't interested.

Accompanying Activities

Community interviews or calls to **telephone contacts** usually precede these meetings, since it is during these interviews that concerned citizens groups are identified and contacted. Possible meeting locations also can be identified during the community interviews.

Distributing **fact sheets** at these meetings also may be appropriate, depending on when they are held.

Advantages and

The primary benefit of informal meetings is that they allow two-way interaction between citizens, local officials, the permitting agency, and the

Limitations

facility. Not only will citizens be informed about the developments, but the facility owner/operator and officials responsible for the site can learn how citizens view the site.

Informal meetings also add a personal dimension to what might otherwise be treated as a purely technical problem. Informal meetings offer citizens, facility staff, and officials a chance to increase their familiarity with how the process works, increase awareness of each other's point of view, and actively promote public participation. Informal meetings also may diffuse any tension between stakeholders.

Some groups may perceive your efforts to restrict the number of attenders as a "divide and conquer" tactic to prevent large groups from exerting influence on potential actions and to exclude certain individuals or groups. One way to prevent this perception is to hold informal meetings with those organizations who express concern about being left out of the process.

Irate groups or individuals also may accuse your staff of telling different stories to different groups at these small meetings. You can avoid this criticism by inviting a cross-section of interests to each small meeting or by having a large public meeting. Alternatively, you can keep a written record of the informal discussions and make it available upon request or include it in the information repository. A record of discussions is required for any legally-required meetings held during the public comment period.

Checklist for Informal Meetings with Other Stakeholders

__ Determine purpose of meeting

__ Determine number of attenders: _____

__ Determine location(s) for meeting (complete for each available facility)

__ Facility name, location _____

__ Contact person at facility _____

__ Phone number _____

__ Occupancy size _____

__ Handicap accessibility _____

__ Features:
- __Restrooms
- __Public telephones
- __Adequate parking

__ Determine date, time of meeting:

Date:_____

Time:_____

__ Identify interested citizens and officials

__ Contact citizen groups, invite a representative to the meeting

__ Prepare meeting agenda

__ Overview of project

__ Identify decision-makers

__ Allow time for discussion, question/answers

__ Follow-up

Public Meetings

Regulatory Requirements

The pre-application meeting that a permit applicant is required to conduct under § 124.31 is a type of public meeting, though it need not be restricted to the type of meetings described in this section. In some cases, different meeting formats will fulfill the requirements (see "The Pre-Application Meeting" in Chapter 3). Permit holders are also required to hold public meetings when requesting a class 2 or 3 permit modification under § 270.42(b) or (c).

Description of Activity

Public meetings are not public hearings . **Public hearings** are regulatory requirements that provide a formal opportunity for the public to present comments and oral testimony on a proposed agency action. Public meetings, on the other hand, are less formal: anyone can attend, there are no formal time limits on statements, and the permitting agency and/or the facility usually answers questions. The purpose of the meeting is to share information and discuss issues, not to make decisions. Due to their openness and flexibility, public meetings are preferable to hearings as a forum for discussing complex or detailed issues.

Public meetings sometimes complement public hearings. Public meetings can be especially useful for allowing discussion before a public hearing and can be scheduled immediately before the hearing (**workshops** , see below, can also fulfill this need). Comments made during a public meeting do not become part of the official administrative record as they do during a hearing. Public meetings provide two-way communication, with community members asking questions and the permitting agency providing responses. Unlike the activity in the section above ("Informal Meetings with Other Stakeholders"), public meetings are open to everyone.

While public meetings are usually called and conducted by the permitting agency (e.g., before public hearings) or the facility (e.g., during permit modification procedures), it is common for civic, environmental, and community organizations to hold public meetings where ideas can be discussed freely.

EPA's regulations require several specific public meetings. Section 124.31 calls on prospective permit applicants to announce and hold an informal public meeting prior to submitting a permit application. The permitting agency is not required to attend the meeting. See Chapter 3 for more information about the pre-application meeting. Permittees are required to hold public meetings when requesting a class 2 or 3 modification under § 270.42.

Level of Effort

While a public meeting should require less planning than a public hearing, it may take several days to a week to arrange the location and logistics. See

the “Public Notice” section above in this chapter to determine the resources you will need to announce the meeting. Other activities include preparing and copying materials for distribution. You may be able to distribute some of the same materials at the meeting and the public hearing (if applicable).

How to Conduct the Activity

To hold a public meeting, you will follow many of the same steps as for a public hearing (see Chapter 3 for specific guidance regarding pre-application meetings under § 124.31):

1. **Anticipate the audience and the issues of concern.** Identify the audience's objectives, expectations, and desired results. With this information you will know what topics to spend time on and what materials and exhibits to provide. If a part of your audience does not speak English, arrange for a translator.

2. **Schedule the meeting location and time** so that citizens (particularly handicapped individuals) have easy access. Ensure the availability of sufficient seating, microphones, lighting, and recorders. Hold the meeting at a time and place that will accommodate the majority of concerned citizens.

3. **Announce the meeting** at least 30 days before the meeting date. Provide notice of the hearing in local newspapers, broadcast media, signs, and mailings to interested citizens (you can find requirements for pre-application meetings in § 124.31(d)). Choose communication methods that will give all segments of the community an equal opportunity to participate. Use multilingual notices where appropriate. Make follow-up phone calls to interested parties to ensure that the notice has been received. Provide the name of a contact person.

4. **Make relevant documents available for public review.** If you are a permittee requesting a class 2 or 3 permit modification, you must place a copy of the modification request and supporting documents in a location that is publicly accessible and in the vicinity of the facility (see § 270.42(b)(3) and (c)(3)). Announce the location in the public notice for the meeting. For other public meetings, you should consider making important documents available prior to the meeting.

5. **Provide an opportunity for people to submit written questions and comments.** Not all individuals will want, or be able, to attend the meeting. Announce in public notices and mailings that written comments and questions can be submitted to the contact person. You may want to raise some of these written comments and questions at the public meeting.

6. **Post a sign-up sheet** so that attendees can voluntarily provide their names and addresses. If you are a permit applicant holding a pre-application meeting under § 124.31, you can use this sheet to produce

and submit an attendee list as part of your part B application (as required under § 124.31© and § 270.14(b)(22)). The permitting agency will use the attendee list to help generate the facility mailing list.

7. **Take notes** about the major issues of concern and **prepare a summary of all oral and written comments.** If you are a permit applicant holding a pre-application meeting under § 124.31, you must submit a summary of the meeting as part of your part B permit application (as required under § 124.31© and § 270.14(b)(22)). For other public meetings, you should make a summary available for public review and announce where it is available.

When to Use

Some permitting agencies have had success in holding public meetings prior to a public hearing. Public hearings are often "staged" events with little opportunity for new input or discussion. Some participants have criticized them as opportunities for grandstanding. Public meetings, on the other hand, allow interested parties to ask questions and raise issues in an informal setting. A public meeting can provide a useful means of two-way communication at any significant stage during the permitting or corrective action process.

If you are a permit applicant required to hold a pre-application meeting under § 124.31, the public meeting format is one option you can use. Refer to the discussion in Chapter 3 for more information.

Accompanying Activities

Provide **public notice** of the meeting and designate a **contact person**. **Fact sheets** and **exhibits** can inform people about permitting issues at public meetings. You may also consider establishing an **information table** where people who may feel uneasy speaking during the meeting can ask questions and pick up materials. Another option is to make your staff available after in the meeting, in the same manner as an **availability session** or an **open house**. **Information repositories** can complement the meeting by making important documents available for public review.

Advantages and Limitations

A public meeting provides a forum where interested people can ask questions and discuss issues outside of the formality of a public hearing. They are flexible tools that are open to everyone.

Some citizens may be reluctant to speak up at public meetings. You can address this concern by providing one-on-one access to your staff via an information table or an open house, or by scheduling informal meetings. Public meetings, like public hearings, could become adversarial.

Checklist for Public Meetings

(As applicable):

__ Determine location for public meeting

- __ Facility name, location _____
- __ Contact person at location _____
- __ Phone number _____
- __ Occupancy size _____
- __ Handicap accessibility _____
- __ Features:
  - __ Restrooms
  - __ Public telephones
  - __ Adequate parking
  - __ Security

__ Determine date, time of public meeting:

Date: _____

Time: _____

__ Confirm availability at location (if location is not available, determine new location or new date)

__ Announce the public meeting. (Pre-application meetings under § 124.31 must be announced through a display advertizement in a newspaper of general circulation, over a broadcast medium, and through a sign posted on or near the site of the facility or proposed facility).

- __ Contact local officials
- __ Notify key agencies and other stakeholder groups

__ Provide an opportunity, in the notice, for people to submit written comments

__ Determine whether a translator is needed

__ Determine presentation requirements (depending upon the specific requirements of your presentation, some of these items may be optional)

- __ Electrical outlets
- __ Extension cords

Checklist for Public Meetings (continued)

__ Accessible lighting control panel

__ Podium

__ Stage

__ Table(s) and chairs for panel

__ Table skirt

__ Sign-up sheet for the mailing list. (If you are conducting a pre-application meeting under § 124.31, you are required to provide a sign-up sheet or another means for people to add their names to the facility mailing list. You must provide the sheet to the permitting agency as a component of your part B permit application).

__ Water pitcher and glasses

__ Sound system

__ Microphones (stand, tabletop)

__ Cables

__ Speakers

__ Technician/engineers available for hearing

__ Visual aids

__ Slides

__ Slide projector

__ Extra projector bulbs

__ Flip chart

__ Flip chart markers

__ Overhead transparencies

__ Overhead machine

__ VCR and monitor

__ Screen

__ Table for projection equipment

Checklist for Public Meetings (continued)

__ Security personnel (if necessary)

__ Table for meeting recorder (who will produce a meeting transcript or summary)

__ Registration table

__ Registration cards

__ Writing pens

__ Signs

__ Miscellaneous supplies:

__ Scissors

__ Tape (masking, transparent)

__ Thumbtacks

__ Public information materials (fact sheets, etc.)

__ Prepare meeting agenda. (Facility owners/operators conducting a pre-application meeting under § 124.31 should refer to chapter 3 of this manual for information on the subjects they should cover during the meeting).

__ Arrange contingency planning. Decide what to do if:
- more people show up than capacity
- equipment malfunctions

__ Prepare the meeting summary/transcript and make it available to the public. (Facility owners/operators conducting a pre-application meeting under § 124.31 must provide the summary to the permitting agency as a component of the part B application).

Public Hearings

Regulatory Requirements

Public hearings are required if requested (§ 124.11) by the public during the draft permit stage, during an agency-initiated modification under § 270.41, or a Class 3 permit modification under § 270.42(c)(6). The agency will also hold a public hearing at the draft permit stage when there is a high level of public interest (based on requests), or when the agency thinks that the hearing might clarify relevant issues (§ 124.12). The agency will also hold a hearing if these conditions apply during closure or post-closure at interim status facilities (§§ 265.112(d)(4) and 265.118(f)).

Description of Activity

Public hearings provide an opportunity for the public to provide formal comments and oral testimony on proposed agency actions. Occasionally the agency will present introductory information prior to receiving comments. All testimony received becomes part of the public record.

In contrast to a public hearing, a **public meeting** (see above in this Chapter) is intended to provide two-way discussion and is not always recorded for the public record.

Permittees and facility staff have no official role during a hearing. The hearing is a regulatory requirement of the permitting agency.

Level of Effort

Several days to a week may be required to arrange for a public hearing, including the location, hearing logistics, and agenda preparation. Other activities include preparing the notice for the hearing, conducting a dry-run of the hearing, and preparing and copying materials.

How to Conduct the Activity

To conduct public hearings:

1. **Anticipate the audience and the issues of concern.** Identify the audience's objectives, expectations, and desired results. With this information you can determine whether the hearing is likely to be confrontational, or if the audience will need more detailed information about a permit or corrective action. If a part of your audience does not speak English, arrange for a translator.

2. **Schedule the hearing location and time** so that citizens (particularly handicapped individuals) have easy access. Identify and follow any procedures established by the local and state governments for public hearings. Ensure the availability of sufficient seating, microphones, lighting, and recorders. Hold the hearing at a time and place that will accommodate the majority of concerned citizens.

3. **Arrange for a court reporter** to record and prepare a transcript of

the hearing.

4. **Announce the public hearing** at least 30 days before the hearing date. Provide notice of the hearing in local newspapers and mailings to interested citizens. Under § 124.10(b), you may combine the hearing notice with the draft permit notice. Make follow-up phone calls to interested parties to ensure that the notice has been received.

5. **Provide an opportunity for people to submit written comments.** Not all individuals will want to provide oral testimony. Publicize where written comments can be submitted and how they will be reviewed.

6. **Prepare a transcript of all oral and written comments.** Announce where the transcript will be available for public review.

The following are general tips on conducting public hearings:

Be clear and up front with meeting format and logistics. Public hearings are very limited in the amount of information that is exchanged and the extent to which responses are given. Participants should not expect the question and answer format found in public meetings.

Establish meeting format. Public hearings should be managed by a hearings officer or moderator, whose responsibility it is to ensure that all comments are taken for the public record.

- Establish a speakers list . A moderator should develop a list of speakers from the list of respondents to public notices (e.g., those responding to a notice saying, "those wishing to be placed on the list of commenters should contact ...") and/or by asking those wishing to speak to identify themselves on a sign-up list on the way into the hearing. While limiting commenters to a pre-developed list may be inappropriate, such lists serve as valuable management tools in bringing forward commenters in an orderly and expeditious manner.

- Establish time limits for commenters . A moderator should establish a set time limit for an individual to make comments. Typically the limit is five minutes or less. Those wishing to make more detailed comments should be encouraged to submit their comments in writing.

- Establish time limits (if any) for the hearing . Based on your speakers list, and assuming a limited speaking time for individual commenters, the moderator may establish time limits (if any) on the hearing. Most hearings last between two and five hours. However, for very controversial topics, public hearings have been known to extend over a period of days.

- Interacting with commenters . Because comments become part of the public record, the moderator should ask all commenters to give their

names and addresses. If there is doubt about spelling, the moderator should ask the commenters to spell names or street names. In cases where there may be litigation, it is common practice to further request that anyone legally representing any party as part of the permit process or decision identify that fact.

When giving the floor to a commenter, the moderator should also note the person's name, so that he/she can thank the commenters by name at the conclusion of the comment (e.g., "Thank you for those comments, Ms. Smith.").

- Speakers from the permitting agency . There are no set rules for who should participate or speak at a public hearing. In the spirit of the law, the participants from the agency should be those who will be most involved with making the actual decision -- that is, the permit writer, and senior staff who will weigh all information, including these public comments, prior to reaching a final decision. Speakers from the agency should be limited to explaining briefly the decision being made (e.g., "We are here to discuss a proposed modification to the facilities permit to conduct the following activities...").

When to Use

- When requested by a member of the public during a public comment period on a permit, closure, or corrective action. Once requested, hearings require a minimum 30-day advance notice.
- Public hearings are usually conducted during the public comment period following the issuance of a draft permit, major permit modification, or at the selection of a proposed corrective measure.
- Public hearings may be appropriate at other times during the process, especially if the level of community concern warrants a formal record of communication.

Accompanying Activities

Public notices distributed to the **mailing list** and published in local newspapers are used to announce hearings to the public. If a hearing is held to solicit comments on either a draft permit decision or proposed corrective measure, the agency must prepare a **response to comments** . The response to comments documents all submitted public comments and includes the agency's responses. An educational **workshop** or **public meeting** may be useful shortly before the public hearing to explain key issues of the proposed decision or corrective measure and respond to citizen concerns.

Advantages and Limitations

A hearing provides a record of communication so citizens can be sure that their concerns and ideas reach the permitting agency. Public hearings generally should not serve as the only forum for citizen input. They occur at the end of a process that should have provided earlier public access to information and opportunities for involvement. Earlier opportunities

should answer most questions and arguments that are based on curiosity, emotion, sensationalism, or a lack of knowledge about the situation, thereby freeing the hearing for factually-based questions. Meet citizens' needs for information before a formal hearing with techniques such as fact sheets, small-group meetings, and one-on-one briefings.

The formality of a public hearing often creates an atmosphere of "us versus them." There may be little opportunity to interact with citizens. This may be frustrating to some; however, informal gatherings and question and answer sessions are often effective ways to interact with the public on an interpersonal level. A variety of informal techniques, ranging from talking to citizens groups to holding workshops, are discussed throughout this chapter.

Public hearings can easily become adversarial. One way to avoid hostility or confrontation is to make sure the community has had an opportunity to express concerns in a less formal setting prior to the hearing. More frequent contact with concerned citizens before a formal public hearing will reduce the likelihood of a confrontation.

Checklist for Public Hearings

(As appropriate):

__ Determine location(s) for public hearing

- __ Facility name, location _____
- __ Contact person at facility _____
- __ Phone number _____
- __ Occupancy size _____
- __ Handicap accessibility _____
- __ Features:
  - __ Restrooms
  - __ Public telephones
  - __ Adequate parking
  - __ Security

__ Determine date, time of public hearing:

Date: _____

Time: _____

__ Confirm hearing facility availability (if facility not available, determine new facility or new hearing date)

__ Announce the public hearing through a public notice in at least one newspaper 30 days prior to the hearing

- __ Contact local officials
- __ Notify key agencies

__ Determine presentation requirements (depending upon the specific requirements of your presentation, some of these items may be optional)

- __ Electrical outlets
- __ Extension cords
- __ Accessible lighting control panel

Checklist for Public Hearings (continued)

__ Podium

__ Stage

__ Table(s) and chairs for panel

__ Table skirt

__ Water pitcher and glasses

__ Sound system

__ Microphones (stand, tabletop)

__ Cables

__ Speakers

__ Technician/engineers available for hearing

__ Visual aids

__ Slides

__ Slide projector

__ Extra projector bulbs

__ Flip chart

__ Flip chart markers

__ Overhead transparencies

__ Overhead machine

__ VCR and monitor

__ Screen

__ Table for projection equipment

__ Security personnel

Checklist for Public Hearings (continued)

- __ Table for court reporter
- __ Registration table
- __ Registration cards
- __ Writing pens
- __ Signs
- __ Miscellaneous supplies:
- __ Scissors
- __ Tape (masking, transparent)
- __ Thumbtacks
- __ Public information materials (fact sheets, etc.)

__ Prepare meeting agenda

__ Determine hearing participants/speakers

_____

_____

_____

_____

__ Prepare opening comments for hearing officer

__ Arrange contingency planning, decide what to do if:
- more people show up than capacity
- the crowd becomes disruptive

__ Coordinate with public involvement coordinator on notification of the media

__ Set date and time for debriefing following the hearing

Availability Sessions/Open Houses

Regulatory Requirements

None. (In some cases, an availability session or an open house may fulfill the pre-application meeting requirement under § 124.31, as long as the meeting achieves the standards of that section. See “The Pre-Application Meeting” in Chapter 3 for more detail.)

Description of Activity

Availability sessions/open houses are informal meetings in a public location where people can talk to involved officials on a one-to-one basis. The meetings allow citizens to ask questions and express their concerns directly to project staff. This type of gathering is helpful in accommodating individual schedules.

Availability sessions and open houses can be set up to allow citizens to talk with representatives from all interested organizations. Citizens can find out more about all sides of a permitting issue through conversations with agency officials, facility staff, and representatives of involved interest groups and civic organizations.

Level of Effort

An availability session/open house may take two to three days to plan and conduct. Allow sufficient time to select a date, time, and location for the meeting, plan for the session, prepare supporting materials, and meet with and brief your staff who will attend the meeting. You should plan for about five hours for the actual session.

How to Conduct the Activity

To conduct an availability session/open house:

1. **Select a date, time, and location for the availability session/open house that encourages attendance.** Evening hours usually are preferable. The location should be in an easily accessible building familiar to residents (such as a public library, school, or local meeting room).

2. **Anticipate the number of attenders and plan accordingly.** If a large number of people is expected, consider the possibility of holding two availability session/open houses to enable staff to meet and talk with each attender. Alternatively, you can increase the number of staff or the length of the availability session/open house. As a general rule, planning for one staff member per 15-20 attenders should foster an informal atmosphere for conversation, and thereby avoid the situation where a staff member has to speak to a "crowd."

3. **Develop or gather together appropriate explanatory materials.** These materials may include poster boards, handouts, or fact sheets.

4. **Publicize the availability session/open house at least two weeks ahead of time, if possible.** Send announcements to newspapers, television and radio stations, citizens on the mailing list, and any interested community organizations that publish newsletters.

5. **Ensure that appropriate staff attend,** so that citizens can meet those who will be responsible for facility activities. The staff present should be able to answer both technical and policy questions.

6. **Meet with and brief staff and rehearse for the session.** Anticipate questions that may be asked during the session and prepare answers.

When to Use

An availability session/open house is most appropriate:

- When scheduling of meetings is difficult because of community members' schedules;
- When new information is available on several different technical or regulatory issues that would make explaining it in its entirety would be too long for a more formal meeting;
- When community members have widely varying interests or levels of knowledge;
- When an informal setting is appropriate to enhance your credibility with the community;
- When staff is available;
- When larger crowds will make it difficult for certain members of the public to raise questions; and
- In some cases, to fulfill the pre-application meeting requirements in § 124.31 (see “Regulatory Requirements” above in this section).

Accompanying Activities

Exhibits and **fact sheets** can provide background information that enables citizens to ask more informed questions about the facility during the availability session/open house.

Advantages and Limitations

The one-to-one conversations during an availability session/open house can help build trust and establish a rapport between citizens and project staff. An informal, neutral setting will keep officials and the public relaxed and make communications smoother. Citizens can find out more about all viewpoints concerning a permitting action if public interest groups, civic

organizations, agency officials, and facility staff are present at the session.

Planning and conducting an availability session/open house can require a significant amount of staff time. A low turnout may not justify the effort. Hence, community interest in the site should be significant before an availability session/open house is planned.

Checklist for Availability Sessions/Open Houses

(* If you are conducting this activity to fulfill the requirements of § 124.31, the activity must meet the standards of that section. See Chapter 3 for more information).

(As appropriate):

__ Determine location(s) for meeting (complete for each available facility)

- __ Facility name, location _____
- __ Contact person at facility _____
- __ Phone number _____
- __ Occupancy size _____
- __ Handicap accessibility _____
- __ Features:
  - __ Restrooms
  - __ Public telephones
  - __ Adequate parking

__ Determine date, time of meeting:

Date: _____

Time: _____

__ Prepare draft notice (public notice, flier)

__ Coordinate internal review of notice

__ Prepare final notice

__ Determine what officials will attend availability session/open house

__ If applicable, coordinate with other organizations that will be available at the session

__ Notify citizens of availability session/open house

- __ Direct mailing to citizens on facility mailing list
- __ Verify that mailing list is up-to-date
- __ Request mailing labels
- __ Public notice in local newspaper(s)

__ Prepare handouts, other informational material for availability session/open house

Workshops

Regulatory Requirements

None.

Description of Activity

Workshops are seminars or gatherings of small groups of people (usually between 10 and 30), led by a small number of specialists with technical expertise in a specific area. In workshops, participants typically discuss hazardous waste issues where citizens comment on proposed response actions and receive information on the technical issues associated with the permitting process and the RCRA program in general. Experts may be invited to explain the problems associated with releases of hazardous substances and possible remedies for these problems. Workshops may help to improve public understanding of permit conditions or hazardous waste problems at a facility and to prevent or correct misconceptions. Workshops also may identify citizen concerns and encourage public input.

Level of Effort

A one-day workshop may take about three days to a week to plan and execute. Another day will probably be required to follow up on any issues that arise during the workshop.

How to Conduct the Activity

To conduct a workshop:

1. **Determine the focus of the workshop.** Decide what topic or topics will be covered in either one or more workshops. Suggested topics include: purpose of RCRA; description of the permit process or corrective action program; proposed remedies; risk assessment; identified health or environmental problems; and/or method and format for receiving citizen comments on the proposed or ongoing actions. Determine what staff will be needed at each workshop and whether any outside experts will be needed.

2. **Plan the workshop.** Decide ahead of time on a minimum and maximum number of participants. If there are too few, consider holding an informal meeting and postpone the workshop until additional interest develops. Identify a convenient location and time for the workshop, and set a date that does not conflict with other important meetings or interests (for example, town council meetings, high school sporting events).

3. **Announce the workshop** by publishing a notice well in advance (at least 3 weeks) in the local newspapers. Send a notice of workshops with mailings to all citizens on the facility mailing list and distribute posters around town. Send out invitations and registration forms to

concerned citizens. Provide for multiple registrations on each form to accommodate friends who also might be interested in the workshop. Emphasize that the number of participants is limited, and provide a deadline for registration.

When to Use

Workshops are appropriate:

- When the RCRA process needs to be explained to community members interested in participating in the process;
- When specific topics needs to be discussed in detail, especially health or risk assessment issues; and
- When technical material needs to be explained and feedback from the community is important to make sure that citizens understand the material.

Accompanying Activities

Workshops can be conducted before formal **public hearings** or during **public comment periods** to give citizens some ideas on developing and presenting testimony. **Fact sheets** and **exhibits** can complement the workshop.

Advantages and Limitations

Workshops provide more information to the public than is possible through fact sheets or other written materials. Workshops have proven successful in familiarizing citizens with key technical terms and concepts before a formal public meeting. Workshops also allow two-way communication, making them particularly good for reaching opinion leaders, interest group leaders, and the affected public.

If only a limited number are held, workshops can reach only a small segment of the affected population.

When planning a workshop, you should make sure that it is announced in local newspapers, to help ensure that it will be well-attended. In addition, it may be helpful to specifically invite all residents who have expressed an interest in the site.

Checklist for Workshops

(As appropriate):

- __ Determine purpose of workshop _____
  - __ Determine number of attenders _____
- __ Plan the workshop
  - __ Identify topics to be presented
  - __ Identify agency officials to present topics, handle registration
  - __ Prepare handouts, other informational materials
- __ Determine location(s) for workshop (complete for each available facility)
  - __ Facility name, location _____
  - __ Contact person at facility _____
  - __ Phone number _____
  - __ Occupancy size _____
  - __ Handicap accessibility _____
  - __ Features:
    - __ Restrooms
    - __ Public telephones
    - __ Adequate parking
- __ Determine date, time of workshop:

  Date: _____

  Time: _____
- __ Prepare draft notice announcing workshop (public notice, flier)
- __ Coordinate internal review of notice
- __ Prepare final notice

Checklist for Workshops (continued)

- __ Notify citizens of workshop
  - __ Direct mailing to citizens on facility mailing list
  - __ Verify that mailing list is up-to-date
  - __ Request mailing labels
  - __ Public notice in local newspaper(s)
- __ Determine presentation requirements
  - __ Electrical outlets
  - __ Extension cords
  - __ Accessible lighting control panel
  - __ Window covers
  - __ Podium
  - __ Stage
  - __ Table(s) and chairs for panel
  - __ Water pitcher and glasses
  - __ Sound system
  - __ Microphones (stand, tabletop, lavaliere)
  - __ Cables
  - __ Speakers
  - __ Technician/engineers available for hearing
  - __ Visual aids
  - __ Slides
  - __ Slide projector

Checklist for Workshops (continued)

- __ Extra projector bulbs
- __ Flip chart
- __ Flip chart markers
- __ Overhead transparencies
- __ Overhead machine
- __ VCR and monitor
- __ Screen
- __ Table for projection equipment
- __ Registration table
- __ Registration cards
- __ Writing pens
- __ Signs
- __ Miscellaneous supplies:
- __ Scissors
- __ Tape (masking, transparent)
- __ Thumbtacks
- __ Public information materials (fact sheets, etc.)

__ Arrange and conduct at least one rehearsal

Attending Other Stakeholder Meetings and Functions

Regulatory Requirements

None. (The permitting agency may need to attend public meetings held by the permittee under § 270.42 in order to respond to public comments on the modification request. Agencies may also want to attend the applicant's pre-application meeting held under § 124.31. See the section on the "Pre-Application meeting" in Chapter 3 for more detail.)

Description of Activity

Permitting agencies, facilities, local governments, environmental organizations, religious and civic groups may all hold meetings or other gatherings during the permitting process. Some may be required by regulation and others may be informational meetings or discussions of important issues. As an involved stakeholder, you can learn more about the views of other stakeholders by attending their meetings. You can join in important discussions and provide information. Some groups may invite you to give a **presentation** or a **briefing**.

Level of Effort

The time you commit to attending other stakeholder meetings or functions will depend on the level of your participation. Meetings can vary in length; your resource commitment will be more substantial if you agree to give a **briefing** or a **presentation** (see those sections of this chapter for more information). You will need a few hours to prepare notes for your file after the meeting.

How to Conduct the Activity

If you decide to attend a meeting, you may want to inform the host organization that you plan to attend the meeting. If you choose to identify yourself at the meeting, be prepared to answer questions. You may want to bring fact sheets or other information you can provide upon request. In any case, be prepared to listen to the discussion and prepare notes for your files.

The host organization may ask you to provide a **briefing** or a **presentation**. See those sections of this chapter for more information.

When to Use

You may want to attend other stakeholders' meetings when the meetings are open and you want to learn more about the views held by other stakeholders. In some cases, a group may invite your organization to attend a meeting to provide input or answer questions. In such cases, you should be prepared to answer questions or present the views of your organization.

If appropriate, you may want to make **fact sheets** available upon request at

Accompanying Activities

the meeting. Provide the name of a **contact person**. If you are representing the permitting agency, let participants know about how to put their names on the facility **mailing list**.

Advantages and Limitations

Attending meetings or functions held by other stakeholders can provide useful insight to other opinions and concerns. This information can help you plan other public participation events and complement data you gather from community interviews.

This activity should not be used in place of informal meetings or other activities that may be more appropriate. If your attendance has the potential to cause problems, make sure to contact the host before the meeting.

Citizen Advisory Groups

Regulatory Requirements

None.

Description of Activity

A Citizen Advisory Group (CAG) provides a public forum for representatives of diverse community interests to present and discuss their needs and concerns with government and/or the facility. Although CAGs may come in many different forms and have different responsibilities and roles, they are generally composed of a board of stakeholders that meets routinely to discuss issues involving a particular facility. The purpose of a CAG is usually to advise a facility owner/operator or the permitting agency on permitting or corrective action activities.

CAGs can be a good way to increase active community participation in environmental decision-making and provide a voice for affected community members and groups. They promote direct, two-way communication among the community, the permitting agency, and the facility.

The make-up and mission of a CAG may vary -- there is no set formula governing the make-up or responsibilities of the group. The best type of CAG to use will depend on the situation. For instance, a citizen organization may create a CAG of affected community members to provide an official voice from the community. Facility owner/operators may create a CAG of affected community members to provide informal or formal advice. A permitting agency may form a CAG that includes stakeholders from the facility, the community, and the agency.

In establishing a CAG, it is important to bear in mind that the size of a group can often have an impact on its effectiveness -- for example, too large of a group can inhibit how efficiently it can work and come to consensus on issues, and too small of a group may not be adequate to represent diverse community concerns.

Forming a CAG does not necessarily mean that there will be universal agreement about permitting or corrective action issues. Nor does having a CAG mean there will be no controversy during the process. However, when decisions made by the facility or the permitting agency differ from the stated preferences of a CAG, the facility or the agency should accept the responsibility of explaining its decision to CAG members.

RCRA regulations do not require the use of advisory groups; however, EPA regulations do contain standards for advisory groups if EPA decides to require them under 40 CFR. These standards are located in 40 CFR 25.7.

Although these standards may not apply to all types of advisory groups used in conjunction with RCRA permitting, they provide useful guidance for agencies, facilities, and public interest groups who may want to use advisory groups. A copy of the part 25 regulations is available Appendix F.

EPA's Office of Emergency and Remedial Response has issued guidance on the use of CAGs at Superfund sites (see Appendix E). Although there are many differences between the Superfund and RCRA programs (most notably that Superfund often deals with abandoned sites while RCRA typically deals with existing or potential facilities), a large part of the Superfund CAG guidance discusses CAG development, membership, and training that may be applicable to some RCRA CAGs. Superfund terminology and process aside, the guidance contains some very useful, concise advice on various aspects of CAGs.

Although CAGs are a useful tool in many situations, they may not always be appropriate. See the section "When to Use" below for a list of factors you should consider before forming a CAG.

Level of Effort

CAGs can be a time-consuming and expensive endeavor. Membership selection, meeting preparation and follow-up, information dissemination, and training all take a lot of resources. Unlike the Superfund program, agencies that implement RCRA cannot provide Technical Assistance Grants (TAGs) to help defray the costs of CAGs.

How to Conduct the Activity

See EPA's *Guidance for Community Advisory Groups at Superfund Sites* and 40 CFR § 25.7 (in Appendices E and F) for information on how to set up CAGs. Keep in mind that CAGs under the RCRA program will differ from CAGs under Superfund. You may want to obtain a copy of the reference list of public participation and risk communication literature (available through the RCRA Hotline or the RCRA Information Center in Docket Number F-95-PPCF-FFFFF) to look for additional information sources on this topic.

When to Use

A CAG can be formed at any point in the permitting or corrective action process, and may be most effective in the early stages. Generally, the earlier a CAG is formed, the more members can participate in and impact decision-making.

CAGs may not be appropriate in every situation. If you are considering use of a CAG, you should consider the following factors:

- the level of community interest and concern;
- community interest in forming a CAG;
- the existence of groups with competing agendas in the community;

- environmental justice issues or concerns regarding the facility;
- the history of community involvement with the facility, or with environmental issues in general; and
- the working relationship between the facility, the community, and the permitting agency.

Accompanying Activities

Depending on the make-up and the purpose of the CAG, you may want to provide **public notice**, hold a **public meeting**, and issue a **news release** before forming the CAG. The CAG may choose to provide public participation activities (such as **meetings**, **newsletters**, or **availability sessions**) as part of its mission.

Advantages and Limitations

CAGs can increase active community participation in environmental decision-making and provide a voice for affected community members and groups. They promote direct, two-way communication among the community, the permitting agency, and the facility and can highlight your organization's commitment to inclusive stakeholder input.

CAGs can be time- and resource-intensive. CAGs that do not accurately reflect or account for public concerns may lose support in the community. In addition, uncertainty about the group's charter may cause conflict and hard feelings. If you plan to use a CAG, the mission and responsibilities of the CAG must be made clear from the start. Finally, CAGs can spend so much time agreeing on procedures that they drive away people who are concerned with substance. The need for elaborate procedures can be sharply reduced if an advisory group agrees to work on a consensus basis rather than by majority vote.

APPENDIX A -- LIST OF EPA CONTACTS

EPA Headquarters 401 M Street, SW
Washington, DC 20460

Directory Assistance	(202) 260-2090 (TDD 260-3658)
Office of Solid Waste and Emergency Response	(202) 260-4610
Office of Solid Waste	(202) 260-4627
Office of Enforcement and Compliance Assurance	(202) 260-4134
RCRA Hotline	(800) 424-9346 (TDD 553-7672)
(Washington, DC Metro Area)	(703) 412-9810 (TDD 412-3323)
Hazardous Waste Ombudsman	(800) 262-7937
(Washington, DC Metro Area)	(202) 260-9361
Office of Environmental Justice	(800) 962-6215
(Washington, DC Metro Area)	(202) 260-6359
Pollution Prevention Information Clearinghouse	(202) 260-1023
Public Information Center	(202) 260-2080
RCRA Information Center	(703) 603-9230 (see brochure)

EPA Regional Offices

Region 1 (CT, ME, MA, NH, RI, VT)	JFK Federal Building Boston, MA 02203-0001 (617) 565-3420
Region 2 (NJ, NY, PR, VI)	290 Broadway New York, NY 10007-1866 (212) 637-3000
Region 3 (DE, DC, MD, PA, VA, WV)	841 Chestnut Building Philadelphia, PA 19107 (215) 597-9800
Region 4 (AL, FL, GA, KY, MS, NC, SC, TN)	345 Courtland St., NE Atlanta, GA 30365 (404) 347-4727
Region 5 (IL, IN, MI, MN, OH, WI)	77 West Jackson Blvd. Chicago, IL 60604-3507 (312) 353-2000
Region 6 (AR, LA, NM, OK, TX)	Fountain Place 12th Fl., Suite 1200 1445 Ross Avenue Dallas, TX 75702-2733 (214) 665-6444
Region 7 (IA, KS, MO, NE)	726 Minnesota Avenue Kansas City, KS 66101 (913) 551-7000

Region 8 (CO, MT, ND, SD, UT, WY)	999 18th Street, Suite 500 Denver, CO 80202-2466 (303) 293-1603
Region 9 (AZ, CA, HI, NV, AS, GU)	75 Hawthorne St. San Francisco, CA 94105 (415) 744-1305
Region 10 (AK, ID, OR, WA)	1200 Sixth Avenue Seattle, WA 98101 (206) 553-1200

APPENDIX B -- LIST OF STATE RCRA CONTACTS

Alabama Department of Environmental Management
1751 Cong. Wm. L. Dickinson Drive
Montgomery, AL 36130
(205) 271-7730

Alaska Department of Environmental Conservation
410 Willoughby Avenue, Suite 105
Juneau, AK 99801-1795
(907) 465-5150

For American Samoa, contact:
U.S. EPA Region 9
Hazardous Waste Management Division
75 Hawthorne Street
San Francisco, CA 98101
(415) 744-2098

Arizona Department of Environmental Quality
3303 N. Central Avenue
Phoenix, AZ 85012
(602) 207-4146

Arkansas Department of Pollution Control and Ecology
8001 National Drive
PO Box 8913
Little Rock, AR 72219-8913
(501) 562-7444

California Department of Toxic Substances Control
10151 Croydon Way, Suite 3
Sacramento, CA 95827
(916) 255-3618

Colorado Department of Health
4300 Cherry Creek Drive So.
HMWMD
Denver, CO 80222-1530
(303) 692-3300

Connecticut Department of Environmental Protection
State Office Building
165 Capitol Avenue
Hartford, CT 06106
(203) 566-4869

Delaware Department of Natural Resources and Environmental Control
PO Box 1401, 89 Kings Highway
Dover, DE 19903
(302) 739-3689

District of Columbia Department of Consumer and Regulatory Affairs
Environmental Regulation Administration
2100 Martin Luther King Jr. Ave., SE
Washington, DC 20020
(202) 404-1167

Florida Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-0300

Georgia Department of Natural Resources
1154 East Tower
205 Butler Street, SE
Atlanta, GA 30334
(404) 656-7802

Guam Environmental Protection Agency
Harmon Plaza, Complex Unit B-107
103 Orjas Street
Harmon, Guam 96911

Hawaii Department of Health
Five Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813

Idaho Department of Environmental Quality
1410 N. Hilton, Third Floor
Boise, ID 83706
(208) 334-5879

Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, IL 62706
(217) 785-8452

Indiana Department of Environmental Management
105 S. Meridian Street
PO Box 6015
Indianapolis, IN 46225

For Iowa, contact:
U.S. EPA Region 7
RCRA Branch
726 Minnesota Ave.
Kansas City, KS 66101
(913) 551-7646

Kansas Department of Health and Environment

Forbes Field, Building 740
Topeka, KS 66620
(913) 296-1600

Kentucky Department of Environmental Protection
Fort Boone Plaza, Building No. 2
14 Reilly Road
Frankfort, KY 40601
(502) 564-6716

Louisiana Department of Environmental Quality
PO Box 82178
Baton Rouge, LA 70884-2178
(504) 765-0332

Maine Department of Environmental Protection
State House Station #17
Augusta, ME 04333
(207) 289-2651

Maryland Department of the Environment
2500 Broening Highway
Baltimore, MD 21224
(410) 631-3343

Massachusetts Department of Environmental Protection
One Winter Street, 5th Floor
Boston, MA 02108
(617) 292-5851

Michigan Department of Natural Resources
Box 30241
Lansing, MI 48909
(517) 373-2730

Minnesota Pollution Control Agency
520 Lafayette Road, North
St. Paul, MN 55155
(612) 297-8330

Mississippi Department of Environmental Quality
PO Box 10385
Jackson, MI 39289-0385
(601) 961-5171

Missouri Department of Natural Resources
Jefferson Building
205 Jefferson Street (13/14 Floor)
PO Box 176
Jefferson City, MO 65102
(314) 751-3176

Montana Department of Health and Environmental Sciences
Cogswell Building
Helena, MT 59620
(406) 444-1430

Nebraska Department of Environmental Quality
State House Station
PO Box 98922
Lincoln, NE 68509-8922
(402) 471-2186

Nevada Division of Environmental Protection
333 West Lye Lane
Carson City, NV 89710
(702) 687-5872

New Hampshire Department of Health and Welfare
Health and Welfare Building
6 Hazen Drive
Concord, NH 03301
(603) 271-2900

New Jersey Department of Environmental Protection
120 South Stockton St.,CN-414
Trenton, NJ 08625
(609) 292-9880

New Mexico Environment Department
Harold Runnels Building
1190 St. Francis Drive
PO Box 26110
Santa Fe, NM 87502
(505) 827-2911

New York Department of Environmental Conservation
PO Box 7252
Albany, NY 12233-7251
(518) 457-9257

North Carolina Department of Environment, Health, and Natural Resources
PO Box 27687
Raleigh, NC 27611-7687
(919) 733-4996

North Dakota Department of Health and Consolidated Laboratories
1200 Missouri Ave.
PO Box 5520
Bismarck, ND 58502-5520
(701) 221-5166

For Northern Mariana Islands, contact:
U.S. EPA Region 9
Hazardous Waste Management Division

75 Hawthorne Street
San Francisco, CA 94105
(415) 744-2098

Ohio Environmental Protection Agency
1800 Watermark Drive
Columbus, OH 43215
(614) 644-2977

Oklahoma Department of Environmental Quality
1000 Northeast 10th Street
Oklahoma City, OK 73117-1212
(405) 271-5338

Oregon Department of Environmental Quality
811 Southwest 6th Avenue
Portland, OR 97204
(503) 229-5356

Pennsylvania Department of Environmental Resources
400 Market Street, 14th Floor
Harrisburg, PA 17105-8471
(717) 787-6239

For Puerto Rico, contact:
U.S. EPA Region 2
Air and Waste Management Division
26 Federal Plaza, Room 1037
New York, NY 10278
(212) 264-0504

Rhode Island Department of Environmental Management
204 Canon Building, 75 Davis Street
Providence, RI 02908
(401) 277-2797

South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
(803) 734-4711

South Dakota Department of Environment and Natural Resources
319 Coteau
c/o 500 E. Capital Avenue
Pierre, SD 57501-5070
(605) 773-3153

Tennessee Department of Public Health
401 Church St.
LNC Tower, 5th Floor
Nashville, TN 37243-1535
(615) 532-0780

Texas Natural Resources Conservation Commission
P.O. Box 13087, Capitol Station
Austin, TX 78711-3087
(512) 908-1000

Utah Department of Environmental Quality
PO Box 144880
Salt Lake City, UT 84114-4880
(801) 538-6170

Vermont Agency of Environmental Conservation
103 South Main Street
Waterbury, VT 05676
(802) 241-3888

For Virgin Islands, contact:
U.S. EPA Region 2
Air and Waste Management Division
26 Federal Plaza, Room 1037
New York, NY 10278
(212) 264-0504

Virginia Department of Waste Management
Monroe Building, 11th Floor
101 North 14th Street
Richmond, VA 23219
(804) 225-2863

Washington Department of Ecology
PO Box 47658
Olympia, WA 98504-7658
(206) 459-6316

West Virginia Department of Commerce, Labor, and Environmental Protection
1356 Hansford Street
Charleston, WV 25301
(304) 558-5393

Wisconsin Department of Natural Resources
PO Box 7921
Madison, WI 53707
(608) 266-1327

For Wyoming, contact:
U.S. EPA Region 8
Hazardous Waste Management Division
999 18th Street, Suite 500
Denver, CO 80202-2405
(303) 294-1361

THE LEAGUE OF WOMEN VOTERS OF THE U.S.
1730 M STREET, NW
WASHINGTON, DC 20036-4587
202-429-1965 - FAX 202-429-0854

STATE
PRESIDENT'S NAME
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DELAWARE

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WILMINGTON, DE 19802-3809
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JULIA C. GRAVES
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APPENDIX D -- ENVIRONMENTAL JUSTICE PUBLIC PARTICIPATION CHECKLIST

Introduction:

The environmental justice movement has sparked a lot of discussion on ways to improve communications and working relations among agencies, industries, and communities. The InterAgency Working Group on Environmental Justice, led by EPA, developed a Public Participation Checklist that lays out ways to identify, inform, and involve stakeholders (e.g., environmental organizations, business and trade associations, civic/public interest groups, grassroots/community-based organizations, tribal governments, and industry). It reflects a combination of: guiding principles for setting up and conducting activities, such as public meetings; specific activities for ensuring widespread and meaningful involvement; and recommendations on how to effectively carry out those activities.

Although the checklist was initially developed in the context of environmental justice, to help federal agencies prepare for the first public meeting to discuss their EJ strategies, it embodies sound principles that apply to public participation for all communities.

Revised 1/13/95

ENVIRONMENTAL JUSTICE
PUBLIC PARTICIPATION CHECKLIST

1. Ensure that Agency's public participation policies are consistent with the requirements of the Freedom of Information Act, the Emergency Planning and Community Right to Know Act and the National Environmental Policy Act.

2. Obtain Senior Management Support to ensure that the Agency's policies and activities are modified to ensure early, effective and meaningful public participation, especially with regard to Environmental Justice stakeholders. Identify internal stakeholders and establish partnering relationships.

3. Use following Guiding Principles in setting up all public meetings:
   - Maintain honesty and integrity throughout the process.
   - Recognize community\indigenous knowledge.
   - Encourage active community participation.
   - Utilize cross-cultural formats and exchanges.

4. Identify external Environmental Justice stakeholders and provide opportunities to offer input into decisions that may impact their health, property values and lifestyles. Consider at a minimum individuals from the following organization as appropriate:

Environmental Organizations
Business and Trade Organizations
Civic / Public Interest Groups
Grassroots \ Community-based Organizations
Congress
Federal Agencies
Homeowner and Resident Organizations
International Organizations
Labor Unions
Local and State Government
Media \ Press
Indigenous People
Tribal Governments
Industry
White House
Religious Groups
Universities and Schools

5. Identify key individuals who can represent various stakeholder interests. Learn as much as

possible about stakeholders and their concerns through personal consultation, phone, or written contacts. Ensure that information gathering techniques include modifications for minority and low -income communities, for example, consider language \ cultural barriers, technical background, literacy, access to respondent, privacy issues and preferred types of communications.

6. Solicit stakeholder involvement early in the policymaking process, beginning in the planning and development stages and continuing through implementation and oversight.

7. Develop co-sponsoring/co-planning relationships with community organizations, providing resources for their needs.

8. Establish a central point of contact within the Federal agency to assist in information dissemination, resolve problems and to serve as a visible and accessible advocate of the public's right to know about issues that affect health or environment.

9. Regionalize materials to insure cultural sensitivity and relevance. Make information readily accessible (handicap access, Braille, etc.) and understandable. Unabridged documents should be placed in repositories. Executive summaries/fact sheets should be prepared in layman's language. Whenever practicable and appropriate, translate targeted documents for limited English-speaking populations.

10. Make information available in a timely manner. Environmental Justice stakeholders should be viewed as full partners and Agency customers. They should be provided with information at the same time it is submitted for formal review to state, tribal and/or Federal regulatory agencies.

11. Ensure that personnel at all levels in the Agency clearly understand policies for transmitting information to Environmental Justice stakeholders in a timely, accessible and understandable fashion.

12. Establish site-specific community advisory boards where there is sufficient and sustained interest. To determine whether there is sufficient and sustained interest, at a minimum, review correspondence files, review media coverage, conduct interviews with local community members and advertise in local newspapers. Ensure that the community representation includes all aspects and diversity of the population. Organize a member selection panel. Solicit nominations from the community. Consider providing administrative and technical support to the community advisory board.

13. Schedule meetings and/or public hearings to make them accessible and user-friendly for Environmental Justice stakeholders. Consider time frames that don't conflict with work schedules, rush hours, dinner hours and other community commitments that may decrease attendance. Consider locations and facilities that are local, convenient and which represent

neutral turf. Ensure that facility meets American with Disabilities Act Statements for equal access. Provide assistance for hearing impaired individuals. Whenever practical and appropriate provide translators for limited-English speaking communities. Advertise the meeting and its proposed agenda in a timely manner in the print and electronic media. Provide a phone number and/or address for communities to find out about pending meetings, issues, enter concerns or to seek participation or alter meeting agenda.

Create an atmosphere of equal participation (avoid a "panel of experts" or "head table"). A two day meeting is suggested with the first day reserved for community planning and education. Organize meetings to provide an open exchange of ideas and enough time to consider issues of community concern. Consider the use of a neutral facilitator who is sensitive and trained in environmental justice issues. Ensure that minutes of the meetings are publically available. Develop a mechanism to provide communities with feedback after meetings occur on actions being considered.

14. Consider other vehicles to increase participation of Environmental Justice stakeholders including:

Posters and Exhibits
Participation in Civic and Community Activities
Public Database and Bulletin Boards
Surveys
Telephone Hotlines
Training and Education Programs, Workshops and Materials

15. Be sure that trainers have a good understanding of the subject matter both technical and administrative. The trainers are the Ambassadors of this program. If they don't understand - no one will.

16. Diversity in the workplace: whenever practical be sure that those individuals that are the decision makers reflect the intent of the Executive Order and come from diverse backgrounds, especially those of a community the agency will have extensive interaction with.

17. After holding a public forum in a community establish a procedure to follow up with concrete actions to address the communities' concerns. This will help to establish credibility for your agency as having an active role in the federal government.

18. Promote interagency coordination to ensure that the most far reaching aspects of environmental justice are sufficiently addressed in a timely manner. Environmental problems do not occur along departmental lines. Therefore, solutions require many agencies and other stakeholders to work together efficiently and effectively.

19. Educate stakeholders about all aspects of environmental justice (functions, roles, jurisdiction, structure and enforcement).

20. Ensure that research projects identify environmental justice issues and needs in communities, and how to meet those needs through the responsible agencies.

21. Establish interagency working groups (at all levels) to address and coordinate issues of environmental justice.

22. Provide information to communities about the government's role as it pertains to short term and long term economic and environmental needs and health effects.

23. Train staff to support inter and intra agency coordination, and make them aware of the resources needed for such coordination.

25. Provide agency staff who are trained in cultural, linguistic and community outreach techniques.

26. Provide effective outreach, education and communications. Findings should be shared with community members with an emphasis on being sensitive and respectful to race, ethnicity, gender, language, and culture.

27. Design and implement education efforts tailored to specific communities and problems. Increase the involvement of ethnic caucuses, religious groups, the press, and legislative staff in resolution of Environmental Justice issues.

28. Assure active participation of affected communities in the decisionmaking process for outreach, education, training and communities programs -- including representation on advisory councils and review committees.

29. Encourage federal and state governments to "reinvent government" -- overhaul the bureaucratic in favor of community responsive.

30. Link environmental issues to local economic issues to increase level of interest.

31. Use local businesses for environmental cleanup or other related activities.

32. Utilize, as appropriate, historically Black Colleges and Universities (HBCU) and Minority

Institutes (MI), Hispanic Serving Colleges and Universities (HSCU) and Indian Centers to network and form community links that they can provide.

33. Utilize, as appropriate, local expertise for technical and science reviews.

34. Previous to conducting the first agency meeting, form an agenda with the assistance of community and agency representatives.

35. Provide "open microphone" format during meetings to allow community members to ask questions and identify issues from the community.

Bibliography:

"Interim report of the Federal Facilities Environmental Restoration Dialogue Committee," February 1993, Environmental Protection Agency and the Keystone Center

"Community Relations in Superfund: A Handbook," January 1992, Environmental Protection Agency, Document # EPA-540-R-92-009 and # PB92-963341

DRAFT "Partnering Guide for DoD Environmental Missions," July 1994, Institute for Water Resources, U.S.A.C.E

"Improving Dialogue with Communities: A Short Guide for Government Risk Communications," September 1991, Environmental Communications Research Program, New Jersey Agriculture Experiment Station, Cook College, Rutgers University

OSD/DUSD/ES/OR/Ann Davlin/703/695-3329/28 September 94

APPENDIX H -- EXAMPLES OF RCRA NOTICES

March 4, 1996 Washington Post (page B5)

Example of a public notice placed as a display advertisement

INFORMAL PUBLIC MEETING
and FORMAL PUBLIC HEARING
on PROPOSED DISTRICT
DRINKING WATER ORDER

WHO: The United States Environmental Protection Agency, Region III

WHAT: EPA will conduct both an informal public meeting and a formal public hearing to discuss the District of Columbia's drinking water supply.

WHEN:

Tuesday, April 9, 1996	Informal Public Meeting: 5-9 pm
Wednesday, April 17, 1996	Formal Public Hearing: 6:30-9 pm

WHERE: National Guard Association of the United States
"Hall of States" (first floor)
One Massachusetts Avenue, NW
Washington, DC 20001

WHY: On November 13, 1995, EPA issues a Proposed Administrative Order (PAO) to the water system of the District of Columbia for violations of section 1414(g) of the Safe Drinking Water Act [42 USC §3000-3(g)]. These sessions are authorized under 40 CFR §25.5, §25.6 and §142.205.

The **meeting** will focus on concerns about drinking water produced by the US Army Corps of Engineers' Washington Aqueduct and distributed by the District of Columbia Water Systems. Representatives of the Washington Aqueduct and DC Drinking Water System will attend the meeting.

The **hearing** is to determine if the PAO: correctly states the nature and extent of the District's SDWA violations, and if the PAO provides, where appropriate, a reasonable time for the District to comply with the SDWA and applicable rules. EPA will transcribe the hearing.

HOW: For further information and/or to obtain copies of the proposed Administrative Order, call Joyce Baker at 1-800-438-2474 or 215-597-2460. The PAO is also available for review at the Martin Luther King, Jr. Library, Southeast Branch, 403 7th Street, SE, Washington, DC 20003.

ROLLINS
ENVIRONMENTAL SERVICES (NJ) INC.

P.O. Box 337, Bridgeport, NJ 08014, 609/467-3100 General Offices, 609/467-3105 Sales Office

PUBLIC NOTICE OF HSWA PERMIT MODIFICATION REQUEST

Rollins Environmental Services (NJ) Inc. [RES(NJ)] submitted a request on January 25, 1996 to the U.S. Environmental Protection Agency (EPA) for modification of its Hazardous and Solid Waste Amendments of 1984 (HSWA) Permit. The facility, located in Logan Township, New Jersey includes hazardous waste storage, transfer and treatment units. In this modification request, RES(NJ) is seeking authorization to continue to receive sixty-four newly listed wastes designed as hazardous wastes by EPA on August 9, 1995.

The public is invited to submit written comments on this request to the following Agency contact through the 60-day period ending March 25, 1996:

Ms. Ellen Stein
U.S. Environmental Protection Agency
Air & Waste Management Division
290 Broadway, 22nd Floor
New York, NY 10007-1866
(212) 637-4114

The permittee's compliance history during the life of the permit being modified is available from the Agency contact person.

A copy of the permit modification request and supporting documentation may be viewed and copied at the following location:

Logan Township Municipal Building
73 Main Street
Bridgeport, New Jersey 08014

Please call Ms. Elizabeth Bullock, Township Clerk, at 467-3424 to schedule your visit to the Municipal Building.

RES(NJ) will hold a meeting open to the public on Tuesday, February 13, 1996 at 4:00 pm for the purpose of describing the request and to address comments on the request. The meeting will be held at the Bridgeport Holiday Inn at Exit 10 of Interstate 295.

The RES(NJ) contact person is:

Mr. Gerard V. Hartig
Rollins Environmental Services (NJ) Inc.
P.O. Box 337
Bridgeport, New Jersey 08014
(609) 467-3100

Squibb Manufacturing, Inc.
P.O. Box 609 Humacao Puerto Rico 00092-0609
Tel. (809) 852-1255 Fax (809) 852-3800

March 21, 1995

FEDERAL EXPRESS

Mr. Richard Yue
U.S. Environmental Protection Agency
Hazardous Waste Facilities Branch
290 Broadway
New York, NY 10007

Dear Mr. Yue:

Re: Squibb Manufacturing Inc.
RCRA Permit Application

Pursuant to your request today, I am please to submit for your consideration and records, copy of documents generated since early 1995 related to our RCRA Permit Renewal Application. These documents are attached and consist of the following:

Annex 1

Correspondence dated January 18, 1995.
Leaflet distributed among residents of Villa Humacao and El Junquito, advising them that:

a. SMI filed a RCRA Permit Renewal Application at EPA and EQB

b. EPA will soon publish public notice announcing the date and time for a public meeting related to the renewal process

c. copy of the documents are in the Public Library

d. the general community is welcome to participate in these proceedings

Annex 2

Correspondence dated January 26, 1995.
Leaflet distributed among residents of El Junquito inviting them to a community meeting to be held on January 31, 1995, to discuss environmental issues including the RCRA Permit Renewal Application. (A similar meeting was held at the request of Villa Humacao residents during December, 1994).

Annex 3

Copy of a January 25, 1995 newspaper article in Humacao's El Oriental, related to our application and inviting the Humacao community to request any desired information pertaining to the application maintained in the Public Library and the Plant.

Additionally, we advised the community of a meeting to be held at El Junquito and the planned EPA Public Meeting.

Annex 4

(Not included)

Annex 5

Copy of correspondence dated January 30, 1995. SMI requests WALO radio station to notify the Humacao community of the forthcoming January 31, 1995 meeting at El Junquito and the February 8, 1995 Public Meeting.

Annex 6

Copy of public notice published on February 1, 1995 in Humacao's El Oriental regarding EPA's February 8, 1995 Public Meeting.

Annex 7

Copy of a February 8, 1995 newspaper article published in Humacao's EL Oriental, related to our waste management activities and the particulars of the permit renewal process.

Annex 8

Copies of correspondence addressed to Humacao community leaders and government officials which served as cover letters to the four-volume RCRA Permit Renewal Application deliver individually and by-hand.

Please advise if I may be of further assistance.

Sincerely,

Julio Ortiz Torres
Environmental Affairs Manager

JOT/c
Attachments
Yue

SQUIBB MANUFACTURING, INC.

15 de enero de 1995

Estimados vecinos:

Squibb Manufacturing, Inc., en su compromiso con la comunidad de Humacao, desea por este medio informarles que ha radicado su solicitud de renovación de permiso como facilidad de manejo de desperdicios sólidos peligrosos ante la Agencia de Protección Ambiental Federal (EPA pos sus siglas en inglé s).

Próximamente la EPA anunciara el día y el lugar donde se celebrara una reunión pública con el prepósito de informar sobre la renovación de Squibb y las oportunidades que tiene el publico en general de revisar la solicitud de renovación de permiso y posteriormente someter sus comentarios de conformidad con la reglamentaciones federal. Copia de la solicitud de renovación ya está disponible para el público en la Biblioteca Municipal de Humacao, Puerto Rico (Te. 850-6446) y en nuestras facilidades en la Carretera #3 Km., 77.5 en Humacao.

Squibb invita a la comunidad en general a participar en el proceso y está en la mejor disposición de proveer cualquier información u orientación sobre este asunto, en cuyo caso pueden comunicarse con el Ing. Julio Ortiz-Torres, Gerente de Asuntos del Ambiente, al teléfono 850-6731.

Héctor J. Totti
Gerente General

Annex 1

Squibb Manufacturing, Inc.
P.O. Box 609 Humacao Puerto Rico 00792-0609
Tel. (809) 852-1255 Fax (809) 852-3800

25 de enero de 1995

Estimados vecinos:

Cordialmente los invitamos a nuestra próxima reunión de comunicación con la comunidad a llevarse a cabo martes, 31 de enero de 1995, comenzando a las 7:00 de la noche en el Centro de Reuniones del Comité de Seguridad Vecinal en Junquito. Esa noche compartiremos con ustedes información relacionada con asuntos ambientales de suma importancia para la comunidad.

Los esperamos,

Sinceramente,

Héctor J. Totti
Gerente General

Annex 2

En defensa del Incinerado

"Las facilidades para el manejo de los desperdicios peligrosos que opera Squibb Manufacturing Inc. en Humancao, complen con los estrictos controles reglamentarios e lay ley federal", sostuvo el gerente general de esta planta, Héctor Totti, en un comunicado de prensá enviado a El Oriental.

Sobre las mencionadas facilidades de desperdicios sólidos que despuntan como el foco de una nueva controversia ambiental en la región, el ejecutivo de la plana aseguró que fueron diseñadas y construídas, "y se operan y se mantienen", en conformidad con las estrictas disposiciones reglamentarias que impone la Ley Federal de Desperdicios Peligrosos.

Totti descartó la percepción de que la operación es una nueva; señalando que lo que su ompañía ha hecho es radicar una solicitud de renovación de permiso como facilidad de manejo "de desperdicios peligrosos ante la Agencia Federal de Protección Ambiental (EPA pos sus siglas en inglés). "Esta facilidad lleva operando desde los años 60", puntualizó.

Según el ejecutivo, el único efecto que tendría la renovación del permiso sería el de permitirle a la Squibb continuar disponiendo en su planta de los desperdicios peligrosos que resultan del proceso de manufactura de los productos farmaceúticos.

"Los incineradores son indispensables para continuar nuestras actividades de manufactura", señaló el gerente, agregando que; "conforme a nuestro compromiso de mantener informada a la comunidad sobre este extenso proceso", se han programado una serie de reuniones con varios sectores de la comunidad.

En diciembre pasado se realizó una de estes reuniones en la urbanización Villa Humacao y próximamente, según anunció, se estará realizando otra en al comunidad del Junquito.

"Además la EPA tiene programado una reunión sobre este asunto, para principios de febrero próximo, reveló.

Totti extendió una invitación a la comunidad en general para que participar de este proceso y reliero "el compañía de la Squibb Manufacturing de p?? Information y aclarar dudas que sobre el proyecor".

A estos efectos, ofreció el número de teléfono, 850-6731, a donde puedenaquellos intersados en obtener información sobre el mismo, e inu que existe una copía de la solicitud de renovación, disponible en la Biblioteca Municipal de Humacao, la JCA y propia planta.

Source: 8- El ORIENTAL - 25 de enero del 1995

Squibb Manufacturing, Inc.
P.O. Box 609 Humacao Puerto Rico 00792-0609
Tel. (809) 852-1255 Fax (809) 852-3800

30 de enero de 1995

Sa. Mercy Padilla
WALO Radio Oriental
Call Box 1240
Humacao, Puerto Rico 00792

Estimada Sa. Padilla:

Nos hacemos eco de la preocupación expresada por la Sra. Ferrer y Sra. Martínez en torno a la remoción de letreros y cruzacalles de su área vecinal.

Squibb no promueve y condena este tipo de acción ya que apoya totalmente la libre expresión de todos los sectores de la comunidad. Es por eso que estamos promoviendo un diálogo abierto entre todos para dilucidar y aclarar todas las dudas en cuanto al proceso de renovación de permisos.

Estamos participando en reuniones con las comunidades adyacentes. La próxima reunión es el martes, 31 de enero, con los residentes de la Comunidad de Junquito en el Centro de Seguridad Vecinal a las 7:00 p.m. El miércoles, 8 de febrero, la EPA celebrará una reunión en el Caracolillo con el objetivo de darle toda la información relacionada con este proceso.

Exhortamos a todos los vecinos de estas comunidades a asistir a estas reuniones para que puedan aclarar dudas y expresar sus preocupaciones.

Sinceramente,

Julio Ortiz-Torres
Gerente, Asuntos del Ambiente

GOVERNMENT OF PUERTO RICO/
OFFICE OF THE GOVERNOR
PUBLIC NOTICE

U.S. ENVIRONMENTAL PROTECTION AGENCY
26 FEDERAL PLAZA- REGION II
NEW YORK, NEW YORK 10278

PUBLIC NOTICE: PN #: DATE: JANUARY 27, 1995
EPA I.D. NUMBER: PRD090021056

NOTICE OF RECEIPT OF RCRA PART B PERMIT RENEWAL APPLICATION
AND HAZARDOUS WASTE INCINERATOR RISK ASSESSMENT REPORT

Notice is hereby given that the U.S. Environmental Protection Agency (EPA) Region II, is in receipt of the Resource Conservation and Recovery Act (RCRA) Part B permit renewal application dated September 1, 1994, and the hazardous waste incinerator risk assessment report dated October 7, 1994, submitted by:

The Squibb Manufacturing Incorporated
State Road No. 3, Km 77.5
P.O. Box 609
Humacao, Puerto Rico 00792
Attention: Mr. Hector J. Totti, Vice President

The Squibb Manufacturing Incorporated (" Squibb") operates a pharmaceutical manufacturing facility which produces drugs for human consumption. The facility has been in operation since 1970. A permit was issue to Squibb effective on March 1, 1990 by EPA under the authority of the Resource Conservation and Recovery Act (RCRA), (42 U.S.C. _6901 et seq.), as amended by the hazardous and solid waste amendments of 1984 (HSWA), for the management of six (6) above-ground hazardous waste storage tanks, and the operation of two (2) incinerator units (the " trane" and " brule"). The trane unit is permitted to incinerate hazardous waste, while the brule unit is permitted to incinerate only ignitable waste. The brule unit is scheduled for closure in 1995. The current RCRA permit expires on March 1, 1995.

Squibb has applied to renew their permit for the management of hazardous wastes at the Humacao facility. Under the RCRA permit renewal application, Squibb proposes to continue the operation of the trane incinerator treating hazardous wastes. Addition, Squibb proposes to treat hazardous wastes in the existing caloric 1 incinerator and in a new caloric 2 incinerator which is currently being constructed. The three hazardous waste incinerator units that are included in the permit renewal application (trane, caloric 1, and caloric 2) will burn hazardous waste generated solely from the Squibb facility. With regards to the storage of hazardous wastes in the tank system, Squibb proposes to operate a new seventh (7) above-ground hazardous waste storage tank, along with the six(6) existing storage tanks.

This notice of the receipt of the RCRA permit renewal application is for the administrative record. The administrative record consists of this notice, RCRA Part B permit renewal application which includes the trial burn plan, and the hazardous waste incinerator risk assessment report submitted by Squibb, and other data and materials assembled or prepared by EPA and the Puerto Rico Environmental Quality Board (EQB) for the Squibb facility. Its contents may be inspected any time between 9:30 a.m. to 4:00 p.m. Monday through Friday, except Holidays. Copies of these documents are available at $.15 per copy sheet. To make an appointment to inspect the administrative record is also on file at the Puerto Rico Environmental Quality Board, and pollution control area, 431 Ponce De Leon Avenue Hato Rey Puerto Rico 00919. To make an appointment to inspect the administrative record at EQB, please contact Mr. Santos Cabrera at (809) 767-8181 ext. 2351.

For citizens residing near the Humacao municipality, a public information repository has been established by the facility for all citizens interested in becoming involved during the permitting process. The public information repository will have copies of the administrative record documents, and other information material relevant to the facility which is available for public review. The repository will also include the name and telephone number of EPA and EQB' s contact office, and the mailing address to which comments and inquiries may be directed during the permit review process the repository will be maintained throughout the permitting process at the following location: the public library of the municipality of Humacao, Road No. 3, Km 77.5, Humacao, Puerto Rico. Telephone number: (809) 850-6446. A public meeting will be held on February 8, 1995, between 6:00 pm to 10:00 pm, at the Caracolillo Restaurant, Road No. 3, Km. 74.5, Humacao, Puerto Rico, 00791, Telephone number: (809) 850-0833. The purpose of the public meeting is to answer any questions the public

may have regarding the RCRA permit renewal application. This notice also provides the citizens interested in receivin g relevant permitting information and future public notices on the draft and final permit determination an opportunity to b e included in the facility or EPA' s mailing list.

Finally, this notice also services the initial notification that Squibb may request a temporary emergency permit to treat hazardous waste in the existing non-permitted caloric 1 incinerator. If issued, the emergency permit would authorize Squibb to treat hazardous waste in the caloric 1 incinerator while th e trane unit is used to perform trial burn tests to determine applicab le permit operating conditions. Squibb must demonstrate to EPA and EQB that the temporary authorization i s necessary for the facility' s hazardous waste management activities and will minimize the over-accumulation of hazardous waste on-site, therefore, allowing for safer management of on-site hazardous waste.

Any written comments concerning the permit renewal process or temporary emergency permit. Requests fo r information, and requests to be on the EPA' s mailing list should be made to:

Mr. Andrew Nellina, P.E.
Chief, Hazardous Waste Facilities Branch
U.S. Environmental Protection Agency, Region II
26 Federal Plaza, Room 1037
New York, New York 10278

[Note: Text of notice also provided on next page.]

PUBLIC NOTICE

U.S. ENVIRONMENTAL PROTECTION AGENCY - REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10278
DATE: January 27, 1995

PUBLIC NOTICE: PN #_____
EPA I.D. NUMBER: PRD090021056

NOTICE OF RECEIPT OF RCRA PART B PERMIT RENEWAL APPLICATION
AND HAZARDOUS WASTE INCINERATOR RISK ASSESSMENT REPORT

NOTICE IS HEREBY GIVEN THAT THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) REGION II, IS IN RECEIPT OF THE RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) PART B PERMIT RENEWAL APPLICATION DATED SEPTEMBER 1, 1994, AND THE HAZARDOUS WASTE INCINERATOR RISK ASSESSMENT REPORT DATED OCTOBER 7, 1994, SUBMITTED BY:

THE SQUIBB MANUFACTURING INCORPORATED
STATE ROAD NO. 3, KM 77.5
P.O. BOX 609
HUMACAO, PUERTO RICO 00792
ATTENTION: MR. HECTOR J. TOTTI, VICE PRESIDENT

THE SQUIBB MANUFACTURING INCORPORATED ("SQUIBB") OPERATES A PHARMACEUTICAL MANUFACTURING FACILITY WHICH PRODUCES DRUGS FOR HUMAN CONSUMPTION. THE FACILITY HAS BEEN IN OPERATION SINCE 1970. A PERMIT WAS ISSUED TO SQUIBB EFFECTIVE ON MARCH 1, 1990 BY EPA UNDER THE AUTHORITY OF THE RESOURCE CONSERVATION AND RECOVERY ACT (RCRA), (42 U.S.C. § 6901 ET SEQ.), AS AMENDED BY THE HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984 (HSWA), FOR THE MANAGEMENT OF SIX (6) ABOVE-GROUND HAZARDOUS WASTE STORAGE TANKS, AND THE OPERATION OF TWO (2) INCINERATOR UNITS (THE "TRANE" AND "BRULE"). THE TRANE UNIT IS PERMITTED TO INCINERATE HAZARDOUS WASTE, WHILE THE BRULE UNIT IS PERMITTED TO INCINERATE ONLY IGNITABLE WASTE. THE BRULE UNIT IS SCHEDULED FOR CLOSURE IN 1995. THE CURRENT RCRA PERMIT EXPIRES ON MARCH 1, 1995.

SQUIBB HAS APPLIED TO RENEW THEIR PERMIT FOR THE MANAGEMENT OF HAZARDOUS WASTES AT THE HUMACAO FACILITY. UNDER THE RCRA PERMIT RENEWAL APPLICATION, SQUIBB PROPOSES TO CONTINUE THE OPERATION OF THE TRANE INCINERATOR TREATING HAZARDOUS WASTES. ADDITION, SQUIBB PROPOSES TO TREAT HAZARDOUS WASTES IN THE EXISTING CALORIC 1 INCINERATOR AND IN A NEW CALORIC 2 INCINERATOR WHICH IS CURRENTLY BEING CONSTRUCTED. THE THREE HAZARDOUS WASTE INCINERATOR UNITS THAT ARE INCLUDED IN THE PERMIT RENEWAL APPLICATION (TRANE, CALORIC 1, AND CALORIC 2) WILL BURN HAZARDOUS WASTE GENERATED SOLELY FROM THE SQUIBB FACILITY. WITH REGARDS TO THE STORAGE OF HAZARDOUS WASTES IN THE TANK SYSTEM, SQUIBB PROPOSES TO OPERATE A NEW SEVENTH (7) ABOVE-GROUND HAZARDOUS WASTE STORAGE TANK, ALONG WITH THE SIX(6) EXISTING STORAGE TANKS.

THIS NOTICE OF THE RECEIPT OF THE RCRA PERMIT RENEWAL APPLICATION IS FOR THE ADMINISTRATIVE RECORD. THE ADMINISTRATIVE RECORD CONSISTS OF THIS NOTICE, RCRA PART B PERMIT RENEWAL APPLICATION WHICH INCLUDES THE TRIAL BURN PLAN, AND THE HAZARDOUS WASTE INCINERATOR RISK ASSESSMENT REPORT SUBMITTED BY SQUIBB, AND OTHER DATA AND MATERIALS ASSEMBLED OR PREPARED BY EPA AND THE PUERTO RICO ENVIRONMENTAL QUALITY BOARD (EQB) FOR THE SQUIBB FACILITY. ITS CONTENTS MAY BE INSPECTED ANY TIME BETWEEN 9:30 A.M. TO 4:00 P.M. MONDAY THROUGH FRIDAY, EXCEPT HOLIDAYS. COPIES OF THESE DOCUMENTS ARE AVAILABLE AT $.15 PER COPY SHEET. TO MAKE AN APPOINTMENT TO INSPECT THE ADMINISTRATIVE RECORD IS ALSO ON FILE AT THE PUERTO RICO ENVIRONMENTAL QUALITY BOARD, LAND POLLUTION CONTROL AREA, 431 PONCE DE LEON AVENUE HATO REY PUERTO RICO 00919. TO MAKE AN APPOINTMENT TO INSPECT THE ADMINISTRATIVE RECORD AT EQB, PLEASE CONTACT MR. SANTOS CABRERA AT (809) 767-8181 EXT. 2351.

FOR CITIZENS RESIDING NEAR THE HUMACAO MUNICIPALITY, A PUBLIC INFORMATION REPOSITORY HAS BEEN ESTABLISHED BY THE FACILITY FOR ALL CITIZENS INTERESTED IN BECOMING INVOLVED DURING THE PERMITTING PROCESS. THE PUBLIC INFORMATION REPOSITORY WILL HAVE COPIES OF THE ADMINISTRATIVE RECORD DOCUMENTS, AND OTHER INFORMATION MATERIAL RELEVANT TO THE FACILITY WHICH IS AVAILABLE FOR PUBLIC REVIEW. THE REPOSITORY WILL ALSO INCLUDE THE NAME AND TELEPHONE NUMBER OF EPA AND EQB'S CONTACT OFFICE, AND THE MAILING ADDRESS TO WHICH COMMENTS AND INQUIRIES MAY BE DIRECTED DURING THE PERMIT REVIEW PROCESS THE REPOSITORY WILL BE MAINTAINED THROUGHOUT THE PERMITTING PROCESS AT THE FOLLOWING LOCATION: THE PUBLIC LIBRARY OF THE MUNICIPALITY OF HUMACAO, ROAD NO. 3, KM 77.5, HUMACAO, PUERTO RICO. TELEPHONE NUMBER: (809) 850-6446. A PUBLIC MEETING WILL BE HELD ON FEBRUARY 8, 1995, BETWEEN 6:00 PM TO 10:00 PM, AT THE CARACOLILLO RESTAURANT, ROAD NO. 3, KM. 74.5, HUMACAO, PUERTO RICO, 00791, TELEPHONE NUMBER: (809) 850-0833. THE PURPOSE OF THE PUBLIC MEETING IS TO ANSWER ANY QUESTIONS THE PUBLIC MAY HAVE REGARDING THE RCRA PERMIT RENEWAL APPLICATION. THIS NOTICE ALSO PROVIDES THE CITIZENS INTERESTED IN RECEIVING RELEVANT PERMITTING INFORMATION AND FUTURE PUBLIC NOTICES ON THE DRAFT AND FINAL PERMIT DETERMINATION AN OPPORTUNITY TO BE INCLUDED IN THE FACILITY OR EPA'S MAILING LIST.

FINALLY, THIS NOTICE ALSO SERVICES THE INITIAL NOTIFICATION THAT SQUIBB MAY REQUEST A TEMPORARY EMERGENCY PERMIT TO TREAT HAZARDOUS WASTE IN THE EXISTING NON-PERMITTED CALORIC 1 INCINERATOR. IF ISSUED, THE EMERGENCY PERMIT WOULD AUTHORIZE SQUIBB TO TREAT HAZARDOUS WASTE IN THE CALORIC 1 INCINERATOR WHILE THE TRANE UNIT IS USED TO PERFORM TRIAL BURN TESTS TO DETERMINE APPLICABLE PERMIT OPERATING CONDITIONS. SQUIBB MUST DEMONSTRATE TO EPA AND EQB THAT THE TEMPORARY AUTHORIZATION IS NECESSARY FOR THE FACILITY'S HAZARDOUS WASTE MANAGEMENT ACTIVITIES AND WILL MINIMIZE THE OVER-ACCUMULATION OF HAZARDOUS WASTE ON-SITE, THEREFORE, ALLOWING FOR SAFER MANAGEMENT OF ON-SITE HAZARDOUS WASTE.

ANY WRITTEN COMMENTS CONCERNING THE PERMIT RENEWAL PROCESS OR TEMPORARY EMERGENCY PERMIT. REQUESTS FOR INFORMATION, AND REQUESTS TO BE ON THE EPA'S MAILING LIST SHOULD BE MADE TO:

MR. ANDREW BELLINA, P.E.
CHIEF, HAZARDOUS WASTE FACILITIES BRANCH
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION II
26 FEDERAL PLAZA, ROOM 1037
NEW YORK, NEW YORK 10278

AVISO PUBLICO

AGENCIA DE PROTECCION AMBIENTAL DE LOS ESTADOS UNIDOS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10275

EPA ID. NO. PRDO90021056 27 DE ENERO DE 1995

Por este medio, la Agencia de Protección Ambiental de los Estados Unidos (EPA, por sus siglas en inglés), Región II, da aviso de haber recibida la Solicitud de Renovación de Permiso Parte B de la Ley de Conservación y Recuperación de Recursos (RCRA) el día 1ro de septiembre de 1994, y el Reporte de Estudio de Riesgo de Incinerador de Desperdicios Peligrosos el día 7 de octubre de 1994, sometido por:

Squibb Manufacturing, Incorporated
Carr. Num. 3, Km. 77.5
P.O.Box 609
Humacao, Puerto Rico 00792
ATTN: Sr. Héctor J. Totti, Vice-Presidente

Squibb Manufacturing Incorporated (" Squibb") opera una facilidad que manufactura productos farmacéuticos, el cual produce drogas para consumo humano. La facilidad ha estado en operación desde 1970. Un permiso fue emitido a Squibb efectiva el 1 de marzo de 1990 por EPA bajo la autoridad de RCRA, (42 U.S.C. §6801 et seq.), según revisada por las Enmiendas a los Desperdicios Sólidos y Peligrosos de 1984 (HSWA, por sus siglas en inglés), para el manejo de seis (6) tanques de almacenaje de desperdicios peligrosos sobre el terreno, y la operación de dos (2) unidades de incinerador (el " TRANE" y " BRULE"). En la unidad " TRANE" lo es permitido incinerar desperdicios peligrosos, mientras en la unidad " BRULE" lo es permitido incinerar solo desperdicios ignitivos (" ignitables"). La unidad " BRULE" está programada para cerrarse en 1995. El permiso de RCRA actual expira el 1 de marzo de 1995.

Squibb ha solicitado renovar su permiso para el manejo de desperdicios peligrosos en la facilidad de Humacao. Bajo la solicitud de renovación de permiso RCRA, Squibb propona continuar con la operación del incinerador " TRANE" tratando desperdicios peligrosos. En adición, Squibb propone el tratar desperdicios peligrosos en el incinerador existente Caloric 1 y en el nuevo incinerador Caloric 2 el cual está actualmente en construcción.

Los tres incineradores de desperdicios peligrosos que están incluidos en la solicitud de renovación de permiso (TRANE, Caloric 1 y Caloric 2) quemará desperdicios peligrosos generados únicamente de la facilidad de Squibb. Con respecto al almacenaje de desperdicios peligrosos en el sistema de tanques, Squibb propone operar un nuevo séptimo (7) tanques sobre el terreno para almacenar desperdicios peligrosos. Junto con los seis (6) tanques de almacenaje existentes.

Este aviso del recibo de la solicitud de renovación de permiso RCRA es para el archivo administrativo. El archivo administrativo consiste de este aviso, la solicitud de renovación de permiso RCRA Parte B, la cual incluye la prueba de quemado (" Trial Burn Plan"), y el reporte de estudio de Riesgo del Incinerador de desperdicios peligrosos sometido por Squibb, y otra información y material reunido o preparado tanto por EPA como por la Junta de Calidad Ambiental de Puerto Rico (JCA) para la facilidad de Squibb. Su contenido puede ser inspeccionado en cualquier momento entre las 8:30 A.M. a las 4:00 P.M. de Lunes a Viernes, excepto días feriados. Copias de estos documentos están disponibles a $.20 por página. Para hacer una cita con el propósito de inspeccionar el archivo administrativo en EPA en la ciudad de Nueva York, favor de comunicarse con el Sr. Richard Yue al (212)264-9339. El archivo administrativo se encuentra también disponible en la Junta de Calidad Ambiental; Área Control Contaminación de Terrenos, Avenida Ponce de León #431, Hato Rey, Puerto Rico 00919. Para hacer una cita con el propósito de inspeccionar el archivo administrativo en la JCA, favor de comunicarse con el Sr. Santos Cabrera al teléfono (809)767-8181 ext. 2351.

Para los ciudadanos residentes en o cerca del municipio de Humacao, interesados en conocer sobre el caso durante el proceso de permiso se ha designado un lugar donde estará disponible la información pública. En este lugar se tendrá disponible al público copia de los documentos del archivo administrativo y otro material de información relevante a la facilidad, nombres y números de teléfono de las oficinas de contacto de EPA y la JCA, y la dirección a la cual los comentarios y las preguntas deben ser dirigidas durante el proceso de evaluación del permiso. La información estará disponible durante todo el proceso de permiso en la siguiente localización: La Librería Pública en el municipio de Humacao, Carretera Núm. 3, Km. 77.5, Humacao, Puerto Rico. Número de teléfono (809)850-6464.

Una reunión pública se llevará a cabo el 8 de febrero de 1995, entre las 6:00 P.M. e 10:00 P.M., en el Restaurante El Caracolillo, Carr. Núm. 3, Km. 74.5, Humacao, Puerto Rico, 00791. Número de teléfono (809)850-0833. El propósito de la reunión pública es aclarar cualquier pregunta que el público pueda tener con respecto a la solicitud de renovación de permiso RCRA. Este aviso también provee el cuidadano interesado en recibir información relevante al permiso y avisos públicos futuros en el borrador y la determinación de permiso final una oportunidad para ser incluido en la lista de envío (" Mailing List") de la facilidad o en la de la EPA.

Finalmente, este aviso también sirve de notificación inicial de que Squibb solicita un permiso temporero de emergencia para tratar desperdicios peligrosos en el incinerador existente Caloric 1 no-permitido. Si es emitido, el permiso de emergencia puede autorizar a Squibb a tratar desperdicios peligrosos en el incinerador Caloric 1 mientras que la unidad " TRANE" es usada para efectuar pruebas de quemado para determinar condiciones de operación aplicables al permiso. Squibb debe demostrarlo a la EPA y a la JCA que la autorización temporera es necesaria para actividades de manejo de desperdicios peligrosos en el sitio de tal forma que permita un cuidadoso manejo de los desperdicios peligrosos en el sitio.

Cualquier comentario escrito con relación al proceso de renovación de permiso o al permiso temporero de emergencia, solicitudes de información y solicitudes para estar en la lista de envío (" Mailing List") de EPA puede ser sometidos a:

Mr. Andrew Bellina, P.E.
Chief, Hazardous Waste Facilities Branch
US Environmental Protection Agency
26 Federal Plaza - Region II - Room 1037
New York, New York 10278

HECTOR RUSSE MARTINEZ
PRESIDENTE
JUNTA CALIDAD AMBIENTAL

Insisten en defensa del Incinerador

Por: Magaly Monserrate Cerpa

Varios ejecutivos de la Squibb Manufacturing, entre los que se encontraba el gerente general de la planta de Humacao, insistieron en la seguridad y confiabilidad de sus incineradores y reiteraron que la compañía cumple con los estrictos controles reglamentarios de la Ley Federal de Desperdicios Peligrosos, durante una entrevista realizada por este rotativo en sus facilidades.

En la reunión que se produjo por invitación de la Squibb, el gerente de Asuntos Ambientales, Ing. Julio Ortíz rechazó algunos de los argumentos que han sido esbozados por detractores de los actuales planes de esta compañía, en las reuniones y manifestaciones que recientemente ha realizado el grupo opositor.

Ortíz comenzó por aclarar el comentario de que engañaban a la comunidad al decirles que estaban solicitando un permiso para disponer de desperdicios líquidos cuando el documento de solicitud indica que se trata de desperdicios sólidos peligrosos. Al respecto, indicó, que se trataba de un mal entendido producto del desconocimiento de la Reglamentación, que bajo la clasificación de Desperdicios Sólidos Peligrosos, cobija también a los líquidos.

"No hemos engañado a nadie, vamos a trabajar como hasta la fecha lo hemos hecho, con desperdicios líquidos, pero la Reglamentación no contempia una clasificación aparte para éstos, que no sea dentro de la de Desperdicios Sólidos Peligrosos". Debe quedar claro que no vamos a procesar solidos", arguyó.

Rivera también descartó de plano el comentario de que estuvieran contemplando trasportar hasta las facilidades de Humacao los desperdicios de las plantas de Barceloneta y Mayaguez, para ser procesados en los incineradores de acá.

Sobre la interrogante mas neurálgica relacionada con el nuevo incinerador, el impacto al ambiente ya la salud de los vecinos de la zona que tendrá esta nueva operación, aseguró que no se produciría aumento alguno en las emisiones.

En este tema, entró Héctor Totti, el gerente general de la planta, para señalar que "por el contrario" con este incinerador y los cambios que proponen hacer en el área de disposición, se minimizan los desperdicios sólidos peligrosos que genera la planta".

"La nueva reglamentación federal nos obliga a instituir un programa agresivo de minimización de estos desperdicios. Lo que estamos haciendo responde a la necesidad de avanzar en la tecnología para seguir cumpliendo con los restricciones federales y estatales de disposición de desperdicios peligrosos", expresó Totti.

Otro aspecto de la controversia en la que los propios ejecutivos coincidieron a generado confusión, por lo que intentaron explicarla, es la mezcla de dos procedimientos a un mismo tiempo.

Sobre ésto, Ortíz Torres explicó que cuando en el 1990 tramitaron la renovación del permiso para disponer de desperdicios sólidos peligrosos incluyeron los incineradores Trane y Brule pero no así el Caloric-1, que se encontraba en diseño. Poco después solicitaron a la EPA la inclusión de este último incinerador (para desperdicios sólidos peligrosos) pero esta agencia se dilató en su respuesta. Esa es la razón, por la que actualmente cuando se tramita nuevamente la renovación del referido permiso (que por ley tiene que hacerse cada cuatro años) se aprovecha para solicatar nuevamente la inclusión de este incineratador y el nuevo Caloric-2. Por instrucciones de la EPA, en lugar de hacer dos documentos, ambas cosas se incluyen en uno.

Agregó que estos dos incineradores, el Caloric-1 y el Caloric-2 deberán estar sustituyendo eventualmente al Trane (desperdicios peligrosos) y al Brule (de desperdicios peligrosos). El primero que deberá salir de operación se el Brule; en septiembre de este año y posteriormente (una fecha que no se especicico) el Trane.

Con esta nueva technología, reiteró Totti, lo que persigue es minimizar los desperdicios líquidos de manejo que la operación de la planta sea cada vez menos, impactando al ambiente. "En esto, aseguró, invertimos la mayor parte de nuestro presupuesto para mejoras. Un 70 por ciento de éste, está destinado a pruebas y labores conducente a disminuir este impacto. Esto lo venimos haciendo desde hace años, por ejemplo en nuestra área de experimentación con nuevos solventes, conocidos como environmentally friendly", concluyó

Squibb Manufacturing, Inc.
P.O. Box 609 Humacao Puerto Rico 0092-0609
Tel. (809) 852-1255 Fax (809) 852-3800

20 de enero de 1995

Hon. Joel Rosario Hernández
Representante
Cámara de Representantes
Apartado 2228
San Juan, PR 00902

Señor Representante:

Squibb, en su compromiso de mantener a la comunidad informada, por este medio le entrega copia de la solicitud de renovación de permiso para sus unidades de manejo de desperdicios líquidos peligrosos y del análisis de riesgo realizado como parte de la misma. Esta solicitud fue radicada ante la Agencia Federal de Protección Ambiental (por sus siglas en inglés "EPA") y Junta de Calidad ambiental ("JCA").

Squibb es una farmacéutica dedicada a la manufactura de productos para el consumo humano. Entre ellos se producen Mycolog, Corgard, Capoten, y Zerit- un producto para el tratamiento del SIDA. A planta ha estado en operación desde los años setenta. Esta consiste de varios edificios de producción, y facilidades de apoyo tales como laboratorios de control de calidad y de desarrollo e investigación, utilidades, área de recobro y reuso de solventes, área de tratamiento de aguas usadas, área de manejo de desperdicios líquidos peligrosos, y otras.

En los procesos de manufactura se utilizan compuestos orgánicos, incluyendo solventes, como es usual en este tipo de industria. Se generan residuos líquidos en los diferentes procesos de manufactura, los cuales son reciclados en nuestra planta de forma óptima para minimizar su impacto en el ambiente. Aquellos residuos que no son reutilizables se clasifican como desperdicios líquidos peligrosos para disposición mediante incineración, la mejor tecnología para disponer de éstos. Los mismos consisten principalmente de una mezcla de agua (85% a 98%) y pequeñas cantidades de solventes.

Desde sus comienzos en la década de 1970, Squibb opera unidades de incineración dentro de sus predios para el manejo de estos desperdicios. Estas unidades han sido autorizadas por la EPA y la JCA. Respondiendo al desarrollo de la tecnología cada vez más avanzada, a través de los años Squibb ha mejorado los incineradores incorporando unidades más modernas.

En estos momentos, Squibb está renovando el permiso para sus unidades de manejo de desperdicios líquidos peligrosos. Estas incluyen tanques de almacenamiento e incineradores. Se incorporan dos modernos incineradores, que sustituirán uno que ya fue cerrado y otro programado para cierre durante este año.

Pruebas de eficiencia demuestran que estos nuevos incineradores cumplen tanto con toda la reglamentación aplicable como con políticas establecidas recientemente por la EPA para unidades de incineración.

Más aún, como parte del proceso se realizó un análisis de riesgo. Este establece que la operación de los incineradores, presumiendo condiciones de exposición extremas e improbables, no afecta la salud ni el ambiente del área.

En agosto de 1994 Squibb comenzó un proceso de comunicación pública con el propósito de divulgar información sobre los nuevos incineradores, para así promover la participación ciudadana en el proceso de permiso. A tales efectos, se celebró una reunión pública el 14 de septiembre de 1994, y otra en Villa Humacao el 1 de diciembre de 1994. Próximamente se celebrará otra en Junquito, similar a la ya celebrada en Villa Humacao. Además, EPA tiene otra reunión pública programada durante el mes de febrero.

Nos reiteramos a su disposición para proveer información adicional o aclarar cualquier duda con respecto a estos particulares. Puede comunicarse conmigo o con el Ing. Julio Ortiz-Torres, Gerente de Asuntos del Ambiente, al teléfono 850-6731.

Cordialmente,

Héctor J. Totti
Gerente General

wwin/data/environ.123
Anejo

APPENDIX I -- EXAMPLES OF ADDITIONAL RCRA PUBLIC PARTICIPATION TOOLS (FACT SHEETS, PUBLIC INVOLVEMENT PLANS, NEWS RELEASES)

United States
Environmental Protection
Agency

Region 10
1200 Sixth Avenue
Seattle, WA 98101

Alaska
Idaho
Oregon
Washington

EPA News Release

90-14

Contact: Dawnee Dahm
EPA Region 10
Hazardous Waste Program
442-2867

March 12, 1990

FOR IMMEDIATE RELEASE

EPA AND DEQ ANNOUNCE HAZARDOUS WASTE PERMIT FOR TEKTRONIX

A draft hazard waste permit has been issues for public comment which would allow Tektronix to operate hazardous waste storage units, to administer "post-closure" care to closed hazardous waste disposal units, and to carry out corrective activities or the closed hazardous and solid waste disposal units at its Beaverton facility.

The draft permit will be available for public review and comment until April 23, 1990.

Tektronix manages hazardous waste generated as by-products of manufacturing operations at its Beaverton facility and routinely manages wastes from other Tektronix facilities.

The draft permit requires Tektronix to take corrective action for tricholoethylene (TCE) contaminated groundwater at the facility and to monitor and maintain I closed surface impoundments for a at least 30 years. The permit also sets out operational requirements for Tektronix's hazardous waste storage units. These storage units include tanks and containers.

Copies of the permit are available at the Oregon Department of Environmental Quality, 811 S.W. Sixth Avenue, Portland and at the Beaverton City Library, 12500 S.W. Allen Blvd.

(more)

Public comments on the draft permit will be accepted until April 23, 1990. A public hearing will be held if enough interest is expressed. Comments should be sent to:

Fred Bromfeld	**Dawnee Dahm**
DEQ	**EPA Region 10, HW-112**
811 S.W. Sixth Avenue	**1200 Sixth Avenue**
Portland, OR 97204	**Seattle, Washington 98101**

United States
Environmental Protection
Agency

Office of Public Affairs
Region 5
230 South Dearborn Street
Chicago, Illinois 60604

Illinois Indiana
Michigan Minnesota
Ohio Wisconsin

Public Involvement Plan
Ohio Technology Corporation
Proposed Incineration Facility

April 1989 - Revised

PUBLIC INVOLVEMENT PLAN

OHIO TECHNOLOGY CORPORATION

PROPOSED INCINERATION FACILITY

NOVA, OHIO

APRIL 1989

EPA WORK ASSIGNMENT NUMBER 96-5Q00.0

Prepared for: U.S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, Illinois 6064

Prepared by: ICF Technology, Inc.
35 East Wacker Drive
Suite 800
Chicago, Illinois 60601
Associates Firm, REM IV Contract No. 68-01-7251

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I. INTRODUCTION

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) to regulate the generation, treatment, storage, and disposal of municipal and industrial solid wastes that are generated across the country. The RCRA law requires that before a facility can treat, store, or dispose of any hazardous waste, it must obtain a permit rom either the United States Environmental Protection Agency (U.S. EPA) or an authorized state government agency. [1] In addition to reviewing technical information, federal and state agencies encourage public involvement during the permitting process to ensure that residents understand proposed plans for handling hazardous wastes in their communities, and to provide an opportunity for residents to voice any concerns they may have.

This public involvement plan identifies some community concerns regarding Ohio Technology Corporation's application to build and operate a hazardous waste incinerator facility in Nova, Ohio. The plan details specific activities that U.S. EPA will engage in to disseminate information to the Nova community and to encourage public involvement as the Ohio Technology Corporation application is reviewed. The plan consists of the following sections:

€ Description of the proposed facility;
€ Community information;
€ Community concerns;
€ Objectives of the public involvement program;
€ Public involvement activities; and an
€ Implementation schedule.

The objectives and activities discussed in this plan are based on an assessment of community concerns collected during interviews with local officials, several residents, and local community opposition

[1] In many instances, authority for implementing RCRA has been given to the states by U.S. EPA. The State of Ohio, however, does not have such authority and all RCRA laws are currently enforced in Ohio by U.S. EPA.

groups conducted by U.S. EPA and contractor personnel in August 1988. Background information included in the plan was obtained from reviewing state and federal files; interviews with state, federal, and local officials; and local community opposition groups.

This plan has been prepared in accordance with U.S. EPA's Guidance on Public Involvement in the RCRA Permitting Program (Draft, January 1986).

II. DESCRIPTION OF THE PROPOSED ACTIVITY

A. Location and Description of Facility

Ohio Technology Corporation (OTC) proposed to construct and operate a hazardous waste and toxic substance treatment facility in Nova, Ohio, located in Troy Township, Ashland County. The property purchased by OTC in 1987 consists of approximately 280 acres of rural farm land along Township Road 791, one mile east of Nova and approximately 12 miles northeast of the City of Ashland (see Figures 1 and 2). The Nova Reservoir is located on the southwest portion of the property. Of the 280 acres, approximately 40 acres would be used for the facility.

The proposed facility includes construction of an incinerator called a Hybrid Thermal Treatment System developed by IT Corporation. The system involves a modularly designed rotary kiln incinerator for the destruction of a wide variety of organic wastes. As designed, fumes resulting from the kiln are burned in a secondary combustion chamber. In Nova, the proposed incinerator would be operated to burn both general hazardous wastes and polychlorinated biphenyls (PCBs). The Hybrid Thermal Treatment System would be designed to incinerate liquid wastes, viscous fluids, solids, soil, and other contaminated debris.

The proposed facility is designed not to discharge wastewater from the facility operating areas, but would be designed to treat wastewater on the site and reuse wastewater in the incineration process. Debris resulting from the incineration process, including processed solids and incinerator ash, are proposed to be disposed of in a RCRA licensed disposal facility off the site.

Access to the proposed OTC facility would be gained from Township Road 791. Trucks entering the facility would include tractor-trailer trucks carrying wastes contained in drums. Tankers trucks containing bulk liquids also would enter the facility. Fully loaded trucks would weigh approximately 30,000 to 50,000 pounds. An average of eight to 12

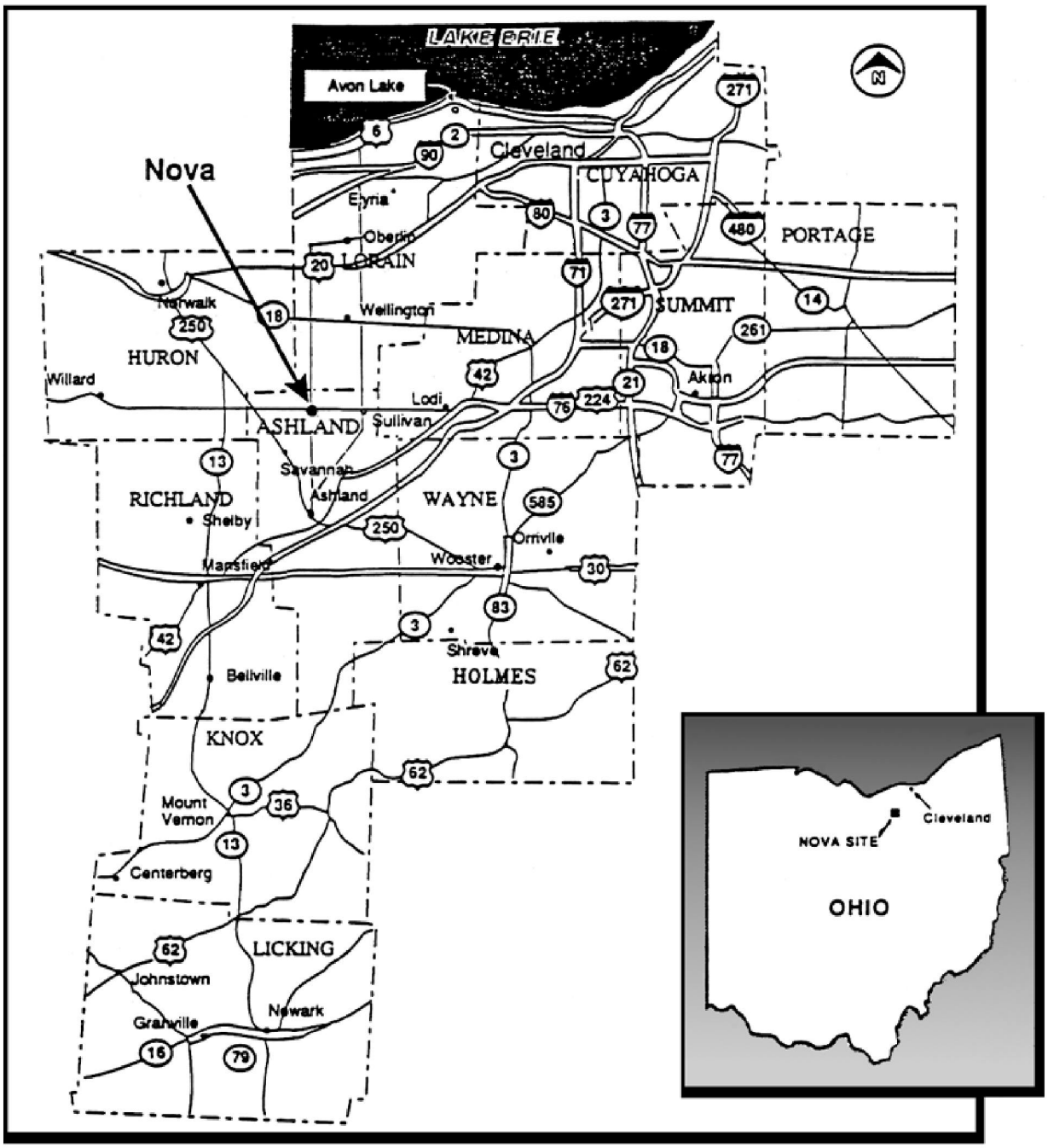


Figure 1
Proposed Facility Location Map

trucks would enter the facility per day.

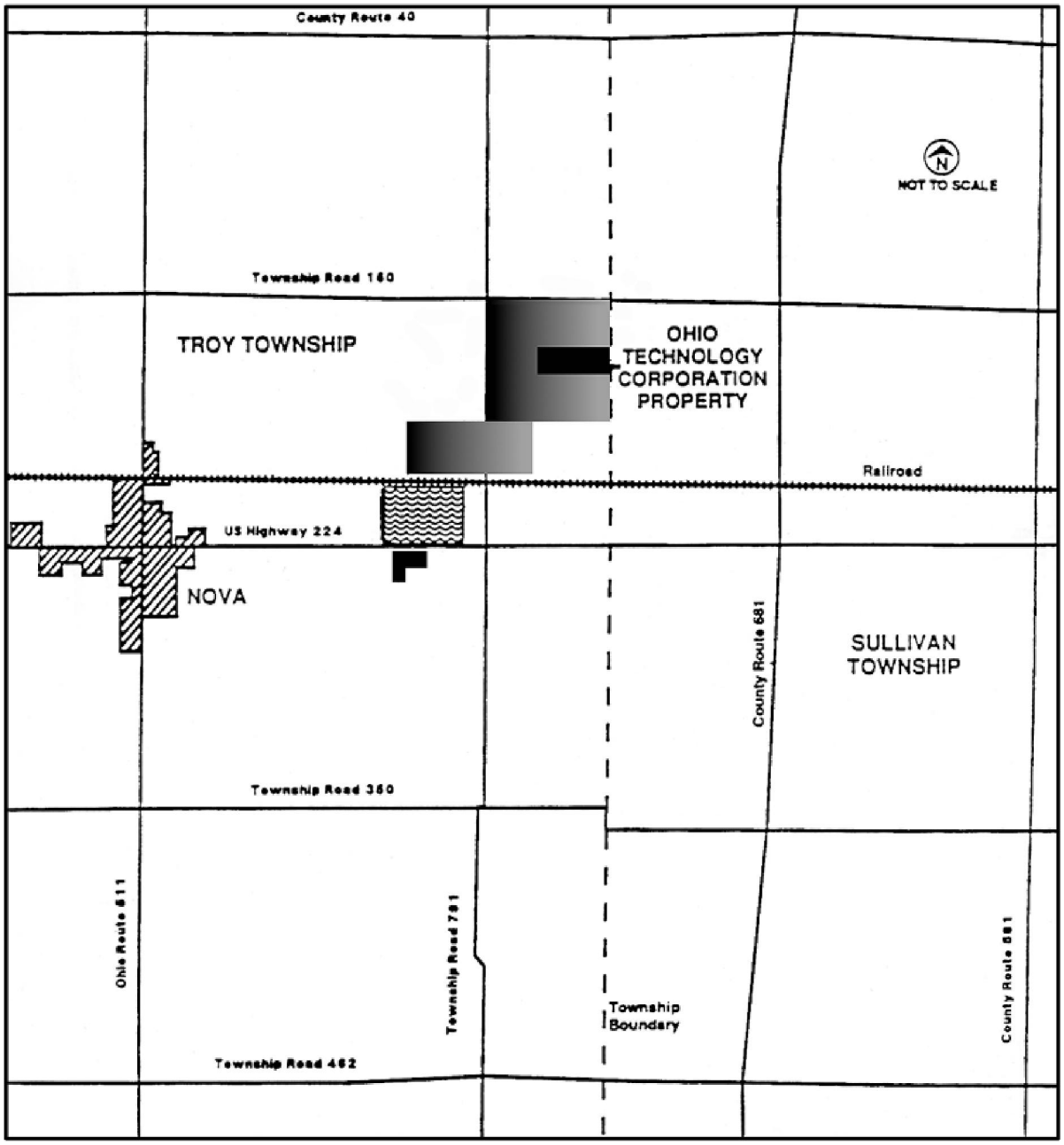


Figure 2
Proposed Facility Area Map

B. Owner/Operator Information

The current owner of the property is OTC which is also named as the proposed owner of the incineration facility in the RARA permit application. IT Corporation would operate the facility. OTC's headquarter offices are located in Cleveland, Ohio and IT Corporation's regional offices are located in Monroeville, Pennsylvania. According to an OTC official, the facility as proposed could reach its capacity by accepting wastes from within Ohio, although the facility is designed to be a regional hazardous waste treatment facility.

C. Regulatory Agencies

In order to obtain the required permits to construct and operate the incineration facility, OTC must submit permit applications to the Ohio Environmental Protection Agency (OEPA) and the U.S. EPA. Because OTC desires to build a facility that will burn both hazardous waste and PCBs, U.S. EPA permits are required from under both RARA and the Toxic Substance Control Act (TSCA). The RCRA permit is required for incineration of hazardous wastes, and the TSCA permit is required for incineration of wastes containing PCBs.

In addition, OTC must apply for and be issued permits from the State of Ohio. The primary permits required are a permit to install and a permit to operate a hazardous waste facility, both of which would be issued by the Ohio Hazardous Waste Facility Board. All proposed facilities in Ohio must receive these permits before any construction can begin. The application for the permits must be submitted for review to OEPA's Division of Solid and Hazardous Waste Management before a ruling on the applications is approved or denied by the Hazardous Waste Facility Board. In addition, OTC must receive an Air Permit to Install from OEPA's Division of Air Pollution, and a National Pollutant Discharge Elimination System (NPDES) permit -- a provision of the Clean Water Act -- from the Division of Water Pollution control. The air permit addresses the potential air emissions that could result from operations from the proposed incinerator, and the NPDES permit addresses potential discharges to water.

Currently, OTC has submitted permit applications to both OEPA and U.S. EPA. By law, permit applications must be reviewed for completeness and technical adequacy before the permits are either granted or denied.

III. COMMUNITY INFORMATION

A. Community Profile

Located in Troy Township, Nova is a rural, unincorporated town with a population of approximately 200 people. According to several residents interviewed, approximately 50% of the population are full-time farmers, and the remainder farm half time in addition to having jobs in other parts of the region.

Nova residents describe themselves as people not interested in urbanization. Several expressed pride in their families that have a long regional heritage, and have continued to live in the Nova area generation after generation. Several residents have recently move into the area away from more urban surroundings, preferring the clean air and rural atmosphere. According to residents interviewed, Nova residents view their population as one consisting of diverse individuals who possess a broad range of interests, all of which add to the character of the community.

Troy Township has a population of 450 people and is governed by a board consisting of three trustees and one clerk. Trustee and clerk elections are held every two years. The next election will be held in November 1989. The township chairperson is appointed every January by the trustees. The township administration also includes a Township Zoning Commission and a Zoning Board of Appeals. Both the Commission and Board of Appeals consists of five members of the community who are appointed by the township trustees to serve four-year terms.

Ashland County is governed by three county commissioners who each serve four-year terms. County Commissioner elections are held every two years. The commissioners elect a president each January.

B. Public Involvement to Date

In the Nova community, public involvement in issues surrounding the proposed facility has to date been primarily channeled through community groups. The next few paragraphs characterize the major community groups involved.

1. STOP IT

According to residents interviewed, community interest and concern over the proposed facility began when OTC purchased its property at an auction in 1987. Soon after the property was purchased, the community learned that OTC planned to install and operate a hazardous waste incinerator on the property. Concerned over the potential impact of the incinerator on the Nova community, Nova residents formed a citizens group called Nova's Right to Know in July 1987. The intent of the group was to collect information about the proposed project from Ohio Technology, International Technology, and local, state, and federal government agencies. In September 1987, the group change its name to STOP IT ("IT" stands for IT Corporation, the proposed operator of the facility) because the group's constituency broadened beyond the Nova community. STOP IT is managed by a director, three co-chairpersons, and an executive committee. Currently, membership in the group consists of approximately 400 people.

STOP IT activities have included establishing an information center in Nova, holding public meetings working with the state of legislature, coordinating with national and international environmental groups, and disseminating information to its membership and other interested parties. The goal of STOP IT is to prevent the proposed incinerator from being built. According to group members, STOP IT does not want to negotiate a permit; the organization does not want any permits issued to OTC at all. STOP IT is a highly organized group whose leadership possesses a strong commitment to its position. STOP IT has conducted various activities to heighten awareness of the proposed incinerator, and has worked to increase support for its position in Ashland County and other surrounding counties. According to an August

1988 STOP IT newsletter, the group's networking activities have resulted in the formation of other STOP IT chapters in Ashland, Parma, and Wellington. When U.S. EPA granted an extension for completion of the application to OCT in May 1988, U.S. EPA received over 400 telephone calls in protest. The telephone calling was largely organized by STOP IT. U.S. EPA responded in writing to each telephone call.

2. Citizens Against Pollution

In August 1987, residents from communities near the proposed facility formed a grassroots citizens group called Citizens Against Pollution (CAP). News of the proposed facility in Nova motivated the formation of the group which is run by a director and a board of trustees. With offices in Huntington, Ohio, the group consists of chapter representatives from neighboring communities such as Sullivan, Nova, Homerville, Medina, Ruggles, Spencer, and Elyria. CAP's major issue is the proposed incinerator, although the group's focus has widened over the past year to address several other environmental issues in Ohio, and is viewed as a growing grassroots environment organization in the state. Adopting a global ecosystem philosophy, CAP representatives indicated that they would like to see a moratorium placed on incineration technologies until the global impact of incineration can be adequately evaluated. According to a CAP representative, the group is interested in working with both OEPA and U.S. EPA to "stop the environmental degradation of Ohio."

3. The Amish Communities

One of the distinct features of the proposed facility is its proximity to several Amish settlements. The Lodi and Ashland settlements are the closest to the OTC property, but the proposed facility has captured the interest of Amish settlements throughout the region, including Holmes County, the largest Amish settlement in the world.

In April 1988, leaders of the Amish community traveled to Columbus, Ohio and participated in a press conference conducted with

support from STOP IT. The purpose of the conference was to present over 4,000 petition signatures from the Amish community in opposition to the proposed facility. Invited to the press conference were OEPA, U.S. EPA, the Ohio Hazardous Waste Facility Board, and state and federal government representatives. In a written statement, the Amish contingency voiced their concerns:

> We are meeting here today because of a concern. The old Order Amish are thankful to God for the privilege to live in a country where we can live, work and share our lives with our neighbors and fellowman.
>
> We still adhere to and believe in the Golden Rule: Do unto others as you world that others do unto you.
>
> It is with this in mind that we have over 4,000 signatures protesting a proposed toxic waste incinerator site in Ashland County.
>
> Living close to this site is an Amish community of over 100 families that would be severely disrupted and handicapped if this site was approved. Without any doubt these people would have to relocate.
>
> Also from information we have received we would be subject to toxic emissions in our area.
>
> So we plead with meekness to please accept our protests with an open mind and sincere concern.

The involvement of the Amish in this manner -- a people not known for their political activism -- generated significant media attention and was reported by the Chicago Tribune, U.S.A. Today, and the New York Times. Leaders of the Amish settlements keep informed about the status of the project, and are in contact with both STOP IT and CAP.

Public involvement over the last year can be characterized as significant. The work of the citizens groups has served to heighten awareness of the proposed project all over the region. In April 1988, the Troy Township Trustees polled their constituents and concluded that 94% of the responders were opposed to the proposed facility. In addition, several communities and organizations from a wide geographical area have adopted ordinances and resolutions in opposition to the proposed facility (see Appendix A). Although opposition to the proposed facility is widely known and publicized, there is some evidence of

support for OTC's project within the region. Newspaper reports indicate, however, that although there may be support for the facility, the strength of the opposition to the facility has caused proponents to keep their views to themselves.

Political interest in the proposed project has also grown over the last year. Responding to letters of concern from their constituents, U.S. Senator Howard Metzenbaum, U.S. Senator John Glenn, Congressman Don Pease, State Representative Ron Amstutz, and State Senator Dick Schafrath have all taken positions in opposition to the proposed facility. In addition, Cleveland's mayor, George Voinovich, has opposed the project. Many residents have written their concerns to both U.S. EPA and OEPA.

IV. COMMUNITY CONCERNS

The following community concerns were expressed by Nova area residents and local officials during interviews conducted in August 1988.

A) Lack of trust in the proposed operator of the facility. Residents interviewed expressed concern regarding IT Corporation's involvement in the proposed project. Nova area residents and members of STOP IT and CAP feel strongly that IT Corporation is not a reliable company to be operating the proposed facility. The citizens groups have distributed information about IT Corporation, including a list of violations of State of California environmental regulations and the Louisiana State Ethics Code. Members of STOP IT cite a recent *Forbes* article which discusses management and financial problems of IT Corporation, and the fact that the company insures itself against environmental liabilities as proof of IT Corporation's instability (see "Warning -- Hazardous Management," *Forbes*, Volume 142, Number 2, July 25, 1988, Page 60). Residents also are concerned that IT Corporation will purchase OTC and that OTC is merely acting as a "front" for IT Corporation.

B) Effects of proposed facility on quality of life. Residents interviewed stressed their concern regarding the impact of the proposed facility on the quality of life in the area. Residents said that the major reason why people move into rural areas and stay in these areas is the clean air, and non-urbanized, undeveloped characteristics of these regions. These residents feel that construction and operation of an incinerator in the area would destroy the appeal of the area, negatively impact property values, and drive people away. Moreover, residents and members of the Amish community pointed out that siting an incinerator in the Nova area is counter-culture to the Amish way of life. CAP stressed the fact that the Amish communities increase the tourist appeal of the area. According to newspapers reports, the Amish community has hinted to the possibility that the Amish settlements in the area may relocate if the incinerator is licensed and built. Community interviews with

Amish representatives, however, indicated that this would be a last resort.

C) Effects of proposed facility on environmental quality in the region. All residents interviewed expressed the greatest concern about the impacts of the proposed facility on the environment. The community is very concerned about air emissions from the proposed incinerator and feels strongly that there would be a threat of toxic air contamination. CAP and STOP IT also spoke about the fact that the facility would be located near the headwaters of the Black and Vermilion rivers. The groups feel that these rivers would be endangered by contamination resulting rom operation of the incinerator. The Amish leaders voiced their concern that air emissions would contaminate rainwater which is a primary water source through cisterns and wells on many of the Amish properties. The Amish are concerned about how their livestock and crops may be affected by the proposed incinerator. Such a concern is echoed by other farmers in the area who view the proposed incinerator as a threat to their livelihoods.

D) Inappropriateness of site selection. Most people interviewed questioned why Nova was chosen as the site for OTC's project. These people feel that it is inappropriate for an incinerator to be located in a rural community where natural resources are a significant aspect of the economy. Two residents interviewed, one that breeds Navajo Churro sheep (an endangered species) and another that propagates native American seeds, were particularly concerned that an incinerator in the area could endanger their projects. The Amish leaders expressed similar concerns and asked why incinerators had to be cited in places where people lived. They suggested that a better location would be in a desert, or some other unpopulated area.

E) Waste management in Ohio . Both CAP and STOP IT said that they wanted to obtain more information about the waste management industry in Ohio. These groups feel that there are plenty of incinerators in the area, and that building another one is not necessary. The groups are interested in exploring alternative waste management technologies to incineration. Their interests in this area reflect their concerns that OTC and IT are not acting in the best interest of the community or the state, and are proposing the incinerator for their own financial benefit.

F) Safety of the proposed incinerator . Residents and local officials brought up several safety issues. Most people interviewed said they are concerned about having trucks filled with contaminated material driving through the area. According to several residents, the roads in the area have several sharp curves which could lead to accidents by trucks traveling to the facility. In addition, residents cited air and fugitive emissions, and public health effects of long-term exposure to such emissions as major concerns.

Residents who oppose incineration altogether as a waste management technology believe that too little information is known about the synergistic effect of several chemicals burning at once, and feel that such an occurrence is a health threat to the area.

Many of the people interviewed wanted clarification on monitoring of the incinerator should it become operational. These residents wanted to know who would conduct the monitoring and how often it would be done. STOP IT and CAP expressed reservations about monitoring programs and said that the proposed incinerator would not be adequately monitored. These groups suspect that officials would only monitor for a narrow range of contaminants.

CAP representatives shared their frustration about the safety issue and rhetorically asked why the burden of making the incinerator safe rested with the residents. They expressed distrust in the ability of government officials to protect the environment and public health.

G) Emergency response capabilities in the area. Several concerned residents and local officials felt that siting the facility in the Nova area places the region in peril should an accident occur. Nova itself has no emergency response capabilities and relies on the City of Ashland and other communities for such assistance. The community is concerned that should an accident occur, there would be no efficient and comprehensive way of responding. Moreover, the Amish representatives expressed concern that should an accident occur, emergency communication with the settlements and evacuation would be impossible due to their lack of telephone, electricity, and modern transportation systems.

H) Confusion regarding the permitting process. Most of all the residents and local officials agreed that the permitting process is confusing. Many expressed frustration about the many levels of government involved and wanted clarification on the authorities of the federal, state, and local governments. In March 1988, OEPA held an informational session for Nova area residents. At the session, several division representatives from OEPA and U.S. EPA answered questions and provided information on the permitting process. Community members and OEPA officials indicated that the session was informative, although residents said that some confusion still remains about the permitting process.

I) Poor response from government officials. While many residents appeared satisfied with the information provided by government officials, several residents and the citizens groups felt that both the state and federal government officials should provide more information regarding the permitting process and should be more accessible. STOP IT complained bout being “hung up on” by U.S. EPA officials, and said they were frustrated that U.S. EPA had not acknowledged much of the information sent to them by STOP IT. CAP representatives expressed the same concerns.

J) Frustration over limited opportunities for public involvement. Most people interviewed did not understand the extent to which formal opportunities for public involvement exist during the permitting process. Those residents and local officials that are more

aware of public opportunities feel that they are limited and that they do not serve the interests of the communities. Most people interviewed, including the Amish leaders, asked about effective ways of becoming involved in the process so that their concerns can be officially considered before the agencies make any final decisions.

V. OBJECTIVES OF THE PUBLIC INVOLVEMENT PROGRAM

Based on the concerns voiced by area residents and local officials, the following are the objectives of the public involvement program during the permitting process:

A) Establish accessibility among U.S. EPA personnel to the community. As the Nova community works toward becoming informed about the issues surrounding the proposed facility, it will be very important for U.S. EPA personnel to be available to answer questions and provide information. Both STOP IT and CAP already are frustrated with the difficulty they have in contacting U.S. EPA personnel. Maintaining good positive contact with concerned citizens in the Nova community will strengthen U.S. EPA's credibility and allow people to become more involved in the process.

B) Coordinate with OEPA to make sure the community understands the permitting process and opportunities for public involvement. Community interviews reflected the confusion that residents and local officials have about the permitting process and opportunities for public involvement. A crucial component of the public involvement program is to make certain that interested residents and local officials have adequate opportunities to understand and be involved in the permitting process and the opportunities for their involvement. Because so many levels of government are involved in the process, U.S. EPA should work closely with OEPA to provide the community with adequate information and opportunities to ask questions of appropriate government officials.

C) Provide specific information on issues of interest to ensure a strong level of understanding by the community. Both STOP IT and CAP are working hard to acquire information that will put many of the issues of concern into perspective. Much of CAP and STOP IT's activities will involve disseminating information to all interested parties. U.S. EPA and OEPA should work together to provide the community with accurate information on subjects such as incineration technology, alternative waste management practices, emergency response procedures, monitoring

practices, and environmental impacts of waste management practices.

VI. PUBLIC INVOLVEMENT ACTIVITIES

Specific public involvement activities related to the OTC RCRA permit application are required by Title 40 of the Code of Federal Regulations, Part 124 and RCRA Section 7004. The public involvement activities describe below include required activities (indicated by an asterisk), as well as other activities intended to address community concerns and to carry out the objectives established for the public involvement program.

A) Designate U.S. EPA contact to respond to questions from the community. U.S. EPA has assigned one member of the Office of Public Affairs (OPA) staff in the Region V office in Chicago to be the central U.S. EPA liaison for the community (see Appendix B). This person will respond to community requests for information and will field telephone requests for information to other appropriate U.S. EPA personnel. The OPA's name and telephone number will appear on all correspondence between U.S. EPA and the community in addition to U.S. EPA's toll-free number. The OPA official also will be the central contact for local media to acquire information regarding the proposed incinerator, and will keep an up-to-date mailing list of interested individuals.

B) Establish local information repositories for interested parties to review material. In Nova as well as in other nearby communities (see Appendix C), information repositories will be established to provide the community with copies of the permit applications, applicable laws, and other relevant information. As new information is developed, the information repositories will be updated.

C) Coordinate with OEPA to provide fact sheets on issues of concern regarding the proposed facility. U.S. EPA will coordinate closely with OEPA to provide the community with fact sheets that summarize the permitting process in a clear and easy to read format. The first fact sheet will include information on the state and federal permitting process, and on the role of local government and opportunities for public involvement. In addition, separate fact sheets

will be distributed to provide information on other topics of concern expressed by the community. These fact sheets will cover incineration technology, monitoring practices of the U.S. EPA and OEPA, alternative waste management practices, and current information on environmental impacts of incinerators. The fact sheets will be printed and distributed to individuals on U.S. EPA's current mailing list.

D) Conduct availability sessions to answer specific questions. After the fact sheets are prepared and distributed, U.S. EPA in cooperation with OEPA will hold at least three availability sessions in the community. The availability sessions will be designed to accommodate small groups and will consist of representatives of OEPA and U.S. EPA who will be available to answer specific questions of the community. The sessions will be held in different geographic areas of the region and will accommodate members of the Amish community. Notices announcing the availability sessions will be published in local newspapers.

E) Notify the community about progress made on application review. As progress is made on processing of the permit application, or if the schedule for reviewing the application alters significantly, U.S. EPA will notify the community by providing a written update to individuals on the mailing list and media representatives.

*F) Develop and distribute fact sheet on draft permit or denial. It is required by RCRA regulations that one fact sheet, or "Statement of Basis," be distributed that describes both the facility and the permit that is being proposed for that facility. Such a fact sheet will be developed and distributed to individuals on the mailing list, media, and any other interested parties in advance of the public comment period.

*G) Conduct a public comment period on draft permit or denial. RCRA regulations require that the public must be notified through a local newspaper and broadcast over local radio stations that a draft permit has been prepared. A forty-five day period is also required under RCRA regulations to accept public comments. U.S. EPA may extend the public comment period if necessary. U.S. EPA will distribute a

press release to local media and a notice to the mailing list announcing the beginning of the public comment period.

H) Hold public hearing on draft permit or denial. RCRA regulations require that a public hearing be held if an individual organization or community requests one, or if the Regional Administrator determines that one is needed. The purpose of having a public hearing is to officially accept and record public comments. For this site, U.S. EPA has decided to hold a public hearing. U.S. EPA will hold such a hearing and will publicize it via a press release to local media, and advertisements in local newspapers. A notice also will be sent to the mailing list. After the hearing has been held, a tape or transcript will be placed in the information repositories.

*I) Prepare Response to Comments to address community concerns. RCRA regulations require that a response to comments be prepared at the conclusion of the public comment period. This document will consist of a summary of the written comments received, the oral comments presented at the haring, and a response to those comments prepared by U.S. EPA. The Response to Comments will be placed in local information repositories for public review.

* denotes required activity

VI. TIME LINE FOR IMPLEMENTING PUBLIC INVOLVEMENT ACTIVITIES

The following is a time line for public involvement activities through issuance of a final decision on the Ohio Technology Corporation's RCRA permit application. Should a permit be issued, U.S. EPA would continue the public involvement program.

Activity	Approval of the Public Involvement Plan	Completion of Technical Review	Issuance of Draft Permit (if applicable)	Issuance of Final Permit (if applicable)
1. Designate Contact	X			
2. Establish Information Repositories	X			
3. Fact Sheets	----------X	X----------	X	
4. Availability Sessions	----------X	X----------X	----------X	X----------
5. Updates	----------X	X----------X	----------X	X----------As needed-------
6. Public Comment Period			----------X	X----------
7. Public Hearing				X
8. Responsiveness Summary				X

APPENDIX A

LOCAL GOVERNMENTS AND ORGANIZATIONS ISSUING WRITTEN STATEMENTS OF OPPOSITION TO THE PROPOSED INCINERATOR

[obtained from state and federal files]

Government Body	Date resolution adopted
Village of Savannah	December 15, 1987
City of Avon Lake	December 14, 1987
Troy Township	September 28, 1987
Village of Lodi	October 19, 1987
Ashland County Soil and Water Conservation District	April 26, 1988
Russia Township	March 22, 1988
City of Allure	March 21, 1988

Local Organization	Date of written position
Cinnamon Lake Association, Inc.	December 16, 198
Ashland County Farm Bureau, Inc.	May 16, 1988
Episcopal Diocess of Ohio	July 12, 1988
Lodi Rotary Club	January 20, 1988
Lodi Chamber of Commerce	January 20, 1988
Ruritan Club of Lodi	January 20, 1988

APPENDIX B

LIST OF CONTACTS, INTERESTED PARTIES, AND MEDIA

1. Federal Elected Officials

Senator John Glenn (202) 224-3353
503 Senate Hart Office Building
Washington, DC 20510-3501

District Office (216) 522-7095

Federal Courthouse
201 Superior Avenue
Cleveland, OH 44114

Senator Howard Metzenbaum (202) 224-2315
140 Senate Russell Office Building
Washington, DC 20510-3502

District Office (216) 522-7272
Celebreeze Federal Building
Room 2915
1240 East Ninth Street
Cleveland, OH 44199

Congressman Donald Pease (202) 225-3401
2410 Rayburn House Office Building
Washington, DC 20515

District Office (419) 325-4184
The Centre
Suite 101
42 East Main Street
Ashland, OH 44805-2336

2. State Elected Officials

Governor Richard Celeste (614) 466-3555
Office of the Governor
Statehouse
Columbus, OH 43216

State Senator Richard Schafrath (614) 466-8086
Ohio Senate
Statehouse
Columbus, OH 43216

Local Address (419) 994-4161
424 West Main Street
Loudonville, OH 44842

State Representative Ronald Amstutz (614) 466-1474
Ohio House of Representatives
Statehouse
Columbus, OH 43216

Local Address (216) 262-7371
2243 Friar Tuck Circle
Wooster, OH 44691

3. Local Government Officials

Ashland County Commissioners (419) 289-0000
Court House
West Second Street
Ashland, OH 44805
Marilyn Byers, President
C.R."Dick" Myers
Robert Valentine

Ashland County Board of Health (419) 289-0000
c/o Ashland County Health Department
110 Cottage Street
Ashland, OH 44805

Gloria Weirick, President

Ashland County Regional Planning Commission (419) 289-0000
110 Cottage Street
Ashland, OH 44805

Mike Wolfson, Director

Ashland County Disaster Services (419) 289-6511
c/o Ashland City Fire Department
274 Cleveland Avenue
Ashland, OH 44805

John Augustine, Director

Troy Township Trustees
Donald Biddinger, Chairman (419) 652-3462
Ralph Smith, Vice Chairman (419) 652-3258
Richard Robertson (419) 652-3361
Mary Judith Fox, Clerk (419) 652-3187

Troy Township Zoning Inspector
Willard Smith (419) 652-3362

Troy Township Zoning Commission
Leslie White (419) 652-3842
Richard Hawley (419) 652-3021
Delmar Rife (419) 625-3851
Janet Cleugh (419) 652-3760
John M. Gorman (419) 652-3354

Troy Township Zoning Board of Appeals
James R. Callihan (419) 652-2225
Dean Sheppard (419) 652-3838
Tod Crumrine (419) 652-3194
Janice Schneiter (419) 652-3181
Eugene Fowler (419) 652-3808

4. Federal Government Agencies

U.S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, IL 60604

Valdas Adamkus, Regional Administrator (312) 353-2000
Anne Rowan, Public Participation Coordinator (312) 886-7857
Office of Public Affairs
Wen Huang, Environmental Engineer (312) 886-6191
RCRA Permit Branch

Charles Slaustas, Supervisor (312) 886-6190
RCRA Permit Branch
Lisa Pierard , Ohio Section Chief (312) 353-4789
RCRA Permit Branch
Sheldon Simon, Regional PCB Coordinator (312) 886-6087
Pesticides and Toxic Substances Branch

John Connell, Chief (312) 886-6832
PCB Compliance Section
Office of the Environmental Sciences Division

5. State Government Agencies

Ohio Environmental Protection Agency
P.O. Box 1049
1800 Water Mark Drive
Columbus, OH 43266-0149

Richard Shank, Director (614) 644-2782
Linda Whitmore, Public Involvement Coordinator (614) 644-2160
Public Interest Center
Robert Babik, Environmental Engineer (614) 644-2949
Division of Solid and Hazardous Waste
Management

Ohio Hazardous Waste Facility Board (614) 644-2742
P.O. Box 1049
1700 Water Mark Drive
Columbus, OH 43266-0149
James Adair III, Executive Director

Board members :

Richard C. Sahli, Deputy Director
Legal and Governmental Affairs
Ohio Environmental Protection Agency
Warren W. Tyler, Chairman
Ohio Water Development Authority
Charles E. Mauger, Assistant Director
Ohio Department of Natural Resources
Thomas Sweeney, Ph.D., Assistant Vice
President of Research and Graduate Studies
The Ohio State University
W.B. Clapham Jr., Ph.D., Associate Professor of Geology

Cleveland State University

6. Citizens Groups

STOP IT (419) 652-3000
P.O. Box 134
Nova, OH 44859

Dave Schlaufman, Director (419) 652-3862
Vern Hurst, Co-chairperson
Diana Schlaufman, Co-chairperson

Citizens Against Pollution (216) 647-6127
P.O. Box 122 (Mon.,Wed., Fri.)
Sullivan, OH 44880
Ardith Jordan, Trustee

7. Media

Newspapers

Ashland Times Gazette
40 East Second Street
Ashland, OH 44805
(419) 281-0581

Akron Beacon-Journal
44 East Exchange Street
Akron, OH 44328
(216) 375-8111

Elyria Chronicle-Telegram
P.O. Box 4010
225 East Avenue
Elyria, OH 44035
(216) 329-7000

Cleveland Plain Dealer
1801 Superior Avenue
Cleveland, OH 44114
(216) 344-4500

New London Record
P.O. Box 110
New London, OH 44851
(419) 929-3411

Mansfield News Journal
P.O. Box 25
70 West Fourth Street
Mansfield, OH 44901
(419) 522-3311

Wellington Enterprise
P.O. Box 38
Wellington, OH 44090
(216) 647-3171

Television

WAKC-TV
853 Copley Road
Akron, OH 44320
(216) 525-7831

WBNX-TV
P.O. Box 2091
Akron, OH 44309
(216) 928-5711

WEAO-TV
275 Martinel Drive
Kent, OH 44240
(216) 678-1656

WQHS-TV
2681 West Ridgewood
Parma, OH 44134
(216) 888-0061

WEWS-TV
3001 Euclid Avenue
Cleveland, OH 44115
(216) 431-5555

WJW-TV
5800 South Marginal Road
Cleveland, OH 44102
(216) 431-8888

WKYC-TV
1403 East Sixth Street
Cleveland, OH 44114
(216) 344-3333

WUAB-TV
8443 Day Drive
Cleveland, OH 44129
(216) 845-6043

WVIZ-TV
4300 Brockpart Road
Cleveland, OH 44134
(216) 398-2800

Radio

WNCO-Radio
P.O. Box 311
Ashland, OH 44805
(419) 289-2605

WRDL-Radio
Ashland College
401 College Avenue
Ashland, OH 44805
(419) 289-2480

WLKR-Radio
P.O. Box 547
Norwalk, OH 44857
(419) 668-8151

WCLS-Radio
711 McPherson Street
Mansfield, OH 44906
(419) 525-2331

WMAN-Radio
P.O. Box 8
Mansfield, OH 44901
(419) 524-2211

WVNO-Radio
2900 Park Avenue West
Mansfield, OH 44906
(419) 529-5900

WCWS-Radio
College of Wooster
Wooster, OH 44691
(216) 263-2240

WWST-WQKT Radio
South Hillcrest Drive
Wooster, OH 44691
(216) 264-5122

8. Owner/Operator

Ohio Technology Corporation (owner) (216) 464-2121
3350 Lander Road
Cleveland, OH 44124
John Tracy, Principal Manager

International Technology Corporation (operator) (412) 243-3230
Regional Office
William Penn Plaza
2790 Mosside Boulevard
Monroeville, PA 15146-2792
Brian Borofka, Site Assessment Group Leader

Headquarters
23456 Hawthorne Boulevard (213) 378-9933
Torrence, CA 90509

APPENDIX C

LIST OF INFORMATION REPOSITORY LOCATIONS

AND PUBLIC MEETING FACILITIES

1) Information Repository Locations

Ashland Public Library
224 Claremont Avenue
Ashland, OH 44805
(419) 289-8188
Contact:
Constance Wolfson, Librarian

New London Public Library
67 South Main Street
New London, OH 44851
(419) 929-3981
Contact:
Melissa Karnosh, Librarian

Troy Township Trustees
Nova, Ohio
(419) 652-3200
Contact:
Ralph Smith

2) Public Meeting Facilities

Mapleton Middleton School
(Ruggles Troy School)
U.S. Highway 224
Nova, OH 44859
(419) 652-3540
Contact:
John Neighbors, Principal
Capacity: Approximately 250

Mapleton High School
County Rod 620
Polk, OH 44861
(419) 945-2188
Contact:
Mr. Schneider, Principal
Capacity: Approximately 600

Citizens Against Pollution
Corner School House
Sullivan, OH 44880

APPENDIX D

LIST OF PERSONS CONTACTED FOR PREPARATION

OF THE PUBLIC INVOLVEMENT PLAN

(for U.S. EPA and Ohio EPA use only)

Ashland County Board of Commissioners (419) 289-0000

Court House
West Second Street
Ashland, OH 44805

J. Myron Leininger
Marilyn Byers
C. Jay Welsh

Troy Township Trustees

Donald Biddinger (419) 652-3463
Ralph Smith (419) 652-3258
Richard Robertson (419) 652-3361

Ohio Environmental Protection Agency

P.O. Box 1049
1800 WaterMark Drive
Columbus, OH 43266-0149

Linda Whitmore, Public Involvement Coordinator (614) 644-2160
Public Interest Center
Michael Greenberg, Public Information Specialist (614) 644-2160
Public Interest Center
Robert Babik, Environmental Engineer (614) 644-2949
Division of Solid and Hazardous Waste
Management

U.S. Environmental Protection Agency

Region V
230 South Dearborn Street
Chicago, IL 60604

Anne Rowan, Public Participation Coordinator/RCRA Office of Public Affairs	(312) 886-7857
Nancy Sullivan, Public Affairs Specialist/TSCA Office of Public Affairs	(312) 886-6687
Margaret McCue, RCRA Public Participation Manager Office of Public Affairs	(312) 886-6694
George Harper, Ohio Section Chief RARA Permit Branch	(312) 353-4789
Wen Huang, Environmental Engineer RCRA Permit Branch	(312) 886-6191
Charles Slaustas, Supervisor RCRA Permit Branch	(312) 886-6190
Sheldon Simon, Regional PCB Coordinator Pesticides and Toxic Substances Branch	(312) 886-6087

Local Residents and Interested Individuals

Mike Stanfield
962 County Route 40
Nova, OH 44859
(419) 652-3133

Gladys Thomas
838 U.S. Highway 224
Nova, OH 44859
(419) 652-3818

Elaine Drotliff
836 Township Road 150
Nova, OH 44859
(419) 652-3122

Diana Schlaufman
946 Township Road 150
Nova, OH 44859
(419) 652-3862

David Schlaufman
946 Township Road 150
Nova, OH 44859
(419) 652-3862

Vern Hurst
995 Township Road 150
Nova, OH 44859
(419) 652-3337

Frank Rickett
402 Township Road 791
Sullivan, OH 44880
(419) 652-3238

Tod Crumrine
173 State Route 511
Nova, OH 44859
(419) 652-3194

Lois Kinter
Box 15
U.S. Highway 224 West
Nova, OH 44859
(419) 652-3892

Bob Janca
12595 New London E Road
Homerville, OH 44235
(419) 648-2853

Judith Casteel
7730 Firestone Road
Homerville, OH 44235
(419) 625-2141

John Nethers, Ph.D.
Professor of History
Department of Social Sciences
Bixler Hall -- Ashland College
Ashland, OH 44805
(419) 289-5381

Joanne Slorgie
129 Broadway Street
Lodi, OH 44254
(216) 948-2482

Anne Slorgie
129 Broadway Street
Lodi, OH 44254
(216) 948-2482

Linda Martz
Mansfield News-Journal
P.O. Box 25
40 West Fourth Street
Mansfield, OH 44901
(419) 522-3311

Phil Dague
210 Township Road 2150
Jeromesville, OH 44840
(419) 368-3281

Sue Grycza
Ashland Times - Gazette
40 East Second Street
Ashland, OH 44805
(419) 281-0581

Leroy J. Keim
Lodi, OH

David Yoder
Firestone Road
Homerville, OH

Ardith Jordan
Mary Beth Derekito
Mary Warner
Eli Troyer

APPENDIX L -- PERMIT MODIFICATIONS FACT SHEET

United States
Environmental Protection
Agency

Solid Waste and
Emergency Response
(OS-305)

EPA/530-SW-89-050
September 1989

Modifying RCRA Permits

Introduction

The Resource Conservation and Recovery Act (RCRA) requires each hazardous waste treatment, storage, and disposal facility to manage hazardous waste in accordance with a permit issued by the Environmental Protection Agency (EPA) or a state agency that has a hazardous waste program approved by EPA. A RCRA permit establishes the facility's operating conditions for managing hazardous waste. EPA and state agencies use the permit to specify the administrative and technical standards for each facility. Over time, however, the facility needs to modify the permit to improve equipment or make changes in response to new standards. Recognizing this, EPA established procedures early in the program for modifying permits. The Agency has now revised these procedures to provide more flexibility to both owners and operators of facilities and EPA and to increase public involvement. This brochure briefly describes EPA's new procedures for modifying RCRA permits.

These procedures are effective now in states where EPA administers the RCRA program. However, authorized states will not use these procedures until they have adopted them as part of their own programs.

The Old Process

Acknowledges that a permit would need to be modified for various reasons during its life, EPA established in 1980 a process for modifying them. The process included different procedures for major and minor modifications. A minor permit modification allowed a limited number of minor changes to occur, after EPA reviewed and approved the modification request. There was no requirement for public notice and comment.

For major modifications, EPA would follow procedures that were almost the same as those for issuing an initial permit. These procedures included developing a draft permit modification, announcing in a local newspaper and on the radio the availability of the proposed modification, providing a 45-day public comment period, and, if requested, holding a public hearing. Public participation was limited to the specific permit conditions being modified.

A Need for Change

The old permit modification process was becoming increasingly unwieldy. It was impeding the ability of treatment, storage, and disposal facilities to respond quickly to improvements in technology and shifts in the types of wastes being generated. This made the routine changes necessary for effective operations more difficult to accomplish. Furthermore, the procedures often did not involve the public early enough in the modification process.

In response to these concerns, EPA developed new procedures with help from representatives from states and industrial, environmental, and public interest groups. The new process provides more flexibility for facilities to respond to changing conditions, clean up waste, and generally improve their waste management operations. In addition, the new procedures allow for more public involvement by expanding public notification and participation opportunities.

The Congress, in an effort to address the nation's growing concern about its hazardous and solid waste problem, enacted the Resource Conservation and Recovery Act (RCRA). The Hazardous and Solid Waste Amendments of 1984 greatly expanded RCRA and the Environmental Protection Agency's (EPA) authority to regulate the wastes.

As a result, EPA is developing regulations and programs to reduce, recycle, and treat wastes: restrict land disposal and require corrective action for releases of hazardous wastes, or their constituents, into the environment. EPA's Office of Solid Waste, through its publications, aims to foster public understanding and encourage citizen involvement in helping to manage the nation's waste problem.

The New Process

The new process establishes three classes of permit modifications and sets administrative procedures for approving modifications in each class.

Class One addresses routine and administrative changes. Lowest range of permit modifications.

Class Two primarily addresses improvements in technology and management techniques. Middle range of modifications.

Class Three deals with major changes to a facility and its operations. Highest range of modifications.

Class One Modifications

Class One modifications do not substantially alter the conditions in the permit or reduce the facility's ability to protect human health and the environment. Such changes may include

Improving administrative and routine functions.

Upgrading plans and records maintained by the facility.

Replacing some equipment with functionally equivalent equipment.

Most Class One changes do not require approval by the authorized permitting agency -- either EPA or a state -- before they are implemented. There are several types of changes, however, that may require such approval. EPA may deny any Class One modification.

Notifying the Public. Within 90 days of implementing a change, a facility making a Class One modification must notify the public by sending a notice to all parties on its mailing list. This mailing list includes people and organizations who have asked to be notified of the facility's activities. The list is maintained by the permitting agency. Citizens may be added to the mailing list by sending a written request to the agency. Any member of the public may ask EPA to review a Class One modification.

Class Two Modifications

Class Two modifications include those changes that enable a facility to respond to variations in the types and quantities of wastes that it manages, technological advancements, and new regulatory requirements. Class Two changes do not substantially alter the facility's design or the management practices prescribed by the permit. They do not reduce -- and in most cases should enhance -- the facility's ability to protect human health and the environment. Under some circumstances, the permitting agency may determine that the modification request should follow the more restrictive Class Three procedures.

Class Two modifications address change like

Increases of 25 percent or less in a facility's tank treatment or storage capacity.

Authorization to treat or store new wastes that do not require different management practices.

Modifications to improve the design of regulated units or improve management practices.

The new procedures require the facility to submit a request for approval of the change to the permitting agency. The request describes the change, explains why it is needed, and provides information showing that the change complies with EPA's technical standards for the facility. For Class Two modification, a facility may begin construction 60 days after submitting a request, although the permitting agency may delay all or part of the construction.

Involving the Public. The permit holder must notify people and organizations on the facility mailing list about the modification request by sending them a letter and publishing a notice in a major local newspaper. The notice must appear within seven days before or after the facility submits the request to the permitting agency. The newspaper notice marks the beginning of a 60-day comment period and announces the time and place of an informal public meeting.

This public comment period is an opportunity for the public to review the facility's permit modification plans at the same time as the permitting agency -- early in the process. All written comments submitted during the 60-day comment period will be considered by the agency before a final decision is made on the modification request.

The public meeting is conducted by the permittee and is held no fewer than 15 days after the start of the comment period and no less than 15 days before it ends. The purpose of this meeting is to provide for an exchange of views between the public and the facility's owner or operator and if possible, to resolve any issues concerning the permit modification. The meeting is less formal than the public hearings held when a new RCRA permit is under development. Because the meeting is intended to be a dialogue between the facility owner or operator and its neighbors, the permitting agency is not required to attend the meeting. EPA believes that the meeting will result in more public comments being submitted to the agency and perhaps voluntary revisions to the permitted facility's notification request.

To inform citizens about how the facility has met the conditions of the permit the permitting agency must make the facility's compliance history available to the public. A compliance history may include many of any permit violations, when violations have occurred, and how the violations have been corrected.

Default Provision. The procedures for Class Two modifications include a default provision to ensure that the permitting agency responds promptly to the facility's request. The agency must respond to a request within 90 days or, if the agency calls for an extension, 120 days. If the agency does not reach a final decision on the request within 120 days, the facility is automatically allowed to conduct the requested activities for 180 days. During this period, the facility must comply with all federal and state regulations governing hazardous

waste facilities. If the permitting agency still has not acted by day 250, the facility then must let the public know that the facility will become permanently authorized to conduct the proposed activities unless the agency approves or denies the request by day 300. At any time during the Class Two procedures, the agency may reclassify the request as Class Three if thee is significant public concern or if the permitting agency determines that the facility's proposal is too complex for the Class Two procedures. This reclassification would remove the possibility of an automatic decision by default.

Class Two Modification Schedule

Day 1	Modification request received by agency. Newspaper notice published and mailing list notified.
Days 15-45	Informal public meeting held.
Day 60	Written public comments due to agency.
Day 90	Agency response to Class Two modification request due. Deadline may be extended 30 days.
Day 120	If no response, requested activity may begin for 180 days.
Day 250	If still no response, public notified.
Day 300	If still no response, activity permanently authorized.

Class Three Modifications

Class Three modifications address changes that substantially alter a facility or its operation. For example, the following modification requests fall under Class Three:

Requests to manage new wastes that require different management practices.

Major changes to landfill, surface impoundment, and waste pile liner, leachate collection, and detection systems.
Increases in tank, container, or incinerator capacity of more than 25 percent.
Major changes to the facility's groundwater monitoring program.

Involving the Public. For Class Three modifications, the facility must initially follow the same public notice, comment, and meeting procedures as for Class Two modifications. This allows for early public review and comment on proposed changes. Then the permitting agency must prepare a draft permit modification, allow 45 days for public comment on the draft, hold a public hearing if requested, and then issue or deny the permit modification request.

Public Involvement Steps for Class Three Modifications:

The facility representative

Requests a modification of the permit to the permitting agency.

Notifies the public.

Holds a public meeting

The permitting agency

Allows 60 days for public comment on the modification requests.

Prepare draft permit modification conditions.

Notifies the public of the agency's draft permit conditions.

Allows 45 fays for public comment on permit conditions.

Holds a public hearing, if requested.

Issues or denies the revised permit conditions.

Temporary Authorization

For certain Class Two or Three modifications, the permitting agency may grant a facility temporary authorization to perform retain activities for up to 180 days. For example, temporary authorization may be granted to ensure that cleanups, or corrective actions, and closure activities can be undertaken quickly and that sudden changes in operations not covered under a facility's permit can be addressed promptly. Activities performed under a temporary authorization must comply with the applicable waste management regulations. The facility must notify the public within seven days of making the request. The permitting agency may grant a temporary authorization without notifying the public. A facility may renew a temporary authorization only by requesting permit modification and initiating public participation.

Administering Permit Modifications

These procedures are effective only in states where EPA administers the RCRA program. States with hazardous waste programs equivalent to, or more stringent than, the federal program may be authorized by EPA to administered RCRA hazardous waste programs. Authorized states are not required to adopt this new permit modification process, although it is expected that many of them will. Therefore, for state-administered RCRA permits, the state agency may use different modification procedures until it adopts the new modification approach. However, EPA may use these new procedures in authorized states whenever it is necessary to change a RCRA permit to implement provisions imposed by federal law. EPA regional offices, listed below, maintain up-to-date information about which states are following this and other hazardous waste programs.

Getting Involved

EPA encourages community involvement in the permitting and permit modification processes. The revised permit modification procedures expand opportunities for the public to be notified and to participate. The procedures also allow for the expeditious approval of requests when there is no apparent public concern about proposed changes.

Citizen Involvement Steps

Contact your EPA regional office or state agency to identify the permitting agency.

Write the permitting agency and

request to be put on the mailing list to receive notices of permit modification requests.

Review modification requests.

State your support for, or objection to, the requested modification during the public comment period by providing written comments.

Participate in the public meetings. These informal meetings allow facility representatives to explain their permit modification requests and answer your questions.

For a copy of the new regulations governing the permit modification process and more information on the new permit modification process or other RCRA programs, call EPA's RCRA Hotline: 800-424-9346; in Washington, DC., the number is 382-3000. Or contact EPA Regional Offices:

Region I
JFK Federal Building
Boston, MA 02203
(617) 573-9644

Region II
26 Federal Plaza
New York, NY 10278
(212) 264-8683

Region III
841 Chestnut Building
Philadelphia, PA 19107
(215) 597-7940

Region IV
345 Courtland Street, N.E.
Atlanta, GA 30365
(404) 347-3433

Region V
230 S Dearborn Street
13th Floor (HR-11)
Chicago, IL 60604
(312) 353-0398

Region VI
First International Bldg..
1445 Ross Avenue
Dallas, TX 75202
(214) 655-6785

Region VII
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2888

Region VIII
999 18th Street
One Denver Pl., Suite 1300
Denver, CO 80202-2413
(303) 293-1676

Region IX
215 Fremont Street
San Francisco, CA 94105
(415) 974-8026

Region X
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-1099

United States
Environmental Protection
Agency
Office of Solid Waste
Washington, DC 20460

APPENDIX M -- PUBLIC PARTICIPATION RESOURCES AVAILABLE TO THE PERMITTING AGENCY

Two keys to developing an effective public participation program are knowing who within your agency or elsewhere can provide support on public participation activities and knowing where to obtain information. Most Regions have one person assigned as the **public involvement coordinator** (PIC). The PIC serves as a liaison between community members and permit writers, enforcement personnel (both EPA and state), facility owners and operators, and other individuals or groups. The PIC oversees the implementation of the overall public participation program. He or she may handle logistics for public meetings, develop and maintain mailing lists, and review and/or help prepare news releases, fact sheets, and informational materials.

Other individuals who may be able to assist with public participation activities include:

Other EPA Staff - Other members of the EPA Regional technical, legal, public affairs, project officer, or permit writer staffs are also valuable resources. It is essential that these staff coordinate their efforts. They can provide technical assessments of the facility for release to the public or provide information relative to permitting issues and aspects of enforcement, compliance, and corrective action activities developed for the facility. Graphic designers, typesetters, and other support staff can help you with your program. In addition, CERCLA community relations coordinators in your office who have sites in the same community could take care of some of your activities, or at least provide you with valuable advice.

State Personnel - In authorized states, most of the public participation responsibilities listed for EPA staff will be assumed by state personnel. Regardless of authorization status, state agencies should play an active role in the development and implementation of public participation programs. For example, agencies in unauthorized states can provide information such as names for inclusion on a mailing list, background information on a facility's history, and knowledge of community attitudes toward the facility.

Facility Staff - While oversight of the permitting and enforcement processes is the sole responsibility of the regulatory agency, facility owners or operators are responsible for conducting a number of activities. In addition, facilities resources and staff can provide for public participation activities that go beyond the regulatory requirements.

Public Interest Groups - Community groups, civic organizations, environmental groups, religious and educational organizations may all provide public participation activities that supplement the requirements. The agency may consider teaming with a local public interest group to provide opportunities for the public to learn more about the permitting process or technical issues. Public interest groups may be able to provide resources or personnel to help maintain repositories or to provide informational newsletters. The agency may also consider contacting an impartial civic organization (e.g., the League of Women Voters) to mediate at public meetings or other functions.

Contractors - Public participation contractors who work for your agency can provide support by conducting some of the more time-consuming activities, such as community interviews or logistics for public meetings.

If There's No One Who Can Help - You may be the only person available to conduct public participation activities, in which case you need to estimate your level of effort carefully so that you can choose the activities that will give you and members of the public the most benefit. You need to consider your schedule as well, and plan activities so that they complement your technical schedule and leave time for appropriate public participation.

Additional Sources of Assistance

Information Resources - Each EPA Regional office should have informational materials available to help plan public participation strategies and assist in assessing a community's needs and in implementing responsive activities. PICs should be able to guide you to specific manuals, guidance documents, and memoranda that elaborate on regulations and principles of public participation and give helpful tips on implementing successful programs. For example, the three-volume *RCRA Public Involvement Reference Catalog* (September

1990) is a repository of materials from which readers can gather ideas and information concerning the RCRA program and RCRA public participation. You may also want to research materials from other EPA programs, such as Superfund, or outside sources to gather ideas that may be useful in dealing with particular permitting situations.

Training - Training is generally available for staff in a variety of areas, including public participation, community relations, risk communication, and community outreach. If training specific to the RCRA program is not available, you can easily adapt community outreach activities used in other programs to your RCRA situation. The techniques and methods used for RCRA public participation programs -- such as public meetings, fact sheets, and information repositories -- are also used in other programs.

Other Materials - There also are ready-made resources available for you to use in your program. EPA has developed fact sheet templates for RCRA actions, storyboards that describe the permitting process, and other information materials to save you time in developing public involvement information. The Regional PIC can provide more information on these materials.

MEMORANDUM

SUBJECT: Implementation of the RCRA Expanded Public Participation Rule

FROM: Elliott Laws, Assistant Administrator

TO: Regional Administrators
Regions I - X

The Agency will soon take a major step forward in its effort to promote public involvement and environmental justice by promulgating the "RCRA Expanded Public Participation Rule."

The final rule will improve the RCRA permitting process by: (1) providing earlier opportunities for public involvement in the process and (2) expanding public access to information throughout the permitting process and the operational lives of facilities. The rule's requirements include: a facility-led pre-application meeting; agency notice at application submittal; agency notice of impending trial burns; and a provision for information repositories.

Immediate Implementation

While the effective date of the rule will not arrive until six months after promulgation, I am recommending that all EPA Regions start meeting the goals of the final rule as soon as possible. The Regions, in turn, should encourage the States and individual RCRA facilities to meet these goals even as States are pursuing authorization for components (e.g., this rule, BIF permitting, and corrective action) of the RCRA program.

Early implementation of the final rule will allow the public to benefit immediately from the rule's new and important procedures. This early implementation will be useful for the entire program and help the Agency fulfill its commitment to meaningful public involvement in RCRA permitting.

I would like to express my appreciation to the Regions for working to achieve these goals since the Agency proposed the rule in June 1994. We are encouraged by the positive reception these new standards have received, and look forward to full implementation.

Guidance on Equitable and Flexible Public Participation

The development of the final rule involved a balance between broader, more equitable public participation and flexibility for individual permit writers, facilities, and communities to adopt the most appropriate, site-specific approaches. Some of the principles underlying the final rule would have been difficult to prescribe through regulation. We decided that, instead of trying to achieve these goals through regulatory language, the public interest would be served best by encouraging permitting agencies and permit applicants to adopt these principles through guidance.

Consistent with this approach, you should abide by the following principles in your permitting efforts:

- Using all reasonable means to ensure that all segments of the population have an equal opportunity to participate in the permitting process and have equal access to information in the process. These means may include, but are not limited to, multilingual notices and fact sheets, as well as translators, in areas where the affected community contains significant numbers of people who do not speak English as a first language;

- Addressing environmental justice concerns, in part, by expanding access to information (particularly in a multilingual format) and opportunities for public input (through tools such as information repositories); and

- Going beyond the regulatory requirements, where appropriate, to provide for a level of public involvement that is commensurate with public interest in the permitting issue.

I also encourage State permitting agencies and permit applicants to adopt these principles in their dealings with the RCRA program. These policies will improve the RCRA permitting program and promote the Agency's commitments in the area of equitable public participation.

We are providing further guidance for implementing the final rule and this policy directive in our update of the 1993 RCRA Public Involvement Manual (EPA530-R-93-006, September 1993). We anticipate issuing the new guidance document in Spring 1996. The revised manual will provide guidance to regulated facilities and affected communities, as well as permitting agencies.

If you need any additional information about the rule, the policies in this memorandum, or the upcoming guidance manual please contact Patricia Buzzell of my staff at (703) 308-8632.

cc: Michael Shapiro
Linda Garczynski, OSPS
Matt Hale
Frank McAlister
Patricia Buzzell
Fred Chanania
Paul Bangser, OGC
Hazardous Waste Management Division Directors, Regions I - X
Hazardous Waste Management Division Branch Chiefs, Regions I - X
RCRA Public Involvement Network
Lance Miller, Permits Improvement Team

APPENDIX 0 -- OVERVIEW OF PUBLIC PARTICIPATION IN THE ENTIRE RCRA PROGRAM (EXCERPT FROM 1990 RCRA ORIENTATION MANUAL)

SECTION VII

PUBLIC PARTICIPATION

OVERVIEW

GENERAL EPA PUBLIC PARTICIPATION REQUIREMENTS

- FREEDOM OF INFORMATION ACT

RCRA PUBLIC PARTICIPATION REQUIREMENTS

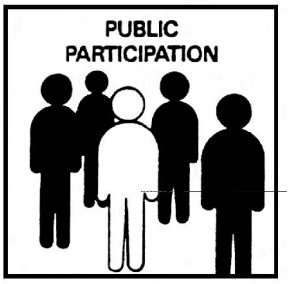
- STATUTORY REQUIREMENTS
- PROGRAM IMPLEMENTATION
- ENFORCEMENT
- REGULATIONS
- CONFIDENTIAL BUSINESS INFORMATION
- GUIDANCE

OUTREACH AND PUBLIC ASSISTANCE

- RCRA/SUPERFUND HOTLINE
- OFFICE OF OMBUDSMAN

SUMMARY

SECTION VII PUBLIC PARTICIPATION



OVERVIEW

The right of the public to participate in government decisions is basic to our democratic system. In few places is this right exercised more than in the area of hazardous waste management. The public is deeply concerned about, and often fretful of, the potential impacts of hazardous waste on their health and safety. In recognition of their rights and interest in hazardous waste management, and in a conscious attempt to include them in the decision-making process, the government gives the public numerous opportunities to get involved in all phases of the RCRA program.

The overall goal of public participation is to build trust and credibility, and to keep emotions, human energy, and conflicts focused on substantive issues and solutions. Public participation provides an opportunity for all interested parties to become informed and involved, and to influence program development and implementation. Further, EPA managers have found that active public participation provides a forum to identify and address concerns thus reducing conflict.

This chapter details the public participation framework established for EPA and, where applicable, specifically for RCRA. It includes descriptions of the statutory and regulatory requirements and a summary of guidance materials that address public participation.

GENERAL EPA PUBLIC PARTICIPATION REQUIREMENTS

In consideration of the importance of citizen involvement, Congress established public participation requirements that apply to all environmental programs administered by EPA. They are outlined in the Administrative Procedures Act ((aAPA) 5 U.S.C. Sections 551-559) and include:

- Providing information and soliciting comments on all proposed and final Agency actions, e.g., the development of regulations

- Incorporating public comments into the decision-making process, and

- Establishing an appeals process for certain Agency decisions.

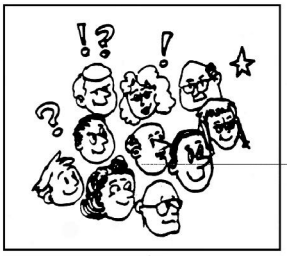
State employees should consult State administrative regulations for further guidance on public participation requirements. The participation requirements in the Federal APA assure the public a voice in EPA decision making.

Freedom of Information Act

The Freedom of Information Act (FOIA) -- which serves as the government's primary mechanism for handling information requests -- guarantees that the public will have access to government records, including those of the EPA. Specifically, it requires each Federal agency to establish procedures for handling FOIA requests regarding government statutes, regulations, standards, permit conditions, requirements, orders, or policies.

EPA, therefore, has pursued a policy of fully disclosing its records to the public, consistent with the rights of persons entitled to confidential business information (CBI), and the need for EPA to promote frank internal policy deliberations. EPA will disclose information to any requester to the fullest extent possible without unjustifiable expense or unnecessary delay.

FOIA requests are written for records held by or believed to be held by EPA. FOIA requests must reasonably describe the records in a manner that will permit proper identification of government documents or records. Although requestors do not need to name the specific documents in question, they must provide a clear description of the information they seek. The FOIA refers to all written requests, regardless of whether the requester refers to the FOIA or not. Any existing form of information may be covered, but the FOIA does not require the creation of new records. A FOIA request can be made by any person, corporation, or organization.



RCRA PUBLIC PARTICIPATION REQUIREMENTS

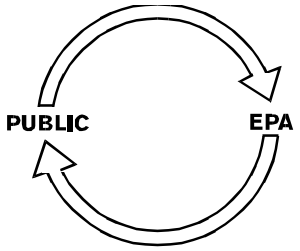
However, because the issues surrounding hazardous waste management often arouse intense public sentiments, the public participation framework developed under RCRA further expands citizen opportunity for involvement well beyond Agency-wide requirements. This framework has three parts:

Statutory requirements
Regulatory requirements, and
Guidance.

Statutory Requirements

When it implements the RCRA program within a State, EPA gives the public access to facility and site information relating to permitting, compliance, enforcement, and inspections. RCRA Section 3006 requires authorized States to make this information available to the public in a manner substantially similar in method and degree to EPA-implemented RCRA programs. In certain cases, however, the information may be confidential and unavailable to the public, e.g., when company trade secrets are involved. The following section discusses the specific requirements for dealing with confidential business information which are principally regulatory requirements.

Program Implementation



Section 3006 of RCRA requires that public comments be solicited before:

A State submits an application for Subtitle C final authorization

EPA decides to grant or deny a State authorization

EPA withdraws a State's authorization, and

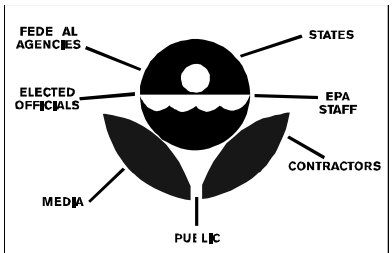
EPA suspends or revokes a hazardous waste facility permit.

Enforcement

Section 7002 of RCRA gives fairly broad legal authority to ensure that the entire RCRA program is properly implemented. It allows a citizen to bring a civil suit against any person or government agency alleged to be in violation of any permit, standard, regulation, condition, requirement, or order that has become effective under the Act.

HSWA expanded citizen rights to bring suit against RCRA violators by allowing private individuals to initiate suits against any past or present generator, transporter, owner, or operator of a facility who has contributed to or is contributing to a condition that may present an imminent and substantial endangerment to human health and the environment.

However, the right of citizens to bring suits under Section 7002 is limited in certain situations. No suit may be brought if EPA or a State is already taking enforcement action against the alleged violator. HSWA further limits the reach of such suits by prohibiting them from impeding permit issuance or facility siting. Finally, citizens are prohibited from suing transporters for problems that arise following the delivery of hazardous waste.



Who Is Involved In Public Participation?

Regulations

The RCRA regulations under 40 CFR Part 25 focus on:

- Ensuring that the public understands the RCRA program and any proposed changes to it
- Responding to public concerns and including the public in the decision-making process
- Developing a close link among EPA, States, and the public, and
- Providing opportunities for public participation beyond what is required, whenever feasible.

To achieve these regulatory goals, agencies implementing RCRA are required to:

- Provide free copies of reports upon request
- Alert interested and affected parties of upcoming public hearings, and
- Establish EPA-funded advisory groups when an issue warrants sustained input from a core group of citizens.

In addition to the 40 CFR Part 25 regulations, EPA's permitting regulations (40 CFR Part 124) also address public participation. They require the permitting agency to:

- Notify the public of the intent to issue or deny a permit
- Provide the public 45 days to comment on the permit application
- Consider public comments regarding permit violations, and
- Notify the public of proposed major modifications to an

operating permit.

In addition, 40 CFR Parts 264 and 265 require public notice and comments on RCRA closure plans.

Confidential Business Information

In the course of administering EPA programs, agency officials have access to material containing CBI, e.g. trade secrets and proprietary information. Because EPA must protect the rights of those who submit privileged information, employees are required to take all reasonable measures to prevent unauthorized disclosure of CBI. Regulations regarding confidentiality are contained in 40 CFR Part 2, Subpart B. These apply to RCRA as well as other EPA programs.

These regulations identify the proper procedures businesses must employ to claim confidentiality. In addition, these regulations establish the guidelines EPA must use to determine the validity of the claim, and impose rules for handling CBI.

When EPA notifies a business that it must submit confidential information for review, EPA also must notify the business of its right to assert a claim of confidentiality. Businesses responding to EPA's queries must clearly identify all confidential documents, materials, and information. EPA then determines the validity of the CBI claim. Businesses can claim information as confidential if it meets certain criteria, e.g., it has been previously protected as confidential, or it is not reasonably obtainable by others.

Employees authorized to use CBI are responsible for the control of such information and they may discuss CBI only with other authorized persons. Any violations should be reported immediately. In addition, employees must not discuss CBI over the telephone and when holding confidential information, they must store the confidential materials in an approved container when not in use. Finally, when working with representatives of businesses that have submitted CBI, employees must verify the representatives' identities before discussing any of the confidential information.

Guidance

To supplement its statutory and regulatory requirements, EPA developed guidance documents regarding public participation in RCRA permitting. The guidance stresses the importance of:

Identifying public concerns early in the permitting process

Encouraging the exchange of information among EPA, the State, the permittee, and the community

Creating open and equal access to the permitting process, and

Anticipating conflicts and providing an efficient method of resolution.

In some cases, EPA or the State may develop a Public Involvement Plan. This plan outlines the steps and actions EPA will take to communicate with the public during the facility permitting process.

OUTREACH AND PUBLIC ASSISTANCE

A number of opportunities exist for the public to obtain RCRA program information and assistance, including fact sheets and pamphlets. Two particularly noteworthy programs include:

The RCRA/Superfund Hotline
The Office of Ombudsman.

RCRA/Superfund Hotline

Hazardous waste regulations often seem complex even to those familiar with EPA's programs. To assist the public in understanding the RCRA and Superfund programs, EPA created the RCRA/Superfund Hotline. Anyone may call the Hotline staff and ask them questions related to the RCRA and Superfund programs. The Hotline is staffed by professionals who are completely familiar with the latest issues and regulations affecting EPA's hazardous waste programs. The Hotline is open Monday through Friday from 8:30 AM to 7:30 PM, and may be contacted at either (202) 382-3000, or toll free (800) 424-9346.

Office of Ombudsman

In order to create a central clearinghouse for public concerns on matters relating to the implementation and enforcement of RCRA, EPA established the Office of Ombudsman and appointed a Hazardous Waste Ombudsman in Headquarters and each Region. The Ombudsman's primary responsibility is to respond to questions and complaints regarding EPA's hazardous waste program. In addition, the Ombudsman makes recommendations to the Administrator based on inquiries received. The Headquarters Ombudsman may be reached at:

Office of Ombudsman
U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Mail Code OS-130
401 M Street, SE
Washington, DC 20460
(202) 475-9361

SUMMARY

The public participation framework developed under RCRA expands citizen opportunity for involvement well beyond Agency-wide requirements (outlined in the Administrative Procedures Act and Freedom of Information Act). This framework consists of:

Statutory requirements
Regulations
Guidance.

RCRA-mandated programs integrate public comment into many decisions, including State authorization and facility permitting.

EPA adheres to legal requirements for the access to and release of information. In order to protect rights of private industry, EPA also has set standards for the use of privileged company data. EPA strictly regulates CBI by carefully limiting employee access to such information, by strictly controlling the use and storage of such information, and by verifying corporate identify before discussing such information.

To assist citizens with the RCRA program, EPA created a number of public outreach programs, the most noteworthy of these are the RCRA/Superfund Hotline and the Office of the Ombudsman.

APPENDIX P -- PUBLIC PARTICIPATION IN ENFORCEMENT AND COMPLIANCE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

May 5, 1987

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Guidance for Public Involvement in RCRA Section 3008(h) Actions

FROM: J. Winston Porter
Assistant Administrator

TO: ADDRESSEES

EPA is committed to providing meaningful opportunity to the public to be informed of and participate in decisions that affect them and their community. This memorandum provides guidance on public involvement actions taken under Section 3008(h) of the Resource Conservation and Recovery Act (RCRA).

It is highly likely that corrective action activities, which differ from normal operations at a facility, will generate public concern. The nature of the problem and the visibility of corrective action activities are two reasons for EPA to involve the public during the corrective action process. If the public is informed early, and allowed to be involved in the decision-making, it is less likely that there will be opposition to the decisions that are made. Also, valuable information can be obtained from concerned citizens who may know the site and facility's history.

Section 3008(h), the interim status corrective action authority, allows EPA to take enforcement action to require clean-up at a RCRA interim status facility when the Agency has information that there has been a release of hazardous waste or hazardous constituents. We anticipate that the cleanup program under Section 3008(h) will frequently be implemented with two orders. The first order would require the owner or operator to conduct a study to characterize the nature and extent of contamination, and to develop a remedy or alternative remedies as needed. Once a remedy has been selected, a second order would require design, construction, and implementation of that remedy.

MINIMUM PUBLIC INVOLVEMENT REQUIREMENTS

Although there will be many situations where much additional public involvement will be necessary, I would like to emphasize that there are minimum requirements for all 3008(h) orders, whether on consent or unilateral. Following the respondent's submission of its report on the RCRA Facility Investigation and Corrective Measures Study, the Agency will develop a proposed plan for corrective measures, or make the decision that no corrective measures are necessary. The Agency shall then (1) publish a notice and brief analysis of the proposed plan for corrective measures, or of its decision that no corrective measures are necessary, and make such information available to the public, and (2) provide a reasonable opportunity (ordinarily 30-45 days) for submission of written comments and, if the Regional Administrator deems it appropriate, a public meeting on the plan. If the Regional Administrator denies a request for a public meeting, he shall explain his decision in writing.

The Agency shall, as necessary, modify its proposed plan for corrective measures on the basis of written and oral comments received. Prior to issuance of the initial order for corrective measures the Agency shall prepare a responsiveness summary indicating whether and why it has accepted or rejected any significant comments. Following finalization of the order for corrective measures but before implementation of corrective measures, notice of the final plan for corrective measures shall be published and the plan shall be made available to the public.

Where, in the interest of protecting human health and the environment, it is important that interim corrective measures be implemented quickly, the public will have no advance opportunity for written or oral comments. Here, EPA will simply provide substantially contemporaneous notice to the public of interim measures being implemented.

EXPANDED PUBLIC INVOLVEMENT MAY BE NECESSARY

The degree of public involvement in a corrective action program will be determined by the amount of public interest in the site, the actual or potential hazard to human health or the environment and the type of clean-up action that will be undertaken. In general, if the Agency has identified releases and determined that they require investigation, the public should be informed that studies are underway. The Region may also want to hold additional public meetings if there is a lot of interest in the facility. The public should be made aware of significant

technical issues at the site. There will be occasions where affected citizens can make valuable contributions to remedy selection through participation in technical discussions with owners or operators and government representatives.

We strongly urge the use of a public involvement plan for sites in which there is likely to be significant public interest. At appropriate points during the process, fact sheets can be developed that should both inform the public and allay fears that could surface if no substantive knowledge were made available. A public involvement plan tailored to each site can also be very helpful. You may refer to Community Relations in Superfund: A Handbook March 1986, and Public Involvement Guidance in the Permitting Program , March 1986, Directive 9500.01, for further information on public involvement techniques and process. The regional RCRA public involvement coordinator can also offer valuable information and assistance.

There are limitations on the release or discussion of certain information during the §3008(h) enforcement process. This is especially true during negotiations. The confidentiality of statements made during the course of negotiations must be maintained. Our goal during negotiations is to encourage frank discussion of all issues, and try to resolve differences. Public disclosure of this information would jeopardize the success of the negotiations. Disclosures of strengths and weaknesses of a case, information that is privileged and protected under the law, enforcement strategy and timing would also jeopardize the government's enforcement position. If a case is referred to the Department of Justice to initiate litigation, further constraints may be placed upon public involvement. In this situation, the scope of public involvement should be discussed with the lead DOJ attorney.

Coordination among EPA and/or State personnel is very important. At some sites, RCRA Permits and Enforcement Personnel and Superfund will be involved, and a coordinated approach will serve the Agency and the public best. In order to establish a network whereby information can be exchanged, I would like each region to appoint a coordinator for public involvement in §3008(h) orders. This person may be from either your public involvement or enforcement staffs. Please call Jackie Tenusak of my staff at FTS 475-8729 with the name of your contact.

Thank you for your attention to this matter. Please do not hesitate to call me, or any of our public involvement staff, if you have questions.

ADDRESSEES

Regional Hazardous Waste Management Division Directors,
Regions I-X

RCRA Enforcement Section Chiefs
Regions I-X

RCRA Enforcement Branch Chiefs
Regions I-X

Public Involvement/Community Relations Coordinators
Regions I-X

cc: Pamela Garrow, OWPE
Olga Corey, OWPE
Vanessa Musgrave, OSW
Melissa Friedland, OERR

United States
Environmental Protection
Agency

Office of
Enforcement
(LE-133)

March 1990

The Public's Role In Environmental Enforcement

1. Introduction

What can the public do to stop pollution? This question is asked EPA every day by citizens who have seen a pollution problem in their community and want to solve it.

This leaflet presents the first basic steps any member of the public an take to help correct a pollution problem. It describes approaches that can help the reader deal with the type of violations most often encountered by the public. Unfortunately, space does not permit coverage of every possible rare case situation.

Section 2 tells you how to determine whether enforcement techniques can help in dealing with your particular pollution problem, and how to make observations that can be used effectively. It describes the basic steps you can use in any pollution case.

Sections 3 through 6 address the violations most often encountered by the public in the major categories of water pollution, air pollution, hazardous waste pollution, and toxic substances pollution. It describes some specialized steps that may be useful for each of those environmental media.

2. The First Steps

The two most important things to do when you see a potential pollution problem are: (1) make careful observations of the problem and (2) report it to the proper authorities.

You should fully record your observations. Write down when you observed the problem (both date and time), where you observed the pollution, and how you came to notice the pollution. If the pollution problem has occurred more than once or is continuing, write that down. If possible, try to identify the person or source responsible. If it is a truck dumping wastewater or garbage, write down the license plate of the truck, the type of truck if possible, and note any signs or emblems on the truck. If you have noticed a particular type of smell, write down your best description of the smell or odor. If the pollution is visible and you have a camera, take a picture. If possible, you may want a friend, neighbor, or family member to confirm your observations.

Once you have carefully observed the problem and written down your observations, you should call the appropriate local or state authorities to inform them of your observations. Look in your local telephone book in the government pages for the county or city office that might handle the problem. Typically, such offices will be listed as environmental, public health, public works, water pollution, air pollution, or hazardous waste agencies. If you cannot find a county or city office, look for a state government environmental office. It may require a few calls to find the correct offices, but hang in there!

Once you reach the appropriate office, give the official all the information on what you observed and ask him or her to look into the problem. You should ask the official whether the problem you have identified is likely to be illegal, how common it is, and how and when the office will investigate. Make sure you get the person's name and telephone number. If the person does not call back or respond promptly, call the person back and ask what is going on.

If the city or county environmental agency does not respond adequately to your telephone call, you may call back and ask to speak to the official supervisor or boss. If the supervisor is not available, get his or her name and address. You may then write this person a letter describing the problem you have observed and explaining your dissatisfaction with the office's response to it. Or you could contact the appropriate state environmental office directly, by telephone or letter. If you cannot get an adequate response from local or state environmental offices, or you cannot find a local or state office to call, you may call the U.S. EPA regional office that covers your area. A listing of all the U.S. EPA regional offices, with telephone numbers, is in the last section of this booklet.

If the pollution problem persists and the local, state, and regional U.S. EPA offices appear unwilling or unable to help, you may contact U.S. EPA headquarters in Washington, DC. If you do not believe the government agencies have adequately responded to the pollution problem, and you believe the pollution is illegal and the problem appears to be continuing, you may have certain individual rights under the citizen suit provisions of the various federal environmental laws that you can assert to remedy the

pollution problem yourself. You may wish to contact your own attorney or a public interest environmental group. A listing of national and state environmental groups is contained in the *Conservation Directory* , published annually by the National Wildlife Federation, Washington, D.C., and available in many public libraries. If you win such a lawsuit, the polluter will likely be required to correct the problem causing the pollution, pay penalties to the United States for violating the law, and pay your attorney's fees.

Finally, if you are told that the pollution problem you have observed is legal, but you believe it should not be legal, you are free to suggest changes in the law by writing to your U.S. Senator or Representative in Washington, D.C. or to your state governor or state legislators to inform them of the problem. Local libraries should have the names and addresses of these elected officials.

3. How to Identify And Respond to A Water Pollution Problem

Periodically, people may become concerned that pollution of a river, stream, lake, or ocean is occurring. This concern may be caused by the sight of an oil sheen on the surface of a river, stream, or lake. It might be caused by their observing a discoloration of the water in a stream or a pipe discharging apparently noxious liquids into a water body. Concern might also arise because an unusual odor is emanating from a body of water, or a bulldozer is seen filling in a marsh or wetland.

While some water pollution is an unfortunate consequence of modern industrial life, there are national, state and local laws that limited the amount and kinds of water pollution allowed, and in some cases these laws completely prohibit certain types of water pollution. Sometimes it will be easy for a citizen to identify water pollution that is a violation of the law, and sometimes it will be difficult to identify the water pollution problem without sophisticated equipment.

Here are a few general types of water pollution problems a citizen might observe:

Rivers and Lakes - A citizen might observe wastewater flowing out of a pipe directly into a stream, river, lake, or even an ocean. Persons are only allowed to discharge wastewater into a water body if they have receive a National Pollutant Discharge Elimination System ("NPDES") permit and they are complying with the requirements of that permit. NPDES permits limit the amount of pollutants which persons are allowed to discharge. Unfortunately, it is often difficult to tell with the naked eye if a person is complying with the terms of a NPDES permit. However, some reliable indicators of violations are a discharge that level visible oil or grease on the water, a discharge that has a distinct color or odor, or one that contains a lot of foam and solids. Further, if there are dead fish in the vicinity of the discharge, this is a strong indicator of a water pollution violation.

Citizens should be aware that all persons who discharge wastewater to U.S. waters must report their discharges. These monthly reports (commonly called Discharge Monitoring Reports, or "DMRs") indicate the amount of pollutants being discharged and whether the discharger has complied with its permit during the course of the month. These reports (DMRs) are available to the public through state environmental offices or EPA regional offices.

Wetlands or Marshes - Under the Federal Clean Water Act, persons are only allowed to fill wetlands (commonly known as marshes or swamps) pursuant to the terms of a special discharge permit, commonly called a Section 404 permit. "Filling a wetland" generally means that a person is placing fill or dredge material (like dirt or concrete) into the wetland in order to dry it out so that something can be built on the wetland. The Section 404 wetlands program is jointly administered by the U.S. Army Corps of Engineers and EPA. In general, the United States is committed to preserving its wetlands (sometimes called the "no-net loss" program) because of the valuable role wetlands play in our environment. In brief, wetlands provide a habitat for many forms of fish, wildlife, and

migratory birds; they help control flooding and erosion; and they filter out harmful chemicals that might otherwise enter nearby water bodies.

In general, there is usually no way to know if a wetland is being filled legally or illegally without knowing whether the person has a Section 404 permit and knowing the terms of that permit. However, if you notice fill activity going on in a suspicious manner, e.g., late at night, this may suggest that the wetland is being filled illegally. If you see a wetland being filled and are curious whether there is a permit authorizing such filling, you may call the local Army Corps of Engineers' office or the EPA regional offices in your state. If possible, you should tell the Army Corps or EPA the location of the wetland being filled, what kind of filling activity you noticed, and who is doing the filling.

Drinking Water - The Nation's drinking water is protected through the Federal Safety Drinking Water Act. Under this law, suppliers of drinking water are required to ensure that their water complies with federal standards (known as maximum contaminant levels, or "MCLs" for various pollutants and chemicals, such as coliform bacteria. If drinking water suppliers exceed a federal standard, they are required to immediately notify their users and implement measures to correct the problem. While you may not be able to tell if your drinking water is meeting all federal standards without testing equipment, if you notice any unusual smell, taste, or color in your water, you should immediately notify the person who supplies your water and the appropriate state agency.

In many of the circumstances when citizens become aware of a water pollution problem, there are actions that they can take to begin the process of correcting the problem and forcing the violator to comply with the law. The first step is always to make careful observations of the pollution event that you are observing. It is best to make a written record of the time and place of the sighting. As many details as possible should be recorded concerning the nature of the pollution, for instance its color, smell, location, and its "oiliness". It is extremely important, if possible, that the source of the pollution be identified, including the name and address of the perpetrator. If the pollution is visible and you have a camera, you may take a picture. If possible, you may want a friend, neighbor, or family member to confirm your observations.

Once you have carefully observed the problem and written down your observations, you should call the appropriate local or state authorities to inform them of your observations. Look in your local telephone book in the government pages for the county or city office that might handle the problem. Typically, such offices will be listed as environmental, public health, public works, or water pollution agencies. If you cannot find a county or city office, look for a state government environmental office.

As the next step, a determination must be made as to the legality of the discharge. If the discharge is, in fact, illegal, the perpetrator must be confronted, the discharging of pollutants or the filling of the wetland must be halted, and, if feasible, the environmental damage caused by the perpetrator's actions must be corrected. Confrontation of the polluter is most practically achieved by contacting the local, state, or federal environmental protection agency. In general, the state environmental agency is responsible for making a preliminary assessment of the legality of the pollution event observed, for investigating the vent, and, if necessary, for initiating an enforcement action to bring the polluter into compliance with the law. The citizen may also contact the U.S. EPA regional office that covers your state for assistance. A listing of all the U.S. EPA regional offices, with telephone numbers, is listed at the end of this booklet.

If the pollution problem persists and the local, state, and regional U.S. EPA offices appear unwilling or unable to help, you may contact U.S. EPA headquarters in Washington, D.C.

Lastly, if you do not believe the federal, state, or local governments have adequately responded to the pollution problem, and you believe the pollution is illegal and appears to be continuing, you may have certain individual rights under the citizen suit provisions of the various federal environmental laws that you can assert to remedy the pollution problem yourself. The Federal Clean Water Act provides that a citizen adversely affected by water pollution may bring a lawsuit on behalf of the United States to correct the problem. If you want to do this, you will probably need a lawyer to make an assessment of the illegality of the pollution event and your chances of succeeding in a lawsuit. There are a number of public interest organizations who can be contacted that are in the business of bringing this kind of lawsuit. (A listing of national and state

environmental groups is contained in the *Conservation Directory* , 1987, 32nd Edition, published by the National Wildlife Federation, Washington, DC) If you win such a lawsuit, the polluter will likely be required to correct the problem causing the pollution, pay penalties to the United States for violating the law, and pay your attorney's fees.

Finally, if you have obtained "insider" information that water pollution is occurring, the Clean Water Act protects you from recrimination if the polluter is your employer. Your employer may not fire you or otherwise discriminate against you based on your "blowing the whistle".

To repeat, there are two ways to proceed if you suspect that water pollution is occurring: either contact your state EPA or the U.S. EPA to disclose your information and/or initiate your own citizen's lawsuit.

4. Air Pollution

Smoke or Odor - There are several air pollution situations a citizen might observe. You might observe visible emissions of air pollutants, such as black clouds of smoke, coming from a source such as a factory or power plant. You might also notice a discharge of air pollution because you can smell a strong odor. In either of these situations, these discharges may or may not be a violation of the Clean Air Act.

The Clean Air Act does allow some pollution discharges. The goal of the Clean Air Act is to keep the overall concentration of the major air pollutants at a level that will protect the public health. States then decide how they are going to meet these air pollution goals. A state may decide not to regulate a particular category of air pollution sources at all and to concentrate its efforts elsewhere in meeting its goals. Regulated sources may have permits from the state allowing them to discharge a certain level of pollution.

The best course of action for a citizen to take in these two situations is first to try to determine the exact source of the pollution. If it is a visible discharge, take a photograph. Also, note the exact time, day and location you observe the pollution.

Then notify your local or state air pollution or environmental agency of your observations. They should be able to determine if the source you observed is regulated, and if so, whether the discharge of pollution you observed is legal. EPA usually defers to the state for enforcement. Only in limited, appropriate circumstances does EPA intervene to take enforcement action. However, if you have difficulty in getting a response from your state or local agency, contact the nearest regional office of EPA and report your observations.

Asbestos - Another situation a citizen might encounter involves construction work. Many old buildings contain the hazardous material, asbestos. Asbestos is extremely harmful to human health inhaled or ingested. When buildings containing asbestos are renovated or demolished, the asbestos is broken up and can become airborne and, therefore, a health hazard.

EPA regulations require all parties associated with renovations and demolitions involving asbestos to notify EPA of the work and follow certain work practice requirements aimed at eliminating or at least minimizing the amount of airborne asbestos. These requirements largely consist of wetting the asbestos at all stages of the process so that it does not become airborne. The regulations also require the asbestos to be stored and disposed of in a particular manner.

There are several ways a citizen might help identify a violation of the asbestos regulations. If you pass a construction site, you may notice large amounts of white dust coming from the site or scattered around the site. These could be violations if the debris in question contains asbestos. One way a citizen could verify that asbestos is involved is looking for a brand-name label stamped on insulation that is still intact.

Otherwise, trained inspectors will have to take samples and laboratory analysis of the debris must be done to verify that it contains asbestos.

The most effective action to take is to notify the nearest EPA regional office about the site.

EPA personnel can then check their records to see if they have received notice of the demolition or renovation, and can do an inspection if it seems likely that asbestos is involved.

Auto Warranties - The Clean Air Act requires that motor vehicles sold in the United States meet prescribed emissions standards. In order to ensure that vehicle emissions remain low for the useful life of the vehicle, manufacturers are required to provide broad emission warranty coverage for vehicles that are less than five years old and have been operated for less than 50,000 miles. This warranty applies to defects in any part whose primary purpose is to control emissions, such as the catalytic converter, and in any part that has an effect on emissions, such as the carburetor (except parts that have annual replacement intervals, such as spark plugs). Manufacturers must make emissions warranty repairs free of charge for any labor or parts. If you believe you are entitled to an emissions warranty repair, contact the person identified by the manufacturer in your owner's manual or warranty booklet.

If you are not satisfied with the manufacturer's response to your emissions warranty claim, you may contact EPA for assistance by writing: Field Operations and Support Division (EN-397F), U.S. Environmental Protection Agency, Washington, DC 20480.

Removing Emission Control Devices - The Clean Air Act also seeks to prevent automotive pollution by prohibiting the removal or rendering inoperative of emission-control devices by new and used car dealers, repair shops and fleet operators. In addition, gasoline retailers are prohibited from introducing leaded gasoline into motor vehicles which require unleaded gasoline, and gasoline that is sold as unleaded must not contain excess lead or alcohol. If you know of a violation of the anti-tampering or motor vehicle fuel rules, please contact EPA by writing to the address listed above.

The Clean Air Act also has a provision allowing citizens to sue any person alleged to be in violation of an emission standard under the Clean Air Act (42 U.S.C. section 7604).

5. Hazardous Waste

Abandoned Sites, Barrels, etc.

When citizens see leaking barrels (or barrels that look like they might leak), pits or lagoons on abandoned property, they should avoid contact with the materials, but note as thoroughly as possible their number, size, and condition (e.g., corroded, open, cracked) and the material leaking (e.g., color, texture, odor) and report these to the local fire department or the hazardous waste hotline (800-424-8802 or 202-367-2675).

If possible, take a photograph of the area, but do not get too close to the materials. If the substances are hazardous, the statute most likely involved is the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or the Superfund Law), and EPA or the state should take the lead. Under CERCLA, citizens have the opportunity to, and are encouraged to, involve themselves in the community relations program which includes citizen participation in the selection of a remedial action

A citizen may file suit against any person, including the United States, who is alleged to be in violation of any standard, regulation, condition, requirement or order that has become effective under CERCLA, provided that the citizen gives the violator, EPA, and the state sixty days 'notice of the intent' to sue. A citizen suit cannot be brought, however, if the United States is diligently prosecuting an action under CERCLA.

Hazardous Waste Facilities

When citizens encounter leaks, discharges or other suspect

emissions from a hazardous waste treatment, storage or disposal (TSD) facility, they should contact their state hazardous waste office or the local EPA Regional office to determine if the facility has a Resource Conservation and Recovery Act (RCRA) permit or has been granted interim status to operate while it applies for a RCRA permit. Any citizen may obtain copies of a TSD facility's permit and monitoring reports, which would document any violations, from the state agency or EPA Regional office.

A citizen may bring a civil judicial enforcement action against a RCRA violator provided he gives the violator, EPA, and the state sixty days notice of the intent to sue, during which time the state or EPA may pursue an enforcement action. With certain limitations, a citizen may also bring an action against any person who has contributed to or who is contributing to the past or present handling of any solid waste, including hazardous waste, that may present an imminent and substantial endangerment to human health or to the environment.

Transportation Spills

If you see a spill from a truck, train, barge or other vehicle, you should report it immediately to the local fire and police. If it is possible to read any labels on the vehicle, without getting too close, then you should report this information as well.

If you see a spill from a barge, ship, or other vessel into navigable waters or the ocean, such as an oil pill from a tanker, you should report the spill and location to the United States Guard, or call the hazardous waste hotline (1-800-424-8802) or (202) 267-2675).

Citizens who provide information leading to the arrest and conviction of persons who commit certain criminal violations under CERCLA may be eligible for a reward of up to $10,000. These awards are often offered in connection with a violator's failure to make a required report on a release of a hazardous substance or the destruction or concealment of required records.

6. Pesticides and Toxic Substances

When citizens encounter instances of pollution involving pesticides or toxic substances, the law that was actually violated will most often be the Clean Water Act, the Clean Air Act, or the Resource Conservation and Recovery Act. Most violations of the Toxic Substance Control Act or the Federal Insecticide, Fungicide and Rodenticide Act will be discovered only by persons with special training or with access to information that is not generally available to the public.

TSCA

Violations of the Toxic Substances Control Act (TSCA) that the public might observe include:

-- Demolition of a building containing asbestos without proper measures to keep the asbestos contained.

-- Improper storage or disposal of transformers containing PCBs (polychlorinated biphenyls).

-- Improper storage of asbestos.

If you think you are seeing such a violation, you should contact: Office of Compliance Monitoring (EN-342), U.S. Environmental Protection Agency, Washington, D.C. 20460, or call the National Response Center for Oil and Hazardous Material Spills at (800-424-8802).

Citizens suits are authorized under TSCA (15 U.S.C. section 2619). Citizens may sue violators of provisions concerning PCBs, asbestos, required testing of chemical substances, notification to EPA

before manufacturing or importing new chemicals, or beginning a significant new use of chemicals.

FIFRA

Citizens may encounter violations of the provisions of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) that govern the use of pesticides. FIFRA requires that pesticides be used by the public only as specified on the label. Many pesticides are labeled for use only by specially licensed applicators. Others have been banned from almost all uses, except for particular uses where no other pesticide **[remainder of text missing]**.

Violations of FIFRA that citizens may observe include:

-- Sale or use of banned pesticides that are not registered with EPA. These would lack the EPA registration number that must appear on every pesticide label.

-- Use of pesticides in a manner inconsistent with the directions on the label.

-- Application of restricted-use pesticides by unlicensed applicators.

-- False or misleading labeling or advertisement of pesticides.

If you think you are seeing such a violation, you should contact: Office of Compliance Monitoring (EN-342), U.S. Environmental Protection Agency, Washington, DC 20460, or cal the National Response Center for Oil and Hazardous Material Spills at (800 424-8802.

There is no citizen suit authority under FIFRA.

EPCRA

The Emergency Planning and Community Right-to-Know Law (EPCRA) requires a wide range of businesses that manufacture, import, process, use or store chemicals to report certain information to federal, state and local governments. For example, these businesses are required to report annual estimates of the amounts and types of toxic chemicals they released or disposed of during each calendar year. The data must be reported to EPA and to state agencies, and they are available to the public through an EPA compilation called the Toxics Release Inventory. The data in this inventory may be used by the public to examine the practices of particular manufacturers.

If you believe that a business that was subject to the EPCRA requirement failed to report to the Toxics Release Inventory, you should contact: Of Compliance Monitoring (EN-342), U.S. Environmental Protection Agency, Washington, DC 20460. A business' failure to report toxic releases may also be challenged through a citizen suit under 42 U.S.C. section 11046(a)(1).

7. For Further Information

State and local governments have responsibility for enforcing most environmental laws in the area where you live. You can locate them through your telephone directory. In most communities, the responsible agency is the city or county health department. At the state level, there is usually an environmental agency that carries out the pollution-control laws, while an agriculture agency often handles regulation of pesticides.

EPA operates primarily through ten regional offices, which will help answer your questions if your state or local agencies have been unable to do so. Each region has a staff specializing in each of the environmental programs discussed in this publication. To locate a person who can help you, call the public affairs office in your EPA regional office.

These offices and the states they cover are:

Region 1:	Boston (617) 835-3424	CT, MA, ME NH, RI, VT
Region 2:	New York City (212) 264-2515	NY, NJ, PR, VI
Region 3:	Philadelphia (215) 597-9370	DE , DC, MD, PA, VA
Region 4:	Atlanta (404) 257-3004	AL, FL, GA, KY, MS, NC, SC, TN
Region 5:	Chicago (312) 353-2073	IL, IN, MI, MN, OH, WI
Region 6:	Dallas (214) 255-2200	AR, LA, NM, OK, TX
Region 7:	Kansas City (913) 757-2803	IS, KS, MO, NE
Region 8:	Denver (303) 564-7666	CO, MT, AND, SD, UT, WY
Region 9:	San Francisco (415) 484-1050	CA, HI, NV, Guam, American Samoa
Region 10:	Seattle (206) 399-1466	AK, ID, OR, WA

APPENDIX Q -- PUBLIC PARTICIPATION MANUAL REVISIONS -- TASK GROUP PARTICIPANTS

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401 M Street, SW
Mail Code 5303W
Washington, DC 20460

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726 Minnesota Ave.
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401 M Street, SW
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Mike Cast
US Army Environmental Center
Attn: SF IM-AEC-PA (Mike Cast)
Aberdeen Proving Grounds, MD
21040

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US EPA, Region 8
OCPI
999 18th Street, Suite 500
Denver, CO 80202-2466

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Baton Rouge, LA 70804-9095

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Colorado Dept. of Public Health and
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HMWMD-ADM-B2
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Helena, MT 59624

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US EPA, Office of Solid Waste
401 M Street, SW
Mail Code 5303W
Washington, DC 20460

Sharon Lloyd O'Connor
League of Women Voters
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Montana Office
Federal Building -- 301 Park Street
Drawer 10036
Helena, MT 59625-0096

State Pollution Prevention Programs

Source: National Pollution Prevention Roundtable, November 1995

Region 1

Connecticut Technical Assistance Program
(ConnTAP)
50 Columbus Blvd. 4th Floor
Hartford, CT 06106
Phone: 203/241-0777
Fax: 203/244-2017
Contact: Rita Lomasney

Maine Department of Environmental Protection
State House Station #17
Augusta, ME 04333
Phone: 207/287-2811
Fax: 207/287-2814
Contact: Ronald Dyer

Maine Waste Management Agency
160 Capitol Street, SHS# 154
Augusta, ME 04333-0154
Phone: 207/287-5300
Fax: 207/287-5425
Contact: Gayle Briggs

Massachusetts Dept of Environmental Protection
One Winter Street
Boston, MA 02202
Phone: 617/556-1075
Fax: 617/556-1049
Contact: Lee Dillard

Massachusetts Executive Office of Environmental Affairs
Office of Technical Assistance for Toxics Use Reduction
100 Cambridge Street; suite 2109
Boston, MA 02202
Phone: 617/727-3260
Fax: 617/727-3827
Contact: Barbara Kelley

Toxics Use Reduction Institute
University of Massachusetts at Lowell
1 University Avenue
Lowell, MA 01854-2881
Phone: 508/934-3275
Fax: 508/934-3050
Contact: Ken Geiser/Janet Clark

Rhode Island Dept of Environmental Management
Office Of Environmental Coordination P2 Section
83 Park Street
Providence, RI 02903
Phone: 401/277-3434
Fax: 401/277-2591
Contact: Richard Girasole, Jr.

Vermont Department of Environmental Conservation
Pollution Prevention Division
Environmental Assistance Div. West Office Building
103 South Main Street
Waterbury, VT 05671-0404
Phone: 802/241-3629
Fax: 802/241-3296
Contact: Paul Van Hollebeke

Region 2

New Jersey Department of Environmental Protection
Office of Pollution Prevention
CN423; 401 East State Street
Trenton, NJ 08625
Phone: 609/777-0518
Fax: 609/777-1330
Contact: Jeanne Herb

New Jersey Technical Assistance Program
for Industrial Pollution Prevention (NJTAP)
New Jersey Institute of Technology
CEES Building University Heights
Newark, NJ 07102-1982
Phone: 201/596-5864
Fax: 201/596-6367
Contact: Dr. Marcus J. Healey

New York State Dept of Environmental Conservation
Pollution Prevention Unit
50 Wolf Road
Albany, NY 12233-8010
Phone: 518/457-2480
Fax: 518/457-2570
Contact: William F. Eberle

Region 3

Pennsylvania Dept of Environmental Resources
Pollution Prevention Program
PO Box 8472
Harrisburg, PA 17105-8472
Phone: 717/787-7382
Fax: 717/787-1904
Contact: Meredith Hill

Pennsylvania Technical Assistance Program
Penn State University
117 Tech Center
University Park, PA 16802
Phone: 814/865-0427
Fax: 814/865--5909
Contact: Jack Gido

Delaware Department of Natural Resources and
Environmental Conservation
Pollution Prevention Program
P.O. Box 1401, 89 Kings Highway
Dover, DE 19903
Phone: 302/739-2411
Fax: 302/739-6242
Contact: Andrea Farrell

Virginia Department of Environmental Quality
Office of Pollution Prevention
PO Box 10009
Richmond, VA 23240-0009
Phone: 804/762-4344
Fax: 804/762-4346
Contact: Sharon K. Baxter

West Virginia Division of Environmental
Protection, Office of Water Resources
Pollution Prevention Services
2006 Robert C. Byrd Drive
Beckley, WV 25801-8320
Phone: 304/256-6850
Fax: 304/256-6948
Contact: Barbara Taylor

Region 4

Alabama Department of Environmental
Management
Special Projects, P2 Unit
PO Box 301463
Montgomery, AL 36130-1463
Phone: 334/213-4303
Fax: 334/213-4399
Contact: Gary Ellis

Florida Dept of Environmental Resource Mgmt
Pollution Prevention Program
33 SW Second Avenue, Suite 800
Miami, FL 33130
Phone: 305/372-6804
Fax: 305/372-6729
Contact: Lori Cunniff

Georgia Department of Natural Resources
Pollution Prevention Assistance Division
7 Martin Luther King, Jr. Drive, Suite 450
Atlanta, GA 30334
Phone: 404/651-5120
Fax: 404/651-5130
Contact: G. Robert Kerr

Kentucky P2 Center
Rm 312 Ernest Hall, University of Louisville
Louisville, KY 40292
Phone: 502/852-7260
Fax: 502/852-0964
Contact: Cam Metcalf

Mississippi Dept of Environmental Quality
PO Box 10385
Jackson, MS 39289-0385
Phone: 601/961-5241
Fax: 601/961-5376
Contact: Thomas E. Whiten

North Carolina Department of Environment,
Health and Natural Resources
Office of Waste Reduction
PO Box 29569
Raleigh, NC 27626-9569
Phone: 919/715-6500
Contact: Gary Hunt

South Carolina Dept of Health & Env Control
Center for Waste Minimization
2600 Bull Street
Columbia, SC 29201
Phone: 803/734-4761
Fax: 803/734-9934
Contact: Robert E. Burgess

Univ of South Carolina Inst of Public Affairs
Hazardous Waste Management Research Fund
937 Assembly Street
Columbia, SC 29208
Phone: 803/777-8157
Fax: 803/777-4575
Contact: Doug Dobson

Region 5

Illinois Environmental Protection Agency
Office of Pollution Prevention
2200 Churchill Road PO Box 19276
Springfield, IL 62794-9276
Phone: 217/782-8700
Fax: 217/782-9142
Contact: Michael J. Hayes

Illinois Hazardous Waste Research and Information Center
One East Hazelwood Drive
Champaign, IL 61820
Phone: 217/333-8940
Fax: 217/333-8944
Contact: David Thomas

Indiana P2 7 Safe Materials Institute
1291 Cumberland Avenue, Suite C1
West Lafayette, IN 47906
Phone: 317/494-6450
Fax: 317494-6422
Contacts: Lynn A. Corson, Ph.D or James R. Nooman

Indiana Dept of Environmental Management
Office of P2 & Technical Assistance
100 North Senate Avenue P.O. Box 6015
Indianapolis, IN 46206-6015
Phone: 317/232-8172
Fax: 317/233-5627
Contact: Tom Netner

Michigan Department of Natural Resources Assistance
PO Box 30457
Lansing, MI 48909-7957
Phone: 517/335-7310
Fax: 517/335-4729
Contact: Karl Zollner, Jr.

Minnesota Office of Environmental Assistance
520 Lafayette Road, 2nd Floor
St. Paul, MN 55155
Phone: 612/215-0242
Fax: 612/215-0246
Contact: Kevin McDonald

Minnesota Pollution Control Agency
Pollution Prevention Program
520 Lafayette Road
Phone: 612/296-8643
Fax: 612/297-8676
Contact: Eric Kilberg

Ohio Environmental Protection Agency
Office of Pollution Prevention
PO Box 1049
Columbus, OH 43216-1049
Phone: 614/644-3469
Fax: 614/728-1245
Contact: Michael W. Kelley, Anthony Sasson, Roger Hannahs

Wisconsin Department of Natural Resources
Hazardous Waste Minimization Program
PO Box 7921
Madison, WI 53707
Phone: 608/267-3763
Fax: 608/267-2768
Contact: Lynn Persson

Wisconsin Department of Natural Resources
Pollution Prevention Program
PO Box 7921
101 S. Webster
Madison, WI 53707
Phone: 608/267-9700
Fax: 608/267-5231
Contact: Tom Eggert

Region 6

Oklahoma Department of Environmental Quality
Pollution Prevention Program
1000 NE 10th Street
Oklahoma City, OK 73117-1212
Phone: 405/271-1400
Fax: 405/271-1317
Contact: Dianne Wilkins

Texas Natural Resource Conservation Commission
Office of Pollution Prevention and Recycling
P.O. Box 13087
Austin, TX 78711-3087
Phone: 512/239-3100
Fax: 512/239-3165
Contact: Andrew C. Neblett

University of Texas at Arlington
Environmental Institute for Technology Transfer
PO Box 19050
Arlington, TX 76019
Phone: 817/273-2300
Fax: 817/794-5653
Contact: Gerald Nehman

Region 7

Iowa Department of Natural Resources
Waste Reduction Assistance Program

Wallace State Office Building
Des Moines, IA 50319-0034
Phone: 515/281-8941
Fax: 515/281-8895
Contact: Larry Gibson

Iowa Waste Reduction Center
University of Northern Iowa
Cedar Falls, IA 50614-0185
Phone: 319/273-2079
Fax: 319/273-2926
Contact: John L. Konefes

Kansas Department of Health and Environment
Office of Pollution Prevention
Building 283, Forbes Field
Topeka, KS 66620
Phone: 913/296-6603
Fax: 913/296-3266
Contact: Theresa Hodges

Missouri Department of Natural Resources
Technical Assistance Program
Pollution Prevention Program
P.O. Box 176
Jefferson City, MO 65102
Phone: 314-526-6627
Fax: 314/526-5808
Contact: Becky Shannon

Region 8

Colorado Dept of Public Health & Environment
Pollution Prevention Unit
4300 Cherry Creek Drive South
Denver, CO 80222
Phone: 303/692-3003
Fax: 303/782-4969
Contact: Parry Burnap

Montana Pollution Prevention Program
Montana State University Extension Service
109 Taylor Hall
Bozeman, MT 59717
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Contact: Dr. Michael P. Vogel

State of Montana Water Quality Division
PO Box 200901
Helena, MT 59620
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Fax: 406/444-1374
Contact: Patrick Burke

Energy and Environmental Research Center
University of North Dakota
PO Box 9018
Grand Forks, ND 58202-9018
Phone: 701/777-5000
Fax: 701/777-5181
Contact: Gerald Groenewold

North Dakota Department of Health
Environmental Health Section
P.O. Box 5520
Bismarck, ND 58506-5520
Phone: 701/328-5153
Fax: 701/328-5200
Contact: Jeffrey L. Burgess

South Dakota Department of Environment &
Natural Resources
Pollution Prevention Program
Joe Foss Building
523 E. Capitol Avenue
Pierre, SD 57501-3181
Phone: 605/773-4216
Fax: 605/773-4068
Contact: Dr. Dennis Clarke

Utah Department of Environmental Quality
Office of Planning and Public Affairs
168 N 1950 W. P.O. Box 144810
Salt Lake City, UT 84114-4810
Phone: 801/536-4477
Fax: 801/536-4401
Contact: Stephanie Bernkopf or Sonia Wallace

Wyoming Department of Environmental Quality
Solid and Hazardous Waste Division
122 West 25th Street
Cheyenne, WY 82002
Phone: 307/777-6105
Fax: 307/777-5973
Contact: Patricia Gallagher

Region 9

Arizona Department of Environmental Quality
3033 N Central Avenue
Phoenix, AZ 85012
Phone: 602/207-4337
Fax: 602/207-4872
Contact: Linda Allen

California State Department Toxic Substances
Control
Office of Pollution Prevention and Technology
Development

PO Box 806
Sacramento, CA 95812-0806
Phone: 916/322-3670
Fax: 916/327-4494
Contact: David Hartley, Kim Wilhelm, Kathy Barwick, Alan Ingham

State of Hawaii Department of Health
Waste Minimization Division
919 Ala Moana Blvd., Room 212
Honolulu, HI 96814
Phone: 808/586-4373
Fax: 808/586-7509
Contact: Jane Dewell, Waste Minimization Coordinator

Nevada Small Business Development Center
Business Environmental Program
MS-032 University of Nevada at Reno
Reno, NV 89557-0100
Phone: 702/784-1717
Fax: 702/784-1375
Contact: Kevin Dick

Guam Environmental Protection Agency
PO Box 22439
Guam Main Facility
Barrigada, Guam 96921
Phone: 671-472-8863
Fax: 671/477-9402
Contact: Joseph C. Cruz

Region 10

Idaho Division of Environmental Quality
Prevention and Certification Bureau
1410 North Hilton
Boise, ID 83706
Phone: 208/334-5860
Fax: 208/334-0576
Contact: Katie Sewell

Oregon Department of Environmental Quality
Toxics Use and Hazardous Waste Reduction Program
811 SW 6th Avenue
Portland, OR 97204
Phone: 503/229-5918
Fax: 503/229-6977
Contact: Sandy Gurkewitz

Washington State Department of Ecology
Hazardous Waste and Toxics Reduction Program
PO Box 47600
Olympia, WA 98504
Phone: 360/407-6086
Fax: 360/407-6989
Contact: Thomas Eaton

Local, County and Regional Pollution Prevention Programs

Source: National Pollution Prevention Roundtable, November 1995

Region 1

Northeast Waste Management Officials' Association (NEWMOA)
129 Portland Street
Boston, MA 02114
Phone: 617/367-8558
Fax: 617/367-0449
Contact: Terri Goldberg

New Hampshire WasteCap
122 North Main Street
Concord, NH 03301
Phone: 603/224-5388
Fax: 603/224-2872
Contact: Barbara Bernstein

Region 2

Erie County Dept of Environment and Planning
Erie County Office of Pollution Prevention
95 Franklin St. Rm. 1077
Buffalo, NY- 14202
Phone: 716/858-7674
Fax: 716/858-7713
Contact: Tom Hersey

Region 3

Metro Washington Council of Governments
Department of Environmental Programs
777 North Capitol St., NE Suite 300
Washington, DC 20002-4201
Phone: 202/962-3355
Fax: 202/962-3201
Contact: George L. Nichols

Allegheny County Health Department
Div of Environmental Toxics and P2
Building #3, 3901 Penn Avenue
Pittsburgh, PA 15224-1345
Phone: 412/578-8375
Fax: 412/578-8065
Contact: Wilder D. Bancroft

Center for Hazardous Materials Research
320 William Pitt Way
Pittsburgh, PA 15238
Phone: 412/826-5320
Fax: 412/826-5552
Contact: Roger L. Price, P.E./Stephen T. Ostheim

Pennsylvania Technical Assistance Program
Penn State University
117 Tech Center
University Park, PA 16802
Phone: 814/865-0427
Fax: 814/865-5909
Contact: Jack Gido

Region 4

Alabama WRATT Foundation
Box 1010
Muscle Shoals, AL 35662-1010
Phone: 205/386-2807
Fax: 205/386-2674
Contact: Roy Nicholson, C.O.O.

Dade County Department of Environmental Resources Management
Pollution Prevention Program
33 SW Second Ave., Suite 1200
Miami, FL 33130
Phone: 305/372-6825
Fax: 305/372-6760
Contact: Nichole Hefty

Tennessee Valley Authority
Industrial Waste Reduction
400 West Summit Hill Drive
Knoxville, TN 37902-1499
Phone: 615/632-8489
Fax: 615/632-3616
Contact: Steve Hillenbrand

Region 7

Great Plains-Rocky Mountains Hazardous Substance Research Center
Kansas State University
101 Ward Hall
Manhattan, KS 66506
Phone: 913/532-4313
Fax: 913/532-5985
Contact: Larry Erickson

Lincoln/Lancaster County Health Department
Environmental Health Division
3140 N Street
Lincoln, NE 68510
Phone: 402/441-8040
Fax: 402/441-8323
Contact: Richard Yoder

Region 9

City of Phoenix
Water Services Department Pollution Control Division
2303 W. Durango
Phoenix, AZ 85009
Phone: 602/262-6997
Fax: 602/534-7151
Contact: Jenee Gavette

Chief Administrator Officer's Hazardous Waste Management Program
3801 3rd Street, Suite 600
San Francisco, CA 94124
Phone: 415/695-7337
Fax: 415/695-7377
Contact: Alex Dong

City of Irvine
1 Civic Center Plaza
Irvine, CA 92713-9575
Phone: 714/724-6356
Fax: 714/724-6440
Contact: Jan Noce

City of Los Angeles Board of Public Works
Hazardous and Toxic Materials Office
201 N Figueroa Street, Suite 200
Los Angeles, CA 90012
Phone: 213/580-1079
Fax: 213/580-1084
Contact: Donna Toy-Chen

Co of Riverside Department of Health Services
Hazardous Materials Division
P.O. Box 7600 (AEH)
Riverside, CA 92513-7600
Phone: 909/358-5055
Fax: 909/358-5017
Contact: Doug Thompson

Co Sanitation Districts of Los Angeles County
Industrial Waste Section
P.O. Box 4998
Whittier, CA 90607
Phone: 310/699-7411
Fax: 310/692-5103
Contact: Mischelle Mische/Ann Heil

Monterey County Health Department
Division of Environmental Health
Hazardous Materials/Solid Waste Branch
1270 Natividad Rd
Salinas, CA 93906
Phone: 408/755-4541
Fax: 408/755-4880
Contact: Jon Jennings

Nevada County Hazardous Waste Task Force
950 Maidu
Nevada City, CA 95959
Phone: 916/265-1768
Fax: 916/265-7056
Contact: Daryl Kent/Traci LoBianco

Orange County Health Care Agency
Environmental Health Division
2009 E. Edinger
Santa Ana, CA 92705
Phone: 714/667-3700
Fax: 714/972-0749
Contact: Pearl Hoftiezer

San Diego County Pollution Prevention Program
PO Box 85261
San Diego, CA 92186-5261
Phone: 619/338-2215
Fax: 619/338-2848
Contact: Linda Giannelli Pratt

Ventura County Environmental Health Division
800 S. Victoria Avenue
Ventura, CA 93009-1730
Phone: 805/654-2127
Fax: 805/654-2480
Contact: Steve Kephart

Region 10

Thurston County Hazardous Waste Program
2000 Lakeridge Drive, SW
Olympia, WA 98502
Phone: 360/754-4663
Fax: 360/754-2954
Contact: Sally Toteff

Department of Commerce: Manufacturing Extension Program Centers

Region 1

Connecticut State Technology Extension Program
170 Middle Turnpike
Storrs, CT 06269-2041
Phone: 203/486-2585
Fax: 203/486-3049
Contact: Peter Laplaca

Massachusetts Manufacturing Partnership (MMP)
Bay State Skills Corp.
101 Summer Street 4th Floor
Boston, MA 02110
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Fax: 617/292-5105
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Region 2

Hudson Valley Manufacturing Outreach Center
Hudson Valley Technology Development Center
300 Westgate Business Center Suite 210
Fishkill, NY 12524
Phone: 914/896-6934
Contact: Douglas Koop

Manufacturing Outreach Center of New York - Southern Tier
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61 Court St., 6th Floor
Binghamton, NY 13901
Phone: 607/774-0022
Fax: 607/774-0026
Contact: E. Kay Adams

New York City Manufacturing Outreach Center
NY ITAC
253 Broadway Room 302
New York, NY 10007
Phone: 212/240-6920
Fax: 212/240-6879
Contact: Jeffrey Potent

New York Manufacturing Extension Partnership (NYMEP)
385 Jordan Road
Troy, NY 12180-8347
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Fax: 518/283-1212
Contact: John F. Crews

Western New York Tech Development Center
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Amherst, NY 14228
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Contact: William Welisevich

Region 3

Delaware Manufacturing Alliance
Delaware Technology Park
One Innovation Way, Suite 301
Newark, DE 19711
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Maryland Manufacturing Modernization Network
Maryland Department of Economic Development
Division of Business
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Baltimore, MD 21202
Phone: 410/333-0206
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Northeast Pennsylvania Manufacturing Extension Program
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A.I. Philpott Manufacturing Center
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Kentucky Technology Service
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Lexington, KY 40589
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Region 5

Chicago Manufacturing Center
HWRIC-Clean Manufacturing Program
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Chicago, IL 60624
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Industrial Technology Institute
Midwest Manufacturing Technology Center (MMTC)
Energy and Environmental Program
PO Box 1485 2901 Hubbard Road
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Fax: 313/769-4021
Contact: Kenneth J. Saulter, Christine A. Branson

Minnesota Technology Inc.
Upper Midwest Manufacturing Technology Center (UMMTC)
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Minneapolis, MN 55401
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Contact: Sandy Voight

Great Lakes Manufacturing Technology Center (GLMTC)
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Cleveland, OH 44103-4314
Phone: 216/432-5350

Plastics Technology Deployment Center
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4600 Prospect Avenue
Cleveland, OH 44103
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Fax: 216/361-2088
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Region 6

New Mexico Industry Network Corporations
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Albuquerque, NM 87106
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Fax: 505/272-7810
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OK Alliance for Manufacturing Excellence, Inc.
252 South Main, Suite 500
Tulsa, OK 74103
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Fax: 918/592-1417
Contact: Edmund J. Farrell

Region 7

Iowa Manufacturing Technology Center
2006 South Ankeny Blvd. ATC Building, 3E
Ankeny, IA 50021
Phone: 515/965-7040
Fax: 515/965-7050
Contact: Dr. Del Sheppard

Mid-American Manufacturing Technology Center (MAMTC)
10561 Barkley, Suite 602
Overland Park, KS 66208
Phone: 913/649-4333
Fax: 913/649-4498
Contact: Paul Clay

Region 8

MAMTC Colorado Regional Office
Rockwell Hall
Colorado State University
Fort Collins, CO 80523
Phone: 303/224-3744
Contact: Craig Carlile

Region 9

California Manufacturing Technology Center
(CMTC)
13430 Hawthorne Blvd.
Hawthorne, CA 90250
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Fax: 310/676-8630
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Institute for Research and Technical Assistance
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Santa Monica, CA 90404
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Fax: 310/453-2660
Contact: Katy Wolf

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MAMTEC Southern Regional Office
Rolla, MO

Nebraska Industrial Competitiveness Service
Lincoln, NE

Defense Enterprise Empowerment Center
Kettering, OH

Tennessee Manufacturing Extension Program
Nashville, TN

VA Alliance for Manufacturing Competitiveness
Richmond, VA

Northwest WI Manufacturing Outreach Center
Menomonie, WI

State Small Business Assistance Programs

Source: National Pollution Prevention Roundtable, November 1995

Region 1

Connecticut Dept. Of Environmental Protection
Small Business Assistance Program
79 Elm Street
Hartford, CT 06106-5127
Phone: 203/424-3382
Fax: 203/424-4063
Contact: Tracy R. Babbidge, Kirsten Cohen

New Hampshire Small Business Technical &
Environmental Compliance Assistance Program
64 North Main Street, 2nd floor
Concord, NH 03302-2033
Phone: 603/271-1370
Fax: 603/271-1381
Contact: Rudolph A. Cartier, Jr., P.E.

Region 2

New York State Dept of Economic Development
Environmental Ombudsman Unit
Division for Small Business
1515 Broadway 51st floor
New York, NY 10036
Phone: 212/827-6157 or 800/STAT-ENY ext. 157
Fax: 212/827-6158
Contact: Doreen Monteleone, Ph.D.

Region 3

Maryland Department of Environment
Air and Radiation Management Administration
Small Business Assistance Program
2500 Broening Hwy.
Baltimore, MD 21224
Phone: 800/433-1AIR or 413/631-3165
Fax: 410/631-3896
Contact: Linda Moran

Region 4

Alabama Dept. of Environmental Management
Ombudsman
PO Box 301463
Montgomery, AL 36130-1463
Phone: 800/533-2336
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Contact: Blake Roper

Florida Department of Environmental Protection
Small Business Assistance Program
2600 Blair Stone Rd.
Tallahassee, FL 32399-2400
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Fax: 904/922-6979
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Tennessee Clean Air Assistance Program
Clean Air Small Business Assistance Program
401 Church St., 8th Floor, L&C Annex
Nashville, TN 37243-1551
Phone: 615/532-0760
Fax: 615/532-0231
Contact: Linda F. Sadler

Region 5

Minnesota Pollution Control Agency
Small Business Assistance Program
520 Lafayette Road
St. Paul, MN 55155
Phone: 612/297-2316
Fax: 612/297-7709
Contact: Leo Raudys

Wisconsin Department of Natural Resources
Small Business Assistance Program
PO Box 7921 AM/7
Madison, WI 53707-7921
Phone: 608/267-3136
Fax: 608/267-0560
Contact: Robert Baggot

Region 6

Arkansas Industrial Development Commission
Industrial Waste Minimization Program
One State Capital Mall
Little Rock, AR 72201
Phone: 501/682-7322
Fax: 501/682-7341
Contact: Ed Davis

Louisiana Department of Environmental Quality
Air Quality Department
Small Business Assistance Program
7920 Blue Bonnett Blvd.
Baton Rouge, LA 70810
Phone: 504/765-2453
Fax: 504/765-0921
Contact: Victor Tompkins

Louisiana Governor's Office of Permits
Small Business Assistance Program Ombudsman
1885 Wooddale Blvd. 1st floor, PO Box 94095
Baton Rouge, LA 70806
Phone: 504/922-3252
Fax: 504/922-3256
Contact: Martha Madden

Texas Natural Resources Conservation Commission
Small Business Advocate
PO Box 13087
Austin, TX 78753
Phone: 800/447-2827 or 512/239-1066
Fax: 512/239-1065
Contact: Tamra Shae Oatman

Texas Natural Resources Conservation Commission
Small Business Technical Assistance Program
PO Box 13087 MC 115
Austin, TX 78711-3087
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Fax: 512/239-1055
Contact: Kerry Drake

Region 7

Iowa Air Emissions Assistance Program
75 BRC/UNI
Cedar Falls, IA 50614-0185
Phone: 319/273-2079
Fax: 319/273-2926
Contact: Mark Trapani

Kansas Department of Health and Environment
Office of Pollution Prevention
Forbes Field, Building 283
Topeka, KS 66620
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Fax: 913/291-3266
Contact: Janet Neff, Public Advocate

Nebraska Department of Environmental Quality
Office of P2
PO Box 98922
Lincoln, NE 68509-8922
Phone: 402/471-2266
Fax: 402/471-2909
Contact: Wanda Blasnitz

Region 8

Montana Small Business Assistance Program
PO Box 200501
Helena, MT 59620-0501
Phone: 406/444-2960
Fax: 406/444-1872
Contact: Mark Lembrecht

North Dakota Department of Health
Ombudsman
PO Box 5520
Bismarck, ND 58506-5520
Phone: 701/328-5153
Fax: 701/328-5200
Contact: Jeff Burgess

Utah Department of Environmental Quality
Division of Air Quality
Small Business Assistance Program
150 N. 1950 W. 84116
Salt Lake City, UT 84114-4820
Phone: 801/536-4056
Fax: 801/536-4099
Contact: Frances Bernards

Utah Department of Environmental Quality
Office of Planning and Public Affairs
168 N. 1950 W., PO Box 144810
Salt Lake City, UT 84114-4810
Phone: 801/536-4477
Fax: 801/536-4401
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Wyoming Department of Environmental Quality
Air Quality Division
Small Business Assistance Program
122 W. 25th Street
Cheyenne, WY 82002
Phone: 307/777-7391
Fax: 307/777-5616
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Region 9

California Air Resources Board
Small Business Assistance Program
PO Box 2815
Sacramento, CA 95812
Phone: 916/322-3976
Fax: 916/445-5745
Contact: Victor Espinosa

Nevada Small Business Development Center
Business Environmental Program
MS-032 University of Nevada at Reno
Reno, NV 89557-0100
Phone: 702/784-1717
Fax: 702/784-1395
Contact: Kevin Dick

Region 10

Alaska Dept of Environmental Conservation
Air Quality Small Business Assistance Program
555 Cordova Street
Anchorage, AK 99501
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Fax: 907/273-9652
Contact: Marianne See

Oregon Department of Environmental Quality
Air Quality Small Business Assistance Program
811 SW 6th Avenue
Portland, OR 97204-13909
Phone: 503/229-5946
Fax: 503/229-5675
Contact: Terry Obteshka

Washington State Department of Ecology
Air Quality Division Business Assistance Program
PO Box 47600
Olympia, WA 98504-7600
Phone: 206/407-6805
Fax: 206/407-6802
Contact: Jerry Jewett

APPENDIX T -- GLOSSARY OF ACRONYMS

ANPR	Advance Notice of Proposed Rulemaking
CAG	Community Advisory Group
CAMU	Corrective Action Management Unit
CBEP	Community Based Environmental Protection
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FR	Federal Register
HQ	EPA Headquarters
HSWA	Hazardous and Solid Waste Amendments
LEPC	Local Emergency Planning Committee
NOD	Notice of Deficiency
OSW	EPA Office of Solid Waste
OSWER	EPA Office of Solid Waste and Emergency Response
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SWDA	Solid Waste Disposal Act
SWMU	Solid Waste Management Unit
TAG	Technical Assistance Grant
TRI	Toxics Release Inventory
TSD	Treatment, Storage, and Disposal Facility

The hardcopy version of the 1996 RCRA Public Involvement Manual also includes the following appendices:

- Appendix E - Guidance for Community Advisory Groups at Superfund Sites
- Appendix F - Public Participation Regulations in 40 CFR Part 25
- Appendix G - Public Participation Regulations in 40 CFR Part 124 Subpart A
- Appendix J - Hazardous Waste Facility Permitting Process Fact Sheet (1996)
- Appendix K - RCRA Expanded Public Participation Final Ruleand Brochure (December 11, 1995)
- Appendix R - Accessing EPA Information (which includes two documents):
  How to Access the RCRA Information Center; and
  Environmental Fact Sheet -- Electronic Resources Guide.

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Catherine McCrakken, Region 9	Community Relations US EPA Region 9 SFD-3 75 Hawthorne Street San Francisco, CA 94015	ofc 415/744-2184 fax 415/744-1796
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EPA

Community Advisory Groups (CAGs) at Superfund Sites

Office of Emergency and Remedial Response
Community Involvement and Outreach Center (5204G)

Quick Reference Fact Sheet

The United States Environmental Protection Agency (EPA) is committed to early, direct, and meaningful public involvement in the Superfund process. One of the ways communities can participate in site cleanup decisions is by forming a Community Advisory Group (CAG). A CAG is made up of representatives of diverse community interests. Its purpose is to provide a public forum for community members to present and discuss their needs and concerns related to the Superfund decision-making process. EPA's *Guidance for Community Advisory Groups at Superfund Sites* (OSWER Directive 9230.0-28) was issued in December 1995 for Community Involvement Coordinators (CICs) and Site Managers to encourage the use of CAGs and to promote a better understanding of CAGs at Superfund sites. This fact sheet summarizes the main points in the guidance.

CAG Scope of Authority

A CAG can help EPA and the public make better decisions on how to clean up a site. It offers EPA a unique opportunity to hear—and seriously consider—community preferences for site cleanup and remediation. The existence of a CAG does not eliminate the need for the Agency to keep the community informed about plans and decisions throughout the Superfund process.

Determining the Need for a CAG

The impetus for establishing a CAG should come from the community, and CAGs may not be appropriate for every site. CAGs may be beneficial at removal sites, particularly non-time-critical removal sites, as well as sites involved in long-term cleanups, and they can be formed at any point in the cleanup process. The earlier a CAG is formed, however, the more its members can participate in and affect site activities and cleanup decisions. EPA may assist communities in determining the need for a CAG by helping them evaluate the level of community interest in site activities and examine if there is an existing broad-based group that might function as a CAG, or if there are too many competing interests to make forming a truly representative CAG a realistic option.

Preparing To Form a CAG

A CAG information meeting can be used to introduce the CAG concept to the community. In advance of this meeting, EPA, in conjunction with appropriate State, Tribal, or local governments, should inform and educate the community about the purposes of a CAG and the opportunities for participating in it. This is especially important at sites where there has been relatively limited community participation in the Superfund process.

Because every site is different, techniques appropriate for educating the public about CAGs will vary from site to site. No matter what methods are used, the information provided must be understandable to the community. In many cases, news releases, fact sheets, and public notices in the local news media may be useful for disseminating information about CAGs. Other outreach options—such as flyers, announcements in churches, and personal contacts with community groups or individual citizens—also may be used.

CAG Information Meeting

EPA may sponsor the CAG Information Meeting and, in consultation with the appropriate State/Tribal/local governments, should schedule it as early as possible in the cleanup process. The meeting should be held in a central, accessible location and at a convenient time for community members. The agenda for the meeting should reflect important community concerns raised in relation to the Superfund response. The agenda also may include discussions about the purpose and mission of the CAG, the process and timetable for selecting members, member responsibilities, CAG Operating Procedures, the status of site cleanup plans, and the interface between the CAG and other EPA community involvement activities.

CAG Startup

Although the interval will vary from site to site, EPA should encourage CAGs to be in full operation within six months after the CAG Information Meeting in order to maximize their effectiveness in the Superfund decision-making process. In the interim, the Agency can assist the community in determining the appropriate size and composition of the CAG, soliciting nominees, and selecting CAG members.

Size of the CAG

The size of a CAG will depend on the needs of the affected community. While it often is difficult to ensure that everyone has an opportunity to participate and to achieve closure in large groups, the CAG should include enough members to adequately reflect the diversity of community interests regarding site cleanup and reuse. Typically CAGs have approximately 15-20 members.

CAG Composition

To the extent possible, membership in the CAG should reflect the composition of the community near the site and the diversity of racial, ethnic, and economic interests in the community. At least half of the CAG members should be members of the local community. CAG members should be drawn from among residents and owners of residential property near the site; others who may be directly affected by site releases; Native American tribes and communities; minority and low-income groups; local environmental or public interest groups; local government units; local labor representatives; and local businesses. If an EPA Technical Assistance Grant (TAG) has been awarded for the site, EPA should encourage that a representative of the TAG group also be included on the CAG to facilitate information sharing between the two groups. Facility owners and other PRPs also may be included, but the community may choose to limit the number or designate them as *ex officio* members.

CAG Member Solicitation

EPA may begin to advise the community about opportunities for CAG membership as part of outreach efforts (the CAG fact sheet and any public notices and news releases) prior to the CAG Information Meeting. The information also should be made available through the local information repositories and posted at information kiosks and community centers. It may be necessary to focus solicitations for specific groups. For example, the EPA could send a letter to selected groups representing diverse interests.

CAG Member Selection

CAG members may be selected in a number of ways. For example:

- In some cases, CAGs may be self-selecting. That is, individuals who believe they represent the diverse interests of their community could nominate themselves.

- An existing group in the community—such as a group with a history of involvement at the Superfund site—could be selected as the CAG for that community if it represents diverse interests.
- The local government could select, in a fair and open manner, members of the community to serve on the CAG.
- EPA, with State/Tribal/local governments, could assist the community in organizing a Screening Panel to review nominations for CAG membership. EPA could review (not approve/disapprove) the Panel's list of nominees and offer advice, as needed, to ensure all community interests are represented.
- EPA, with the appropriate State/Tribal/local governments, could select a Core Group that represents the diverse interests of the community. Members of this Core Group then could select the remaining members of the CAG in a fair and open manner.

Because each community is unique, selection methods will vary; a formal process may not be necessary in every case. The key is to ensure that the CAG will be fully representative of the community and will be able to function effectively as a group.

CAG Member Training

Many of those selected as members of the CAG may require some initial training to enable them to perform their duties. EPA may work with State/Tribal agencies, local government(s), local universities, PRP(s), and others to provide training, prepare briefing materials, and conduct site tours for new CAG members.

Roles and Responsibilities

Generally, CAG members should be expected to participate in CAG meetings, provide data and information to EPA on site issues, and share information with their fellow community members. They must be prepared to fairly and honestly represent not only their own personal views but also those of the community members they represent.

CAG members may select a Chairperson from within their ranks and determine an appropriate term of office. The primary functions of the CAG Chairperson are to conduct CAG meetings in a manner that encourages open and constructive participation by all members; to ensure that all pertinent community concerns are raised for consideration and discussion; and to attempt, whenever possible, to achieve consensus among CAG members.

EPA, as the lead Superfund Agency, should provide the CAG with information and technical expertise on site cleanup and facilitate discussion of issues and concerns relative to Superfund actions. The Agency should listen and respond to views expressed by CAG members, giving them substantial consideration when making site decisions, especially when views are those of most or all CAG members. Even though they are not CAG members, EPA's Site Manager and CIC should attend CAG meetings on a consistent basis to demonstrate the Agency's commitment to meaningful public participation in the cleanup process. Representatives of other pertinent Federal agencies, and State/Tribal/local governments also should attend CAG meetings regularly and serve as information resources for the CAG.

CAG Operation

Each CAG should develop a Mission Statement describing the CAG's specific purpose, scope, goals, and objectives. Each CAG also should develop a set of procedures to guide day-to-day operations. These procedures should address such topics as how to fill membership vacancies; how often to hold meetings; and the process for reviewing and commenting on documents and other materials.

CAG Meetings

CAG meetings should be open to the public. The meetings should be announced publicly (via display ads in newspapers, flyers, etc.) well enough in advance to encourage maximum participation of CAG and community members. CAG members should determine the frequency and location of CAG meetings based on the needs at their particular site. The format for CAG meetings may vary depending on the needs of the CAG. A basic meeting format might include an update on site status by the project's technical staff; discussion of current issues; a question/answer session that includes audience participation; review of "action items," and discussion of the next meeting's agenda.

CAG Response to Requests for Comments

EPA should consider making all documents available to the CAG for the same length of time as it does for State/Tribal and peer review groups. EPA should explain, however, that the comment period for some documents may have to be less than 30 days. In those cases, the CAG should be ready to complete its review and provide comments in the shorter time period. The Agency may have the opportunity to respond to many CAG comments on key documents and other issues during CAG meeting discussions, but, unless otherwise stated, these responses should not be considered part of the formal Agency "Response to Comments" (as required under CERCLA and the NCP).

Administrative Support for the CAG

EPA, together with State/Tribal/local government(s), local universities, the PRP(s), and others, may assist the CAG with administrative support on issues relevant to the Superfund site cleanup and decision-making process. This may include support for arranging and documenting meetings, preparing and distributing meeting notices and agendas, duplicating site-related documents for CAG review, maintaining CAG mailing/distribution lists, and providing translation and meeting facilitation services when needed. If meeting facilitation is needed, it is preferable to use someone from the community with facilitation experience or a professional meeting facilitator. A neutral facilitator is particularly effective at sites where some controversy is anticipated.

Additional CAG Information Resources

Additional information about CAGs is available in the *Guidance for Community Advisory Groups at Superfund Sites* (OSWER Directive 9230.0-28). Case studies of CAGs at sites in five Regions also are available. For information, please call the Superfund Information Hotline at 800-535-0202 or to place an order, fax your request to the Superfund Document Center at 703-603-9240.

Public Availabilities/Poster Sessions

Description

See Public Meetings, Tab II-24

Poster sessions and public availabilities are less structured alternatives to ***Public Meetings***. These informal forums are preferred in situations where ***Public Meetings*** are not required. Poster sessions are a refinement of public availabilities in that "posters" are prominently displayed by an expert who is at that location to discuss the topic specified in the poster.

Poster sessions/public availabilities serve many purposes:

- They are an opportunity for getting feedback and for uncovering issues about the site that are not fully understood by the community.
- They present a great deal of detailed information on multiple topics in a short time period.
- They break down complex concepts into understandable terms.
- They allow the site team to clarify any previous misunderstandings.
- They allow individual community members to easily locate and inquire about the issues that most concern them without having to attend an entire ***Public Meeting.***
- They afford the opportunity for less outspoken citizens to be heard individually.
- They allow residents to speak freely with EPA personnel on a one-on-one basis.
- They help citizens speak with you and get to know you and other members of the site team as caring, listening people who are willing to talk about their concerns.
- They focus on the material at hand, not on emotions, and minimize grandstanding.

Required Activity?

No.

Making it Work

When to Use

Use public availabilities/poster sessions when you have a great deal of compartmentalized information to present in detail. They also are good for covering special topics that are generating, or are likely to generate, concern among residents. For example, if local drinking water is affected by the site, have information available on how and why local water is affected, what types of actions EPA is considering, or taking, and how residents can help protect themselves.

This tool is useful for periodic updates and continued contact with the community. This shows that the site team will provide site information throughout the process, not just when required by law.

When preparing for the Proposed Plan ***Public Meeting***, it is advantageous to have a poster session/public availability shortly after the plan is released and before the ***Public Meeting***. The site team can use the citizens' questions to develop the Proposed Plan ***Public Meeting*** agenda. You may circumvent a potentially heated situation at the ***Public Meeting*** by knowing and understanding the community's concerns and questions before the Proposed Plan ***Public Meeting*** is held. You can have a court recorder to take citizen comments.

Public Availabilities/Poster Sessions

Public availability/poster sessions are commonly used in the early stages of the Remedial Investigation and Feasibility Study (RI/FS) process. This puts people at ease by answering any questions they have about what will be done at the site, what contaminants have been found, and what steps EPA is taking to protect safety. This also allows the community a chance to develop confidence in EPA's decisions about the site's cleanup activities.

It is wise to schedule a public availability/poster session before deletion of a site from the NPL. This final session would be for the public's benefit. It would bring closure for the residents and provide the last opportunity for citizens to question what EPA has accomplished for them. The residents can be assured that all the necessary cleanup activities have been completed, and that EPA cared enough to clarify any final questions.

Generally speaking, all poster sessions/public availabilities should be held during hours that are convenient for community members. Generally, these events work best when you provide access during both day and evening hours, such as between 2:00 PM and 5:00 PM and then again between 7:00 PM and 9:00 PM. Depending on your community, Saturday afternoons may be a good alternative.

Do not use this tool to make a major or controversial announcement. It is usually hard for residents to appreciate any answers from the site team when they feel that a bad news "bomb" was just dropped on them. In this case, the event may deteriorate into a verbal attack against you.

Ensure that the site team is in complete agreement about what information will be distributed. Everyone on the team must know EPA's direction. They must have the same information, the same explanations, and be in agreement about what they will say and use.

Ensure that the site team or regional management is ready to accept and seriously consider community concerns. Offering residents the opportunity to express their concerns and comments implies that EPA will take what they say into consideration.

Avoid using this tool at certain times of the year. Residents are less likely to attend site activities, such as: major national holidays like Martin Luther King Day, Memorial Day, 4th of July, Labor Day, Election Day, President's Day, and any other three day holiday weekends; between Thanksgiving and New Year's Day, especially Thanksgiving week and Christmas week; Easter Week, Passover, and other major religious holidays; and any extended school breaks, where parents may take a vacation with their children. Avoid the week of April 15. Do not compete with local special events. Many communities have traditional events or festivals during which they are not interested in other activities. Whatever you do, however, do not compete with them. Know when important weekly community events are and schedule around them. Also, consider vacation periods, such as the yearly period when the largest employer traditionally closes shop.

Do not use this tool as the first communication effort. Poster sessions/public availabilities may not be the best tool to initially inform the community about any topic regarding the site. These forums are generally used for answering questions regarding information that has already been disseminated.

How to Use

To design an effective Poster Session/Public Availability, there are four planning stages:

- Set-up
- Content and format

- Response to questions; and
- Follow-up

You will find several attachments at the end of this tab, including an overall planning checklist, to help you through each of these stages; but here are some basic guides. First, know why you are holding the session and what your message is. Decide: Poster Session or an Availability? Decide time and place.

The facility must meet the requirements of the Americans with Disabilities Act (ADA). For requirements, visit the Center for Independence (CFI) ***Internet*** site: *http:// www.gj.net/~cfi/ index.html*. The site includes weekly updates and information about making your public space accessible: For a free copy of the ADA Guide for Small Businesses, published by the U.S. Department of Justice, call CFI at (970) 241-0315. Provide ample notice. Decide on topics to cover. Schedule a knowledgeable expert to discuss each topic. Ensure the experts are prepared. Hold a dress rehearsal. On the day of the event, arrive early to greet the citizens. Ensure that questions are answered on a one-on-one basis. Meet with the team to discuss lessons learned. Keep a list of, and follow through on your promises.

See Internet, Tab III-B

Tips

- Do not provide inconsistent information to the public.
- Clearly label topics on posters.
- Listen; if you hear the same comments, you might need additional outreach.
- Take every opportunity to make your points. The one thing most people care about is their safety. Practically every conversation will afford the opportunity to address that point.
- Include children as a target audience.
- Do not confine your locations to meeting rooms; consider an area on the site.
- Be sensitive to attempts, whether conscious or otherwise, to monopolize a site team member's time, leaving other citizens impatient for their turn.
- Take advantage of any local call-in radio shows.

Related Tools/Resources in the Toolkit

- Public Meetings, See Tab II-24
- Local Resources, See Tab III-F
- Frequently Asked Questions/Referrals, See Tab III-D
- Exhibits, See Tab II-11
- Informal Activities, See Tab II-15
- Presentations, See Tab II-21

Attached Items Within this Tool

- Attachment 1: Variations on a Theme
- Attachment 2: Poster Session/Public Availability Planning
- Attachment 3: Poster Session/Public Availability Checklist

Attachment 1: Variations On A Theme

- Do something for the children:
  - Hold a poster contest for kids at the event, or for a single school.
  - Include a topic just for kids, like a kids corner.
  - Have an entire event for children, or for a specific school, and hold the event at the school.
- Consider having stamps at each topic area, and a card for citizens to have stamped for each topic area attended. You can have a drawing to win a prize for those who received all available stamps (this also helps you update your mailing list).
- Try to have some "hands on" demonstrations that citizens can do themselves.
- Have a video showing work at the site. Include pictures of workers in protective gear and a few near-by workers in regular clothes.
- Approach an appropriate store or mall to sponsor a small Poster Session/Public Availability or, at least, to allow you to set up a table in a conspicuous spot.
- If the community is having an annual event that is "fair-like" in concept, ask if you may have a booth or table. This allows you to accomplish your goal with only a minimum of work. Check the community calendars of the hospitals, police departments, fire departments, and civic and service clubs for upcoming community events. This gives you the opportunity to participate in the event, attend the event or, at the very least, avoid schedule conflicts.

Attachment 2: Poster Session/Public Availability Planning

Planning - Event Content and Format

- Use the Checklist at the end of this tab to ensure that you have done everything possible to make the event go smoothly.
- Know why you are holding the session and what message you wish to convey. Decide if a Poster Session or a Public Availability will accomplish your purpose.
- Check with your community contacts to determine the best time for your activity.
- Check your Community Involvement Plan for preferred locations.
- Give at least two weeks notice, preferably three. Do not rely solely on the obvious ad in the local paper or fact sheet to inform community members. Do something more to grab their attention, such as placing door hangers at their homes (do not use mail boxes for anything other than mail), or handing out flyers in the local supermarket and schools. Use community bulletin boards on radio and TV stations.
- Clearly identify what topics will be covered and who will discuss each topic. The key to holding a successful Poster Session/Public Availability is to have individuals available who can speak knowledgeably about each topic to be covered. If you try to have one person cover too many topics, or do not have someone available who can address questions and concerns about a certain aspect of site activities, it will frustrate or anger those who attend the session. If the session is to have a limited scope, be sure to include that information in your announcements.
- Prepare a list of most-likely questions on each topic covered in the poster session. Take some time to review the last few activities and announcements you issued. Check recent issues of local papers for letters to the editor or editorials that could give insight into community concerns or issues. Help the team prepare appropriate answers.
- Conduct a rehearsal or dry run to make sure all site team members are responding to the potential questions in a uniform manner. Have someone play the role of your average citizen and ask the questions. They should make sure their question is answered directly, and that the team member is not going off on a tangent about another point. You also should listen to ensure that all answers are stated in plain English.

Pl···ing - Event Logistics

- Arrive before the citizens, so you can welcome them. Allow yourself enough lead time in case you need to rearrange the room or take care of other last minute situations that invariably arise. Have two sign-in sheets at the door; one sheet that the guests will initial for an attendance count, and another list for them to complete if they wish to be put on a confidential mailing list for information about the site. Depending on which method that you choose, you should either give name tags to the representatives, or have nameplates on the tables to identify the team members and their function.
- Design the room lay out to best suit your needs. Take time to think about the best way to line up the team members, in order to make a logical progression through the topics covered as guests move through the room. You could:
- Have the team members seated at tables, with a poster designating the topic covered by each team member hanging on the wall behind that member, and two or three chairs in front of each table for residents to sit in while talking;
- Have the team seated all at one table in a logical order, with posters (tent signs on the table) clearly indicating which topic each team member will discuss;
- Have the team members addressing different topics standing in different areas of the room, again with topic areas clearly marked for anyone who approaches;
- Be the guide or greeter who directs the citizens to the appropriate team member located throughout the room;
- Place a flip chart at the entrance of the room that can be used as a guide. It should identify team members present,

their specialty, and where they can be found. Consider having a stack of maps identifying the location of the topics throughout the room. Place them at the entrance, or by the sign in sheets. Be sure to give a few to all team members.

- Familiarize yourself with the facility. Know the locations of lighting system/switches, water fountains, rest rooms, telephones and controls for the sound and ventilation systems, and locate all exits.
- Use effective visual aids. If you are presenting complex technical information, such as different components of a cleanup plan, take advantage of diagrams and maps to help explain what will be done, when, and where. Remember, people usually understand technical information more easily if they can see it, rather than hear or read about it.
- Enlist someone to record important comments, concerns, and suggestions for each topic area covered. This is optional, but it could supply extremely useful information for the EPA. It would also show the community that you care and are seriously interested in their thoughts. At least give every team member a pen and some paper for their use.
- Be open and responsive to all questions posed to you. Answer those nontechnical questions that you can, but remember to refer technical questions to the appropriate site team expert. If no one present has the proper answer to a question, record the person's name, address, phone number, and question and promise to get back to them with an answer; then be sure that you do.
- Have literature or fact sheets available, either at the entrance or with the individual site team members. This serves three purposes: First, it will help the community to better understand the latest happenings, enabling them to ask questions about what they do not already know or comprehend. Second, it gives people something to read if they need to wait to speak to the site team member. And third, it gives people written information to take with them for reinforcement purposes. This is especially helpful if a perception of distrust is brewing.
- Have data and facts to back up your answers. Each site team member should gather information and facts pertaining to their area of expertise so that they can physically present findings/results to the citizens to support their verbal answers.
- Maintain the one-on-one format. Make every effort to answer the questions on an individual basis so that citizens feel the "personal touch" of this activity. If you are the greeter or guide at the door, take a few minutes to explain the concept to the people as you welcome them.
- Above all else, smile, be friendly, appear open, and have empathy for your guests. One goal of this activity is to foster trust and confidence between the community and EPA; nothing goes further than a genuine smile and a truly interested ear!!!

Planning - The Questions

Go over this basic information with each individual handling a topic area.

- Repeat or rephrase the question before answering. Often, we think we hear and comprehend a question, but it is very possible that you have misinterpreted the question. Restating the question in your own words gives you time to formulate a response while ensuring that you are responding to the right question. It is acceptable to pause and think before responding, it shows that you care about the question and your reply.
- ATQ — Answer the question that was asked at the most basic level; avoid the temptation to go off onto tangents, no matter how relevant they seem to you. Let the citizen set the direction of the session and move you into more technical areas. A too detailed answer may confuse or intimidate the person. However, always be alert for opportunities to make key points on which the site team agreed.
- Remember that every question is a valuable one. Citizens are coming to you for information. Make them feel that their questions are important. Answer them with respect and in terms they can understand. Be prepared to answer the same question several times.
- Be aware of the terminology you use when answering questions; if you have to, constantly remind yourself and the rest of the team members to answer in plain English and simple terms. Of course, use your judgement; if you are dealing with someone who seems to have a firm technical grip on the situation, speak with them on an appropriate level to avoid appearing condescending.

- Never answer in a defensive manner, become argumentative, or enter into a debate. No matter how hostile or agitated a citizen may be or become, always maintain your composure. Answer questions calmly and kindly, then move on to the next person.
- Try to avoid giving an opinion; stick with the facts, do not make editorial statements. Your opinion will be construed as being EPA's position. If they ask for your personal opinion, stick with the party line that EPA has established for that topic.
- Listen - every question is an opportunity for you to gain a greater understanding of your site community. You can uncover the community's concerns, needs, suggestions, desires, and even things to be wary of in the future regarding your site.

The Follow up

- Soon after the session, team members should gather to analyze their effectiveness. The team can discuss what they felt was particularly effective, what could be improved upon, and discuss suggestions obtained from community members at the session.
- Follow up on any promises made to citizens. Send out all information that you promised, and compose a new mailing list including any additional community members who indicated this desire.

Attachment 3: Poster Session/Public Availability Checklist

Site: _____

MEETING PREPARATION

___ Meeting Date & Time
___ Meeting Location
Rental Rate _____
___ Seating Capacity _____
Name _____
Phone # _____
___ # of People Expected
___ Someone to Record Comments (record for each topic covered)
Yes ___ No___
Staff or Contractors Name _____
___ Translator Needed
Yes ___ No___
Name _____
Contacted/Confirmed ___
Rate _____
___ Panel Members Who Will Participate
___ Directions Distributed
___ Basic Info. for the Event Given to Facility
___ Point of Contact for Facility Arrangements
___ RPM
___ Tox
___ Hydro
___ State
___ Local Officials
___ Others
___ Prepare Meeting Evaluation Forms
___ Prepare Visual Presentation Materials
___ Set Dry Run Date and Location
Date _____ Time _____
Location _____
___ Conduct Dry Run
___ Establish Ground Rules
___ Last Minute Review and Pep Talk for the Team

ANNOUNCEMENT

___ Call All Key Community Contacts
___ Print Set of Mailing Labels
___ Prepare and Distribute Fact Sheet
___ Prepare Press Release
Release Date: _____
___ Send Materials to Information Repositories

AUDIO-VISUAL EQUIPMENT

___ Slide Presentation/Projector
___ Overhead Transparencies/Projector
___ Videotape Presentation/Television Set
___ Film Presentation/Projector Decor
___ Projection Screen
___ Microphones (stationary &/or remote)
___ Cassette Recorder/Tapes/Batteries
___ Press Hookup (for radio & TV mics)
___ 35mm Camera/Flash/Film
___ Video Camera/Tape
___ Extension Cord
___ 3-Prong Electric Adaptor (several)
___ Pointer for Projection Screen
___ Extra Bulb for Projectors

ROOM ARRANGEMENTS

___ Room Layout _____
___ Meets ADA standards
___ Room Setup
___ Tables ___ Chairs Is There a Cost?___
Who Does it? You ___ Them___
___ Time Available _____
___ Set-Up Time _____
___ Must Vacate by Time _____
___ Security (meet prior to & day of)
___ Janitorial Services
___ Restrooms Open
___ Ventilation
___ First Aid Supplies
___ Return Room to Original Condition
Who Does it? You___ Them ___
___Telephone Access in Case of Emergency

BASIC SUPPLIES

___ Name Plates/Name Tags
___ Directional Signs
___ Evaluation Form
___ Copies of Most Recent Fact Sheets (and other handouts)
___ 3" x 5" Index Cards
___ Pens/Pencils
___ Markers
___ Easel/Flip chart
___ Poster Paper
___ Pad of Blank Paper (for each site team member, and extras)
___ Masking Tape
___ Scissors
___ Business Cards
___ Plastic Drinking Cups ~ Pitcher
___ One Yard of Strong Cord
___ Stapler

MEETING FOLLOW-UP

___ Return Equipment
___ Debriefing Among Meeting Participants
___ Respond to Requests for Information
___ Prepare/Distribute Meeting Summary
___ Prepare Meeting Evaluation
___ Prepare and Distribute Recommendations for Future Sessions
___ Add Meeting Attendees to Mailing List
___ Send Names & Phone #s to GPRA Contractor

Description

EPA's Alternative Dispute Resolution (ADR) program provides resources CICs can use in special situations to facilitate decision making and to mediate conflicts. ADR refers to a process that uses an objective third party or neutral party to assist in resolving disputes. ADR is primarily a component of EPA's enforcement program but is an option for CICs under certain circumstances.

ADR can help CICs promote meaningful community involvement by fostering collaborative decision making processes and mediating conflicts as they arise. CICs can consult with Regional ADR Specialists to discuss options for using neutral facilitation, mediation, or other dispute resolution tools at hazardous waste sites.

Required Activity?

No. Although the 1996 Administrative Dispute Resolution Act (5 U.S.C. 571-583) directs agencies to establish alternative dispute resolution programs, CICs are not required to use ADR.

Making it Work

When to Use

Mediation can be useful when disagreements seem unresolvable. Mediation is a process in which a third party, with no decision making authority, assists disputing parties to reach a negotiated settlement. An expert mediator or panel of mediators assists the disputing parities by helping them identify and discuss issues of mutual concern, explore solutions, and develop mutually acceptable settlements. The disputing parties are responsible for devising their own solutions to the conflict with the help of a structured process established by the mediator.

Neutral facilitation is appropriate:

- At contentious sites with numerous stakeholders
- Where there are environmental justice interests
- In high-conflict situations
- At sites with many competing interests
- Where there is mistrust among participants
- In situations in which leadership is not clear
- Where participants mistrust the government; and
- When EPA has or is perceived to have a vested interest in the results of the process

ADR is most useful when:

- Time is a major factor
- Multiple or complex issues need to be resolved
- Failure to agree does not clearly benefit one party
- Tensions, emotions, or transaction costs are running high

- Communications between the parties have broken down; and
- Parties want or need to maintain some ongoing relationship

ADR is least useful when negotiations will substantively affect parties who are not present and cannot be represented. ADR also is not useful when there is a need to focus public attention or make an example of a "bad actor" or an emergency situation does not allow time for negotiation.

How to Use

CICs can consult with a Regional Alternative Dispute Resolution (ADR) Specialist for more information on the use of facilitation or other ADR techniques, and for assistance in obtaining a neutral or third-party.

A third-party neutral facilitator:

- Identifies stakeholders initially and throughout the process
- Maintains a level playing field for all participants
- Helps parties identify the issues that need to be discussed
- Helps clarify roles and purposes of the group
- Drafts procedural guidelines for group process
- Builds trust with parties through confidential pre-meeting and between-meeting interviews
- Breaks through impasses that develop because of technical complexity, political visibility, poor communication, personalities, or past history
- Summarizes and documents agreements to date
- Maintains the momentum of the process
- Coordinates and builds linkages among participants; and
- Ensures that all issues are addressed

In addition, Superfund Regional Ombudsmen or other staff in some regions act as Project Officers or Work Assignment Managers for a contract providing neutral facilitation, mediation, and conflict resolution services to support the community involvement program. Contact your Regional Ombudsman for more information.

Related Tools/Resources in the Toolkit

- Facilitation, See Tab II-12
- Contract Management, See Tab II-9
- Public Meetings, See Tab II-24
- Superfund Regional Ombudsman, See Tab III-J

Attached Items Within this Tool

- Attachment 1: ADR Specialists

Attachment 1: ADR Specialists

Office	Name	Phone	Fax
Region 1	Ellie Tonkin	(617) 565-1154	565-1141
	Marcia Larnel	565-3435	565-1141
	Bruce Marshall*	573-9686	573-9662
Region 2	Tom Lieber	(212) 637-3158	637-4417
	Janet Feldstein*	637-3115	637-4429
Region 3	Pat Hilsinger	(215) 566-2642	566-3151
	Kathy Hodgkiss*	566-2603	566-3005
Region 4	Charles Mikalian	(404) 562-9575	562-8890
	Ray Strickland*	562-9487	562-8842
Region 5	John Tielsch	(312) 353-7447	886-4752
	Doug Ballotti	353-3906	886-7160
Region 6	Jim Dahl	(214) 665-2151	665-2182
	Carl Bolden*	665-6713	665-6660
	Arnie Ondarza	665-6790	665-6660
Region 7	Cheryle Micinski	(913) 551-7274	551-7925
	Phil Page	551-7580	551-7925
Region 8	Maureen O'Reilly*	(303) 312-6402	312-6409
	Kevin Kellen	312-6518	312-6953
	Carl Castillo	312-7054	312-6953
Region 9	Shauna Woods	(415) 744-1360	744-1041
	Kim Muratore*	744-2373	744-1917
	Marie Rongone	744-1313	744-1041
Region 10	Ted Yackulic*	(206) 553-1219	553-0163

** denotes Waste Management or Hazardous Waste Division/All others ORC*

Headquarters

ADR Liaison	**David Batson**	(202) 564-5103	564-0093
ADR Coordinator	Lee Scharf	564-5143	564-0091
Resolve Contract	Debbie Dalton	260-5495	260-5478

** denotes Waste Management or Hazardous Waste Division/All others ORC*

Risk Communication

Description

Risk communication is the process of informing people about the hazards of a Superfund site. The purpose of risk communication is to help residents of affected communities to: understand risk assessment and risk management; form scientifically valid perceptions of the likely hazards; and participate in making decisions about how risk should be managed.

The process of informing people about site hazards is a two-way conversation in which the site team informs and is informed by affected community members. This means that the site team must listen to community fears and identify knowledge gaps and desired cleanup strategies. This tool contains techniques for effectively communicating risk to the public.

Required Activity?

No. Although the specific communication techniques contained in this tool are merely suggested, the general process of risk communication can be construed as implied by the NCP. For removal actions, the NCP [at 40 CFR § 300.415(n)(1)] requires that a spokesperson be designated by the lead agency to inform the community of actions taken, respond to inquiries, and provide information concerning the release. For remedial actions, the NCP [at 40 CFR § 300.430(c)(2)(C)] requires that the lead agency provide appropriate opportunities for the community to learn about the site.

Making it Work

When to Use

Risk communication is an ongoing dialogue, the timing of which varies with the situation and should be coordinated with the On-Scene Coordinator (OSC) or Remedial Program Manager (RPM). While CICs do not have total responsibility for risk communication, CICs should be involved in risk communication during all phases of site cleanup. For instance, they could be involved at the site assessment stage asking residents to allow EPA to test their water; at the remedy selection stage helping people understand the technical aspects of the cleanup options; or at construction completion speaking about the future of the site and how the community can return it to productive use. All of these instances require skilled risk communication and a sincere willingness to involve the affected community with decision making about the site.

How to Use

EPA policy encourages maximum community involvement in risk communication because people are entitled to make decisions about issues that directly affect them. Furthermore, experience has shown that greater community involvement leads to greater understanding of the real level of hazard at the site, and greater input from citizens in EPA decision making. The resulting cooperation among all stakeholders increases the credibility of the entire endeavor.

Analyze the audience. One of the most critical components of risk communication is analyzing the audience and the situation. This analysis helps you to understand: (1) what people want to know; (2) what needs to be delivered to ensure they understand and participate; (3) what the best tools are with which to communicate; and (4) what can realistically be done within the constraints of the situations.

Earn trust and establish credibility. Trust and credibility are difficult to obtain and precious to keep. Once lost, they are extremely difficult to regain. For these reasons, the CIC must work carefully and with great sensitivity to win the community's confidence. A credible

Seven Cardinal Rules of Risk Communication

1. **Accept and involve the public as a legitimate partner.** The goal is to produce an informed public, not to defuse public concerns.
2. **Plan carefully and evaluate your efforts.** Different goals, audiences, and media require different actions. Analyze the audience; learn what works for each situation.
3. **Listen to the public's specific concerns.** People often care as much about credibility, competence, and empathy as they do about risk levels, statistics, and details.
4. **Be honest, frank, and open.** Trust and credibility are difficult to obtain; once lost they are almost impossible to regain.
5. **Coordinate and collaborate with other credible sources.** Conflicts among organizations makes communication with the public more difficult.
6. **Meet the needs of the *Media*.** The *Media* are usually more interested in simplicity than complexity, danger than safety. Make sure they have what they need to portray the situation fairly.
7. **Speak clearly and with compassion.** Never let your efforts prevent acknowledgment of the tragedy of an illness, injury, or death.

See Media, Tab II-19

person is accurate, keeps promises, and makes sure others do the same. To build such a reputation, the CIC must first listen.

Second, the CIC must react honestly. Where they exist, admit to mistakes and past problems. Let people know EPA is trying to do better with community involvement, and acknowledge how difficult it is for experts to remember that other people need more background information.

Third, the CIC must be patient and compassionate. The CIC needs to imagine the anxiety and trepidation he/she might feel under a similar unknown threat. Impatience can be moderated by remembering that every new audience is hearing this information for the first time, and that many people must hear it more than once.

Fourth, the CIC must consider appearance and dress. CICs should project a neat and professional appearance, while remaining approachable and somewhat similar to the audience.

Fifth, the CIC must get rid of barriers like the podium and the microphone, go into the crowd, and shake hands. It may be helpful to rehearse with a video camera to keep body language and mannerisms positive.

Sixth, the CIC must help colleagues communicate. The CIC should translate over-technical terminology for audiences.

Some examples of how the CIC can earn trust and credibility are: (1) return telephone calls or e-mails within 24 hours (if an answer to the question is not ready, explain what is being done to investigate and when an answer will be ready); (2) at meetings, let the audience know that they are being understood (Repeat questions after they are asked to clarify the intent. Make a list of action items to follow up on as a result of the meeting, as well as any questions that still need to be answered.); (3) explain how information was obtained and

where the community can go for a "second opinion," or to find out more information on their own.

Identify previous community involvement activities. A myriad of scenarios can exist as a result of previous community involvement and risk communication efforts at a site. Evaluating this factor is even more pertinent if the CIC is not entering the process at the outset. If this is the case, it will be necessary to determine not only the level of trust and credibility, good or bad, that others had established with the community, but also the types of activity and involvement that have occurred. The following questions will help the CIC collect initial background information that will help shape the risk message(s):

- **Who are allies?** No matter where the site is in the cleanup process, the CIC should first review the ***Community Involvement Plan*** and then meet with the RPM/OSC and people from other government agencies to discuss events that occurred up until the time of the CIC's involvement, the current situation, and roles and responsibilities. If a meeting is not feasible, the CIC should speak to everyone individually.

See Community Involvement Plans Tab II-6

- **Who are the audiences?** Identify those around or near the site with whom no risk communication has yet occurred. Identify what they want to know, how they view the risks from the site, and what has been the level of local involvement.
- **What is the current situation?** After establishing what has been communicated to whom, assess the results and how the public's perceptions have been affected. What were the communities' responses to any communication efforts that took place? How did the media report on the situation? Did any organized citizen groups form? Then, using the information collected, classify the situation. Has there been good communication but a hostile audience, no communication and an apathetic audience, good communication and an interactive audience?

Incorporate risk communication into your *Communication Strategy*. A large part of developing a successful risk communication strategy involves setting realistic goals and measures of success. Risk communication goals will be influenced by those activities that are

See Communication Strategies, Tab II-2

Potential Risk Communication Limitations

Regulatory requirements—Comply, at a minimum, with CERCLA public participation requirements for Superfund sites. Other laws such as the National Environmental Policy Act (NEPA) may apply as well. (See pipeline timeline foldout at end of Handbook for required and recommended activities.)

Organizational requirements—These requirements can apply, for example, to the amount or type of data available to the public, especially if it relates to legal actions or proprietary information. Be careful not to release or promise to release information that is restricted.

Audience requirements—Sometimes certain audience characteristics may limit the manner chosen to communicate. For example, techniques for communicating with a transient population would differ from those used with a stable one.

mandated by applicable laws and regulations, and those that are unique to the specific situation. Be honest with people about the constraints the team faces, and they will be more willing

to accept those limitations. Promise no more than can be delivered. The box below provides examples of such constraints.

Keep the strategy simple; it should be a guide. Develop an overarching risk communication goal (*i.e.*, "achieve consensus on the remedy"), and then work to select the pipeline-specific interim messages that must be delivered to achieve that goal (*e.g.*, gaining permission to sample drinking water, distributing information on the health effects of the contaminants). Remember that the strategy should not remain static. It will evolve as the site progresses and should be revisited often and modified as necessary.

The first step is to determine the risk message. A risk message should contain no more than three to five points. If the message cannot be articulated that succinctly, then the message should be broken down into an overall message with several interim messages.

The next step is to determine how to deliver the message(s) to meet the goals. A basic template for developing the overall strategy is to follow the questions outlined in the Rutger's University Center for Environmental Communication document, "Ten Questions Environmental Managers Should Ask." The ten questions are summarized below:

1. Why are we communicating?
2. Who are our target audiences?
3. What do our audiences want to know?
4. What do we want to get across?
5. How will we communicate?
6. How will we listen?
7. How will we respond?
8. Who will carry out the plans? When?
9. What problems or barriers have we planned for?
10. Have we succeeded?

Explain the Superfund risk assessment process. The areas of risk science and management can help build a context for the community's understanding of Superfund risks. The Superfund risk assessment estimates the "baseline risks" to human health and the environment present at a site. Let the community know that the risk assessment is tailored. Because each site varies according to the particular contaminants present, each risk assessment is conducted on a site-by-site basis, and estimates the current and possible future risks or hazards if no action were taken at the site.

Put risk in perspective by presenting adequate background when explaining risk numbers. Here are some important considerations:

- **When explaining numbers derived from a risk assessment, explain the risk assessment process before presenting the numbers.** Consider holding a risk assessment workshop to explain the process before the risk assessment is started.
- **Explain and, if possible, show in clear and simple graphics the routes of exposure.** Frequently, the issue is not whether a dangerous substance exists in relatively high quantities, but whether routes of exposure put people at risk.

- **Put the data in perspective.** Avoid the tendency to see risks as "safe" or "dangerous." Instead, explain risk numbers in ranges: 1-10 ppb as "low risk," for example. Show the relationship to similar data and provide a context for reference, such as the regulatory action level and the levels found in other communities. People whose minds are not already made up are very much influenced by how the data are presented.
- **Explain EPA's protective approach to risk assessment and standard setting.** People are often not aware of the extent to which buffers are built into the risk assessments to ensure that they err on the side of caution. The Reasonable Maximum Exposure (RME) as the highest exposure that is reasonably expected to occur at a site needs to be explained to demonstrate the "conservative" nature of the assessment. This technique also helps ensure that the most sensitive, vulnerable individuals in society—children, pregnant and nursing women, immune compromised individuals, and the elderly—are protected.

An important aspect of communicating risk is acknowledging and explaining the inherent uncertainties associated with assessing actual site risks. Failure to do this may result in a loss of credibility with stakeholders.

Five steps are involved in defining or identifying audiences for hazardous waste risk messages:

1. Identify the most contentious or vocal concerns and profile the audiences involved with them.
2. Identify and profile other interested audiences.
3. Discover the informational needs of these audiences.
4. Find key risk communication partners.
5. Customize messages to audiences.

For most of the concerned public, the personal nature of risk issues and the inherent uncertainty associated with estimating risk can provoke considerable anxiety. Well-managed communication and presentation efforts will help ensure that risk messages are successfully formulated, communicated, and received, and that they result in meaningful actions.

You can best deliver the risk message by selecting appropriate communication tools, addressing communication barriers, and managing difficult situations. See Chapter 10 for a thorough discussion of selecting appropriate communication tools, addressing communication barriers and managing difficult situations.

This section of the Tool presents a discussion of three roles you will play to ensure quality risk communication and community involvement.

Site Team Coordinator

As Site Team Coordinator for risk communications you should work closely with all site and off-site staff to determine and present a unified Agency message about the risks to the community. Coordinating your risk communication efforts with the RPM and OSC will ensure you have the latest information about site activities and any related risk information. It also will enable you to choose those appropriate times when you can arrange for the RPM or OSC to communicate directly with citizens and when you can facilitate personal contact between a community member and someone on the site team.

Risk Translator

In your risk communication efforts, you also will serve in the role of Risk Translator. This role takes you off the site and into the neighborhoods and living rooms of your communities. Two qualities make you the ideal translator: you know about the risks presented by a site; and you are adept at "speaking the language" of risk. By explaining, sharing, conveying, and providing risk data, literature, sites activities, and other risk information, you will find yourself "translating" the technical information into understandable concepts for the public. As a translator, you also will need to take care to maintain the original meaning of the risks, so as not to simplify or downplay them. And you will assist the community in comparing risks and understanding uncertainty. If successful, your efforts will make you an ideal intermediary between the site staff and the community. Because you understand both the "hazard" learned as Site Team Coordinator and the "outrage" from your experiences as Community Involvement Liaison (described below), you will be able to help the community appropriately calibrate their level of outrage, which is the ultimate goal of risk communication.

Community Involvement Liaison

Your role as Community Involvement Liaison will involve you most directly in the community. You will balance your role as Site Team Coordinator (bringing information to the public) by obtaining feedback from the community and providing it to the site team. This role requires that you revisit all of the tools and resources at your disposal to serve the risk communication needs of each community. As liaison, you will meet with citizens individually whenever possible. You also will want to work with the ***Community Advisory Groups*** at your sites to ensure the inclusion and involvement of your most active community players and to help them find the resources they need to help you communicate risk in the community; these resources might include risk literature, site updates, and advice on applying for ***Technical Assistance Grants*** to hire risk specialists and consultants.

See Community Advisory Groups, Tab II-3; Technical Assistance for Communities, Tab II-32

Tips

- Plan all risk communication carefully by integrating the risk assessment and management activities with other community involvement activities.
- Coordinate your efforts with those of other site members, including the RPM and OSC.
- Make use of outside experts when appropriate, but continue to serve as the lead contact point for the communication of technical risk information.
- Remember that no other CIC arena is more important than seeing that citizens' fears, questions, and concerns are managed on their terms, not yours.
- Track your progress and evaluate your risk communication strengths and areas for improvement.

Related Tools/Resources in the Toolkit

- Communications Strategies, See Tab II-2
- Community Groups, See Tab II-3
- Community Interviews, See Tab II-4
- Community Involvement Plans, See Tab II-6
- Community Profiling, See Tab II-7

Risk Communication

- Community Visioning Process, See Tab II-8
- Electronic Mail, See Tab III-B
- Cross-Cultural Communications, See Tab II-10
- Exhibits, See Tab II-10
- Facilitation/ConflictResolution, See Tab II-12
- Fact Sheets, See Tab II-13
- Focus Groups, See Tab II-14
- Frequently Asked Questions/Referrals, See Tab III-D
- Hot Sites Template, See Tab III-E
- Information Repository, See Tab II-16
- Internet, See Tab III-B
- LandView, See Tab III-B
- Maps and Aerial Photographs, See Tab II-18
- Media, See Tab II-19
- On-Site Activities, See Tab II-20
- Presentations, See Tab II-21
- Public Availability/Poster Sessions, See Tab II-22
- Public Meetings, See Tab II-24
- Public Notices, See Tab II-25
- Resource Books, See Tab II-27
- Responsiveness Summaries, See Tab II-28
- Special Events, See Tab II-30
- Spokesperson, See Tab II-31
- Technical Assistance for Communities, See Tab II-32
- Telephone, See Tab II-33
- Translation Services, See Tab II-34
- Videos (How to Produce and Use), See Tab II-35 and III-L
- Workshops, See Tab II-36

Attached Items Within this Tool

- Attachment 1: Internet Resources for CICs
- Attachment 2: Internet Resources Available to the Public
- Attachment 3: Useful Terms and Definitions for Explaining Risk

Outside Sources of Information

- *Risk Assessment Evaluating the Effects of Toxic Substances. Hazardous Substance Research Centers.* Environmental Science and Technology Briefs for Citizens. Issue 01-97.

Attachment 1: Internet Resources for CICs

Articles by Peter Sandman

http://www.ch2m.com/ch2mhill/services/environ/Riskext/riskcom.htm

EPA's Seven Cardinal Rules of Risk Communication

http://rtk.net/E12397T748

Risk Communication

http://www.riskworld.com/nreports/1996/risk_rpt/html/nr6aa038.htm

Risk Communication Bibliography

http://excellent.com.utk.edu/~mmmiller/bib.html

Workshop Proceedings on Risk Communication

http://web.health.gov/environment/Casestudies/csapp3.htm

Case Study in Health Risk Communication

http://www.fplc.edu/risk/vol5/winter/trauth.htm

ATSDR—Evaluation Primer on Health Risk Communication Programs, Part 1

http://atsdr1.atsdr.cdc.gov:8080/HEC/evalp1.html

An Evaluation Primer on Health Risk Communication Programs and Outcomes

http://atsdr1.atsdr.cdc.gov:8080/HEC/evalprmr.html

A Primer on Health Risk Communication Principles and Practices

http://atsdr1.atsdr.cdc.gov:8080/HEC/primer.html

EPA's Comparative Risk Project

http://www.epa.gov/opperspd/pdffiles/pag5_6.pdf

Public Information on Risk Communication—Becoming Involved

http://rtk.net/E12396T748

Risk Communication: Notes from a class by Dr. Peter Sandman

http://www.owt.com/users/snowtao/risk.html

Attachment 2: Internet Resources Available to the Public

EPA Superfund Information

http://www.epa.gov/superfund

Risk Assessment for Toxic Air Pollutants: A Citizen's Guide http://www.epa.gov/oar/oaqps/air_risc/3_90_024.html

Integrated Risk Information System

http://www.epa.gov/iris/

Community Risk Assessment Tools

http://www.epa.gov/nceawww1/communit.htm

Risk Assessment as a Major Tool for EPA Policy Decisions

http://www.riskworld.com/Profsoci/sra/newsltrs/2ndqu95/ps5ae217.htm

Guidelines for Exposure Assessment

http://www.epa.gov/ncea/exposure.htm

http://www.epa.gov/nceawww1/exposure.htm

A Citizen's Guide to EPA's Superfund Program

http://www.epa.gov/reg3hwmd/super/sfguide.htm

http://www.epa.gov/superfund/oerr/today/risk.pdf

http://www.epa.gov/superfund/oerr/today/risk2.htm

Introduction to the RCRA, Superfund & EPCRA Hotline Program Areas

http://www.epa.gov/epaoswer/hotline/hotintro.htm

Attachment 3: Useful Terms and Definitions for Explaining Risk

The glossary is intended to assist readers in understanding terms used by the U.S. Environmental Protection Agency. The definitions are not all-encompassing and should not be construed as official EPA definitions.

Acute exposure: Exposure to one dose or multiple doses within a short time - 24 hours to a few days.

Acute Toxicity: A term used to describe immediate toxicity. Its former use was associated with toxic effects that were severe (e.g., mortality) in contrast to the term "subacute toxicity" which was associated with toxic effects that were less severe.

Adverse Health Effect: Any change resulting in anatomical, functional, or psychological impairment that may affect the performance of the whole organism.

Aquifer: An underground geological formation, or group of formations, containing usable amounts of groundwater that can supply wells and springs.

Asbestosis: Scarring of the lung from inhaling airborne asbestos fibers. This disease is often fatal.

Bioaccumulate: To build up a large amount of a substance in the body by ingesting small amounts over an extended period of time.

Carcinogen: Any substance that can cause or promote cancer.

Carcinogenesis: The origin or production of cancer (very likely a series of steps). The carcinogenic event so modifies the genome and/or other molecular control mechanisms in the target cell that they can give rise to a population of altered cells.

Chronic Exposure: Multiple exposures occurring over an extended period of time , or a significant fraction of the animal's or individual's lifetime.

Chronic Toxicity: A term used to describe delayed toxicity. However, the term "chronic toxicity" also refers to effects that persist over a long time, whether or not they occur immediately or are delayed.

Congenital: A condition existing from birth. Congenital conditions are acquired during development in the womb. They are not inherited from the parents.

Cohort Study: An epidemiologic (human) study that observes subjects in different exposed groups and compares the incidence of symptoms. Although ordinarily prospective in nature, such a study is sometimes carried out retrospectively, using historical data.

Cumulative Risk Assessment: A process that involves the consideration of the aggregate ecologic or health risk to a target organism caused by the accumulation of risk from multiple stressors (any physical, chemical, or biological entity that can induce an adverse response) and multiple pathways of exposure.

Developmental Toxicity: Adverse effects on the developing organism (including death, structural abnormality, altered

growth, or functional deficiency) resulting from exposure prior to conception (in either parent), during prenatal development, or postnatally up to the time of sexual maturation.

Dose: Administered dose is the mass of a substance given to an organism and in contact with an exchange boundary (e.g., gastrointestinal tract) per unit body weight, per unit time (e.g., mg/kg-day). Absorbed dose is the amount of a substance penetrating the exchange boundaries of an organism after contact.

Dose Response: How a biological organism's response to a toxic substance quantitatively shifts as its overall exposure to the substance changes (e.g., a small dose of carbon monoxide may cause drowsiness; a large dose can be fatal).

DNA (deoxyribonucleic acid): The carrier of genetic information in cells.

Ecology: The relationship of living things to one another and their environment, or the study of such relationships.

Endocrine Disruptors: Exogenous (outside the body) chemical agents that interfere with the production, release, transport, metabolism, binding, or elimination of the natural hormones in the body, which are responsible for the maintenance of homeostasis and regulation of developmental processes.

Enteric: Relating to the intestines, alimentary.

Exposure: Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., gut, skin, lungs) and available absorption.

Exposure Assessment: The determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure.

Ground Water: Water that moves slowly underground in an aquifer.

Hazardous Waste: Waste defined by the Resource Conservation and Recovery Act (RCA) as those that may cause, or significantly contribute to illness or death, or that may substantially threaten human health or the environment when not properly controlled.

Health Advisory: An estimate of acceptable drinking water exposure to a chemical substance based on health effects information. A Health Advisory is not a legally enforceable standard, but serves as technical guidance to assist federal, state, and local officials.

Incidence: The number of cases of a disease or occurrence of an effect within a specified period of time.

Integrated Pest Management (IPM): A mixture of chemical and other non-pesticide methods to control pests.

Malignant: Tending to become progressively worse and to result in death if not treated; having the properties of anaplasia, invasiveness, and metastasis.

Maximum Contaminant Level (MCL): Maximum permissible level of a contaminant delivered to any user of a public drinking water system. An MCL is an enforceable federal regulation.

Metastasis: The transfer of disease from one organ or part to another one not directly connected with it.

Mitigation: Measures taken to reduce adverse impacts on the environment.

Morbidity: Sickness.

Mortality: Death.

Particulate Matter: Airborne materials that can, depending on their size and composition, lodge in various areas of the respiratory tract.

Pathogens: Microorganisms that can cause disease in other organisms or in humans, animals, and plants (e.g., bacteria, viruses, or parasites) found in sewage, in runoff from farms or rural areas populated with domestic and wild animals, and in water used for swimming. Fish and shellfish contaminated by pathogens, or the contaminated water itself, can cause serious illness.

Restoration: Measures taken to return a site to pre-violation conditions.

Risk: A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

Risk Assessment: The determination of the kind and degree of hazard posed by a specific pollutant, and the present or potential health risk that exists due to that agent. Major steps may include:

- Hazard Identification: **Determines whether exposure to a substance can cause cancer, birth defects, or other adverse health effects.**
- Dose Response Assessment: **Determines the possible severity of adverse health effects at different levels of exposure.**
- Exposure Assessment: **Estimates the amount of contact individuals within a population—including potentially sensitive groups, such as children—could have with the substance.**
- Risk Characterization: **Combines the information in the first three steps to determine the level of potential risk to humans and the environment.**

Risk Management: The process of evaluating and selecting alternative regulatory and non-regulatory responses to risk. The selection process necessarily requires the consideration of legal, economic, and behavioral factors.

Smelter: A facility that melts or fuses ore, often with an accompanying chemical change, to separate its metal content. Emissions cause pollution. "Smelting" is the process involved.

Solvent: A liquid capable of dissolving a material and holding it in solution. For example, paint remover is a paint solvent.

Superfund: Federal authority, established by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, to respond directly to releases or threatened releases of hazardous substances that may endanger health or the environment.

Surface Water: Water at the surface of the earth, including lakes, rivers, ponds, and streams. It is the source of much ground water through the larger hydrologic cycle as water moves from the surface to aquifers below ground.

Toxic: Poisonous

Toxicology: The study of the adverse effects of chemicals in living organisms.

Volatile: Any substance that evaporates readily.

The Community Visioning Process

Description

This tool is a process that enables citizens to realize their vision for the future of the site as it relates to all aspects of community life. This process encourages the full participation of all community members in goal development, action planning, and implementation. By considering a community's vision of future land uses for Superfund sites, EPA can tailor cleanup options to fit community goals.

Required Activity?

No.

Making it Work

When to Use

The visioning process should be implemented before decisions are made. A visioning process can last one day, several days, or months depending on the complexity of issues facing the community. Visioning is best used when addressing large areas of land, such as federal facilities, watersheds, and mining sites. It is vital to help communities think of long-term strategies for future land use. EPA should begin the process in the earliest stages, most likely as a set of questions during the ***Community Interviews.***

See Community Interviews, Tab II-4

How to Use

Community involvement is the key to a successful visioning project. Through early involvement of those who must implement the vision, a CIC can motivate citizens to work actively towards the future they desire, while demonstrating EPA's willingness to work with the community. The overall goal of the visioning process is to empower communities and provide a method of comprehensive goal-setting. To reach this goal, the Office of Sustainable Ecosystems and Communities (OSEC) has developed a series of publications to assist communities in the community visioning process. The four steps of the visioning process, as defined by OSEC, are:

- Step 1: Community Brainstorming and Suggestions
- Step 2: Establishing Goals, Developing a Vision
- Step 3: Bringing Commitment to the Vision, and
- Step 4: Implementing the Vision

Tips

- Select an independent facilitator to help the community implement the visioning process. Consult with your ***Regional Ombudsman*** to identify options for obtaining an independent facilitator.
- Before kickoff, invite media representatives, key community leaders, and the public to a 30- to 45-minute presentation on the cleanup.
- For project kickoff, conduct a public meeting to introduce the visioning initiative.
- During the project, conduct surveys and focus groups to gather feedback from community members to refine the process.

See Superfund Regional Ombudsman, Tab III-J

See Community Involvement Impact Analysis, Tab II-5

See Media, Tab II-19

- Consider volunteering the site to be part of the ***Community Involvement Impact Analysis*** project to obtain unbiased data and feedback from the community.
- Provide for neighborhood or town meetings at which planners can inform the public about the project and receive feedback.
- Use accurate and succinct press releases to maintain contact with the ***Media***. Press releases should be delivered to pre-developed contacts at each news organization, and followed up with a phone call to answer questions and lobby for coverage.
- Use flyers to advertise upcoming events.

EXAMPLE

In Chattanooga, Tennessee, citizens addressed environmental problems through a visioning process by setting goals to achieve a shared vision, designing action plans, and implementing projects throughout the community. The results are documented in the Chattanooga, Tennessee case study, from the EPA's Office of Sustainable Ecosystems and Communities (OSEC) Community Visioning Paper #2:

> "The visioning process, as illustrated by Chattanooga, creates enthusiasm and widespread support, as a community recognizes its shared values and hopes for the future. This enthusiasm and broad-based participation helped draw private and public financial resources to Chattanooga. The high level of commitment generated through an inclusive, open process enabled the community to finance and implement projects without the opposition often seen in community change projects."

RELATED TOOLS/RESOURCES IN THE TOOLKIT

- Community Interviews, See Tab II-4
- Facilitation/ConflictResolution, See Tab II-12

OUTSIDE SOURCES OF INFORMATION

- *Pathways: Building a Local Initiative for Compatible Economic Development*. A community workbook that details the tasks needed to complete a broadly-based, collaborative local plan for compatible economic development. Can be ordered from the Center for Compatible Economic Development, 7 East Market Street, Suite 210, Leesburg, VA 20176 (703) 779-1728
- *Community-Based Environmental Protection: A Resource Book for Protecting Ecosystems and Communities*. U.S. EPA, Office of Policy, Planning and Evaluation. EPA 230-B-96-003 (available on OSEC home page in PDF format)
- For more information on the community visioning process, the following papers are available from OSEC in Washington:
  - *The Visioning Process as a Tool for CBEP: An Annotated Bibliography of Vision ing Resources,* OSEC Community Visioning Paper #3
  - *The Visioning Process as a Tool for CBEP: Visioning Resources on the World Wide Web,* OSEC Community Visioning Paper #4

- ***Internet*** resources for community visioning process information and community-based environmental protection:
  - EPA's Community-Based Environmental Protection Web site: *http://www.epa.gov/region04/cbep/misc/related2.htm*
  - The Community Visioning and Strategic Planning Handbook Web site: *http://www.cpn.org/sections/tools/manuals/manuals.html*
  - EPA's Sustainable Ecosystems and Communities Web site: *http://www.epa.gov/ecosystems/osecbak*

See Internet, Tab III-B

Public Meetings

Description

The public meeting is a public forum that is fairly structured and formal in nature, and open to the general public, including PRPs, unaffected citizens, and activists. It usually features a presentation by the CIC, the RPM, and other members of the site team, as well as an opportunity for interaction with them.

EPA relies heavily upon public meetings as a communication tool. The purpose of the public meeting is to present information to the audience, and to receive information back from them.

Generally speaking, it is an ideal setting to:

- Deliver the same information at the same time to a large group;
- Enable community members to voice their concerns;
- Foster interaction between the site team and the community.

Unfortunately, it also provides the ideal setting for:

- Information to be misunderstood or misheard;
- Exploitation of the forum for grandstanding and ulterior agendas;
- Development of adversarial relationships.

Required Activity?

Yes, as follows:

- Proposed Plan—SARA 113 and 117(a)(2); and the NCP at 40 CFR § 300.430(f)(3)(i)(D) require "[t]he lead agency, after preparation of the proposed plan and review by the support agency, shall...[p]rovide the opportunity for a public meeting to be held during the public comment period at or near the site at issue..." They also require the agency to take a "transcript of the public meeting" and "make such transcript available to the public."
- Post ROD Significant Changes—the NCP at 40 CFR § 300.435(c)(2)(ii)(D) requires that the lead agency "shall [p]rovide the opportunity for a public meeting to be held during the public comment period" that ensues when the ROD is proposed to be amended.
- Completion of the Remedial Design—the NCP at 40 CFR § 300.435(c)(3) requires the lead agency to "[p]rovide, as appropriate, a public briefing prior to the initiation of the remedial action."

Making it Work

When to Use

The required meetings are noted above and discussed in more detail in Chapter 3 of the Community Involvement Handbook. Other than the required meetings, you can use the public meeting to announce the beginning or end of an activity or phase, accomplishment of major milestones, and results of a study (after notifying affected individuals). Consider holding public meetings before the remedial investigation field work begins (as is the policy of some Regions), or at the 75 percent stage of the remedial design.

See Chapter 3 of Handbook

Such meetings allow the citizens to get their questions answered. However, remember that they also provide more opportunities to have others set the agenda once the meeting has

started. Think about how availabilities, and special events might work to your advantage.

Regarding the actual scheduling of meetings, hold them at times that are convenient for the public. Typically, they should be on a weeknight (Monday - Thursday), generally not beginning before 7:00 pm or after 7:30 pm, and lasting not longer than two hours. Saturday afternoons may be a viable alternative.

The public meeting may not be the best tool for all occasions. The negatives associated with the dynamics of the public meeting can be considerable. They are not the recommended forum, other than in the required situations noted above, unless other options are less effective.

- **Do not use public meetings:**
  - For general information purposes without a major announcement.
  - Just because you feel it is time to have a presence in the community.
  - As the first or primary means of communication with a community.
  - To announce for the first time bad or controversial news.
- **At specific times of the year:**
  - Avoid holidays and other vacations.
  - Do not attempt to compete with local special events.
  - Avoid the week of April 15.

The public meeting should be held in a location that is convenient and easily accessible to your target audience, including any disabled residents. The facility must meet the requirements of the Americans with Disabilities Act (ADA). For requirements, visit the Center for Independence (CFI) ***Internet*** site: *http://www.gj.net/~cfi/index.htm*. The site includes weekly updates and information about making your public space accessible: For a free copy of the ADA Guide for Small Businesses, published by the U.S. Department of Justice, call CFI at (970) 241-0315. The location needs to be able to accommodate the anticipated crowd; handle any lighting, ventilation and electrical burdens you may place on it; and have adequate, convenient, well-lighted parking. In most cases, your ***Community Involvement Plan*** should have identified at least one primary location.

See Internet, Tab III-B

See Community Involvement Plans, Tab II-6

How to Use

There is no substitute for good planning; any lack of it will be readily apparent. Several attachments at the end of this tab, including an overall planning checklist, can help you.

Your job in the planning process is to help the RPM and other site team members. You must help them plan the messages, presentations, and visual aides. Help them anticipate questions, and plan the answers. It is up to you to help them to think like a citizen, not like an expert in hazardous waste. More than one site team has been caught off guard at a meeting by something that they thought was so routine as to not be an issue.

It may be the RPM's idea to have a public meeting. Your challenge is to help them decide whether the intended purpose calls for a public meeting or an ***Availability*** or a workshop.

See Public Availability, Tab II-22

If the decision is to go ahead with a public meeting, and it is not the first such meeting for this site, consider having a pre-meeting for new people, rather than making everyone sit through the site history every meeting. Spend half an hour to an hour, before the real meeting starts, to give new people all of the background information. Then, when the real meeting starts, you

can spend just a few minutes to set the stage for everyone and launch into the stated purpose of the meeting. For an established site, you will lose the audience fast if you spend time rehashing everything that has ever been said or done about the site.

Be there early, preferably with the site team, and greet the people as they arrive. Resist the temptation to retreat to a cluster of EPA people. Mingle with the residents, make them feel comfortable, and small talk with them while you are waiting to start the meeting.

Start the meeting on time.

Tips

- **Remember: two-way communication.** Resist the temptation to think of the public meeting merely as an expedient way to get information out to as many people as possible. Expect questions, statements, posturing, grandstanding, antagonism, support, anger, frustration — the whole spectrum of emotion.
- **Prepare a meeting kit.** Something like a catalog case pre-packed with items that invariably are needed at every meeting and, quite often, forgotten in the haste to leave on time. Use the check list at the end of this tab to build your own.
- **Insist on a dry run** with every participant practicing their role.
- **Approach a dry run, and the lessons learned session, candidly.** No one will benefit from a meeting of the mutual admiration society.

Related Tools/Resources in the Toolkit

- Public Availabilities/Poster Sessions, See Tab II-22
- Informal Activities, See Tab II-15
- Community Involvement Plans, See Tab II-6
- Community Interviews, See Tab II-4

Attached Items Within this Tool

- Attachment 1: Public Meeting Check List
- Attachment 2: Preparation
- Attachment 3: Execution — the Room
- Attachment 4: Execution — the Meeting
- Attachment 5: The Follow Up
- Attachment 6: Community Involvement Coordinator Meeting Kit

Attachment 1: Public Meeting Check List

Site: _____

MEETING PREPARATION

___ Meeting date & time: _____
___ Meeting location: _____
  Name: _____
  Phone #: _____
  Rental Rate: _____
  Seating Capacity: _____
___ Directions distributed: _____
___ Point of contact for facility arrangements
___ # of people expected: _____
___ Court reporter needed
  Yes ___ No___
  Name: _____
  Contacted/confirmed: ____
  Rate: _____
___ Translator needed
  Yes ___ No ___
  Name: _____
  Contacted/confirmed: ____
  Rate: _____
___ Panel members notified
  ___ RPM: _____
  ___ Tox: _____
  ___ Hydro: _____
  ___ State: _____
  ___ Local Officials: _____
  ___ Others: _____
___ Prepare agenda
___ Prepare meeting evaluation forms
___ Prepare oral presentations
___ Identify Moderator/Facilitator:
___ Prepare Visual Presentation materials
___ Set dry run date and location
  Date: _____ Time: _____
  Location: _____
___ Conduct dry run
___ Establish ground rules
___ Last minute review and pep talk for the team

ANNOUNCEMENT
___ Call all key community contacts
___ Print set of mailing labels
___ Prepare and distribute fact sheet
___ Prepare press release
  Release date: _____
___ Sends materials to information repositories
___ Prepare public notice
  Run date: (2-3 weeks prior): _____
  Deadline: _____
  Cost: _____
  Purchase request prepared: _____
  Copy sent to newspaper, Date: _____

AUDIO-VISUAL EQUIPMENT

___ Slide presentation/projector
___ Overhead transparencies/projector
___ Video tape presentation/television Set
___ Film presentation/projector
___ Projection screen
___ Microphones (stationary &/or remote)
___ Cassette recorder/tapes/batteries
___ 35mm camera/flash/film
___ Video camera/tape
___ Extension cord
___ 3-prong electric adaptor (several)
___ Pointer for projection screen
___ Extra bulb for projectors
___ Power strip

ROOM ARRANGEMENTS

___ Room layout _____
___ ADA standards met?
___ Room setup
  Who does it? You ___ Them____
___ Time available: _____
___ Set up time: _____
___ Must vacate by time: _____
___ Security (meet prior to & day of)
___ Janitorial services
  ___ Restrooms open
  ___ Ventilation
  ___ First aid supplies
  ___ Return room to original condition
  ___ Who does it? You___ Them ___
___ Lecterns
___ Table w/mic for handicapped
___ Telephone access in case of emergency
___ Press table

BASIC SUPPLIES

___ Name plates/name tags
___ Directional signs
___ Copies of agenda/evaluation form
___ Copies of most recent fact sheets
___ 3" x 5" index cards
___ Pens/pencils
___ Markers
___ Easel/flip chart
___ Poster paper
___ Pad of blank paper
___ Chalk/eraser
___ Sign-in sheets
___ Masking Tape
___ Scissors
___ Business cards
___ Duct tape
___ Plastic drinking cups and pitcher
___ 1 yard of strong cord

MEETING FOLLOW-UP

___ Return equipment
___ Debriefing among meeting participants
___ Respond to requests for information
___ Distribute transcripts/meeting minutes
___ Send thank you letters
___ Prepare meeting evaluation
___ Distribute recommendations
___ Add meeting attendees to mailing list
___ Send names & phone #s to GPRA contractor

Attachment 2: Preparation

- **Use the Check List in attachment 1 to ensure that you have thought of and done everything possible to assure that the meeting goes smoothly.**
- **Establish the purpose.** Know why you are having this meeting. Clearly articulate your purpose and evaluate whether a public meeting is the best forum to achieve that purpose.
- **Plan your messages.** This will require coordination with the RPM and the Site Team. Remember, the average audience does not absorb or comprehend more than three primary messages in one session. Make sure the messages are consistent with your stated purpose.
- **Decide on a date.**
- **Plan the presentations.** Each formal presentation should be *no more than* 15 minutes, and ideally, the total of all the presentations should be 30 minutes or less.
  - The best presentation is brief, focused, and easy to follow and understand.
  - The objective is to present only enough information necessary for the audience to understand the essence of the message, leaving the details for follow up questions.
  - Avoid too much detail. That only serves to confuse, not help or impress.
- **Prepare an agenda.**
  - Identify roles for each key player.
  - The CIC is usually the moderator — opens the meeting, states the purpose of the meeting, establishes the ground rules, provides a very brief update to let people know how you got to this point, keeps things moving, and facilitates the Q&A session.
  - The RPM typically makes the technical presentation. However, this is not "law;" if the RPM is uncomfortable as a public speaker, or just does not come across well, it is appropriate for you to make the primary presentation and use the RPM as the technical expert resource.
  - Let the community participate in planning the meeting.
- **Reserve a meeting room.** Above all else, be sure that it meets ADA requirements. Beyond that, be sure that it is convenient for your target audience; large enough for the anticipated crowd; is reasonably comfortable; and has adequate lighting, ventilation, sound, and rest room facilities. Also, provi' ' adequate parking (preferably free) and ensure the surrounding outside area is well lit.
- **Give at least two weeks' advance notice, preferably three.** A relatively large display ad in the local paper and a notice the fact sheet may be inadequate to stimulate attendance. Do something more to grab the public's attention, like door hangers or a mailing to the entire affected community (as opposed to just the mailing list) cordially inviting them to attend. Also, consider using community bulletin board shows on many local radio and TV stations.
- **Conduct at least one dry run** so that all participants, including yourself, can practice their presentations in front of a mock audience and become comfortable with the format and material. Listen for things that do not make sense or are difficult to understand. Pay close attention to heavy reliance on technical jargon or acronyms, or issues that are unrelated or inappropriate. Look for things in visual aids that make them hard to read or understand. Ask questions that you would logically expect from the audience. Raise issues that are or could be important to the audience, but which are improperly or inadequately addressed in the presentations. Conduct a brutally honest, but professional critique of the presentations after the dry run; stand firm on important points.
- **Arrange to document the meeting.** For the Proposed Plan Public Meeting, and other formal meetings or hearings, you will need to hire a court recorder to take a verbatim transcript and provide a notarized copy for the records. For less formal meetings you can use flip charts, or tape recorders, or have someone simply take notes in the back of the room (this is a perfect role for your contractor).
- **Notify the *media*, either via a news release or media advisory.** Do not assume that they paid attention to the

public notice. Use them to get your message out and get people to attend. Consider a media availability event at the site early in the afternoon before the meeting. This will provide the media with visuals and an opportunity to talk to you and the RPM. The media will probably air the availability event on the early evening news, which will likely increase attendance at the evening meeting. It also can help minimize the tendency for the media to control the meeting, since they will already have their questions answered, and it will give you insight into issues that you or the RPM might not have considered in preparing for the meeting.

Attachment 3: Execution — the Room

- **Arrive well before the meeting.** If it is an evening meeting, get there mid afternoon; if it is an afternoon session, get there in the morning. Go prepared to work; you may want to move tables, chairs, etc.
- **Position the team with an exit behind you.** This is always good advice. However, if you are expecting a contentious, rowdy, or even violent crowd, it is imperative, even if you have to rearrange the room in an odd manner. If you cannot, have your boss, note taker, or someone reliable at the rear of the room, either with a cell phone or where they can reach a phone.
- **Arrange the room with thought.** Arrange the room with an emphasis on sending positive messages like openness and cooperation, rather than negative ones like closed mindedness.
- **Work from floor level.** Even if there is a stage or platform present, do NOT use it. It puts you "above" the audience and the message is immediately negative.
- **Presenters only up front.** There is strength in numbers, and the natural tendency is to have every team member "at the table," such as the RPM's boss and your boss — *Resist it.* There is nothing more disconcerting to the public than to be overwhelmed by a sea of government people. The RPM's supervisor, your supervisor, the hydro-geologist, the toxicologist, the State representatives, the contractors, the PRPs are resources and should be in the first row where they can be easily called upon to help clarify points or add further explanation.
- **If the team will be seated at a table.** Place it in front of the audience, but somewhat off to the side and angled toward them. Avoid the natural tendency to put it across the room between the Team and the audience; this appears to be a barrier and immediately sends a subconscious "us against them" message to the audience. Then plan to talk from the center, not from behind the table.
- **If the team will not be seated at a table.** Seat the presenters in front of the audience, and arrange the audience in a semicircle in front of you. Put your resource people to the side. This may be threatening, or at least uncomfortable, but it works well to break down barriers.
- **Have a lectern in the center.** This gives the speaker something to hold onto, as well as a place to put papers.
- **If you are using overhead transparencies.** Double check that the projector is focused and that all seats have a clear view.
- **Provide directions to the room.** Make sure you post conspicuous signs with arrows directing people from the parking areas to the room.
- **Have a sign-in table near the door.**
- **Have a small table with one chair.** for the court recorder/note taker. Be sure to place it near an electrical outlet.
- **Last-minute location issues.** Make sure there are enough seats for the expected size of the group, and make sure they are spaced comfortably. Check the sound and ventilation systems to ensure that they work and that you know how to control them. Reconnoiter the rest of the facility to locate light switches, water fountains, rest rooms and emergency exits.

Attachment 4: Execution — the Meeting

- **Greet your audience.** As they arrive, mingle with the guests, make them feel welcome, and put them at ease. Have a greeter at the door (your contractor can do this) to explain the sign-in sheets and ask people to sign in. Do not stand in an isolated cluster of EPA people; this only fosters an "us vs. them" attitude. Make note of any local or state elected officials arriving so that you can introduce them during your other introductions.

- *NOTE: EPA's Office of General Counsel has determined that sign-in sheets must be released under FOIA. Do not tell your attendees that it is just for your mailing list and will remain confidential. Instead, tell them the sign-in sheet tells EPA how many people attended. If they are concerned about confidentiality, ask them to use their initials. To build a confidential mailing list, you must have a separate sheet, specifically identified for that purpose.*

- **Distribute the agenda as people enter.** During your opening, establish expectations regarding what citizens want from the meeting, what they can expect from the meeting. If you prefer not to hand out individual copies of the agenda, post the agenda where everyone can see it.

- **Make sure that you and your team are trained in dealing with the media.**
  - Be prepared for media attendance, especially if the site is contentious.
  - Be prepared for them to arrive at anytime before or during the meeting.
  - Be prepared for them to want to talk to residents during the meeting.
  - Be prepared for them to leave at any time during the meeting.
  - Try to have a location set aside that works for them as well as you.
  - If possible, introduce the media to the key players and assist them with their interviews in any way appropriate.

- **Start on Time.** This shows respect for the audience. One CIC tells of citizens referring to "EPA time," certain that EPA does not care because they never start things on time, and rarely even show up on time. He refers to one meeting where the team was still at the dinner table, several miles from the meeting location, when the meeting was scheduled to start.

- **Make necessary introductions.** Introduce yourself, other presenters, other resource people, and state and local elected officials who might be present.

- **Set the stage.** Briefly review the purpose of the meeting, provide a brief update on what brought you to this point, set the ground rules for questions and comments, then introduce the next presenter.

- **Be honest about what they can expect from EPA.** There are many misinterpretations about what EPA can and will do; these often lead to frustration and disillusionment.

- **Remember that you are the government.** Answers like "it's not my job" or "that's not our area of responsibility" never sit well with taxpayers. Remember that you and the other team members are "public servants." Try to be responsive to all issues raised, even if it means having to find another government agency to refer them to. If you have to say "I don't know," make sure you add "but I'll find the answer and get back to you by ... ." Then make sure that you have your assistant get with the person to record the name, phone number, and question so that you *can* get back to them. If you commit to getting back to someone, be sure to do it in a timely fashion.

- **Be flexible.** If the situation warrants it, change your format, agenda and/or approach as appropriate and agreeable with the audience. This might be "your" meeting, but it is for the public. Structure the meeting to convey the information that they need.

Questions/Comments

- **Establish ground rules before you open the floor to questions and comments.** These can vary from meeting to meeting, depending on the physical arrangements, and might include such things as raising your hand to be recognized; one person at a time; one question per person at a time; or form a line at the microphone in the center aisle.

- **Rephrase the questions before answering.** This benefits the entire audience, ensures that the question is understood by the team, and gives the responding team member a few extra moments to formulate an answer.
- **Listen, listen, listen!!** Listen to what is being asked and answer *that* question. Do not answer the question that you want to answer, wish had been asked, or thought had been asked. Do not finish anyone's question or statement.
- **Remember your role as team communicator.** Be alert for a team member resorting to technical jargon in an attempt to answer a question, situations in which the answer does not seem to be working, and situations in which the team member does not seem to understand the question. In such situations, it is appropriate and helpful for you to step in as the team communicator and try to rephrase either the answer or the question. Be sure to be "politically correct" when doing this, but it is an important role that you can fill.
- **Do not "feed the microphone."** Resist the temptation to expound on your answer or the issue. By giving a more detailed answer than is needed, the answer can get lost, the person can get confused, and people waiting to ask questions can get frustrated. If they want to know more or desire greater detail, they will ask.
- **Do not make value judgements about any comments or questions.** Adding comments like "that's a good question" can make those who did not get such a response feel inadequate or stupid, and can often deter further questions. All questions are good ones; there are no stupid questions, so answer all questions without editorializing.
- **Remember the difference between a question and a comment.** Questions require answers; comments do not. Avoid at all costs the urge to explain your position or defend a decision in response to a comment. This is good advice at any public meeting, but it is critical advice for any meeting during the comment period. A simple "thank you," and perhaps something like "we have recorded your comment and will be sure to consider it," is an acceptable, safe response to a comment.
- **Do not be defensive.** It only deteriorates a hostile situation.
- **Do not distance yourself from EPA decisions and positions and do not defend EPA.** Simply explain the position or decision and the rationale behind it without editorial opinion. Refrain from making comments like, "I didn't make that decision."
- **Remember that you are there to get information as well as disseminate it.** You are receiving input, accept it without over-committing. Make sure you understand and communicate the Agency's intentions relative to public comment (this is clearer in instances where a public comment period is required, but is equally important in other instances as well). Do not ask for input that the Agency is not committed to considering.

Attachment 5: The Follow up

- **Have some form of "lessons learned" meeting.** Include the entire team as soon as possible after the meeting. This is important, and needs to be more than just a reassurance of each other's good work. It needs to be a critical review of what went well, what did not go well, why it did or did not, and what can be done to make it better next time.
- **Make sure to follow up on commitments made at the meeting.** If you agreed to get more information, send out materials, or call someone back—Do it!
- **Consider writing a summary response to comments.** If you or the team committed to consider comments, write a summary response to comments and send it to every attendee for whom you have an address and those on the mailing list. You could consider publishing it in the local paper as well. The summary should also state how EPA will proceed.

Attachment 6: Community Involvement Coordinator Meeting Kit

Minimum Contents:

3" x 5" Index cards
Poster paper
Several pads of blank paper
Blank transparencies
Pad of flip chart paper
Business cards
Collapsible pointer
Laser pointer
Multiple outlet power strip
3-prong electrical adapter (at least 1)
50 foot extension cord
Portable easel
Collapsible wheeled cart to carry everything

Pens and pencils
Flip chart markers
Transparency markers
Chalk and eraser
One yard of strong cord
Stapler and staples
Paper clips
Clothes pins (spring type)
Push pins
Masking tape
Duct tape
Scissors

Description

Facilitation is used to guide meetings, mediate conflicts, and deal with contentious situations. In some cases, CICs need outside sources to provide facilitation. However, the nature of the CIC's job often requires the CIC to assume a facilitative role in meetings to help community groups define goals, avoid or resolve conflict, and make decisions.

A facilitator is a neutral party who moderates discussions, monitors speaking time, records key discussion points, periodically summarizes the discussion, and provides constructive feedback. Facilitators help create an atmosphere of trust and fairness by ensuring that all groups have equal say in the discussion and that everyone understands each other. In contentious situations, the facilitator maintains civility and keeps the discussion focused.

Required Activity?

No.

Making it Work

When to Use

Sometimes, the CIC plays a facilitative role by assisting the leader of a community group while the leader retains authority and takes the lead conducting the meeting. This works best when the purpose of the meeting is primarily to share information, generate ideas, or make decisions and there is minimal potential for conflict within the group. The CIC reinforces the group leader's efforts and acts as an observer, providing constructive feedback about what is helping and hindering progress. The CIC also can assist by acting as timekeeper or recording key points on a blackboard or flip charts. In this capacity, the CIC retains the objective role critical to providing advice on process. The group leader must trust the CIC and not be threatened by the feedback provided.

At other times, the CIC acts as an objective facilitator who mediates the discussion so the group's leader can actively participate in the proceedings. This is especially useful when the leader has a vested interest in the outcome, or when there is a potential for conflict to arise. When the group leader wants to participate as a member of the group, the CIC/facilitator may take charge of conducting the meeting.

Because a facilitator must be accepted as objective and neutral, outside facilitation is often necessary. Outside neutral facilitation is appropriate:

- At contentious sites with numerous stakeholders
- Where there are environmental justice interests
- In high-conflict situations
- At sites with numerous competing interests
- Where there is mistrust among participants
- When leadership is not clear
- Where participants mistrust the Federal government; and
- Where EPA has or is perceived to have a vested interest in results of the process

See Conflict Resolution/ADR, Tab II-12

See Public Meetings, Tab II-24

CICs can consult with a Regional Alternative Dispute Resolution (ADR) Specialist for advice on handling difficult situations and for more information about when to use facilitation or other ADR techniques. ADR Specialists can help CICs obtain third-party neutral facilitation or mediation services. (See the discussion of ***Conflict Resolution*** and Use of Neutral Facilitation in this section, and the attached list of Regional ADR Specialists.)

How to Use

CICs play a facilitative role by planning and conducting ***Public Meetings***, informal community meetings, and meetings for Community Advisory Groups (CAGs) or Technical Assistance Grant (TAG) groups. The CIC acts as an objective, neutral party whose function is to help guide the discussion process, not participate in it. The CIC may help plan and make meeting arrangements, develop an agenda, and play a role in conducting and recording the meeting. The facilitator's role also is different from that of group leader, who often has a stake in the outcome of the meeting.

Planning the Meeting

One of the most important aspects of facilitation is planning the meeting. This involves much more than helping with logistics and making meeting arrangements. The basic steps necessary to plan an effective meeting include the following:

- Determine meeting purpose (information sharing, problem solving or decision making)
- Consider meeting context (other situations that influence what you are trying to do)
- Identify stakeholders and/or attendees and their roles in the meeting
- Assess participants' needs and definitions of success for the meeting
- Choose an appropriate meeting place and room arrangements; and
- Decide on an appropriate decision making method (consensus, majority rule)

Building an Agenda

The agenda guides the meeting through sequential steps to reach a desired outcome. Follow these basic steps to develop an effective meeting agenda:

- Consider goals, context, participants' needs, scheduling, and room arrangements
- Determine if further meetings will be necessary
- Write down the meeting purpose and list desired outcomes
- List and order topics that must be covered to reach desired outcomes
- Explain the purpose of the meeting
- Outline the desired outcomes
- Review the proposed agenda
- Define participants' roles
- Identify the steps (*e.g.*, option review, questions and answers) necessary to reach desired outcomes
- Determine the time necessary to complete each step or topic

- Record key points or use a meeting recorder
- Identify potential problems and solutions; and
- Review the draft and make adjustments

Solving Problems

Neutral third-party facilitation is appropriate in highly contentious situations or where issues or personalities involved make conflicts likely. Lead participants through a process that requires them to take responsibility for identifying and solving problems. Build upon small agreements and try to move the focus from personalities to process and results. Emphasize the need to collaborate in looking for win/win opportunities.

Guide participants through a sequence of steps that address the following questions:

- What is the issue and how will we approach the problem in our discussion?
- What is the problem and why does it exist?
- What is the ideal state related to this issue?
- What are the best solutions to this problem?
- How will we implement these solutions?

Mediating Conflict

Conflict occurs when participants are not willing to move from positions based on a win/lose mentality. When there is potential for serious conflict, skilled mediation may be necessary. In these cases, CICs can consult with ADR specialists for advice and assistance.

When less serious conflicts arise, CICs can help move participants past disagreement to mutual gains. Focus attention on the collaborative process by helping participants concentrate on process rather than personality issues.

One useful technique for mediating minor conflicts consists of the following steps:

- Restate points made to empathize with each party's situation.
- Paraphrase what is said to compare your perception with that of the speaker.
- Discover underlying issues without assuming you know anything: ask probing questions and listen attentively. Verify your perceptions of unspoken assumptions, feelings, and thoughts.
- Encourage disputing parties to propose options without asking them to make commitments. Ask for and propose ideas for how to resolve parts or all of each issue in dispute. Explore options without pressuring movement toward agreement. Try not to move too quickly to the solution.
- Address one idea at a time. Concentrate on areas of agreement, not on disagreements. Search for additional opportunities for agreement; and
- If all else fails, agree to disagree, but do not move to this option until all opportunities for reaching agreement have been explored and exhausted.

Getting to a Decision

Reaching decisions involves looking for common ground and building upon a series of small agreements. There are many decision making methods. Two common methods are outlined below. When choosing methods, consider that the degree to which individuals "buy into" an agreement depends on how much ownership they have in the decision making process.

Majority rule:

This requires group members to consider options, discuss pros and cons, and vote. Participants agree that the group will adopt the option(s) that receive a plurality or majority of votes cast. Majority rule works best when the group has demonstrated a willingness to work together cooperatively, and when no one is so heavily invested in one or more options that they will not abide by the group's collective decision.

Consensus:

Consensus means agreement. Building agreement is a key aspect of the facilitator's role. He or she creates a safe atmosphere for discussion and information exchange, identifies areas of agreement, and helps the group move forward through an organized set of steps necessary to reach agreement. The facilitator handles difficult or overbearing participants and helps disputing parties reconcile differences if conflict arises. The key is to foster an atmosphere in which participants see the value of using a collaborative approach and taking responsibility for the meeting's success.

This requires lengthy collaboration. Agreement is reached after group members talk freely and at length, listen to each other's views, and thoroughly review all ideas. Consensus requi respect for every participant's ideas, opinions, and suggestions. While unanimity is not required, each participant must accept the points under discussion before they are incorporated in the group's decision. This method of decision making is very time consuming and should not be rushed. A series of meetings is often necessary. Consensus is the preferred method when it is important for all participants to buy into the result because it gives each participant ownership in the decision making process. It works best when stakeholders are heavily invested in the outcome and the cooperation of all parties is necessary to achieve goals.

The basic steps for reaching a decision include the following:

- Agree on the purpose, desired outcomes, and ground rules
- Choose a decision making method—if the group decides to reach a decision through consensus, select a back-up method to be used if the group cannot reach consensus
- Identify the problem
- Identify and process possible solutions—brainstorm, clarify ideas, group similar ideas together, rank and select options
- Develop an action plan—delineate tasks and specify responsible parties; and
- Review the meeting

Tips

- Explain your role as facilitator and explain responsibilities of participants up front.
- Facilitators must remain neutral.

- Be positive; set the tone for finding solutions.
- Start by getting agreement on the agenda, participants' roles, desired outcomes, ground rules, and the decision making method.
- Focus on the task and observe how the group is working.
- Ask open-ended questions to generate participation.
- Do not evaluate. Encourage speakers to explain their positions and provide background information that will enhance understanding.
- Ask participants to reserve judgement.
- "Listen as an ally" by:
  - Repeating the speaker's exact words or paraphrasing to confirm understanding.
  - Building empathy.
  - Asking probing questions to elicit additional clarifying information.
  - Increasing the comfort level of the speaker by maintaining eye contact, leaning forward, or opening palms when requesting input.
- Share observations about the effectiveness of methods participants are using to resolve problems and make decisions.
- Suggest alternative procedures, if necessary, to help the group reach decisions or accomplish its goals.
- Record or designate a recorder to write down key points on a blackboard or flip chart to focus attention on what has been accomplished and to maintain a meeting record.

Related Tools/Resources in the Toolkit

- Conflict Resolution/ADR, See Tab II-12
- Public Meetings, See Tab II-24
- Superfund Regional Ombudsman, See Tab III-J

Attached Items Within this Tool

- Attachment 1: Examples of Effective Room Arrangements
- Attachment 2: Guidelines for Keeping Good Flip Charts

Outside Sources of Information

- Society for Professionals in Dispute Resolution
- National Institute for Dispute Resolution
- International Association for Public Participation
- Harvard Negotiation Program
- Program for Community Problem Solving

Attachment 1: Examples of Effective Room Arrangements

Room set-up must allow participants to see each other and flip charts or pages posted on a wall. Chairs should move smoothly so participants can adjust their focus of attention easily. Allow enough space for all participants to be comfortable.

Here are a few ways to arrange a room for optimal communications:

Closed Circle or Rectangle Without Tables—Creates an informal atmosphere and encourages eye contact between participants. Reduces status differences between participants. However, the circle lacks a single focal point and can increase distractions because people focus on several different people.

A Closed Circle with Tables—Allows people to write and creates a convenient place for papers, coffee cups, etc.

Semi-Circle Without Tables—Place flip charts in the open end to create a focal point for participants. Reduces status differences between participants.

Semi-Circle Around a Table—Allows the group to focus on the facilitator and the flip charts and to write easily. Reduces differences in status between participants, and encourages interaction.

U-Shape with Tables—Chairs are placed only along the outside, allowing participants to focus on the facilitator and the flip charts. Allows participants ample room for writing, but they may have difficulty seeing other members of the group.

Herringbone with Tables—Two sets of tables are placed in a herringbone pattern, with the facilitator and flip chart in front. Participants can focus on flip charts, and have good eye contact with each other and the facilitator.

Attachment 2: Keeping Good Flip Charts

Keeping a visible record of the meeting encourages the group to remember ideas and agreements, avoid repetition, and stay focused on a task. Use flip charts to record words, ideas, options, and decisions offered by the group. Use an easel or series of easels with attached pads of blank paper. Have a multi-color collection of felt-tip markers and plenty of tape or tacks to attach completed pages to walls or easels for display. Either the facilitator or a designated recorder can do the writing. Completed flip charts also can be used to prepare minutes after the meeting.

Follow these general guidelines to ensure that flip charts are readable and useful to group members:

- Put the easel where it can be seen by all participants. Check by viewing it from all parts of the room prior to the meeting.
- Stand at an angle to the easel as you write and to its side while listening to the next speaker. Make sure you stand where you do not block anyone's view.
- Use two or more flip charts if you want participants to compare or contrast ideas or information.
- Write clearly in large, block letters about two-inches high.
- Leave at least two inches between lines.
- Write no more than ten lines per page and only on the top two-thirds of the sheet.
- Use as few words as possible.
- Ask for help or clarification if you do not know how to spell a word or record an idea.
- Verify with the speakers to be sure you are accurately reflecting their comments.
- Use abbreviations and symbols, but only if everyone understands them.
- Use several colored marking pens.
- Highlight key words with circles, boxes, underlining, arrows, asterisks, or contrasting colors.
- As you complete a sheet, tear it off, and post it on a wall. Make arrangements for assistance with this task beforehand so you do not miss information that should be recorded.

References for 'Open Window' Communication

Supplemental References and Resources

! Communication During Changing Times, U.S. EPA, RBCA TALK, July 1997. Available to download from the Internet: http://www.epa.gov/swerust1/rbdm/talk3_1.htm

! Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations. Docket No. S0035, Executive Order 12898, February 1994. Available from the RCRA Docket Information Center

! Public Participation in U.S. Department of Energy Environmental Restoration Activities, Office of Environmental Guidance. EH Document Number: DCE-EH-0221

! Hazardous Waste Data: http://www.epa.gov/epaoswer/hazwaste/data

! RCRA Hotline Phone Number - (800) 424-9346

! RCRA Public Participation Manual, Chapter 4, EPA 530-R-96-007, September 1996.

ENVIRONMENTAL INDICATORS

DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

Interim Final 2/5/99

RCRA Corrective Action
Environmental Indicator (EI) RCRIS code (CA725)

Current Human Exposures Under Control

Facility Name: _____
Facility Address: _____
Facility EPA ID #: _____

1. Has **all** available relevant/significant information on known and reasonably suspected releases to soil, groundwater, surface water/sediments, and air, subject to RCRA Corrective Action (e.g., from Solid Waste Management Units (SWMU), Regulated Units (RU), and Areas of Concern (AOC)), been **considered** in this EI determination?

   _____ If yes - check here and continue with #2 below.

   _____ If no - re-evaluate existing data, or

   _____ if data are not available skip to #6 and enter"IN" (more information needed) status code.

BACKGROUND

Definition of Environmental Indicators (for the RCRA Corrective Action)

Environmental Indicators (EI) are measures being used by the RCRA Corrective Action program to go beyond programmatic activity measures (e.g., reports received and approved, etc.) to track changes in the quality of the environment. The two EI developed to-date indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated groundwater. An EI for non-human (ecological) receptors is intended to be developed in the future.

Definition of "Current Human Exposures Under Control" EI

A positive "Current Human Exposures Under Control" EI determination ("YE" status code) indicates that there are no "unacceptable" human exposures to "contamination" (i.e., contaminants in concentrations in excess of appropriate risk-based levels) that can be reasonably expected under current land- and groundwater-use conditions (for all "contamination" subject to RCRA corrective action at or from the identified facility (i.e., site-wide)).

Relationship of EI to Final Remedies

While Final remedies remain the long-term objective of the RCRA Corrective Action program the EI are near-term objectives which are currently being used as Program measures for the Government Performance and Results Act of 1993, GPRA). The "Current Human Exposures Under Control" EI are for reasonably expected human exposures under current land- and groundwater-use conditions ONLY, and do not consider potential future land- or groundwater-use conditions or ecological receptors. The RCRA Corrective Action program's overall mission to protect human health and the environment requires that Final remedies address these issues (i.e., potential future human exposure scenarios, future land and groundwater uses, and ecological receptors).

Duration / Applicability of EI Determinations

EI Determinations status codes should remain in RCRIS national database ONLY as long as they remain true (i.e., RCRIS status codes must be changed when the regulatory authorities become aware of contrary information).

2. Are groundwater, soil, surface water, sediments, or air **media** known or reasonably suspected to be **"contaminated"**[1] above appropriately protective risk-based "levels" (applicable promulgated standards, as well as other appropriate standards, guidelines, guidance, or criteria) from releases subject to RCRA Corrective Action (from SWMUs, RUs or AOCs)?

	Yes	No	?	Rationale / Key Contaminants
Groundwater	___	___	___	_____
Air (indoors) [2]	___	___	___	_____
Surface Soil (e.g., <2 ft)	___	___	___	_____
Surface Water	___	___	___	_____
Sediment	___	___	___	_____
Subsurf. Soil (e.g., >2 ft)	___	___	___	_____
Air (outdoors)	___	___	___	_____

_____ If no (for all media) - skip to #6, and enter "YE," status code after providing or citing appropriate "levels," and referencing sufficient supporting documentation demonstrating that these "levels" are not exceeded.

_____ If yes (for any media) - continue after identifying key contaminants in each "contaminated" medium, citing appropriate "levels" (or provide an explanation for the determination that the medium could pose an unacceptable risk), and referencing supporting documentation.

_____ If unknown (for any media) - skip to #6 and enter "IN" status code.

Rationale and Reference(s):

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Footnotes:

[1] "Contamination" and "contaminated" describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriately protective risk-based "levels" (for the media, that identify risks within the acceptable risk range).

[2] Recent evidence (from the Colorado Dept. of Public Health and Environment, and others) suggest that unacceptable indoor air concentrations are more common in structures above groundwater with volatile contaminants than previously believed. This is a rapidly developing field and reviewers are encouraged to look to the latest guidance for the appropriate methods and scale of demonstration necessary to be reasonably certain that indoor air (in structures located above (and adjacent to) groundwater with volatile contaminants) does not present unacceptable risks.

3. Are there **complete pathways** between "contamination" and human receptors such that exposures can be reasonably expected under the current (land- and groundwater-use) conditions?

Summary Exposure Pathway Evaluation Table

	Potential **Human Receptors** (Under Current Conditions)						
Contaminated Media	Residents	Workers	Day-Care	Construction	Trespassers	Recreation	Food[3]
Groundwater	_____	_____	_____	_____			____
Air (indoors)	_____	_____	_____				
Soil (surface, e.g., <2 ft)	_____	_____	_____	_____	_____	_____	____
Surface Water	_____	_____			_____	_____	____
Sediment	_____	_____			_____	_____	____
Soil (subsurface e.g., >2 ft)				_____			____
Air (outdoors)	_____	_____	_____	_____	_____		

Instructions for Summary Exposure Pathway Evaluation Table:

1. Strike-out specific Media including Human Receptors' spaces for Media which are not "contaminated") as identified in #2 above.

2. enter "yes" or "no" for potential "completeness" under each "Contaminated" Media -- Human Receptor combination (Pathway).

Note: In order to focus the evaluation to the most probable combinations some potential "Contaminated" Media - Human Receptor combinations (Pathways) do not have check spaces ("___"). While these combinations may not be probable in most situations they may be possible in some settings and should be added as necessary.

_____ If no (pathways are not complete for any contaminated media-receptor combination) - skip to #6, and enter "YE" status code, after explaining and/or referencing condition(s) in-place, whether natural or man-made, preventing a complete exposure pathway from each contaminated medium (e.g., use optional Pathway Evaluation Work Sheet to analyze major pathways).

_____ If yes (pathways are complete for any "Contaminated" Media - Human Receptor combination) - continue after providing supporting explanation.

_____ If unknown (for any "Contaminated" Media - Human Receptor combination) - skip to #6 and enter "IN" status code

Rationale and Reference(s):
_____
_____
_____
_____
_____

[3] Indirect Pathway/Receptor (e.g., vegetables, fruits, crops, meat and dairy products, fish, shellfish, etc.)

4 Can the **exposures** from any of the complete pathways identified in #3 be reasonably expected to be **"significant"**[4] (i.e., potentially "unacceptable" because exposures can be reasonably expected to be: 1) greater in magnitude (intensity, frequency and/or duration) than assumed in the derivation of the acceptable "levels" (used to identify the "contamination"); or 2) the combination of exposure magnitude (perhaps even though low) and contaminant concentrations (which may be substantially above the acceptable "levels") could result in greater than acceptable risks)?

_____ If no (exposures can not be reasonably expected to be significant (i.e., potentially "unacceptable") for any complete exposure pathway) - skip to #6 and enter "YE" status code after explaining and/or referencing documentation justifying why the exposures (from each of the complete pathways) to "contamination" (identified in #3) are not expected to be "significant."

_____ If yes (exposures could be reasonably expected to be "significant" (i.e., potentially "unacceptable") for any complete exposure pathway) - continue after providing a description (of each potentially "unacceptable" exposure pathway) and explaining and/or referencing documentation justifying why the exposures (from each of the remaining complete pathways) to "contamination" (identified in #3) are not expected to be "significant."

_____ If unknown (for any complete pathway) - skip to #6 and enter "IN" status code

Rationale and Reference(s):

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[4] If there is any question on whether the identified exposures are "significant" (i.e., potentially "unacceptable") consult a human health Risk Assessment specialist with appropriate education, training and experience.

5 Can the "significant" **exposures** (identified in #4) be shown to be within **acceptable** limits?

_____ If yes (all "significant" exposures have been shown to be within acceptable limits) - continue and enter "YE" after summarizing and referencing documentation justifying why all "significant" exposures to "contamination" are within acceptable limits (e.g., a site-specific Human Health Risk Assessment).

_____ If no (there are current exposures that can be reasonably expected to be "unacceptable")- continue and enter "NO" status code after providing a description of each potentially "unacceptable" exposure.

_____ If unknown (for any potentially "unacceptable" exposure) - continue and enter "IN" status code

Rationale and Reference(s):

6. Check the appropriate RCRIS status codes for the Current Human Exposures Under Control EI event code (CA725), and obtain Supervisor (or appropriate Manager) signature and date on the EI determination below (and attach appropriate supporting documentation as well as a map of the facility):

____ YE - Yes, "Current Human Exposures Under Control" has been verified. Based on a review of the information contained in this EI Determination, "Current Human Exposures" are expected to be "Under Control" at the _____ _____ facility, EPA ID #_____, located at _____ under current and reasonably expected conditions. This determination will be re-evaluated when the Agency/State becomes aware of significant changes at the facility.

____ NO - "Current Human Exposures" are NOT "Under Control."

____ IN - More information is needed to make a determination.

Completed by (signature)_____ Date _____
(print)_____
(title)_____

Supervisor (signature)_____ Date _____
(print)_____
(title)_____
(EPA Region or State)_____

Locations where References may be found:

_____
_____
_____
_____
_____

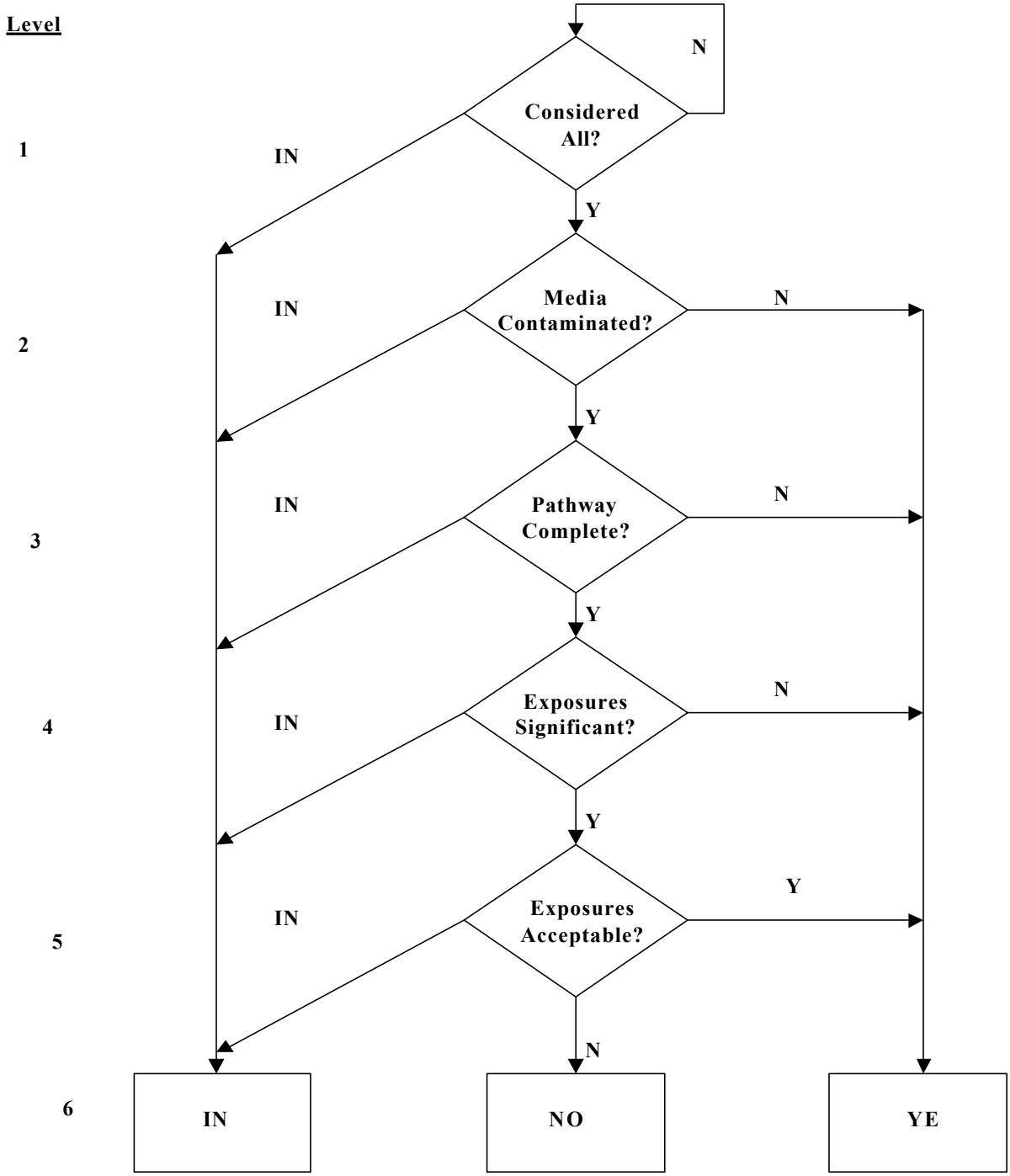
Contact telephone and e-mail numbers

(name) _____
(phone #) _____
(e-mail) _____

FINAL NOTE: THE HUMAN EXPOSURES EI IS A QUALITATIVE SCREENING OF EXPOSURES AND THE DETERMINATIONS WITHIN THIS DOCUMENT SHOULD NOT BE USED AS THE SOLE BASIS FOR RESTRICTING THE SCOPE OF MORE DETAILED (E.G., SITE-SPECIFIC) ASSESSMENTS OF RISK.

Facility Name: _____
EPA ID#: _____
City/State: _____

CURRENT HUMAN EXPOSURES UNDER CONTROL (CA 725)



DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

Interim Final 2/5/99

RCRA Corrective Action
Environmental Indicator (EI) RCRIS code (CA750)

Migration of Contaminated Groundwater Under Control

Facility Name: _____
Facility Address: _____
Facility EPA ID #: _____

1. Has **all** available relevant/significant information on known and reasonably suspected releases to the groundwater media, subject to RCRA Corrective Action (e.g., from Solid Waste Management Units (SWMU), Regulated Units (RU), and Areas of Concern (AOC)), been **considered** in this EI determination?

   _____ If yes - check here and continue with #2 below.

   _____ If no - re-evaluate existing data, or

   _____ if data are not available, skip to #8 and enter"IN" (more information needed) status code.

BACKGROUND

Definition of Environmental Indicators (for the RCRA Corrective Action)

Environmental Indicators (EI) are measures being used by the RCRA Corrective Action program to go beyond programmatic activity measures (e.g., reports received and approved, etc.) to track changes in the quality of the environment. The two EI developed to-date indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated groundwater. An EI for non-human (ecological) receptors is intended to be developed in the future.

Definition of "Migration of Contaminated Groundwater Under Control" EI

A positive "Migration of Contaminated Groundwater Under Control" EI determination ("YE" status code) indicates that the migration of "contaminated" groundwater has stabilized, and that monitoring will be conducted to confirm that contaminated groundwater remains within the original "area of contaminated groundwater" (for all groundwater "contamination" subject to RCRA corrective action at or from the identified facility (i.e., site-wide)).

Relationship of EI to Final Remedies

While Final remedies remain the long-term objective of the RCRA Corrective Action program the EI are near-term objectives which are currently being used as Program measures for the Government Performance and Results Act of 1993, GPRA). The "Migration of Contaminated Groundwater Under Control" EI pertains ONLY to the physical migration (i.e., further spread) of contaminated ground water and contaminants within groundwater (e.g., non-aqueous phase liquids or NAPLs). Achieving this EI does not substitute for achieving other stabilization or final remedy requirements and expectations associated with sources of contamination and the need to restore, wherever practicable, contaminated groundwater to be suitable for its designated current and future uses.

Duration / Applicability of EI Determinations

EI Determinations status codes should remain in RCRIS national database ONLY as long as they remain true (i.e., RCRIS status codes must be changed when the regulatory authorities become aware of contrary information).

2. Is **groundwater** known or reasonably suspected to be **"contaminated"**[1] above appropriately protective "levels" (i.e., applicable promulgated standards, as well as other appropriate standards, guidelines, guidance, or criteria) from releases subject to RCRA Corrective Action, anywhere at, or from, the facility?

_____ If yes - continue after identifying key contaminants, citing appropriate "levels," and referencing supporting documentation.

_____ If no - skip to #8 and enter "YE" status code, after citing appropriate "levels," and referencing supporting documentation to demonstrate that groundwater is not "contaminated."

_____ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):_____

Footnotes:

[1]"Contamination" and "contaminated" describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriate "levels" (appropriate for the protection of the groundwater resource and its beneficial uses).

3. Has the **migration** of contaminated groundwater **stabilized** (such that contaminated groundwater is expected to remain within "existing area of contaminated groundwater"[2] as defined by the monitoring locations designated at the time of this determination)?

_____ If yes - continue, after presenting or referencing the physical evidence (e.g., groundwater sampling/measurement/migration barrier data) and rationale why contaminated groundwater is expected to remain within the (horizontal or vertical) dimensions of the "existing area of groundwater contamination"[2]).

_____ If no (contaminated groundwater is observed or expected to migrate beyond the designated locations defining the "existing area of groundwater contamination"[2]) - skip to #8 and enter "NO" status code, after providing an explanation.

_____ If unknown - skip to #8 and enter "IN" status code.

Rationale and
Reference(s):_____
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[2] "existing area of contaminated groundwater" is an area (with horizontal and vertical dimensions) that has been verifiably demonstrated to contain all relevant groundwater contamination for this determination, and is defined by designated (monitoring) locations proximate to the outer perimeter of "contamination" that can and will be sampled/tested in the future to physically verify that all "contaminated" groundwater remains within this area, and that the further migration of "contaminated" groundwater is not occurring. Reasonable allowances in the proximity of the monitoring locations are permissible to incorporate formal remedy decisions (i.e., including public participation) allowing a limited area for natural attenuation.

4. Does "contaminated" groundwater **discharge** into **surface water** bodies?

_____ If yes - continue after identifying potentially affected surface water bodies.

_____ If no - skip to #7 (and enter a "YE" status code in #8, if #7 = yes) after providing an explanation and/or referencing documentation supporting that groundwater "contamination" does not enter surface water bodies.

_____ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):_____

5. Is the **discharge** of "contaminated" groundwater into surface water likely to be **"insignificant"** (i.e., the maximum concentration[3] of each contaminant discharging into surface water is less than 10 times their appropriate groundwater "level," and there are no other conditions (e.g., the nature, and number, of discharging contaminants, or environmental setting), which significantly increase the potential for unacceptable impacts to surface water, sediments, or eco-systems at these concentrations)?

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_____ If yes - skip to #7 (and enter "YE" status code in #8 if #7 = yes), after documenting: 1) the maximum known or reasonably suspected concentration[3] of key contaminants discharged above their groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and 2) provide a statement of professional judgement/explanation (or reference documentation) supporting that the discharge of groundwater contaminants into the surface water is not anticipated to have unacceptable impacts to the receiving surface water, sediments, or eco-system.

_____ If no - (the discharge of "contaminated" groundwater into surface water is potentially significant) - continue after documenting: 1) the maximum known or reasonably suspected concentration[3] of each contaminant discharged above its groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and 2) for any contaminants discharging into surface water in concentrations[3] greater than 100 times their appropriate groundwater "levels," the estimated total amount (mass in kg/yr) of each of these contaminants that are being discharged (loaded) into the surface water body (at the time of the determination), and identify if there is evidence that the amount of discharging contaminants is increasing.

_____ If unknown - enter "IN" status code in #8.

Rationale and
Reference(s):_____
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[3] As measured in groundwater prior to entry to the groundwater-surface water/sediment interaction (e.g., hyporheic) zone.

6. Can the **discharge** of "contaminated" groundwater into surface water be shown to be "**currently acceptable**" (i.e., not cause impacts to surface water, sediments or eco-systems that should not be allowed to continue until a final remedy decision can be made and implemented[4])?

_____ If yes - continue after either: 1) identifying the Final Remedy decision incorporating these conditions, or other site-specific criteria (developed for the protection of the site's surface water, sediments, and eco-systems), and referencing supporting documentation demonstrating that these criteria are not exceeded by the discharging groundwater; OR
2) providing or referencing an interim-assessment,[5] appropriate to the potential for impact, that shows the discharge of groundwater contaminants into the surface water is (in the opinion of a trained specialists, including ecologist) adequately protective of receiving surface water, sediments, and eco-systems, until such time when a full assessment and final remedy decision can be made. Factors which should be considered in the interim-assessment (where appropriate to help identify the impact associated with discharging groundwater) include: surface water body size, flow, use/classification/habitats and contaminant loading limits, other sources of surface water/sediment contamination, surface water and sediment sample results and comparisons to available and appropriate surface water and sediment "levels," as well as any other factors, such as effects on ecological receptors (e.g., via bio-assays/benthic surveys or site-specific ecological Risk Assessments), that the overseeing regulatory agency would deem appropriate for making the EI determination.

_____ If no - (the discharge of "contaminated" groundwater can not be shown to be "**currently acceptable**") - skip to #8 and enter "NO" status code, after documenting the currently unacceptable impacts to the surface water body, sediments, and/or eco-systems.

_____ If unknown - skip to 8 and enter "IN" status code.

Rationale and Reference(s):_____
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_____
_____
_____

[4] Note, because areas of inflowing groundwater can be critical habitats (e.g., nurseries or thermal refugia) for many species, appropriate specialist (e.g., ecologist) should be included in management decisions that could eliminate these areas by significantly altering or reversing groundwater flow pathways near surface water bodies.

[5] The understanding of the impacts of contaminated groundwater discharges into surface water bodies is a rapidly developing field and reviewers are encouraged to look to the latest guidance for the appropriate methods and scale of demonstration to be reasonably certain that discharges are not causing currently unacceptable impacts to the surface waters, sediments or eco-systems.

7. Will groundwater **monitoring** / measurement data (and surface water/sediment/ecological data, as necessary) be collected in the future to verify that contaminated groundwater has remained within the horizontal (or vertical, as necessary) dimensions of the "existing area of contaminated groundwater?"

_____ If yes - continue after providing or citing documentation for planned activities or future sampling/measurement events. Specifically identify the well/measurement locations which will be tested in the future to verify the expectation (identified in #3) that groundwater contamination will not be migrating horizontally (or vertically, as necessary) beyond the "existing area of groundwater contamination."

_____ If no - enter "NO" status code in #8.

_____ If unknown - enter "IN" status code in #8.

Rationale and Reference(s):_____

8. Check the appropriate RCRIS status codes for the Migration of Contaminated Groundwater Under Control EI (event code CA750), and obtain Supervisor (or appropriate Manager) signature and date on the EI determination below (attach appropriate supporting documentation as well as a map of the facility).

_____ YE - Yes, "Migration of Contaminated Groundwater Under Control" has been verified. Based on a review of the information contained in this EI determination, it has been determined that the "Migration of Contaminated Groundwater" is "Under Control" at the _____ _____facility, EPA ID # _____, located at_____. Specifically, this determination indicates that the migration of "contaminated" groundwater is under control, and that monitoring will be conducted to confirm that contaminated groundwater remains within the "existing area of contaminated groundwater" This determination will be re-evaluated when the Agency becomes aware of significant changes at the facility.

_____ NO - Unacceptable migration of contaminated groundwater is observed or expected.

_____ IN - More information is needed to make a determination.

Completed by (signature)_____ Date _____
(print)_____
(title)_____

Supervisor (signature)_____ Date _____
(print)_____
(title)_____
(EPA Region or State)_____

Locations where References may be found:

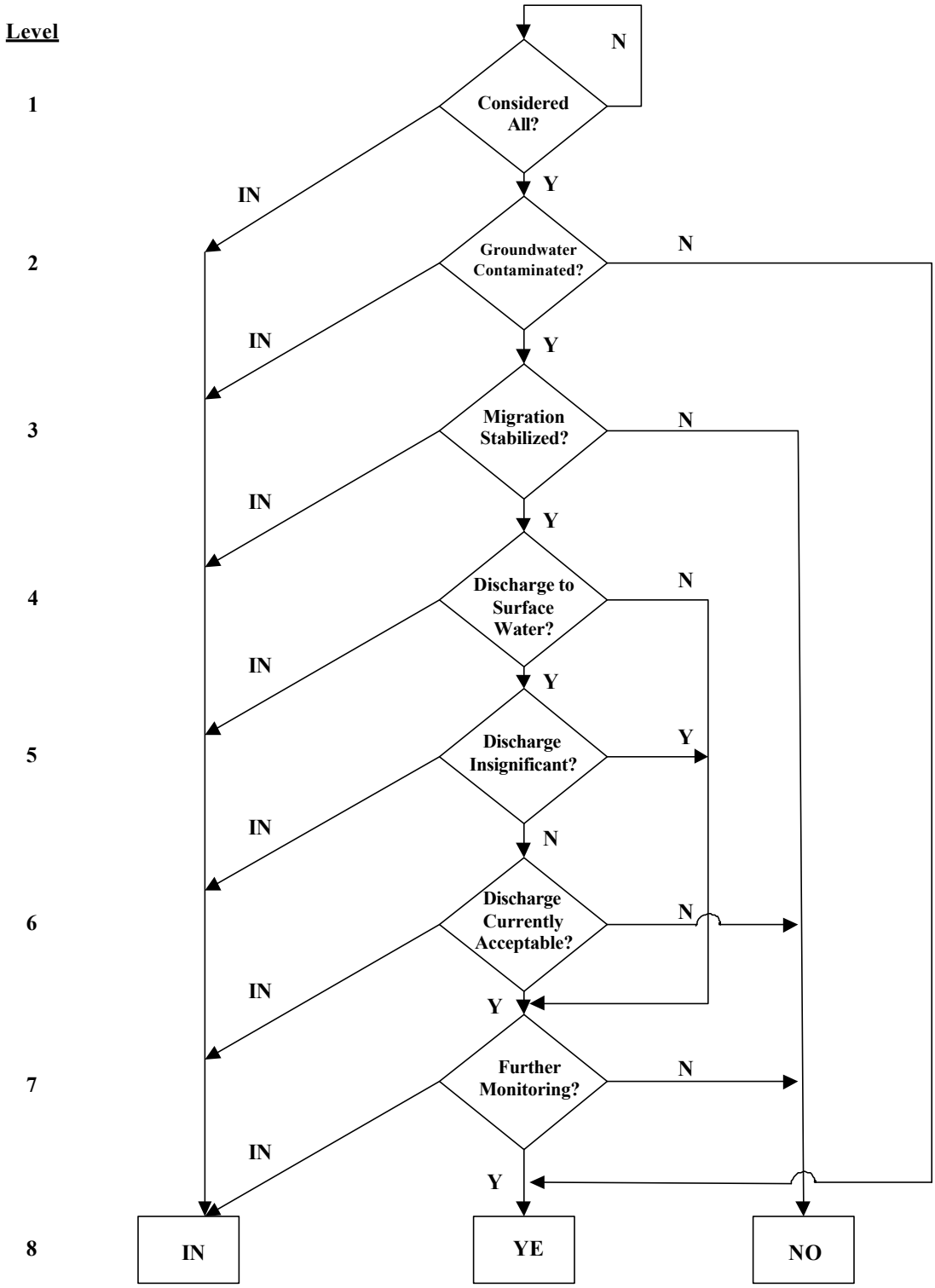
_____
_____
_____
_____
_____

Contact telephone and e-mail numbers

(name)_____
(phone #)_____
(e-mail)_____

Facility Name: _____
EPA ID#: _____
City/State: _____

MIGRATION OF CONTAMINATED GROUNDWATER UNDER CONTROL (CA 750)



// Signed 2/5/99 //

MEMORANDUM

SUBJECT: Interim-Final Guidance for RCRA Corrective Action Environmental Indicators

FROM: Elizabeth Cotsworth, Acting Director
Office of Solid Waste

TO: RCRA Senior Policy Managers
Regions I-X

The RCRA corrective action program and achievement of its Government Performance Results Act (GPRA) goals are of highest priority for the national RCRA program. The RCRA program is using two Environmental Indicators (EI) to measure program performance for GPRA purposes: (1) Current Human Exposures Under Control (CA725), and (2) Migration of Contaminated Groundwater Under Control (CA750).

With this memorandum I am transmitting revised guidance on how to determine if a facility has met the RCRA corrective action Environmental Indicators (EI). This Interim-Final guidance will replace the existing EI guidance (from 1994 and 1995) and will remain the working guidance for at least one year. The Interim-Final guidance is similar to the earlier guidance but has been modified to facilitate more consistent determinations (across regions and states) and to be more explicit with regard to the minimum level of documentation required to ensure that the determinations will be verifiable.

This guidance has been developed with the cooperation and input of representatives from all ten EPA regions and at least one state from each region. The guidance is in the form of questions to be answered in making an EI determination. The questions and answer options express the minimum criteria for EI determinations and are not to be modified for regional, state or site-specific conditions. The “Rationale” portion of the forms can be filled in to explain unique situations to any length necessary. While the signed hard-copies of these forms should reside in the facility’s administrative files, these forms should also be kept in electronic format that can be posted on an “EI database” web site to be developed by the Office of Solid Waste in the near future. The “EI database” will help communicate successes and provide examples for overcoming barriers to progress.

Thank you for your assistance with this important effort. If you have any questions, please call Bob Hall or Henry Schuver of my staff at (703) 308-8432 or 308-8656 respectively.

Attachment

References for Environmental Indicators (EIs)

Module References

- Interim-Final Guidance for RCRA Corrective Action Environmental Indicators (Cover memorandum signed 2/5/99, and guidance forms).

- Flowcharts - for the Environmental Indicators Guidance on Current Human Exposures Under Control and Migration of Contaminated Groundwater Under Control.

- Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Advanced Notice for Proposed Rulemaking (ANPR) May 1, 1996 (61 FR 19432). Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm

- Government Performance and Results Act (GPRA). Available to download from the Internet: http://www.epa.gov/ooaujeag/notebook/gpranew.htm

- RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction

- Environmental Indicators Website: http://www.epa.gov/Indicator

- RCRA Hotline Phone Number - (800) 424-9346

- USEPA, Region 3 Risk Based Concentration (RBC) tables http://www.epa.gov/reg3hwmd/risk/rbc1098.pdf

- Envirofacts “Maps on Demand” web site for identifying surrounding facilities etc. (only point locations of facilities on maps now, but plans for polygons in future) - http//www.epa.gov/region10/www/gisapps/natsite.html

- Electronic format for EI forms is available on the web at www.epa.gov/epaoswer/osw/ei_guida.pdf

DYNAMIC WORKPLANS AND FIELD ANALYTICS

Bob Hall

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
JOHN F. KENNEDY FEDERAL BUILDING
BOSTON, MASSACHUSETTS 02203-0001

3/24/99 mk

January 28, 1999

MEMORANDUM

SUBJECT: Documented Savings Using Field Analytical Technologies

FROM: Harley Laing, Director
Office of Site Remediation and Restoration, Region 1

James Woolford, Director
OSWER/Federal Facilities Restoration and Reuse Office

Walter W. Kovalick, Jr., Ph.D., Director
OSWER/Technology Innovation Office

TO: Addressees

Enclosed you will find a videotape and general guideline produced as part of the implementation of a performance based monitoring strategy at the Hanscom Air Force Base in Bedford, Massachusetts. This project resulted in considerable time and cost savings, and we wanted to share this information and the lessons learned with all of the Regions. It embodies the concept of conducting site investigations to more fully take advantage of advances in sampling and analytical technologies and strategies. It provides an excellent example of how these opportunities can be maximized.

Environmental monitoring technologies are evolving rapidly and inventors are devising more effective tools to identify and map pollution and its movement. Last fall, building off President Clinton's Environmental Technology Initiative (ETI), EPA New England and Tufts University coordinated an ETI-funded project at Hanscom Air Force Base in Bedford, Massachusetts. This "dynamic workplan/adaptive sampling and analysis" project demonstrated cost savings of up to $120,000 and cut project time in half when compared to off-site laboratory analysis and traditional site characterization processes. The project maximized cost effectiveness by evaluating and optimizing data quality objectives, analytical throughput rates, data turnaround times, sample collection rates, and sample analysis costs to meet the site-specific scientific and engineering questions under investigation prior to the beginning of the field work.

Over a two-week period, more than one thousand soil samples were analyzed for volatile organic compounds, PCBs, PAHs and metals by direct measuring thermal desorption gas chromatography/mass spectrometry (TDGC/MS), purge and trap GC/MS and an inductively

Recycled/Recyclable

coupled plasma/optical emission spectrometry (ICP/OES) method. At the end of each day, the data were entered into a software program that helped to visualize site contamination. The maps were used to facilitate the location of subsequent samples collected. The project was a collaborative effort of the USEPA, US Air Force, Massachusetts Department of Environmental Protection, industry, and Tufts. The work was performed and conducted under an EPA approved workplan. Staff from EPA conducted laboratory audits, reviewed standard operating procedures, method detection limit studies, and verified site data.

The project team developed a final report to provide users of environmental data with confidence that screening and quantitative data can be produced in the field and that the data generated will be accepted by the regulatory community. The success at the Hanscom Air Force Base should reduce regulatory uncertainty as to the quality of data that can be produced with these innovative technologies and methods as well as their cost competitiveness. The final report is available upon request. In addition, TIO is preparing an abbreviated case study of the project which will be forwarded to you upon completion.

For more information on this project or a copy of the final report, please contact the EPA-New England Project Officers John Smaldone at (617) 223-5519 and Nora Conlon at (617) 860-4335 or the Tufts University project lead, Dr. Albert Robbat at (617) 627-3474. You will also be able to access the final report on the Clean-Up Information Homepage ("http://clu-in.com") by the end of January. We feel that this type of work exemplifies the savings we are seeking to achieve in the Agency's waste programs. **If you are aware of similar projects in your Region, we would very much be interested in working with you to document the results. If you have such a project, please contact Dan Powell of the Technology Innovation Office at (703) 603-7196.** Thank you very much for your attention to this matter.

Attachments

Addressees:

Don Porteous, Acting Director, OEME, Region 1
Barabara Finazzo, Director, DESA, Region 2
Stan Laskowski, Director, EAPD, Region 3
Russell Wright, Director, SESD, Region 4
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Lynda F. Carroll, ARA, Region 6
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Regional Site Characterization Network
Members, Federal Remediation Technologies Roundtable
Superfund Technical Liaisons

A Guideline
for

Dynamic Workplans and Field Analytics:
The Keys to Cost-Effective Site Characterization and Cleanup

Prepared by

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1.0 Introduction

The ability to rapidly assess the disposition of environmental contaminants at purported or existing hazardous waste sites is an essential component of the nation's environmental restoration program. Each site, whether owned by the public or private sector, must be evaluated to determine whether risk to human health or the environment exists. If the data obtained supports the notion that no risk or an acceptable level of risk exists for the intended land usage then no further action may be required. If, on the other hand, sufficient risk has been determined to warrant a full site characterization, the site investigation effort must delineate the nature, extent, direction, concentration and rate of movement of the contamination along with the physical and chemical site attributes.

Despite the best efforts of the U.S. Environmental Protection Agency[1] (EPA) and other federal agencies including the Departments of Defense and Energy to validate field analytical technologies, field analytics has not played a significant role in either hazardous waste site assessments or cleanup. In 1995, the EPA issued a Request for Proposals in support of President Clinton's efforts to promote application of innovative environmental technologies and to address the many factors that might pose barriers toward their commercialization. The President's Environmental Technology Initiative (ETI) is focused on accelerating environmental protection, strengthening America's industrial base, and increasing exports of U.S. technologies and expertise. The Tufts project was directed at two key objectives identified in the FY95 strategic plan: namely, strengthening the capacity of technology developers and users to succeed in environmental innovation *and* strategically investing EPA funds in the development and commercialization of promising new environmental monitoring, control, and remediation technologies.

The dynamic workplan guidance document represents one aspect of these objectives. The document is aimed at helping federal and state regulators, siteowners and their consulting engineers, and remediation companies understand what is involved in constructing and carrying out a dynamic workplan. The purpose of the document is to illustrate the many factors that should be considered in incorporating field analytical instrumentation and methods into an adaptive sampling and analysis program for expediting the site investigation process. This dynamic process should result in a faster, better, and hopefully cheaper site characterization and cleanup. With this goal in mind, field analytical technologies developed by the Tufts' Center for Field Analytical Studies and Technologies and with in-kind support from several commercial companies were demonstrated in the context of a dynamic workplan/adaptive sampling and analysis strategy. The ETI project, in part, supported an ongoing soil investigation study at Hanscom Air Force Base (Bedford, MA), see Hanscom report.[2] With the assistance of EPA Region 1, the Air Force and its contractor (CH2MHill), a video tape was produced illustrating the dynamic site investigation process.

---

[1] E. Koglin and L. R. Williams, Trends in Analytical Chemistry, 13, 294-299 (1994).

[2] A. Robbat, Jr., Tufts University, Case Study: Dynamic Workplans and Field Analytics: The Keys to Cost-effective Site Investigations, 1997.

1.1 Dynamic Workplans

Successful hazardous waste site investigations should be focused with goals and objectives clearly defined. This does not mean, as has been past practice, that the site investigation process should result in workplans that are "etched in stone." Figure 1 depicts a traditional sampling and analysis program. The workplan relies on pre-specified sampling locations, numbers of samples collected and the types of analysis to be performed. The traditional site investigation is static in its application. It does not provide a framework for changes in direction based on what is learned in the field. Samples are collected, packaged and typically sent off-site for analysis. Because data turnaround times range from several weeks to several months, analytical results are unavailable during the field investigation phase to address data "surprises" or concerns while the sampling team is still on site. Experience has shown that multiple field investigations within the same or subsequent seasons are required to fill data gaps. The traditional process results in several trips to the field by the sample collection and survey teams before the site investigation can be completed. This static process typically occurs during hazardous waste site cleanups as well.

Dynamic workplans, as shown in Figure 2, provide an alternative to the traditional approach. Dynamic workplans rely, in part, on an adaptive sampling and analysis strategy. Rather than dictate the details of the sample analysis to be performed and the location and number of samples to be collected, dynamic workplans specify the decision-making logic that will be used in the field to determine which chemical compounds require analysis, where to collect the samples and when to stop sampling. Adaptive sampling and analysis programs change as the conceptual model for the site is refined based on the analytical results produced in the field. A successful adaptive sampling and analysis program requires analytical methods and instrumentation that are field-practical and can produce data fast enough to support the dynamic workplan process.

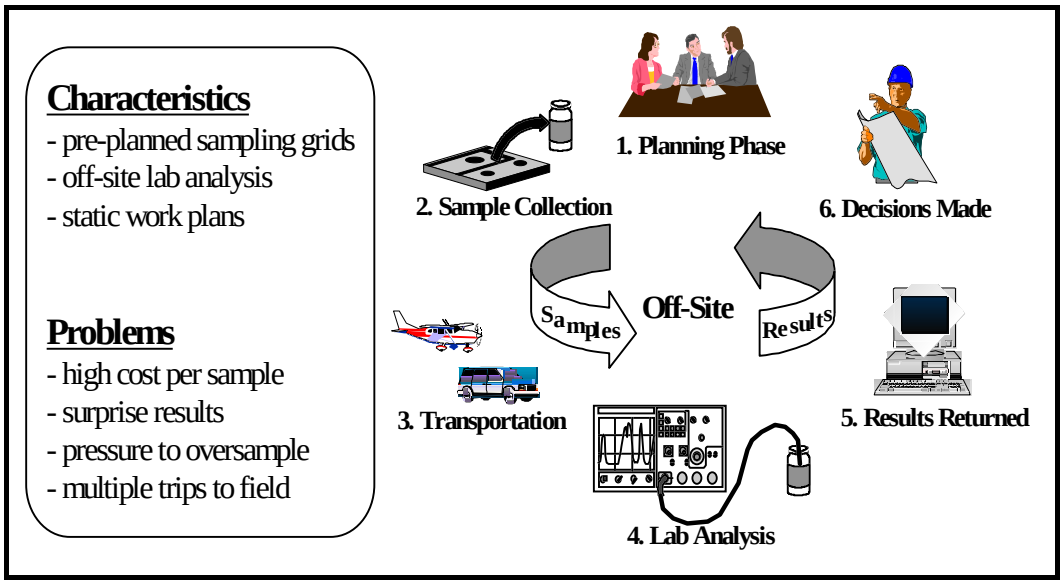

Figure 1. Traditional Site Investigation

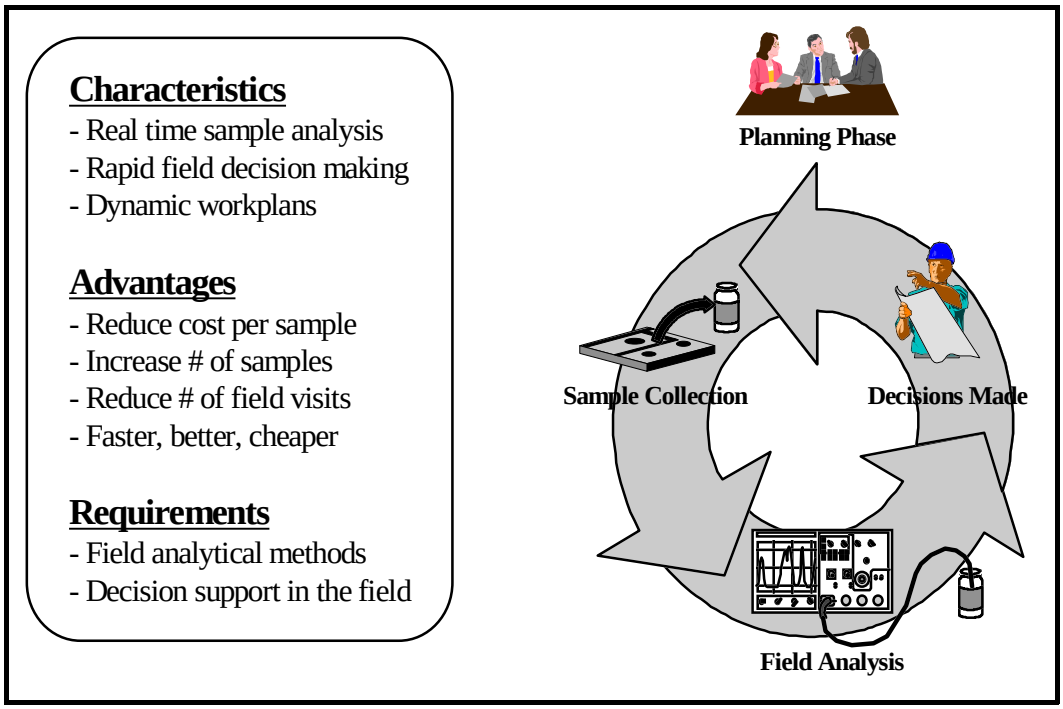

Figure 2. Dynamic Workplan Approach

1.2 Factors to be Considered

When deciding to carry out a Dynamic Workplan/Adaptive Sampling and Analysis program for projects consisting of complex chemical and physical site conditions, environmental contamination, and long duration, several factors should be considered before embarking on this approach. For example:

- Is it possible to assemble a well-rounded core technical team including analytical chemists, engineers, geologists, geochemists, geophysicists, hydrogeologists, risk assessors, and regulators?

- Will the core technical team be in the field for the duration of the field investigation? Is the decision making process well-defined and is the authority vested in an appropriate technical team member?

- Has the action level for field decisions, which rely on developing an understanding of the scientific and engineering questions under investigation, been established as part of the data quality objectives?

- Will the project objectives permit screening and semi-quantitative data or will quantitative data only be required to meet data quality objectives?

- Will more than ten percent of the samples analyzed in the field be sent off-site for laboratory confirmation analysis? Has the methodology for determining field and laboratory data comparisons been addressed?

- When selecting the field instrument or method, have measurement selectivity, sensitivity, precision, accuracy, representativeness, and action levels been addressed?

- When selecting the field instrument or method, have the measurement attributes listed above been addressed in sample throughput rates and cost? (Note that the number of sample cleanup steps and the time needed to prepare samples for analysis to meet the site-specific data quality objectives may limit throughput rates and increase sample costs.)

- Can standard operating procedures and method detection limit studies be completed before mobilization to evaluate matrix interferences that might be associated with a particular field technology?

- Will data management tools and geostatistical sampling tools be integrated into the field investigation?

- Is the site accessible for field analytic deployment including mobile laboratories, electrical power (line voltage versus a generator), and water if necessary?

- Has sufficient space been provided to house analytical instruments and staff, sample preparation, and data management in the field laboratory? Has proper ventilation been incorporated into the field laboratory?

- Does the length of the project and the potential overall cost savings warrant this approach?

2.0 Dynamic Workplan Guideline: Purpose and Objective

Dynamic workplan investigations are site dependent. They include field-based technologies and methods that produce chemical, physical, geological, and hydrogeological information about the site. The data generated must be of sufficient quality, with respect to measurement precision, accuracy, sensitivity, and completeness, to support the objectives of the site investigation or cleanup. The dynamic workplan plan guide described herein is not intended to be all inclusive. It does not address subsurface sampling tools; methods for collecting soil, water, or air samples; remote sensing and geophysical surveys; mathematical or computer modeling; nor will it discuss computer-based statistical sampling or the various site visualization tools. Depending on project objectives, a successful *dynamic* hazardous waste site investigation or cleanup will require one or more of these tools.

The guidance document is aimed at integrating field analytics into the Dynamic Workplan/Adaptive Sampling and Analysis process. It is intended to lay the foundation for incorporating an iterative process into the static <u>but</u> widely-used Data Quality Objectives (DQOs) framework for decision making planning. The guideline outlines field analytical instrument implementation, an adaptive sampling and analysis strategy, and site requirements.

3.0 The Dynamic Workplan Process

In the traditional approach, major decisions concerning the direction of the site investigation or cleanup are generally made by the project manager after the field work has been completed. A report is prepared presenting the findings to the appropriate regulatory body. Discussions begin about whether sufficient information has been obtained to address the scientific and engineering questions of concern. Typically, several field mobilizations occur, reports are written, with many meetings held between the siteowner and its environmental consulting company *and* the siteowner and federal and/or state regulatory agencies. In contrast, these same decisions are made in the field in an adaptive sampling and analysis program. In constructing the dynamic workplan, it is important to determine prior to mobilization what decisions will be made, how these decisions will be made, and who will make them in the field.

Step 1: Select the core technical team whose responsibility it will be to prepare the dynamic workplan. The technical team should possess expertise in analytical chemistry, geology, geochemistry, geophysics, hydrogeology, and risk analysis. The team helps with data management, QA/QC, risk assessment, fate and transport modeling, remedial action, community relations, and health and safety. The technical team will be responsible for:

1) gathering all available information for the site,

2) developing an initial "conceptual" model for the site,

3) identifying the technical objectives and goals to be accomplished,

4) supervising the field effort, making adjustments to the conceptual model based on the data produced in the field, and

5) evaluating the conceptual model and decisions made with respect to federal, state, and local regulations.

The core technical team will be responsible for making decisions in the field. One member of the team must have final decision making authority and responsibility to keep the site investigation process moving forward at a reasonable scientific and cost-effective pace. Some have proposed that the technical team be on site during the entire site investigation study[3]. This may not be practical or economically feasible for every project and is probably unnecessary given the currently available computer and telecommunication technologies. At least one member of the technical team should be on site at all times. This person must have a working knowledge of all aspects of the investigation or cleanup DQOs and be in daily communications with technical team members via electronic data transfer. Field personnel (and off-site technical team members) should be in regular communication with staff from federal and/or state regulatory agencies to ensure that decisions made in the field, typically under the pressures of time and field-resources utilization, are in conformance with the dynamic workplan framework.

---

[3] ASTM Draft Provisional Standard Guide for Expedited Site Characterization of Vadose Zone and Ground Water Contamination, July, 1996.

Step 2: Develop the Initial Conceptual Model and Decision Making Framework.

Initial Conceptual Model. The initial conceptual model contains the best-available information at the start of the project. It depicts the three-dimensional site profile based on vadose zone and ground water flow systems that can exert influence on contaminant movement. Key site features such as roads, buildings, hydrography, depth to bedrock, direction of ground water flow, and potential preferential pathways for contaminant transport are mapped. Map cross sections should include water levels, high and low permeability zones, and aquifers. The conceptual site model is updated as additional data becomes available during the site investigation or cleanup process. The conceptual model is dynamic in nature and changes to reflect the increased site knowledge gained from field activities.

To assure efficient, effective decision-making the regulatory oversight organization should be included in developing the dynamic workplan. Stakeholders should 1) agree at the beginning on the most likely kinds of action(s) to be taken as a result of the field data, 2) implement the appropriate action on a daily basis as the data is generated, and 3) take new directions when the data suggests deviations from the conceptual model. It should be pointed out that site delineation is an iterative process and should be viewed as an ongoing experimental project.

The Decision Making Framework. The initial conceptual model is based on the Data Quality Objectives (DQO) for the site. The DQO process involves a series of planning steps designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application. It relates data needs to specific decisions to be made[4]. Briefly, the data quality objective process involves:

- Statement of the Problem. Concisely describe the overall study objectives outlining the scientific and engineering issues to be addressed. Review prior field studies and existing information to gain an understanding of the problem(s). Fuse soft information with hard data.

- Identify the Decisions to be Made that Will Address Each Problem. Independently, and then collectively, identify the types of decisions that will solve the problem(s) and the quality of sample collection and field analytical data required.

- Identify the Inputs to the Decision. Identify the information that needs to be learned in the field and the type of data quality needed to make field decisions.

- Define the Study Boundaries. Specify the range of conditions (time periods and situations) to which field decisions will apply, and within which field data will be collected.

[4] EPA QA/G-4, "Guidance for the Data Quality Objectives Process" September 1994.

- Develop Decision Rules. Integrate the decision outputs from previous steps into an "if...then..." statement that defines the conditions that would cause the decision maker in the field to choose alternative actions and/or take different directions to solve the problem(s).

- Specify Acceptable Limits on Decisions. Define the decision maker's continuation on a given pathway or alternative action based on field data produced on site: Has the direction followed gone far enough such that any further continuance provides no or marginal added value on a cost/benefit basis?

- Optimize the Conceptual Model. Evaluate information from each previous step and generate alternative sampling and analysis pathways and data quality requirements based on the initial conceptual model. Refine the model and/or pathways toward collecting additional on-site data as new information is provided.

The DQO process is used to define the quantitative and qualitative criteria for determining when, where, and how many sample measurements to collect and at what desired confidence level. Because several different data qualities may be appropriate to answer the site-specific scientific and engineering questions that must be addressed, the term sufficient or acceptable data quality is meaningful only when the intended uses for the data are known. The intended use of the data today may be different from tomorrow. Therefore, it cannot be overemphasized that cost-effective site investigations are highly dependent on anticipating data usage during the life of the characterization-to-cleanup program.

Step 3: Develop Standard Operating Procedures. The next step in developing a dynamic workplan is to establish standard operating procedures (SOPs). SOPs for sample collection and analysis should be produced along with other SOPs required to answer site-specific questions, e.g., geophysical and hydrogeological surveys, etc. The SOPs should be developed by the core technical team and approved by the appropriate regulatory body prior to initiating field activities. The field methods should be "performance based" and provide data of sufficient quality to meet the DQOs, see Section 4. The USEPA is encouraging the use of field analytical technologies and methods to expedite hazardous waste site investigations and cleanups in Superfund, RCRA, and Brownfields[5]. Because these technologies and methods may not be amenable to typical CLP or SW846 methods, QC procedures or data reporting formats, supporting data produced from the proposed field techniques should be provided to document data quality. Note that CLP and SW846 methods are not always required by the EPA to generate data.

Step 4: Develop Data Management Plan. Critical to the success of the dynamic process is the ability to manage and easily use all of the data produced in the field. Data integration (chemical, physical, geological, hydrological), sampling, and analysis protocols should be incorporated into

[5] May 1, 1996, Federal Register 61FR 19431-19463.

an overall data management plan. Protocols for sample logging, analysis, data reduction, and site mapping should be established. Several different organizations may be involved in this process. The data management plan should be established with rules and responsibilities defined prior to mobilization for the collection, assimilation, and presentation of the field generated data. As an example, computers housed in the sample receiving, organics, and metals analysis laboratories can be electronically linked through Ethernet connections to the data management trailer on site. Sampling logging information and the results of the analysis can be managed through a Laboratory Information Management System or through the use of spread sheets. The data can then be downloaded to a computer containing site visualization software for conceptual model update and review. In this manner, contaminant profiles are more easily understood facilitating the on-site decision making process.

Step 5: Develop Quality Assurance Project Plan. This document contains the sampling method, analytical procedures, and appropriate quality assurance (QA) and quality control (QC) procedures. Quality assurance/quality control (QA/QC) defines the responsibility of the technical team and regulators. It describes the procedures to be used to monitor conformance with, or documentation and justification of departure from the SOPs. The overall goal is to ensure that data of known and adequate quality have been produced to support the decision making process. Again, data of varying quality can be produced to support a range of activities from sample collection to risk assessment.

Step 6: Prepare Health and Safety Plan. Finally, a health and safety plan is produced as part of the Dynamic Workplan/Adaptive Sampling and Analysis project. DQOs should be established for the field analytical tools used to monitor worker and community safety and should be presented in the health and safety plan.

After all field organizations have mobilized and all analytical instruments have been calibrated, it is recommended that a dry run be made to ensure that all participants understand their respective roles and that the quality control (QC) systems from sample collection-to-analysis-to-site contaminant visualization are well-understood and can be easily implemented. On-site data verification may also be desirable for projects of large scope and duration.

3.1 Adaptive Sampling and Analysis Strategy

Figures 3 and 4 illustrate the adaptive sampling and analysis strategy for a hypothetical soil screening site investigation aimed at determining contaminant risk to ground water and human health. Figure 3 depicts the decision making flow chart for the investigation. Figure 4 describes the change in analysis based on what is found at the site. Once the initial sampling data (Round 1) is obtained the conceptual model is evaluated for accuracy. Typically, several sampling rounds are required before confidence in the conceptual model is obtained. The number of sampling rounds, made during the same mobilization, is dependent on the DQO specifications for confirming the absence of contaminants in areas thought to be clean (candidates for no further

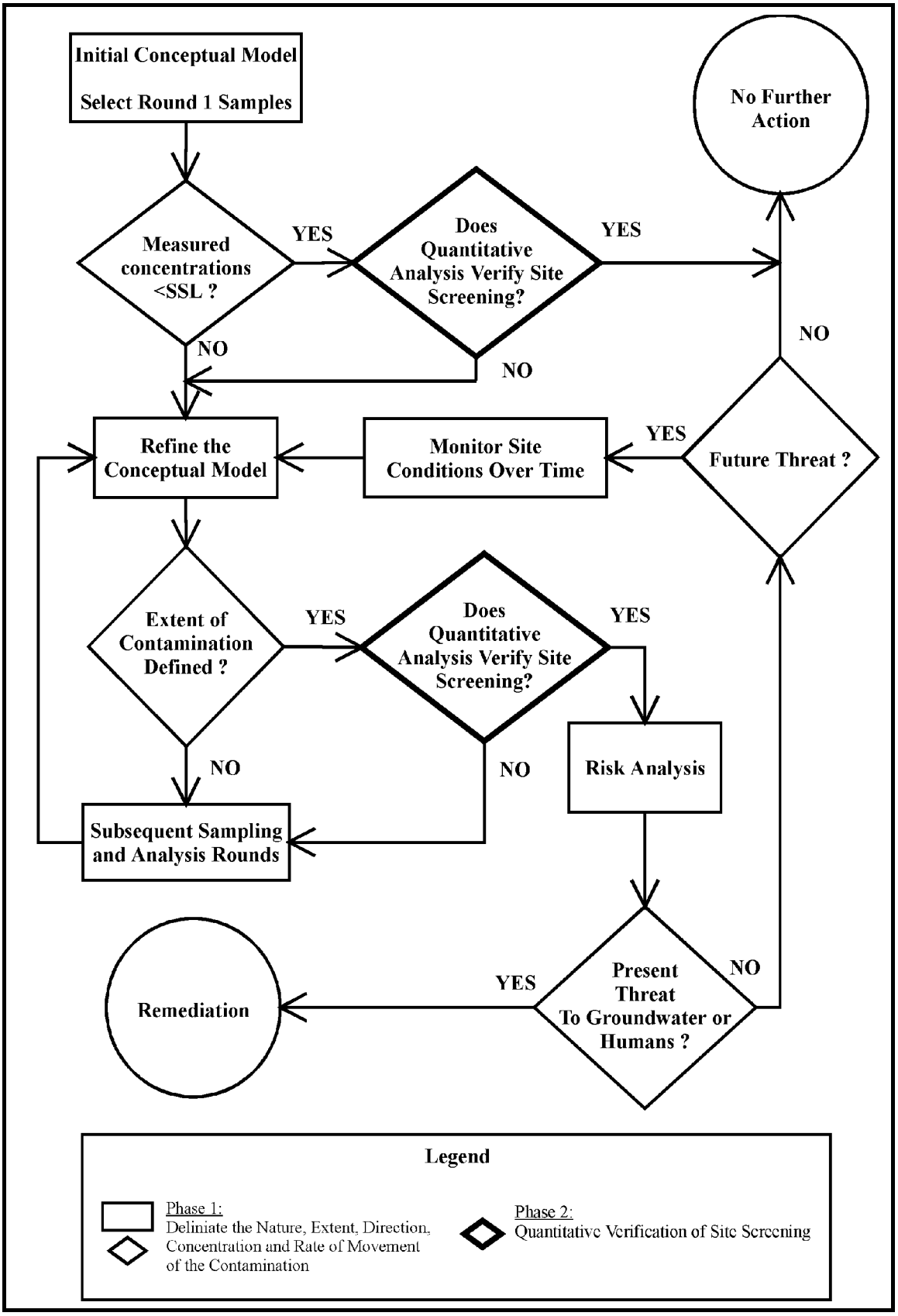

Figure 3. Adaptive Sampling and Analysis Flow Chart

action) *and* for determining the extent, direction, concentration, rate of contaminant migration, volume of contaminated soil and its risk to ground water and human health. Once the soil contamination profile objectives have been met and a verified conceptual model is produced, the data should be capable of delineating whether a particular area of investigation falls within three categories, namely:

- the site is clean or poses acceptable risk - no further action required
- the site is highly contaminated and well above action levels for acceptable risk - remedial action begins
- the site poses marginal risk - cost/benefit of an immediate cleanup not warranted, monitor for future action.

In the example provided, Round 1 samples are analyzed for the full Contract Laboratory Program (CLP) Target Compound List for volatile organic compounds (VOCs), semivolatile organic compounds (semi-VOCs), and metals if no prior field studies have been made. Target compound analysis is then performed for those contaminants found in each subsequent sampling round. As the analyte list decreases, more samples may be analyzed during the workday. Following the decision making logic through to completion, if site samples contain no detectable contaminants above the Soil Screening Levels (SSL) established for the site, site verification is made based on quantitative field analytical measurements. Several outcomes are possible. First, if the quantitative data verifies the field screening data and the data supports the conceptual model, no further action should be required at the site. Second, the comparison between field screening and quantitative measurements are within the site-specific DQOs for the data but the results do not support the conceptual model. In this case, additional sampling rounds are required to refine the model. Third, the comparison between quantitative and screening data fall outside of the acceptable DQOs, reassessment of the field screening tool is then required.

Following the alternative pathway, i.e., site screening measurements result in contaminant concentrations greater than the SSL's, sampling continues and the conceptual model is refined until the site-specific DQOs are met. The findings from the site screening effort are again verified by quantitative field analysis. Once the site data and conceptual model are verified, risk-based decision making occurs with respect to human health and the environment: that is, remediate or monitor for a future threat. At this point, new workplans must be produced to address site remediation or long-term monitoring needs. It should be pointed out that not all present or future threats will necessarily lead to a cleanup remedy. For example, the contamination may be technically impracticable to cleanup (dense non-aqueous phase liquids in bedrock) or natural attenuation may be proposed for the site.

Rather than relying on fixed grids, sampling is directed by geostatistical sampling tools that can predict where the next round of samples is collected. Because quantitative measurements are made on-site, greater confidence should be obtained in the sampling program. Phase 2 in Figure 4 illustrates one approach for verifying the site screening results. Recall that screening, semi-quantitative, or quantitative data can be generated in Phase 1 to develop the site model. If screening quality data, e.g., enzyme kits, is generated then more quantitative field, analytical data

should be produced to verify the results from the site screening phase. The number of locations within and surrounding each contaminated and non contaminated area as well as the number of depth samples at each location should be determined by the core technical team. An example is provided in the figure. The purpose of Phase 2 is to test the model and to verify the analytical results.

In an adaptive sampling and analysis program, contaminated areas are more heavily sampled than in traditional site characterization studies. Therefore, if semi-quantitative or quantitative field analytics is performed, no additional "quantitative" data may be necessary other than what is typical to verify data from one fixed-based laboratory versus another. Rapid, 5 to 15-minutes per sample, measurements should provide the majority of analyses during Phase 1, with 10% to 25% of these samples analyzed quantitatively in Phase 2. Off-site laboratory analysis should be performed only when on site quantitative analysis is not possible or cost-effective (Phase 3).

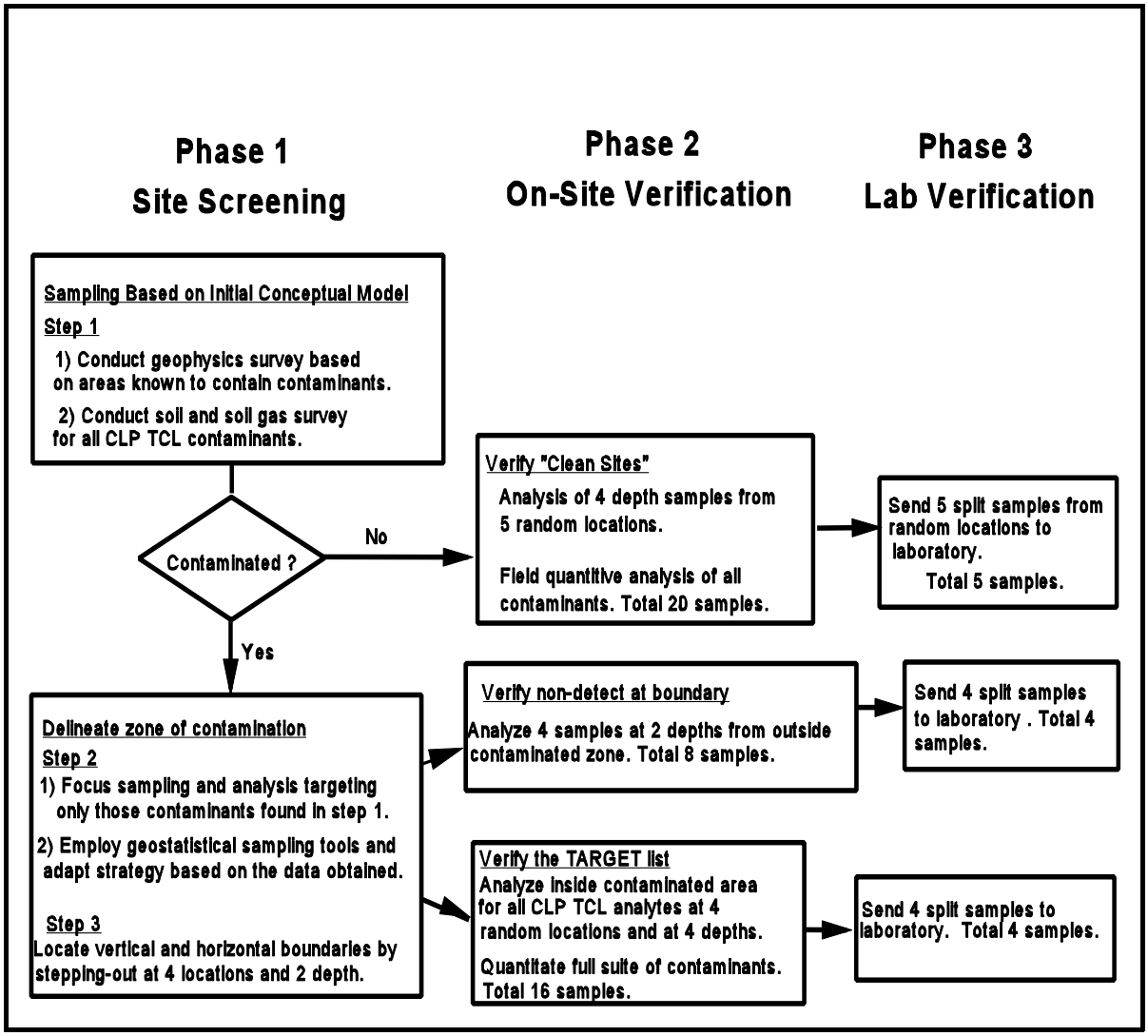

Figure 4. Example of Sampling and Analysis Flow Chart

Field results will differ from off-site laboratory results for VOC contaminated soil samples, with field measurements generally producing higher measurement concentrations because of analyte loss during off-site sample transport and storage. Care must be taken when these types of comparisons are made. Because site investigation and cleanup decisions are made based on field data, off-site laboratory analysis should be performed on no more than 10% of the samples analyzed quantitatively in the field. Field techniques that produce different data quality with the same instrumentation offer cost advantages over analytical techniques that produce either screening level or quantitative data[6]. Time and total project cost savings result when the sample load best matches the sample throughput rate of the instrumentation maximizing the effectiveness of field personnel and equipment, see Section 4.

Finally, field work begins based on the initial conceptual model. As new data are generated scientists and engineers may disagree over the direction(s) taken. Experience has shown that this will most likely occur based firstly on field discipline and secondly on stakeholder bias. One or more changes in direction should be proposed, with start/stop decisions delineated in the dynamic workplan. New results should refine the conceptual model and dictate future directions. Clearly articulated parameters with respect to sample number and DQO specifications obtained as a function of time should be identified in the workplan to set constraints on how long a particular pathway is followed before altering the investigation direction. One member of the siteowner technical team and one member of the regulatory oversight agency must have final site decision making authority. Site work stops when answers to the questions posed in the workplan meet site-specific confidence levels established as part of the DQO process. To ensure that site-specific goals have been met, the project team should statistically evaluate the results of its findings[7]. An adaptive sampling and analysis program focuses staff, equipment, and financial resources in areas where contamination exists while providing a cursory inspection in areas that pose no or little risk to human health and the environment.

4.0 Introduction to Field Analytics

The selection of field analytical methods is critically dependent on the need to make decisions in the field rapidly. Field analytical techniques should be capable of providing data from minutes to tens of minutes. They should have documented measurement sensitivity, precision, and accuracy to meet site investigation and cleanup DQOs. The simpler the technique the more likely it will be used in the field. Field instruments must be transportable, operate under adverse conditions, and provide improved cost/benefit over laboratory analysis. For projects of short duration and low sample volume, staff and equipment mobilization expenses may make field analytics a cost-prohibitive option. In addition, if quantitative measurements are required for all samples, field analytics may not provide a cost-effective means for obtaining site data. Rarely is this the case. Almost all projects will require screening or semi-quantitative data during the field

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[6] B. M. Abraham, T-Y Liu, and A. Robbat, Jr., Hazardous Waste & Management, 10, 461-473, 1993 *and* K. Jiao and A. Robbat, Jr., J. of AOAC International, 79, 1996.

[7] Guidance for Data Quality: Practical Methods for Data Analysis, EPA QA/G-9 EPA/600/R-96/084, July 1996.

screening phase of the site investigation. Even short projects of one to three days, where six to twelve samples per day may be collected, will benefit from field measurements. For example, head space gas chromatography (GC) can be simple and fast for the analysis of VOCs in soil and water samples during underground storage tank removal or well installation and monitoring. Enzyme kits can provide rapid detection of polychlorinated biphenyls (PCBs) or explosives during site characterization or remediation. Field instrumentation, such as in situ fiber optics and electrochemical sensors or portable GCs can be used to provide a security system to monitor underground subsurface contamination migration, process control, or fugitive emissions during site cleanups or long-term monitoring operations.

Field analytics can be routinely used to monitor worker and community health and safety during site investigations and cleanups. For example, the protection of workers from exposure to hazardous substances during sampling is of primary concern. In this case, sampling speed and limited sample handling is an important aspect of the measurement process. The sampling and measurement methods must be suitable to meet guidelines set forth by the National Institute for Occupational Safety and Health.

4.1 Field Measurement and Contaminants of Concern

The action level (or level of concern) defines the contaminant concentration needed to produce useful data to answer site-specific scientific and engineering questions. The selected field method must demonstrate method detection limits below the action level established for the site. The action level defines the concentration at which decisions can be made, including:

- nature and extent of contamination, i.e., field data supports the overall site investigation
- risk to human health and the environment, i.e., field data provides input into baseline risk assessment process
- achievement of cleanup objectives, i.e., field data supports site compliance with regulatory-imposed concentration levels

As an example, the EPA has compiled a list of contaminant soil screening levels for land usages based on different risk factors. These generic soil screening levels take into account the natural attenuation processes for the migration to ground water pathway(s) that can reduce contaminant concentrations in the subsurface. To insure that the field analytical instrumentation and methods selected in the workplan are amenable to a given site, site-specific method detection limit studies should be performed for each class of contaminants (e.g., VOCs, semi-VOCs, and metals) from soil obtained from the site prior to the field investigation. This will help to determine whether matrix interferents or target compounds mask (e.g., portable GC) or cross-react (e.g., enzyme/wet chemical kits) with targeted organics or metals (e.g., by electrochemical detection).

4.2 Field Analytical Techniques

Field analytics can be divided into two categories: real-time and "near" real-time measurements. Real-time measurements include those techniques that provide instantaneous analysis without the need for sample pretreatment. Examples include ion selective electrodes, fiber optic sensors, hand-held gas monitors, direct measuring GC's, and portable x-ray fluorescence (XRF) instruments. With the exception of XRF, these tools are typically used as continuous or in situ monitors for either gaseous or liquid streams.

Near real-time measurements typically include the more quantitative analytical techniques. They generally require some sample pretreatment prior to analysis of complex samples. These techniques include wet chemical and enzyme immunoassay kits; GC with a variety of non-specific detectors such as photoionization (PID) and flame ionization (FID), class-selective detectors such as electron capture (ECD for PCBs and chlorinated pesticides) or chemiluminescence (CD for nitrated explosives), and compound-specific detection by mass spectrometry (MS for identification of individual organic compounds); total petroleum hydrocarbon (TPH) analyzers; *and* inductively coupled plasma/optical emission spectroscopy (ICP/OES); XRF; and anodic stripping voltammetry for metals analysis. The size and experimental operating features dictate whether they are classified as field portable or transportable (laboratory-grade) instruments. For example, portable GCs are typically small in size, can operate off batteries but have ovens that cannot be temperature programmed (isothermal operation) or have slow temperature program ramps from ambient to 200 ^{0}C.[8] In either case, these GCs are best suited to qualitative analysis of VOCs. In contrast, GC/MS instruments require a generator or a line voltage power source, but can produce quantitative analysis of VOCs and semi-VOCs in the field.

In many instances, it is not necessary to have quantitative data for every sample during PCB, PAH, or explosives soil remediation. For example, when excavating soil, measurement accuracy can be as high as 40-70% as long as measurement precision is known. Enzyme kits and rapid screening GC with ECD, FID, or MS can provide this level of data quality. Quantitative analysis, on the other hand, is needed only for the pit closure samples to verify that the cleanup DQOs have been met. Field GC/MS can provide the necessary measurement sensitivity, precision, and accuracy to meet most site-specific cleanup DQOs. Similarly, VOC soil and water analysis by rapid screening GC with ECD/FID or MS is sufficient to determine vadose zone and ground water contamination profiles. More quantitative GC/MS data are required to determine the threat to ground water and the associated risks to human health and the environment. Performance-based methods can provide maximum flexibility to meet site-specific data needs.

A considerable amount of field analytical methods are available. Not every field method is amenable to the full range of environmental contaminants. Some are selective by design (enzyme and wet-chemical kits), while others are limited in scope (portable GC and XRF) or by media type (fiber optic, acoustic wave, and electrochemical sensors). Sample throughput rates in the field can also limit the effectiveness of field analytical measurements. Careful consideration should be given to these issues before selection of field analytical techniques or methods. The amount of sample preparation prior to analysis will determine the sample throughput rates that can be achieved. Experience has shown that field GC/MS can provide both screening and

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[8] Analytical Chemistry, 69, 195A-200A, 1997.

quantitative data for the full range of organics depending on the sample introduction system and data analysis software used. Data quality and throughput rates must be determined before the decision is made as to which field analytical technologies or methods are appropriate. An initial documented statement for the end use of the data incorporated into the data decision process will ensure that inappropriate data uses do not occur.

4.3 Sample Throughput Rates and Analytical Properties

No one laboratory technique or method is universally accepted for all EPA listed organic or inorganic contaminants. The selection of field methods for site characterization and cleanup depends on the material to be examined, contaminants and action levels of concern, QC requirements, sample throughput rates, and cost. Selection of field methods also depends on the type of data quality required to answer site-specific questions. It is important to have a clear understanding of the particular analytical properties required to meet site-specific DQOs and how the economic considerations of a given analytical problem affect some properties over others.

Accuracy and Representativeness are two key attributes of data quality. Accuracy refers to the closeness of the result between the measured and actual ("true") analyte concentration in the sample. Accuracy can be calculated based on the degree of agreement between the observed value and the accepted reference value. Commercially prepared standard reference materials (SRM) or site-specific SRM's are often used to determine accuracy. Representativeness is defined as the consistency between the result and the measured sample as well as between the result and the definition of the analytical problem. Representativeness is the degree to which data accurately and precisely represents the frequency distribution of a specific variable. Measurement accuracy can be influenced by the required measurement sensitivity, selectivity, and precision whereas representativeness is affected by sampling location exactness and sample homogeneity consistency. The influence of sampling on analytical quality is, overall, crucial. For example, blood-sugar from a diabetic more than 1-hr after a hypoglycemic attack is not representative of the blood-sugar concentration at the time of the attack. Likewise, collecting soil samples two feet apart and expecting one of the samples measured by the field laboratory to be representative of the other sample analyzed by either the on-site or off-site laboratory is unreasonable. No other analytical property can be justified without representativeness. Because of subsurface soil inhomogeneities, collecting the many statistical samples necessary to gain the confidence needed to delineate the extent, direction, concentration and rate of contaminant movement is generally too costly in the traditional site investigation approach. The adaptive sampling and analysis strategy helps to focus the sampling effort in areas where contamination has been identified which, in turn, results in more data produced in the areas where it is needed. Nonetheless, the analytical measurement process is most often the bottleneck that controls the rate of the site investigation when compared to sample collection.

Assuming representative samples have been collected, measurement accuracy is directly dependent on the relationship among three key analytical parameters: precision, selectivity, and sensitivity. Accurate results cannot be obtained unless the measurement technique produces selective detection and adequate sensitivity. Selectivity refers to the instrument's or method's ability to respond to target compounds in the presence of nontarget sample constituents. For

example, if the analytical technique responds to the presence of matrix interferents or cross-reactive target compounds, measurement identity is affected and thus, accuracy. Moreover, if the analyte concentrations in the sample are at or just below the method detection limit, the measured concentrations may be inconsistent (precision). Measurement precision is the degree to which a set of analyses of the same parameter conforms to itself. To achieve unambiguous analyte identification and the desired method detection limit, extensive sample preparation procedures may be required to remove matrix constituents, dilute, or pre-concentrate the sample extract. These additional steps lengthen the overall time of the analysis (sample throughput rate).

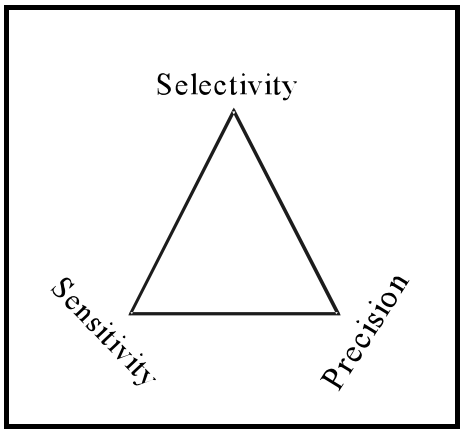

Figure 5. Data Attributes

Generally, as one property of the equilateral triangle is improved, one or both of the remaining analytical properties can become distorted. For example, increasing the number of sample preparation steps prior to the analytical measurement can result in loss of analyte, which, in turn, can influence measurement sensitivity and thus, accuracy (false negative). Another example is the detection of nitrated explosives by selective reagents such as enzymes. Field-practical enzyme immunoassay kits can significantly reduce the time of analysis over laboratory high performance liquid chromatography (HPLC) methods by eliminating the need for sample cleanup procedures. False positive detection is possible, however, due to cross-reactivity with other nitrated organic compounds that might be present in the sample. Although advancements in analytical instrumentation, sophisticated spectral deconvolution software routines, and compound-specific reagent chemistry have increased laboratory productivity, sample throughput rates and data quality are greatly influenced by the triangular interactions among selectivity, sensitivity, and precision. As increasingly more stringent measurement accuracy is specified, sample throughput rates decrease. For example, several published reports document the wide range of measurement precision and accuracy that is obtained when employing EPA method 8080 (20-min/sample) as compared to the more comprehensive congener-specific (90-min/sample) analysis for PCBs.[9,10,11]

The relationship between sample throughput rate, data quality, and field investigation costs can be viewed as follows. Assume a 10-hr workday with two hours set aside for lunch, daily meetings, instrument maintenance and lab cleanup. Also assume that each analysis requires a 5-min cycle time before the next sample can be analyzed and that any sample preparation procedures that might be necessary to remove nontarget matrix interferences occur separately from the analysis. Table 1 summarizes the relationship between number of samples that can provide information about the site and the number of QC or re-analysis samples required to

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[9] R. Eganhouse, and R. Gossett, Anal. Chem., 63, 2130-2137 (1991).

[10] D. Kimbrough, C. Rustum, and J. Wakakuwa, Analyst, 119, 1277-1281 (1994).

[11] G. Frame, J. Cochran, S. Bøwadt, JHRC., 19 657-668 (1996).

determine data quality as a function of sample throughput rate. Assume that in this hypothetical site investigation 300 soil samples are analyzed for PCBs at a soil screening level of 0.5-ppm to determine risk to ground water.

Table 1. Number of Samples Analyzed per Day

	TDGC/MS or Enzyme Kit 10-min/sample		EPA method 8080 20-min/sample	
Total Site Samples	300	300	300	300
Site Samples Analyzed Per Day	22	18	14	10
Site Samples Re-analyzed	3	5	0	2
Blanks	2	2	1	2
Replicate Analysis	2	3	1	2
Accuracy (SRM)	1	2	1	1
Initial/Final Calibration	2	2	2	2
Total Analysis/Day	32	32	19	19
Total Field Days	14	17	22	30

The number of field days needed to complete the site investigation presumes no loss of time for instrument breakdown, repair and/or re-calibration. If, for example, five samples are re-analyzed rather than three due to matrix interferents, detector overload, or frequency of field duplicates *and* three samples are analyzed to determine measurement precision and accuracy, a total of 17 site samples can be analyzed per day as compared to 22 for the 10-min analysis. Increasing the number of quality control or re-analysis samples decreases the number of site samples that can provide information about the site. A total of 18-days will be needed to complete the project as compared with 14-days when the sample throughput rate is 10-min/sample.

When analyzing soil samples by EPA method 8080 in the field, adding additional non site samples will result in the project being completed in 30-days versus 22-days. Apparent is the fact that the sample collection and field analysis rates must be matched and that the site-specific DQOs be well-understood in the context of selecting appropriate field analytical techniques, methods, and QC procedures. If, for example, PAHs must also be analyzed, then no additional analysis time is required by TDGC/MS, i.e., PCBs and PAHs are analyzed simultaneously. When standard laboratory technologies or enzyme kits are employed two separate analyses must be performed,

increasing total project costs. Note that these field laboratory costs do not represent total project costs. For TDGC/MS analyses minimal sample preparation is required. Although the extraction and cleanup of 20 samples can be accomplished in two hours for method 8080, the field laboratory must accommodate the sample preparation station and staff to achieve reasonable throughput. Expenses for the sampling crew and core technical team plus any other field services work must be added to the overall project costs.

When the principal organic contaminants and action levels are known, the selection of the field method should be straightforward. In complex mixtures, indicator compounds such as trichloroethene, carbon tetrachloride, or benzene may be used as surrogates for fast GC analysis. Although dual detector GC with ECD and either FID or PID costs less than most field or laboratory GC/MS instruments and, until recently have been easier to operate, only MS can provide unambiguous identification of VOCs. Contaminant concentrations, persistence in the environment, mobility and/or fate can be estimated from the detection of indicator compounds. If the principal contaminants at a site are unknown, field GC/MS provides the only reliable means of determining compound identity and concentration. For VOC analysis, purge and trap GC/MS can be performed as easily in the field as in the laboratory.

For semi-VOCs sample preparation is the rate-determining step when analyzing the EPA listed target compounds. Semi-VOCs must be extracted from soil or water into an organic solvent prior to analysis. Depending on the complexity of the matrix, the extract is further separated into fractions that contain compounds of similar chemical characteristics (e.g., PCB/pesticides, PAHs, explosives, acids, base/neutrals). These fractions may require additional separation before analysis by GC with ECD or MS; HPLC with UV and/or fluorescence detection; or by class-specific reagent chemistry such as the enzyme immunoassay kits. Sample cleanup, pre-concentration and/or sample dilution add extra steps to the measurement process and must be factored into field-practical sample throughput rates. Until recently, on-site analysis has only been possible for PCBs (portable GC with electron capture detection) and explosives (enzyme kits) because of time and cost constraints (sample preparation) in the field. In contrast to class-selective analysis provided by these technologies, TDGC/MS can provide rapid compound-specific analysis of most semi-VOCs.

Similarly, the same rationale applies to the analysis of soil contaminated by metals. Portable XRF provides screening level to semi-quantitative data without the need for sample preparation. Sample throughput rates exceed the data turnaround times that can be produced by field-based ICP/OES instruments. ICP/OES, however, provides more quantitative data at concentrations several orders of magnitude less than XRF can achieve. In contrast, metals analysis by electrochemical detection (anodic stripping) requires sample preparation for soil samples but not water samples and is more selective and sensitive than portable XRF instruments. As discussed above, every analytical measurement requires a trade-off among the properties precision, selectivity, and sensitivity.

4.4 Site or Facility Requirements

The physical layout of the site must have access to deploy and setup a field laboratory if the field activities extend beyond a one-week period. The site or facility should have line voltage power or a dependable source of electricity from a generator if a wide variety of field instruments and computing power are required. Power from a generator must be put through a filter to smooth out voltage fluctuations to protect analytical instruments and computers. The mobile laboratory or facility must have the proper footprint to house instruments, hoods, computers, refrigerators, and staff comfortably. The mobile laboratory should be heated in the winter and cooled in the summer. For instruments like the ICP/OES, field laboratory temperatures must be climate controlled to within ± 10 ^{0}C to achieve high quality data. Proper ventilation must be provided to protect worker safety and to separate volatile vapors produced during sample preparation procedures from cross-contaminating the organics analysis laboratory.

Access to on-site field laboratories should be limited to authorized personnel. Instrumentation, laboratory equipment, and utilities should be maintained to perform the required operations. Safety equipment should be available and readily accessible, e.g., eye wash, fire blanket, safety supplies. All instruments and equipment should be kept secured when not in use. These are customary practices of fixed-based laboratory operations.

Design and implementation of sampling programs should address situations or conditions necessary for the controlled use, storage, and disposal of sample material (e.g., soil discard, purged waters), equipment decontamination residues and remnants of samples. It should also ensure that all activities that may impact environmental data are documented and recorded in field notebooks. Field analysis will result in the production of waste materials commonly handled in off-site laboratory operations. Regulatory acceptance of these waste handling procedures should be obtained and incorporated into the workplan.

4.5 Quality Control

Sampling designs should minimize integrations between high and low concentration areas, as well as minimize common utilization of equipment, instrumentation, and facilities. A formal active contamination control program should exist that minimizes the potential spread of contamination. The collection of grab samples, e.g., individual samples collected at a specific time and location, is acceptable for TPH, semi-VOCs, VOCs, and metals. Composite samples, collected by homogenizing a sample interval or sample collection from different locations and times, are acceptable for TPH, semi-VOCs, and metals. A composite sample is not acceptable for VOCs since analyte will be lost during the homogenization process.

Prior to selecting the field analytical methods, it should be well-understood by all stakeholders as to the quality of acceptable data that will be sufficient to address site investigation or cleanup DQOs. The DQOs will dictate the limits of measurement error, selectivity, sensitivity, and resolution for the field measurement and how these attributes affect sample throughput rates, the on-site decision making process, and cost. DQOs should, therefore, dictate acceptable limits for measurement precision, accuracy, representativeness, and completeness. Once these attributes

have been defined, specific QC criteria (e.g., initial and continuing calibrations, laboratory control check sample (SRM) accuracy), frequency (e.g., every 10th or 20th predetermined, random, or positively detected sample) and, number (e.g., n = 2 or more) of repetitive sample analysis can be determined. This information must be included in the site specific-SOPs.

Goals for precision and accuracy should be established in the dynamic workplan. For example, site characterization, treatability study, or remedial action measurement precision or accuracy may differ greatly and should be based on the criteria needed to answer project-specific questions concerning the stated problem(s). A well-defined description of precision and accuracy benchmarks, instruments, field methods, chemical standards and reagents employed should be documented.

Goals for data representativeness should be addressed qualitatively since sampling locations, depths, intervals, frequency of split sampling and of QC check samples may change in the field based on new directions and requirements.

Goals for completeness and comparability of investigation are achieved when the study goals have been met. An analytical measurement value is considered complete if QC results are within acceptable ranges. There can be no assurances that the data produced by standard laboratory methods and instruments are any better than the field data. Comparability should be based on how well the field and laboratory produced data within their respective internal and external QC checks *and* through some minimum level of field versus laboratory data comparison (e.g., ≤ 100% may be an acceptable error range for some types of data usages). Federal and state regulators, siteowners, and their consulting engineers have a tendency to be risk-averse. Typically, the highest level of data quality is requested whether needed or not. As shown in Section 4.3, improper matching of sample collection, sample analysis throughput rates, and site-specific DQOs can easily lead to inefficient sampling and analysis programs and thus, cost.

5.0 Dynamic versus Traditional Investigation and Cleanup Costs

Dynamic workplans provide the framework for collecting chemical, physical, geological, and hydrological data in one or two field efforts as compared to the phased engineering approach of collecting data then evaluate, collect more data then evaluate ... until sufficient information is obtained to meet the study objectives. Fixed-based (commercial) laboratories should be able to generate data of comparable (either screening or quantitative data) quality at lower per sample costs than field/mobile laboratories. Economies of scale should be more easily achieved by fixed-based laboratories since they are designed for mass production. However, steep sample surcharges (100-200%) are generally added to the base price if samples are moved up in the queue to obtain one to three day data turnaround times. Moreover, fixed-base laboratory sample analysis costs vary greatly between regional (typically local non Contract Laboratory Program) and national laboratories.

Comparing the selection of field instruments as a function of cost is difficult. Field instruments and methods should be chosen first to meet the data quality requirements and second based on their ability to match the rate at which samples are collected. To illustrate the first

point, assume that the 16 target compound PAHs and PCBs require soil analysis to determine risk to ground water and that the action levels for PAHs are between 2-ppm (benz(a)anthracene, dibenz(a,h)anthracene) and as high as 40,000-ppm (fluoranthene and pyrene) *and* 1-ppm for total PCBs. These values are based on the 20DAF soil screening levels (SSLs, USEPA 1996), which refer to a dilution-attenuation factor (DAF) of 20. The SSLs take into account the natural attenuation process for the migration to ground water pathway that can reduce contaminant concentrations in the subsurface. Assume that the action level for the site has been established at one-half the 20DAF. For PAHs and PCBs these values are 1-ppm and 0.5-ppm, respectively. The method detection limit (sensitivity) has been determined at 0.5-ppm for GC/FID and 0.3-ppm for TDGC/MS.

Table 2 lists site-specific action levels for the hypothetical site investigation along with the data quality attributes, sample analysis, and the total number of samples analyzed per day throughput rates for field GC/ECD, TDGC/MS, and enzyme kit analyses. Tables 1 and 3 illustrate the impact of sample analysis rate and the number of site samples that can be analyzed per day. It may be necessary to make trade-offs among the data quality attributes of selectivity, sensitivity, and precision in conjunction with sample throughput rates to meet the site-specific DQO's and action levels *and* to provide a cost-effective field analytics program. This type of review should be made to insure that the selected field technology meets the site-specific DQOs established for the investigation or cleanup verification program.

The second point is not a trivial or obvious statement. If sample analysis lags behind sample collection, sample collectors and decision support staff sit idle waiting for data to be produced. On the other hand, if sample collection is operating below capacity, analytical instruments and field-laboratory personnel sit idle. In both cases, site investigation efficiency and cost is lost. Therefore, it is essential that the analytical team member play an integral role in designing the sample collection program. Moreover, combining field screening and on-site quantitative analysis into the program should increase the total number of samples analyzed while decreasing the number of samples sent off-site for traditional laboratory analysis.

Table 3 summarizes the field and laboratory sample charges and data turnaround times for the analysis of VOCs, PCBs, PAHs, explosives, and semi-VOCs. Shown in the Appendix are assumptions and costs used to determine the TDGC/MS, portable GC, and enzyme/colorimetric kit per sample charges. Commercial laboratory charges vary widely depending on the size and revenue amount of the laboratory and the number of national programs the laboratory participates in (e.g., Contract Laboratory Program, U.S. Army Corps of Engineers, HAZWRAP, and state certified programs). Field analytical technologies can provide analyses comparable in cost to regional or local laboratories employing EPA standardized methods with same or next day data turnaround times as compared with 14 to 35-days by commercial laboratories. Field analytics compete best when total project cost is considered and when it is incorporated into the Dynamic Workplan/Adaptive Sampling and Analysis Program. Cost savings can be realized when:

- sample selection and locations are optimized. Increased sampling efficiencies result in more targeted sample collection efforts minimizing the handling of samples that provide little value toward answering site-specific DQOs - <u>faster</u> site characterizations and verification of cleanup.

- the identity of the contaminants becomes known. Increased field analytical productivity is obtained when the type of analysis performed is more targeted resulting in more samples analyzed per day - faster site characterizations and verification of cleanup.

- more data are produced in less time. More informative decisions are made that improve the site delineation process, i.e., the separation of highly contaminated areas from non-contaminated areas - better site characterizations and verification of cleanup.

- a more detailed picture of the site is obtained, viz., the nature, extent, direction, concentration and rate of contaminant movement. Increased confidence in evaluating the risk to human health and the environment results - better site characterizations and verification of cleanup.

- more efficient utilization of human and financial resources is obtained. Increased project efficiencies lead to more data obtained at lower total project costs - cheaper site characterizations and verification of cleanup.

The rationale for selecting an adaptive sampling and analysis program should be based on the inherent efficiencies obtained when decisions are made in the field and the overall total project cost savings that can accrue.

Table 2. Comparison of Field Technologies for PCBs and PAHs

		Polycyclic Aromatic Hydrocarbons			Polychlorinated Biphenyls		
Site-specific DQO's and Action Level	**Attributes**	**GC/FID**	**TDGC/MS**	**Enzyme Kits**	**GC/ECD**	**TDGC/MS**	**Enzyme Kits**
Yes	**Selectivity**	No	Speciate	class-specific	Yes	Speciate	class-specific
1-ppm/PAH 0.5-ppm total PCB	**Sensitivity**	0.5-ppm	0.3-ppm	MFG. and Compound Dependent	0.03-ppm	0.2-ppm	Aroclor Dependent 0.5 to 1-ppm
≤ 40%	**Precision**	≤ 40%	≤ 40%	MFG. Dependent ≤ 40%	≤ 30%	≤ 40%	MFG. Dependent ≤ 40 %
No No	**Accuracy biased toward: false positive false negative**	Yes No	No No	Yes No	Yes No	No No	Yes No
	Analysis Rate/Sample	20-min	10-min	10-min	20-min	10-min	10-min
	Total Number of Samples Analyzed per 10-hr work day	19	32	32	19	32	32

Table 3. Field and Laboratory Cost and Data Turnaround Time Comparison

Analyte	Regional Laboratory Data Turnaround: 14 Calendar Days	National Laboratory Contract Laboratory Program Data Turnaround: 35 Calendar Days	Field TDGC/MS Data Turnaround: Next Day	Field GC/PID or GC/ECD Data Turnaround: Next Day	Strategic Diagnostic Enzyme Kits Data Turnaround: Same Day
VOCs	$125/sample SW 846 method 8240/8260 25-min/sample analysis	$165/sample SW 846 method 8240/8260 25-min/sample analysis	$100/sample modified 8260 20-min/sample	$88/sample modified 8021/8015 or headspace analysis 25-min/sample	Not Applicable
PCBs	$100/sample SW 846 method 8080 20-min/sample analysis; sample preparation 2-hr/batch of 20 samples	$150/sample SW 846 method 8080 20-min/sample analysis; sample preparation 2-hr/batch of 20 samples	$100/sample modified 8270 10-min per analysis; sample preparation 1-hr/batch of 20 samples	$88/sample field method 20-min analysis; sample preparation 1-hr/batch of 20 samples	$102/kit field method 10-min analysis time; sample preparation 1-hr/batch of 20 samples
PAHs	$145/sample SW 846 method 8100/8310; 20-min/sample analysis, sample preparation 2-hr/batch of 20 samples	$255/sample SW 846 method 8100/8310 20-min/sample analysis; sample preparation 2-hr/batch of 20 samples		Not Applicable	$102/kit field method 10-min analysis time; sample preparation 2-hr/batch of 20 samples
Explosives	$180/sample SW 846 8330/USAED 30 20-min/sample analysis; sample preparation 18-hr/batch of 20 samples	$220/sample SW 846 8330/USAED 30 20-min/sample analysis; sample preparation 18-hr/batch of 20 samples	$100/sample modified 8270 10-min per analysis; sample preparation 1-hr/batch of 20 samples	Not Applicable	$102/kit field method TNT & RDX kits required 20-min per analysis; sample preparation 1-hr/batch of 20 samples
Semi-VOCs	$400/sample SW 846 method 8270 40-min/sample analysis; sample preparation 4-hr/batch of 20 samples	$450/sample SW 846 method 8270 40-min/sample analysis; sample preparation 4-hr/batch of 20 samples	$150/sample modified 8270 20-min per analysis; sample preparation 1-hr/batch of 20 samples	Not Applicable	Not Applicable

Appendix

Field Analysis Costs

Table 4 illustrates the per sample costs for field-based TDGC/MS, GC with PID or ECD, and wet chemical or enzyme kit analysis. In the cost example, a Hewlett Packard GC/MS (model GCD) was modified to introduce samples via thermal desorption (TD), with the data analysis accomplished by the Ion Fingerprint Detection™ (IFD) software. Field GC/MS instruments such as the Viking Instrument, ~ $120,000 when fully equipped, will add $5.50 to the GC/MS sample cost shown in the table. The TDGC/MS with the IFD software can provide simultaneous detection of PCBs and PAHs in complex petroleum contaminated soil samples in 10-min. The Photovac GC/PID can provide full VOC analysis in the field. As discussed in Section 4, photoionization (PID) and electron capture (ECD) detectors provide qualitative compound-specific information as compared to the MS. These GC detectors can not provide unambiguous compound identification but can provide rapid field screening analysis of VOCs. The cost of a field-based GC/ECD has also been estimated for PCB analysis. The enzyme or colorimetric kit costs shown in the table have been calculated based on an average per kit price that assumes 40 analysis per calibration for either the Ensys or Ohmicron kits. Sample analysis of less than 40 samples per calibration will result in increased sample costs.

The cost analysis is based on a one time purchase of capital equipment and includes any modifications that are required to produce high throughput field analysis; a vehicle for field transport of staff, instrument and supplies; and generator for power. Annual operating costs assume a total of 4,500 soil samples will be analyzed over a 180-day field season by two chemists. This represents an average of 25 samples analyzed per day. Since nearly 70% of the cost to provide service is in salary any additional field days will reduce the per sample cost, while booking work for less than the assumed 180-days will increase the respective sample analysis cost. Finally, the per sample cost was calculated over a five year period. The calculation takes into account the time value of money based on present value of future costs to provide the service. It ignores inflation and assumes a 4% discount rate. Details of the capital purchases and annual operating costs can be found in Tables 5 and 6. Although commercial laboratories provide volume pricing, no one project or account will dramatically affect the laboratory life-cycle per sample cost. Included in the commercial laboratory per sample charges are costs for staff, equipment, supplies, space, management, accounting, marketing and sales. An industry conservative 2.5 multiplier was used to estimate the field comparable per sample charges for each technology.

Table 4. Field Analytical Measurement Costs

	TDGC/MS	GC/PID or ECD	Enzyme Kits
Initial Capital Costs	$76,000	$47,500	$27,500
Total Annual Operating Costs	$178,828	$161,978	$283,595
Present Value of Life-Cycle Costs (assume 4% discount)	$903,890	$797,383	$595,699 (direct costs) $770,818 (kits)
Total Number of Samples Analyzed Over 5-years	22,500	22,500	22,500
Cost per sample analysis	$40	$35	$27 direct cost plus $34/kit
Total Sample Cost with 2.5 multiplier*	$100	$88	$102

* Overhead cost provided by Steve Maxwell, Technology Strategic Group, Boulder, Colorado

Table 5. Capital Equipment Costs

	Capital Equipment		**Capital Equipment**		**Capital Equipment**	
Instrument Costs	HP GC/MS full VOC and SVOC analysis 486 computer, operating/data analysis software and libraries, LaserJet printer, split/splitless inlet, diffusion/rouging pumps	$45,000	Photovac GC/PID full VOC capability oven/column & re-charge battery, start up kit, printer & cable	$26,500	SDI Enzyme Kits PAH, PCB, and Explosives Spectrometer, balance, and computer and printer	$6,500
Modifications	Thermal Desorption Unit	$10,000				
Vehicle	Van	$20,000	Van	$20,000	Van	$20,000
Power Supply	2.5 kW generator	$1,000	2.5 kW generator	$1,000	2.5 kW generator	$1,000
	Total Cost	$76,000	**Total Cost**	$47,500	**Total Cost**	$27,500

Table 6. Annual Operating Expenses

	GC/MS Operating Costs		Portable GC Operating Costs		Enzyme Kits Operating Costs	
Labor	two full time chemists	$120,000	two full time chemists	$120,000	two full time chemists	$100,000
Software	Ion Fingerprint Detection™	$10,000				
Materials and Supplies	GC columns (13), fittings, and septa	$6,500	GC columns (13), fittings, and septa	$6,500	$37/sample average kit price, PAH, PCB, explosive	$166,500
	electron multiplier &source	$3,000	detector lamp	$650	detector lamp	$550
	pump oil	$1,000				
	helium carrier gas ($4/day at 180-day)	$720	He carrier gas ($4/day at 180-day)	$720		
	calibration standards	$3,500	calibration standards	$3,500		
	reagent water ($4/day at 180-day)	$720	reagent water ($4/day at 180-day)	$720	reagent water ($4/day at 180-day)	$720
	vials ($175/case)	$10,938	vials ($175/case)	$10,938	vials ($175/case)	$10,938
	spatula	$50	spatula	$50	spatula	$50
	syringes (15)	$1,000	syringes (15)	$1,000		
	coolers (3)	$120	coolers (3)	$120	coolers (3)	$120
	solvents (40-L)	$750	solvents (40-L)	$750	solvents (10-L)	$187
Vehicle Costs	insurance	$1,500	insurance	$1,500	insurance	$1,500
	maintenance ($100/month)	$1,200	maintenance ($100/month)	$1,200	maintenance ($100/month)	$1,200
	gas (20K miles/year at $1.33/gal)	$1,330	gas (20K miles/year at $1.33/gal)	$1,330	gas (20K miles/year at $1.33/gal)	$1,330
Overhead	QA/QC 2-months	$12,000	QA/QC 2-months	$12,000	QA/QC 2-months	$12,000
	maintenance contract HP	$4,500	maintenance	$1,000		
	Total	$178,828	**Total**	$161,978	**Total labor and supplies**	$128,595
					Cost of 4,500 kits, $37 each	$166,500

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

May 12, 1998

Dear Colleague:

Recent scientific and field analytical technology advances are leading to more effective and faster cleanup strategies. No longer is it necessary to approach contaminated site remediation in a piecemeal fashion, with gaps in the remediation process while samples are gathered and shipped for off site analysis, reports written and results debated before the next phase of the remediation work begins. With the accumulated experiences with some site types and newer more powerful field analytical tools, site work can proceed seamlessly from investigation to remediation to closeout. The opportunities for cost and time savings in site cleanup are far greater now than even five years ago. Our ability to realize those savings hinges on our ability to close the gap between what is technologically possible and what is broadly accepted as standard practice.

Enclosed is a preprint of an article titled, "*EPA Efforts to Promote Improved Processes for Site Characterization and Monitoring.*" This paper describes the roles of the various waste program offices within EPA Headquarters and presents a number of specific projects, supporting resources, and activities to promote smarter approaches to site cleanup. Through these activities we are attempting to synthesize successful innovations and pilot experiences to promote expanded consideration and use of smart investigation, cleanup and monitoring practices.

I hope you find the article informative. If you have any questions regarding the article or EPA activities to promote new site investigation and monitoring technologies and practices, please contact Dan Powell (703) 603-7196 or Deana Crumbling (703) 603-0643.

Sincerely,

Walter W. Kovalick, Jr.

Walter W. Kovalick, Jr., Ph.D.
Director
Technology Innovation Office

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EPA EFFORTS TO PROMOTE IMPROVED PROCESSES AND TOOLS FOR SITE CHARACTERIZATION AND MONITORING

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ABSTRACT

The United States Environmental Protection Agency (EPA) advocates the use of innovative tools and methods to improve the cost-effectiveness and quality of hazardous waste site characterization and monitoring. This paper describes the efforts of various EPA offices within the Office of Solid Waste and Emergency Response to work toward this goal.

INTRODUCTION

EPA promotes the use of innovative methods and technologies relevant to hazardous site remediation. As the environmental marketplace responds with the creation of tools to enable site characterization and cleanup to be performed "better, faster, and cheaper," it is essential that the various sectors of the engineering and regulatory communities keep pace. As described by the recent National Research Council report, *Innovation in Groundwater and Soil Cleanup: From Concept to Commercialization*, two ways that regulators can promote innovation within the remediation arena are by

- coordinating training, education, and dissemination of information about the appropriate use of innovative technologies to increase general regulatory acceptance; and
- coordinating verification and testing programs to define the boundaries of appropriate use, while eliminating duplicative demonstration projects.

The tools available for hazardous site remediation are undergoing rapid transformation. The regulatory, industrial, and public attitudes toward hazardous site remediation have become much more sophisticated since the 1980s, and the body of knowledge generated by research efforts and by practical experience is expanding so quickly that it is difficult to stay current.

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One result of these experiential and technological advances is that practitioners no longer find it necessary to always perform site work in a piecemeal fashion. It is no longer necessary to temporarily halt remedial activities while data are gathered and summarized into reports, with the interpretation of the data roundly debated before the next phase of work is begun. We often have enough experience now with certain site types that we can anticipate or "presume" the problems to be addressed and narrow the menu of technology options to consider. The result is that work at some sites can proceed seamlessly from investigation to remediation and closeout. With both careful planning and the use of rapid turn-around, on-site analytical technologies, investigation and cleanup objectives can be achieved in a fraction of the time and cost of traditional approaches which rely on a prescriptive, linear progression of phases and tasks. Considerable savings are realized both by reducing the number of distinct tasks and by performing multiple tasks simultaneously.

The challenge for advocates of innovative improvement is to begin to close the gap between what is possible through these "new" processes and techniques and what is accepted as "standard practice." We must synthesize successful innovations and pilot experiences into a more widely accepted (and practiced) paradigm that stresses thorough up-front planning of site work, stakeholder involvement, flexibility, and defensible data and decisions. This paradigm needs to be accepted and recognized institutionally within regulatory and legislative frameworks so that impediments to its use can be removed and incentives to its implementation created. We must also educate field practitioners and individual regulators to alleviate misgivings they may have about new methods replacing older, proven ones to which they have grown accustomed and comfortable. It is essential that individual project teams have the tools at their disposal to fully understand and objectively review the application of these techniques at the site level.

EPA is attempting to meet this challenge. The Agency recognizes the progress that is occurring in EPA Regional Offices, other federal agencies, and state environmental agencies that demonstrates the success of this approach. The burden falls to EPA Headquarters to tackle impediments to widespread adoption of this paradigm by addressing issues such as budgetary and regulatory constraints, lack of information or education, and reluctance to break with past practices. This paper describes the roles of the various waste program offices within EPA Headquarters in this regard and it presents an overview of a number of specific EPA projects, supporting resources, and activities that signal progress toward meeting this challenge.

EPA WASTE PROGRAM OFFICES' ROLES

The EPA Headquarters Office of Solid Waste and Emergency Response (OSWER) is the national program manager for the clean-up programs developed pursuant to the major legislative mandates in the area of hazardous waste and site clean-up. A number of these program offices play

unique but interrelated roles in developing, promoting, and implementing activities that affect the manner by which site studies and cleanups are conducted. These offices and their respective roles are summarized as follows:

- **Technology Innovation Office (TIO):** Created in 1990 as an advocate for the use of innovative remediation technologies within OSWER, one of TIO's principal roles is to form partnerships between research programs and waste programs within EPA, as well as with other federal and state governmental organizations, universities and non-profit organizations, and private industry to encourage the exploration and acceptance of promising techniques useful for environmental remediation.

- **Office of Emergency and Remedial Response (OERR):** As the national program manager for the Superfund program, OERR is committed to finding ways to improve site assessment and investigation. OERR is currently working with TIO, the EPA Regional Offices, and the states to develop a number of tools to foster, and perhaps institutionalize, effective innovative site characterization practices. Since OERR is largely responsible for developing policies that govern the investigation and clean-up of Superfund sites, these initiatives are crucial to any efforts to cultivate widespread acceptance and institutional entrenchment of new practices.

- **Office of Solid Waste (OSW):** Equally critical in advancing the acceptance of new practices and techniques in EPA waste programs is the work of the OSW, which is the waste program office responsible for managing the Resource Conservation and Recovery Act (RCRA) regulatory and corrective action programs. Not only does the RCRA Corrective Action program provide national oversight for a large number of sites to be investigated and cleaned up, the guidance and regulations developed under RCRA have a profound effect on the practices employed in many waste clean-up program, both at the federal and state levels. OSW is actively involved on several fronts to support more efficient approaches to site characterization and measurement.

- **Office of Underground Storage Tanks (OUST):** This is the OSWER program office responsible for the regulatory program governing corrective actions for underground storage tanks, particularly petroleum tanks. OUST is developing a number of tools to assist states in their role of leading the investigation, monitoring, and cleanup of this potentially large universe of sites.

- **Federal Facilities Restoration and Reuse Office (FFRRO):** As the office responsible for EPA policy for the investigation and clean-up of facilities owned and operated by the federal government, FFRRO has significant influence over many sites undergoing environmental

restoration. Thus, FFRRO has substantial impact on the ultimate acceptance and implementation of innovative processes at federal facility sites.

In addition to the OSWER program offices, the Agency's Office of Research and Development (ORD) is fully engaged in the area of improved technologies and techniques for site characterization and monitoring. The ORD National Exposure Research Laboratory (NERL), in particular, maintains the Agency's technology expertise for characterization technology. Through their research and technical management of Agency programs, NERL tests and evaluates new processes and technologies.

Each of the offices described above is undertaking a significant set of activities which promote the goal of improved site characterization and monitoring. These activities fall under two broad categories: policy and process improvements, and creating and disseminating better technology information. Together these activities work to create a climate and an institutional framework more receptive to improved technologies and processes in the Nation's waste clean-up programs.

PROCESS AND POLICY INITIATIVES

Performance-Based Measurement System

One of the most significant EPA initiatives to create a more flexible environment for conducting investigation and monitoring activities across all environmental media is the Performance-Based Measurement System (PBMS). PBMS embodies EPA's efforts to break down barriers to using new monitoring techniques and to implement the President's program for reinventing government and reforming regulatory policy. The Agency anticipates that PBMS will expedite development and acceptance of new technologies which may provide less costly options for environmental analyses. The PBMS initiative places regulatory emphasis on obtaining analytical results that provide adequate input into the regulatory decision, but leave the choice of analytical procedure up to the user. Adequate documentation is required to demonstrate that the testing protocol is truly adequate to meet the goal of regulatory compliance.

The Office of Solid Waste (OSW) has always subscribed to a flexible approach for analytical methods. This flexibility is emphasized within the EPA publication, *Test Methods for Evaluating Solid Waste-Physical/Chemical Methods* (commonly known as "SW-846"). The August 31, 1993 *Federal Register* states: "Any reliable analytical method may be used to meet [most] requirements in 40 CFR parts 260 through 270...[SW-846] functions as a guidance document setting forth acceptable, although not required, methods to be implemented by the user, as appropriate, to RCRA-related sampling and analysis requirements." (Emphasis added.)

Unfortunately, the flexibility inherent in the vast majority of SW-846 applications is frequently misunderstood by the environmental community. For this reason, OSW has increased its efforts to educate and inform the public and regulators about method flexibility and regulatory intent by means of national meetings and symposia, information request lines, training courses and workshops, and the development of guidance documents. More information is available from the OSW Methods Team Home Page, entitled *Monitoring Science in the RCRA Program*, on the World Wide Web at **http://www.epa.gov/epaoswer/hazwaste/test/index.htm**.

State of the Practice in Site Assessment

In 1997, EPA prepared a review of the various independent approaches to rapid site assessment that depart from past practice. The goal of this study was to understand the range of work that various parties have done to improve and streamline the study of contaminated sites. The review paper contained the results of interviews and literature searches to identify and summarize uniquely described site characterization approaches within the U.S. There are at least 15 described strategies from a variety of sources, such as government agencies, academia, and professional organizations. Some commonalities underlie these approaches to expediting site characterization work:

- Formulate (at the *start* of the project, and with the involvement of stakeholders) a detailed description of what the site work is expected to accomplish.
  - What is the goal of this project? What is the site decision?
  - What level of uncertainty is permitted in the site decision? What level of documentation is required?
  - What level of funding is available?
- A team approach that includes representatives from various disciplines (risk assessment, engineering, chemistry, compliance, etc.) is vital to adequate planning and implementation of an efficient site characterization project.
- Determine data quality needs, i.e., what types and how much data are needed to answer the site question(s) to the level of uncertainty as formulated above?
- Develop a Conceptual Site Model (CSM).
  - What useful data are already available?
  - What data gaps remain?
  - How will the data gaps be filled?
- Consider data and documentation needs, funding, and regulatory aspects.
  - Will a traditional sampling and analytic scenario be required?
  - Can the use of field analytics and dynamic sampling plans save time and or money and meet all or some data needs?
  - Important: The choice of analytical methodologies must follow *from* the data needs.
- Prepare thorough Sampling and Analysis Plans.

- Address sampling design needs (e.g., statistical and uncertainty considerations, hotspots)
- Address data quality needs (e.g., uncertainty considerations, interferences, detection limits, confirmation requirements).

On-site generation of data provides "immediate" decision-making capability which can rapidly and efficiently guide characterization efforts and focus remediation selection through an adaptive sampling strategy. Flexible or "dynamic" work plans maximize the power of field analytical methods to effect a cost-effective, successful conclusion. A well-written work plan will communicate the rationale for, and use of, each data point to be collected. Technical experts should be available on-site to implement the adaptive sampling strategy by evaluating analytical results and designing subsequent sampling protocols, and to address any problems that arise. such as unexpected analytical interferences.

This type of formalized or systematic planning process is especially vital to site characterization efforts that involve the use of field analytical methods. With standard "fixed lab" procedures and the EPA Contract Laboratory Program (CLP), there is an expectation of a certain minimum level of data quality and analyte detection limits. This "default" level of data quality can be expensive and time-consuming, and (possibly) wasteful if it is not needed for the specific decision objective. However, it does provide a data quality safety net that cannot be automatically assumed with the use of field analytics. Field analysis *can* realize substantial time and cost savings. while providing high quality data to support defensible site decisions, but this can be guaranteed *only* if sufficient advance planning is performed.

Emerging Site Assessment Guidance: Presumptive Site Assessments

In conjunction with the above, EPA is undertaking several initiatives to strengthen and modify the Site Assessment process within the Superfund program. Among these activities is an effort to develop strategic site investigations for specific site types (e.g., manufactured gas plants, grain storage bins, steel manufacturers) that are designed to save time and money. These "presumptive"strategies would function as suggested protocols and could be combined into a compendium of assessments for the purpose of supporting several of EPA's recent initiatives including brownfields, site screening, and rapid site characterization.

Presumptive site assessments are derived from the most current practices. They focus inspection activities on specific strategic objectives, use field analytical methods to satisfy needs when possible, and emphasize a reduction in time and cost (as compared to a conventional site characterization approach) by combining activities. Some prior knowledge of site history will be necessary in order to select an appropriate assessment approach. Based on the type of site and

history, the presumptive site assessment would specify likely contaminants and their probable locations, as well as promising characterization strategies.

EPA hopes to develop example strategies in cooperation with EPA Regional Offices using the Superfund Technical Assessment and Response Team (START) contractors. Region 7 efforts have focused on grain storage sites. Region 6 is exploring creosote sites, aerial applicators, and dry cleaners. All Regions have been encouraged to assist in the development of presumptive site assessment guidance, which need to be practical and useful, reflecting the experience gained from past site assessment efforts. The Regional Offices are working with EPA Headquarters to help frame discussions on the development of these guidance and to deliberate on key policy issues. State requirements and experience will be considered as well. Preliminary discussions with the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) indicate a strong interest. Kansas representatives have written a letter asking to participate. Some EPA Headquarters contract work related to this effort has been completed: four draft templates were prepared which considered dry cleaner operations, manufactured gas plants, steel manufacturing sites, and paint shops.

Brownfields Site Assessment Guidance

A large portion of future site evaluation workload lies in brownfields programs, which link economic development with the environmental restoration of underutilized, abandoned, or idled properties, with the goal of beneficial reuse. A premium is placed on investigations that are less costly and performed more quickly than has been the case in more traditional settings. To provide assistance to state, tribal, and municipal officials, EPA is developing a guidance document entitled *Quality Assurance Guidance for Conducting Brownfields Site Assessments*. It will include a framework for determining the types and quantity of environmental data needed to make decisions regarding site characterization and redevelopment potential, as well as a template Quality Assurance Project Plan (QAPP), which describes the activities needed to ensure that collected data are of known quality to support reasonable, informed decisions.

OERR Site Assessment Team

This team coordinates many of the above activities within the Superfund program, and is comprised of Site Assessment Regional Coordinators from the five OERR Regional Centers. as well as from the various Superfund program "Centers" (State and Tribal Site Identification. Information Management, Contracts Oversight, Community Involvement and Outreach, Program Analysis, and Resource Management). The Team's mission is to ensure consistency and communication across the Regions and to develop policies that facilitate the site assessment process.

RCRA Corrective Action Strategy

In a May 1996 *Federal Register* Notice EPA introduced its strategy for promulgating regulations governing corrective action for contaminant releases at hazardous waste management facilities which are regulated under the Resource Conservation and Recovery Act (RCRA). This Advanced Notice of Proposed Rulemaking (ANPR) emphasized areas of flexibility within the current program and described program improvements under consideration. Section III.C.2 (pp. 19444-19446) emphasizes the critical importance of carefully designed and implemented RCRA Facility Investigations (RFIs) to accurately characterize the nature and extent of site contamination.

Experience in corrective action implementation has demonstrated that poorly focused investigations can become a drain on time and resources and, in some cases, unnecessarily delay remedial actions. EPA emphasizes that remedial investigations should be tailored to the specific conditions and circumstances at the facility and focused on the units, releases, and exposure pathways of concern. A number of approaches were discussed in this ANPR as being particularly helpful in developing focused site investigations:

- The use of dynamic conceptual site models considerably aids planning and risk-based decision-making at a site.
- EPA encourages program implementors and facility operators to take advantage of the cost- and time-savings possible with innovative characterization technologies. Exploitation of innovative site characterization technologies (including on-site analytical techniques and adaptive sampling plans) offers many benefits which include
  - on-site decision-making and optimization of the investigation effort;
  - enhanced 3-dimensional understanding of the site;
  - better identification of actual or potential risks posed to human or ecological receptors: and
  - more rapid assessment of the need for interim actions.
- Tailoring data quality objectives (DQOs) to site-specific needs ensures that environmental data are scientifically valid and defensible for the intended use. EPA has found that site investigations can be expedited considerably when DQOs are carefully established.
- The use of existing information to streamline the remedial investigation can reduce costs and increase the speed of cleanups. Where DQOs have been established, the adequacy and usefulness of existing data is assessed by comparison with the project DQOs.
- Action levels (health- or environmentally-based concentrations derived from chemical-specific toxicity and protectively conservative exposure assumptions) can serve as a trigger mechanism for deciding whether additional investigation is warranted. Actions levels can be most beneficial if they are available during the planning stages of site investigations.
- If thorough advance planning is used, likely remedial strategies will become clear early in the site assessment process. To expedite the corrective action process, EPA encourages

- Sediments sampling technologies.

TIO has worked with the CSCT pilot managers to promote the acceptance of verified technologies. TIO has created or employed a number of mechanisms to publicize and distribute the verification reports to potential technology users:

- A network of characterization technology advocates located in EPA's regional waste and laboratory programs;
- A relationship with the Interstate Technology Regulatory Cooperation (ITRC) Workgroup;
- The use of the Technology Innovation Office's exhibit booth to gain visibility at relevant environmental, regulatory, and professional conferences;
- Internet access to all documents through the Technology Innovation Office web site (CLU-IN) at **http://clu-in.com/char1.htm#verification**;
- Mass mailings of fliers announcing the availability of new CSCT documents;
- Announcements through e-mail and postal mail distribution of the *TechDirect* listserver and *TechTrends* newsletter; and
- Topical seminars and briefings for key user groups at the various levels of government and the private sector.

Documenting Performance

Working with its federal partners, TIO is addressing the need for case studies to document successful applications of field analytical and geophysical technologies and techniques. Mindful of the benefits attributable to collecting this information in a uniform manner, TIO will work with the member agencies of the Roundtable to develop a guide for collecting and presenting case study information relevant to site characterization. This guide will consist of two parts: the first section will facilitate the collection and documentation of information during the actual performance of the project which will be vital to later preparation of a case study report; the second part of the guide will serve as a template for writing the case study report in a consistent format.

TIO is gathering information on intriguing projects already underway in a number of places around the United States. One such effort, recently completed through joint effort of EPA Region 1, Tufts University, and the Air Force at Hanscom AFB (in Massachusetts), is the subject of a case study, which will concisely describe the investigational tools used, the use of the field generated analytical data that addressed the site decision, and the costs. Some information about the work done at Hanscom AFB is currently available through the Clean-Up Information (CLU-IN) Internet site at **http://clu-in.com/char1.htm#regional**. Similar projects have been done by other federal and state programs, with information accessible through Internet sources. TIO will continue to work to identify these projects and disseminate their results through the preparation of additional case

studies. TIO realizes it may be unaware of some projects and is actively seeking information on their existence and results.

Promoting Technology Availability and Use

Tracking technology availability and deployment represents another critical activity in the promotion of improved technologies and processes. To address the need of site managers, consulting engineers, and others for better understanding of the tools and services available to conduct site characterization and on-site chemical analysis, TIO developed the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS). Vendor FACTS is a searchable database of innovative site characterization technologies and vendors, which is updated yearly. It is currently in its third version (Vendor FACTS 3.0), and contains 154 analytical, geophysical, chemical extraction, and sampling technologies provided by 116 technology vendors.

The product information within Vendor FACTS is provided by the vendors (without EPA endorsement), and covers applicability, performance, and current use. It is available from EPA at no charge in CD-ROM format. Alternatively, it can be downloaded from the Internet through the CLU-IN web site at **http://clu-in.com/char1.htm#selection**. Vendor FACTS allows a potential user to quickly screen technologies for a particular application, and to examine particulars such as potential media, analytes, detection limits, interferences, etc. Developers of field analytical technologies are encouraged to participate by completing a Vendor Information Form. Vendor participation is free-of-charge.

EPA is also working with the US Naval Facilities Engineering Command and the US Army Corps of Engineers to develop a *Field Analytical and Sampling Technology Matrix and Reference Guide* for field analytical and sampling/extraction technologies. In poster format, the *Matrix* will provide a tool for project managers to quickly identify technology options and compare them against their specific site problems. Composed of two parts, one for field analytical technologies and one for sampling and extraction technologies, the matrix provides simple ratings on the capabilities and limitations of a wide range of technology options. Parameters include target analytes, throughput, media types, cost, verification/evaluation experience, interferences, depth limitations, etc. The accompanying *Reference Guide* provides more detailed descriptions of how the ratings were derived and lists supporting information resources. The printed matrix will be available summer 1998. The Corps will also arrange for on-line availability at the Federal Remediation Technologies Roundtable home page at **http://www.frtr.gov**. The FRTR homepage already includes the FRTR Treatment Technologies Screening Matrix.

A new EPA report, *Field Analytical and Site Characterization Technologies: Summary of Applications*, was released by TIO in November 1997. It summarizes (in tabular format) over 200

defensible, yet cost effective, manner to achieve the ultimate goal of human health and environmental protection. The range of experience and knowledge gained over the past decade is permitting EPA to capitalize on new technologies and new ideas. To maintain the momentum of this progress, EPA must continue to recognize, coordinate, and promote the often isolated individual initiatives underway, while developing a cohesive program to advance their use. Both in terms of technology and process, significant improvements have been achieved which stand to not only increase the effectiveness of our clean-up programs, but also to save considerable resources. More and more voices within governmental, academic, and private sectors are calling for the use of thorough systematic planning, team participation, field analytical technologies and other innovations to save time and money without sacrificing data quality or the level of protectiveness required of the Agency. The challenge for EPA's clean-up programs lies in communicating and cultivating these advancements within all levels of the decision making structure.

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United States
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Office of Solid Waste and
Emergency Response
(5102G)

EPA-542-R-98-006
September 1998
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EPA

Innovations in Site Characterization

Case Study: Hanscom Air Force Base, Operable Unit 1 (Sites 1, 2, and 3)

Case Study Abstract

Hanscom Air Force Base
Middlesex County, Massachusetts

Site Name and Location: Hanscom Air Force Base Middlesex County, Massachusetts	**Sampling & Analytical Technologies:** 1. Geoprobe; 2. Bruker Thermal Desorption Probe Head on Gas Chromatography/Mass Spectrometer (Bruker TDGC/MS); 3. Tekmar Purge and Trap Concentrator with Hewlett-Packard GC/MS; 4. Ion Signature Technology's Thermal Desorber with Hewlett-Packard GC/MS (Tufts TDGC/MS); 5. Ion Signature Technology's Ion Fingerprint Detection (IFD) Software 6. Field-rugged Inductively Coupled Plasma/Optical Emission Spectrometer (ICP/OES)	**CERCLIS #** MA8570024424
Period of Operation: 1941 - 1973 Supported fighter aircraft operations and maintenance; Air Force Research & Development **Operable Unit:** #01 (Site 1 - Fire Training Area II; Site 2 & 3 - Paint Waste Areas)		**Current Site Activities:** RI/FS complete, ground water pump and treat operational May 1991, total flow 300 GPM. Focused Feasibility Study.
Point of Contact: Robert Lim US EPA - Region 1 J. F. Kennedy Federal Building Boston, MA 02203-2211 (617) 223-5521 http://clu-in.com/hanscom.htm.	**Media and Contaminants:** Groundwater and soils at Hanscom Air Force Base are contaminated with chlorinated and aromatic solvents, metals, and petroleum compounds.	**Technology Demonstrator:** Tufts University, Chemistry Dept. Center for Field Analytical Studies & Technology Medford, Massachusetts 02155 (617) 627-3474

Number of Samples Analyzed during Investigation:
A 10-day Adaptive Sampling and Analysis Program produced the following: 601 soil samples screened for volatile organic compounds (VOC) (<1 min/analysis); 158 soil samples for quantitative analysis for VOCs (15 min/analysis); 69 soil samples for simultaneous quantitative analysis of polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs); 121 quantitative soil samples for metals (8 min/analysis after microwave sample digestion).

Cost Savings:
The cost savings using this approach are estimated at 50% over traditional methods.

Results:
Field analytical methods can provide quantitative data to support remedial decisions for contaminated soil. The assessment of contaminated soil was completed in two weeks using an Adaptive Sampling and Analysis Strategy.

Description:
As part of EPA's Environmental Technology Initiative (ETI), Tufts University conducted a demonstration of the ability of field analytical methods to produce data of sufficient quality to support a risk assessment. The specific risk scenario was soil contamination migration to ground water. Action limits were set at the 20 Dilution-Attenuation Factor (DAF) from EPA's Soil Screening Levels. Over a two week period, subsurface soil cores and samples were collected using a Geoprobe. Soil samples were screened with the Bruker Thermal Desorption GC/MS at an average rate of 75 samples/day. Quantitative VOC analyses were performed using conventional (Tekmar) Purge & Trap GC/MS in conjunction with Tufts-developed IFD software to speed processing of the MS signal and data analysis. After extraction, simultaneous quantitative PAH/PCB analyses were performed by Tufts-developed Thermal Desorber GC/MS and IFD data analysis producing data with only a 10-minute run time. Finally, fixed-lab quality data for metals was produced in the field by the use of batched microwave digestion and a field-adapted ICP/OES.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

August 7, 1998

MEMORANDUM

SUBJECT: Clarification Regarding Use of SW-846 Methods

FROM: Elizabeth Cotsworth, Acting Director | s | Matt Hale for
Office of Solid Waste

TO: RCRA Senior Policy Analysts
Regions I - X

It recently came to the attention of EPA's Office of Solid Waste that additional guidance is needed regarding certain methods in Update III to *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846) and the use of SW-846 methods in general, in order to assure appropriate use by the laboratories and the regulated community. The purpose of this memorandum is to set forth the guidance as a clarification to SW-846 for reference and distribution to the States and to other interested parties, including laboratories and the regulated community.

SW-846 contains the analytical and test methods that EPA has evaluated and found to be among those acceptable for testing under subtitle C of the Resource Conservation and Recovery Act (RCRA). In most situations, SW-846 functions as a guidance document setting forth acceptable, although not required, methods to be implemented by the user, as appropriate, in responding to RCRA-related sampling and analysis requirements. The methods are intended to be used and modified, as needed, to promote unbiased, sensitive, precise, comparable, and specific analyses and test results. In addition, with the exception of method-defined parameters (e.g., Method 1311, the Toxicity Characteristic Leaching Procedure), SW-846 methods need not be applied in a prescriptive manner. The Agency strongly recommends that the regulated entity develop a project-specific sampling and analysis plan in conjunction with other professionals (e.g., laboratories) and the regulating authority, to address both sample collection and method application and to assure the generation of data of the appropriate quality. The Disclaimer and Chapter Two of SW-846 provide additional guidance regarding the appropriate use of SW-846 methods, and Chapter One provides guidance regarding the development of a project-specific sampling and analysis plan.

SW-846 also is a "living document" that changes over time as new information, analytical technologies, and data are developed and made available. Advances in analytical instrumentation and techniques are continually reviewed by the Agency and periodically incorporated into SW-846 to support changes in the regulatory program and to improve method performance. Update III represents such an incorporation into SW-846. The update was finalized on June 13, 1997 (62 FR 32452), and included 37 revised methods and 61 new methods. Besides providing new technologies and improved methods, the Agency strove as part of Update III to address some long-standing concerns or misconceptions regarding the use of SW-846 and its methods.

Subsequent to finalizing Update III, the Office of Solid Waste received additional public comments regarding the content of a few of the methods. The Agency reviewed the comments and determined that additional guidance regarding the subject methods would be beneficial to the regulated community and regulating authorities. The Agency notes that this guidance simply clarifies the original intent of the methods and the manual, and does not represent significant changes to the Update III methods as promulgated on June 13, 1997. In the future, the Agency plans to revise the affected SW-846 methods to include this guidance.

Attachment 1 to this memorandum contains a synopsis of the clarifications to certain portions of the following SW-846, Final Update III methods:

- Method 3550B, Ultrasonic Extraction
- Method 5021, Volatile Organic Compounds in Soils and Other Solid Matrices Using Equilibrium Headspace Analysis
- Method 5035, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples
- Method 6010B, Inductively Coupled Plasma-Atomic Emission Spectrometry
- Method 8000B, Determinative Chromatographic Separations
- Method 8082, Polychlorinated Biphenyls (PCBs) by Gas Chromatography

The methods are discussed in numerical order, as listed above. Attachment 2 to this memorandum provides a more detailed discussion of the issues surrounding the clarifications. The detailed discussions in Attachment 2 should be reviewed to fully appreciate the context on which the clarifications are based. All copies of this memorandum should be distributed with both attachments

cc: Michael Shapiro
Barnes Johnson
Key Regional RCRA Contacts
RCRA Branch Chiefs
Enforcement Division Directors
Larry Reed, Superfund
Anna Virbick, UST
Walt Kovalick, TIO
David Friedman, EMMC
Tony Pagliaro, ACIL

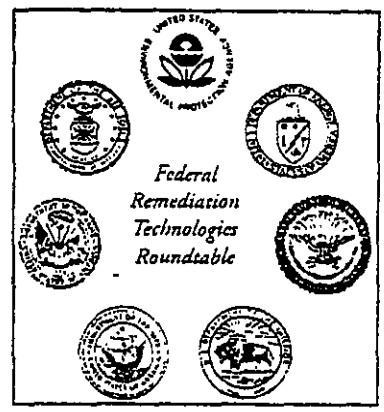
Attachments to this Memorandum can be viewed and downloaded from the following Internet address: http://clu-in.com/sw846mem.htm

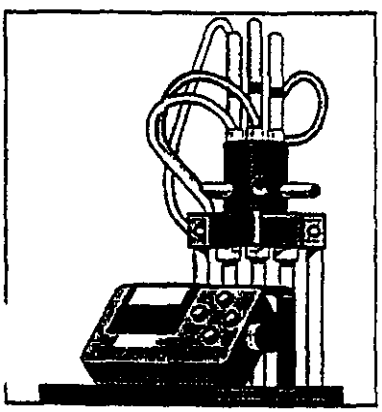
United States Environmental Protection Agency
Solid Waste and Emergency Response (5102G)
EPA 542-F-98-013
July 1998
clu-in.org

EPA

Field Sampling and Analysis Technology Matrix and Reference Guide

The *Field Sampling and Analysis Matrix and Reference Guide* is a quick reference source to provide users with a basic understanding of the sampling and field analytical technology options available for site screening, characterization, and monitoring. This screening tool gives users a general understanding of the applicability of field analytical and innovative sampling technologies by comparing them along a number of application and performance parameters. The matrix and reference guide will enhance technology information transfer and allow site managers to quickly understand and assess a range of technologies that may be appropriate for their specific site problems.



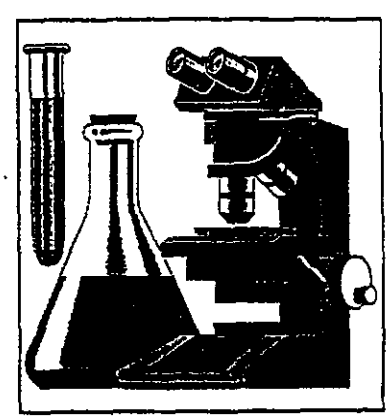


This resource is comprised of three parts. The matrix is actually two matrices (one covering sample analysis technologies, the other for sample access and collection technologies) organized in a poster format. These posters allow project managers to see the range of technology options and their relevance to a number of parameters, including analytes, media, throughput, cost, data quality, investigation derived wastes, stage of development, precision, accuracy, etc. The second part is the accompanying reference guide which provides more detailed descriptions of the technologies and bibliographic references.

The "*Matrix*" was developed by the U.S. Navy, U.S. Army Corps of Engineers, and EPA with input from the other member-agencies of the Federal Remediation Technologies Roundtable to benefit hazardous waste site cleanup program managers. Interagency participation was essential to ensure that the "*Matrix*" meets the needs of project managers in all of the Roundtable agencies as well as decision-makers at non-Federally managed sites.

The matrix and reference guide is patterned after the *Remediation Technologies Screening Matrix and Reference Guide, Version 1* (EPA 542-B-93-005). It draws upon a number of existing resources, including (but not limited to):

- The Vendor Field Analytical and Characterization Technologies System (VendorFACTS)
- The California Military Environmental Coordination Committee (CMECC) *Field Analytical Measurement Technologies, Applications, and Selection* matrix
- EPA compendium of field methods
  Sensor database under development by the Air Force's Armstrong Laboratory
- DOE Field Analytical Technologies Matrices (from the *Preferred Alternatives Matrix*)



Field Sampling and Analysis Technology Matrix and Reference Guide

To Obtain a Copy

Download a copy free of charge from the following on-line source:
Federal Remediation Technologies Roundtable (FRTR) web site
http://www.frtr.gov

Order a free hard copy from:
National Center for Environmental Publications and Information (NCEPI)
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Title: *Field Sampling and Analysis Technology Matrix and Reference Guide*

EPA Document Numbers: EPA-542-B-98-002 (reference guide)
EPA-542-B-98-002A (posters)

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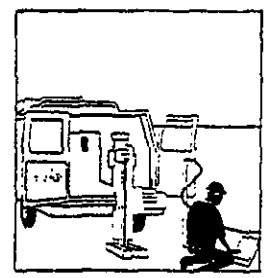
United States
Environmental Protection
Agency

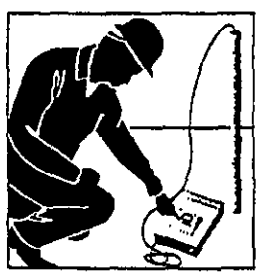
Office of Solid Waste and
Emergency Response
(5102G)

EPA 542-F-97-024
November 1997

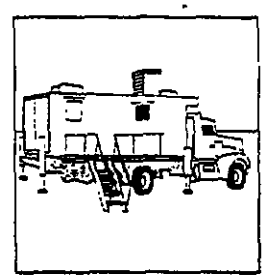
EPA Field Analytical and Site Characterization Technologies
Summary of Applications

Newer field analytical and site characterization technologies offer potential savings in time and cost compared with traditional technologies. The United States Environmental Protection Agency (EPA) Technology Innovation Office (TIO) is interested in increasing awareness of these technologies by encouraging information exchange among federal, state, and private-sector site managers, remediation professionals, and other interested parties.





A report is now available which provides information about experiences in the use of field analytical and site characterization technologies for 204 contaminated site applications. For each technology, information is provided on the reported uses, including the types of pollutants and media, reported advantages and limitations, and cost data, when available. Information for this report was obtained from federal and state site managers and from the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS) database. This report is intended to provide information that will facilitate the broader use of various field analytical and site characterization technologies at hazardous waste sites by encouraging information exchange among federal, state, and private-sector site managers.



This report documents uses of the following field analytical and site characterization technologies at contaminated sites:

Chemical Technologies
- Biosensor
- Colorimetric test strip
- Cone penetrometer mounted sensor
- Fiber-optic chemical sensor
- Fourier-transformed infrared (FTIR) spectrometry
- Gas chromatography
- Immunoassay
- Mercury vapor analyzer
- X-ray fluorescence

Geophysical Technologies
- Bore-hole geophysical
- Direct-push electrical conductivity
- Electromagnetic induction
- Ground penetrating radar
- Magnetometry
- Seismic profiling

Radionuclide Technologies
- Gamma radiation detector
- Passive alpha detector

Sampling and Sampler Emplacement Technologies
- Closed-piston soil sampling
- Direct-push prepacked well screen
- Low-flow ground-water pumping
- Soil gas sampling
- Vertical ground-water profiling
- Vibrating well installation

See the reverse side for information on ordering this report.

Field Analytical and Site CharacterizationTechnologies
Summary of Applications

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Title: *Field Analytical and Site Characterization Technologies, Summary of Applications*

EPA Document Number: EPA-542-R-97-011

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United States Environmental Protection Agency
Solid Waste and Emergency Response (5102G)
EPA 542-F-98-008
April 1998
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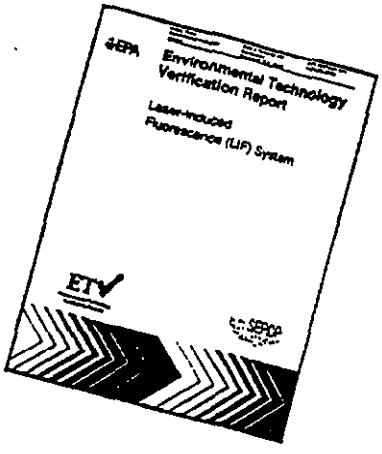
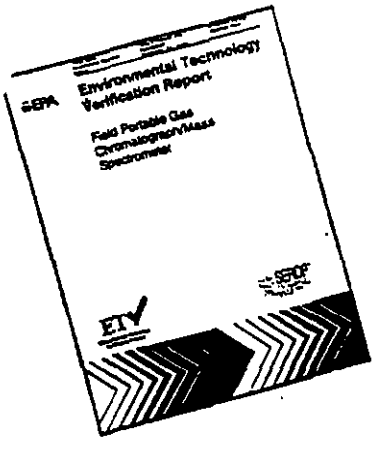
Environmental Technology Verification (ETV) Program

Site Characterization and Monitoring Technologies Pilot



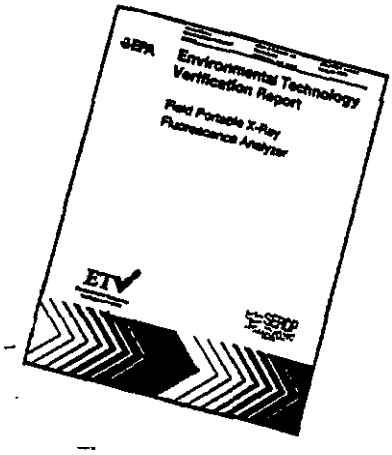
Verification Reports

The Site Characterization and Monitoring Technologies Pilot is one of twelve pilot verification programs operating under the aegis of the EPA Environmental Technology Verification (ETV) Program. One of the roles of this ETV pilot is to plan and execute field evaluations. The goal of this effort is to generate credible cost and performance information.



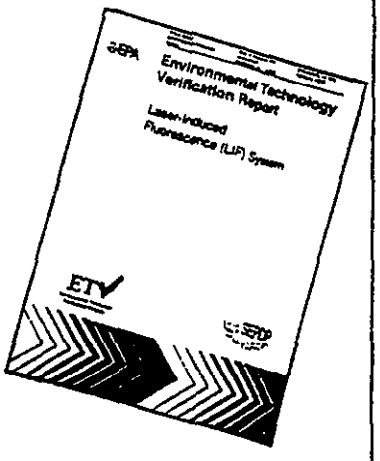
The Pilot will fulfill the need for independent evaluation of monitoring and site characterization technology performance. It brings together the interests of Federal and state regulators; Federal technology evaluation and verification entities; and potential end users of these technologies to facilitate independent and expert verification of technology performance. Customers, investors, and regulators alike will judge a technology on its merits, backed by quality data.

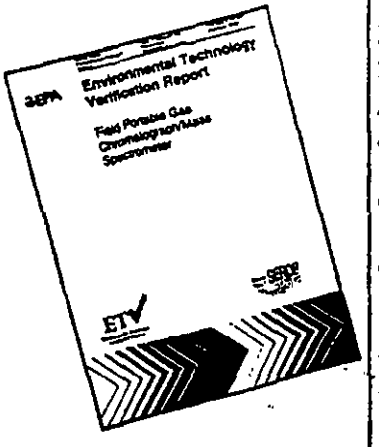
This Pilot employs a third-party verification organization (DOE's Sandia and Oak Ridge National Laboratories) to develop demonstration plans, conduct the evaluations, and write the final reports. Based on the assessment of the needs of users, the Pilot annually solicits available vendors, selects appropriate technologies, and conducts performance evaluations in the field. Technologies are selected based on their applicability to the identified category of need, their maturity (commercially ready, full-scale field units), and the willingness of the vendors to participate. After the field evaluation, this ETV Pilot produces a verification report on each technology. The verification reports document evaluation activities and present data to verify technology performance relative to vendor claims. Each report includes a 3-page verification statement signed by the Director of the National Exposure Research Laboratory.

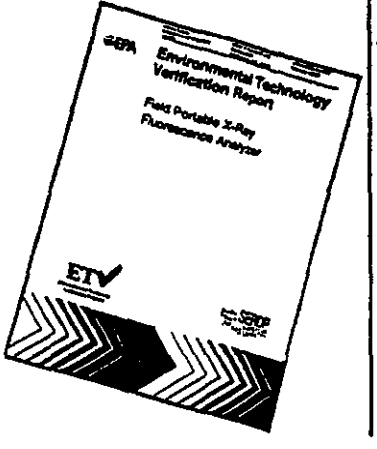


ETV
ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

Environmental Technology Verification (ETV) Program
Site Characterization and Monitoring Technologies Pilot







Cone Penetrometer/Laser Induced Fluorescence

The Site Characterization and Analysis Penetrometer System (SCAPS) LIF Sensor and Support System	EPA 600-R-97-019
The Rapid Optical Screening Tool (ROST) LIF System for Screening of Petroleum Hydrocarbons in Subsurface Soils	EPA 600-R-97-020

Field Portable Gas Chromatograph/Mass Spectrometers

Field Portable GC/MS; Viking Instruments Corporation SpectraTrak™ 672	EPA 600-R-97-148
Field Portable GC/MS; Bruker-Franzen Analytical Systems, Inc. EM640™	EPA 600-R-97-149

Field Portable X-Ray Fluorescence Analyzers

Field Portable XRF Analyzer; Scitec MAP Spectrum Analyzer	EPA 600-R-97-147
Field Portable XRF Analyzer; HNU Systems SEFA-P Analyzer	EPA 600-R-97-144
Field Portable XRF Analyzer; TN 9000 and TN Lead Analyzer	EPA 600-R-97-145
Field Portable XRF Analyzer; Metorex X-MET 920-MP	EPA 600-R-97-151
Field Portable XRF Analyzer; Metorex X-MET 920-P and X-MET 940	EPA 600-R-97-146
Field Portable XRF Analyzer; Niton XL Spectrum Analyzer	EPA 600-R-97-150

Field Analytical Methods for Measuring Polychlorinated Biphenyls (PCBs)

EnviroGard PCB Test Kit; Strategic Diagnostics Inc.	EPA 600-R-98-113
4100 Vapor Detector; Electric Sensor Technology	EPA 600-R-98-114
RaPID Assay System for PCB Analysis; Strategic Diagnostics Inc.	EPA 600-R-98-111
L2000 PCB/Chloride Analyzer; Dexsil Corporation	EPA 600-R-98-109
D Tech PCB Test Kit; Strategic Diagnostics, Inc.	EPA 600-R-98-112
PCB Immunoassay Kit; Hach Company	EPA 600-R-98-110

Soil Gas/Soil Gas Sampling Technologies

AMS Dual Tube Liner Sampler	EPA 600-R-98-09_
JMC Environmentalist's Subsoil Probe; Clements Associates, Inc.	EPA 600-R-98-091
Emflux Soil Investigation System; Quadrel Services, Inc.	EPA 600-R-98-096
Gore-Sorber Screening Survey Passive Soil Gas Sampling System; W.L. Gore & Associates	EPA 600-R-98-095
Core Barrel Sampler; Simulprobe Technologies, Inc.	EPA 600-R-98-094
Large Bore Soil Sampler; Geoprobe Systems, Inc.	EPA 600-R-98-092

Upcoming Reports:

Well-head Monitoring/Measurement of Volatile Organic Compounds (VOCs) in Water
Decision Support Software

To Obtain Hard Copies, Contact:
NCEPI
P.O. Box 42419
Cincinnati, OH 45242
Phone: 1-800-490-9198
Fax: 1-513-489-8695

For More Information:
Eric Koglin
(702) 798-2432
koglin.eric@epa.gov

Steve Billets
(702) 798-2232
billets.steve@epa.gov

Visit the Pilot home page at
http://www.epa.gov/etv/ *or* http://clu-in.com/csct.htm

United States Environmental Protection Agency

Office of Research and Development
Washington, DC 20460

EPA 542-F-98-014
October 1998
www.epa.gov/ord

EPA

Site Characterization Library Volume 1, Release 2

National Exposure Research Laboratory (NERL) - Las Vegas

A Limited Number of Copies of the First Version Are Available from NTIS.
Phone: 1-800-553-6847
Document: PB96-503792
($135.00)

Volume 1, Release 2 of EPA's National Exposure Research Laboratory (NERL - Las Vegas) Site Characterization Library (EPA 600-C-98-001) contains electronic documents and computer programs related to the characterization of hazardous waste sites. EPA has produced this library to facilitate access to these important information resources and computer-based tools.

The CD-ROM contains documents in the following subject areas:

- Project Planning and Data Quality
- RCRA/Superfund Site Assessment Guidance
- Field Operations and Standard Operating Procedures
- General Site Assessment Guidance
- Other Site Assessment Topics: Geophysics, NAPLs, Karst, and Ecological Assessment
- Soil, Vadose Zone, Sediment, and Hazardous Waste Sampling/ Monitoring
- Ground-Water Sampling and Monitoring
- Risk Assessment

In addition, the CD-ROM contains numerous computer-based programs to assist in site characterization.

For More Information:
Jeff VanEe
(702) 798-2367
vanee.jeff@epa.gov

To Obtain a Copy, Contact:
NCEPI
O. Box 42419
ncinnati, OH 45242
Phone: 1-800-490-9198
Fax: 1-513-489-8695

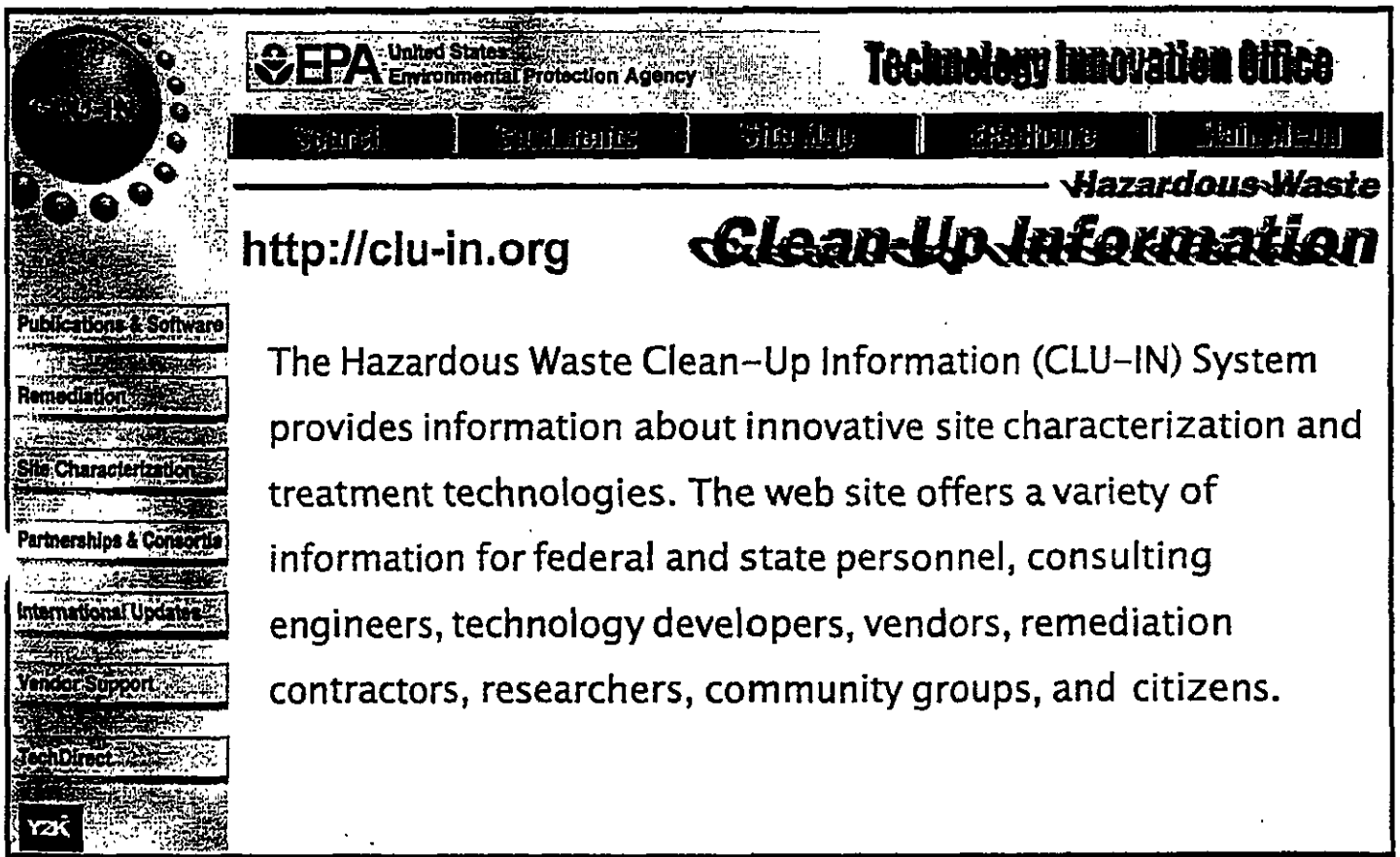
United States
Environmental Protection
Agency

Solid Waste and
Emergency Response
(5102G)

EPA 542-F-99-002
February 1999
clu-in.org

EPA CLU-IN

Hazardous Waste Clean-Up Information World Wide Web Site



The Hazardous Waste Clean-Up Information (CLU-IN) System provides information about innovative site characterization and treatment technologies. The web site offers a variety of information for federal and state personnel, consulting engineers, technology developers, vendors, remediation contractors, researchers, community groups, and citizens.

CLU-IN World Wide Web Site

http://clu-in.org

- Read about the application, development, and commercialization of innovative site characterization and remediation technologies and programs such as interagency consortia and public-private partnerships designed to facilitate their use.
- Download recent documents and access databases designed to aid those responsible for hazardous waste site remediation.
- Locate appropriate funding sources and technical support for all stages of new technology development.
- Subscribe to TechDirect, a free email service that highlights new publications and events of interest to site remediation and site assessment professionals.
- Link to other Internet sources of information on environmental restoration and technology development.

United States
Environmental Protection
Agency

Solid Waste and
Emergency Response
(5102G)

EPA 542-F-99-002
February 1999
clu-in.org

EPA

TechDirect

Technology Information Service

TechDirect is a free information service that highlights new publications and events of interest to site remediation and site assessment professionals. Each month, TechDirect will send you an e-mail message describing the availability of publications and information on upcoming events. For publications, the message will explain how to obtain a hard copy or how to download an electronic version.

To SUBSCRIBE on the CLU-IN website:

Go to: http://clu-in.org/techdrct

If you do not have World Wide Web Access:

STEP 1: Compose an e-mail message to:
listserver@unixmail.rtpnc.epa.gov

STEP 2: Do not include a subject line in your message; however, you may add a period "." if your mailserver requires an entry.

STEP 3: The body of your message should say:
subscribe techdirect ***firstname lastname***
(eg. subscribe techdirect Jeff Heimerman)

TIP: Please have your Postmaster exclude
"techdirect@unixmail.rtpnc.epa.gov"
from your AutoResponder if you are using one.

For more information on policies, programs, organizations, publications and databases useful to waste remediation professionals, visit the Hazardous Waste Clean-Up Information (CLU-IN) Web Site at http://clu-in.org.

If you have any questions or comments concerning this service, please contact the U.S. EPA Technology Innovation Office at (703) 603-9910 or e-mail heimerman.jeff@epa.gov.

TechDirect

Field-Based Site Characterization Technologies Short Course

THE CERCLA EDUCATION CENTER

The CERCLA Education Center (CEC) is a unique training forum implemented by the U.S. Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response (OSWER) Technology Innovation Office (TIO). CEC courses have been developed cooperatively by TIO, the Office of Emergency and Remedial Response (OERR), the Office of Acquisition Management (OAM), the Office of Enforcement and Compliance Assurance (OECA), and the Office of Research and Development (ORD). The CEC's structured curriculum, designed for EPA hazardous waste site managers and other environmental professionals, enables participants to schedule training that is of particular interest to them and most appropriate for their projects and workload.

COURSE DESCRIPTION

'e CEC is pleased to offer the *Field-Based Site haracterization Technologies Short Course*, an advanced workshop designed to offer participants a detailed introduction to a wide array of technologies that can be used on site to characterize the chemical and physical nature of a hazardous waste site. During the short course, participants will be asked to match applicable site characterization technologies to site-specific hazardous waste problems. Participants also will be made aware of the advantages and limitations of each technology, the logistics necessary to use the technology, and the sampling design and implementation considerations that will improve data quality.

AUDIENCE

There are no tuition costs for this course. The course was designed for an audience of environmental professionals and regulators who are involved directly or indirectly in the use or implementation of site characterization technologies or data interpretation related to those technologies. Individuals registering for the course should have: (1) direct or indirect xperience with common sampling methodologies for soil, air, surface water, and groundwater; (2) a general nderstanding of data quality levels; (3) a general science background; and (4) an understanding of common approaches o performing site characterizations.

CONDENSED OUTLINE ▼

The registered participants are surveyed in advance to determine which technologies are of the greatest interest. The technologies they choose are presented during the course; however, participants receive manuals containing information on all of the technologies.

I. Introduction
II. Overview of Site Characterization
III. Geophysical Characterization Techniques and Data Interpretation
   A. *In Situ*
   B. Borehole
   C. Surface
   D. Emerging and Innovative Approaches and Instruments
   E. Hands-On Exercises
IV. Organic Chemical Characterization Techniques and Data Interpretation
   A. Hand-Held Survey Instruments
   B. Colorimetric Indicators
   C. Fluorescence Analyzers
   D. Immunoassay
   E. Gas Chromatography
   F. Infrared Spectroscopy
   G. Chemical Sensors
   H. Emerging and Innovative Approaches and Instruments
   I. Hands-On Exercises for Organic Analysis
IV. Inorganic Chemical Characterization Techniques and Data Interpretation
   A. X-Ray Fluorescence
   B. Mercury Vapor Analyzers
   C. Immunoassay
   D. Anode Stripping Volammetry
   E. Graphite Furnace Atomic Absorption Spectroscopy
   F. Cyanide Sensors
   G. Water Quality Measurement Techniques
   H. Emerging and Innovative Approaches and Instruments
   I. Hands-On Exercises for Inorganic Analysis
VI. Sources for Site Characterization Technology Information
VII. Exercises

REGISTRATION ▼

FIELD-BASED SITE CHARACTERIZATION TECHNOLOGIES SHORT COURSE

The schedule for course offerings for 1999 is currently under development. Please complete the following information if you are interested in registering for the course in 1999.

Name: _____

Organization/Agency: _____ Mail Code: _____

Address: _____

E-Mail Address: _____ @_____

Telephone: _____ Fax: _____

Job Title: ☐ OSC ☐ RPM ☐ SAM ☐ CIC Other (specify): _____

Number of Years of Superfund Experience (if applicable): _____

Supervisor's Name: _____ Telephone: _____

Mail To: CERCLA Education Center
Technology Innovation Office
U.S. EPA (5102G)
401 M Street, SW
Washington, DC 20460

Fax To: (301) 589-8487

OR

E-Mail To: register@emsus.com

For more information about the CEC or this course, please call (703) 603-9910

Field-Based Site Characterization Technologies Course

THE CERCLA EDUCATION CENTER

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COURSE DESCRIPTION

The CEC is pleased to offer the *Field-Based Site Characterization Technologies Course*, an advanced course designed to offer participants a detailed introduction to a wide array of technologies that can be used on site to characterize the chemical and physical nature of a hazardous waste site. During the three-day course, participants will be asked to match applicable site characterization technologies to site-specific hazardous waste problems. Participants also will be made aware of the advantages and limitations of each technology, the logistics necessary to use the technology, and the sampling design and implementation considerations that will improve data quality. Finally, participants will be provided hands-on experience in the use of the most common site characterization technologies and the interpretation of the data they produce.

AUDIENCE

There are no tuition costs for this course. The course was designed for an audience of environmental professionals and regulators who are involved directly or indirectly in the use or implementation of site characterization technologies or data interpretation related to those technologies. Individuals registering for the course should have: (1) direct or indirect experience with common sampling methodologies for soil, air, surface water, and groundwater; (2) a general understanding of data quality levels; (3) a general science background; and (4) an understanding of common approaches to performing site characterizations.

CONDENSED OUTLINE ▼

I. Introduction
II. Overview of Site Characterization
III. Geophysical Characterization Techniques and Data Interpretation
   A. *In Situ*
   B. Borehole
   C. Surface
   D. Emerging and Innovative Approaches and Instruments
   E. Hands-On Exercises
IV. Organic Chemical Characterization Techniques and Data Interpretation
   A. Hand-Held Survey Instruments
   B. Colorimetric Indicators
   C. Fluorescence Analyzers
   D. Immunoassay
   E. Gas Chromatography
   F. Infrared Spectroscopy
   G. Chemical Sensors
   H. Emerging and Innovative Approaches and Instruments
   I. Hands-On Exercises for Organic Analysis
IV. Inorganic Chemical Characterization Techniques and Data Interpretation
   A. X-Ray Fluorescence
   B. Mercury Vapor Analyzers
   C. Immunoassay
   D. Anode Stripping Volammetry
   E. Graphite Furnace Atomic Absorption Spectroscopy
   F. Cyanide Sensors
   G. Water Quality Measurement Techniques
   H. Emerging and Innovative Approaches and Instruments
   I. Hands-On Exercises for Inorganic Analysis
VI. Sources for Site Characterization Technology Information
VII. Exercises

REGISTRATION ▼

FIELD-BASED SITE CHARACTERIZATION TECHNOLOGIES COURSE

The schedule for course offerings for 1999 is currently under development. Please complete the following information if you are interested in registering for the course in 1999.

Name: _____
Organization/Agency: _____ Mail Code: _____
Address: _____
E-Mail Address: _____ @ _____
Telephone: _____ Fax: _____
Job Title: ☐ OSC ☐ RPM ☐ SAM ☐ CIC Other (specify): _____
Number of Years of Superfund Experience (if applicable): _____
Supervisor's Name: _____ Telephone: _____

Mail To: CERCLA Education Center
Technology Innovation Office
U.S. EPA (5102G)
401 M Street, SW
Washington, DC 20460

Fax To: (301) 589-8487

OR

E-Mail To: register@emsus.com

For more information about the CEC or this course, please call (703) 603-9910

Strategies for Field-Based Analytical and Sampling Technologies

THE CERCLA EDUCATION CENTER

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COURSE DESCRIPTION

The CEC is pleased to announce a new course offering—*Strategies for Field-Based Analytical and Sampling Technologies*. This advanced course focuses on the planning aspects of the use of field analytical and innovative sampling and monitoring technologies and complements the existing *Field-Based Site Characterization Technologies Short Course*. In fact, it is TIO's intent that this new course always will begin with the *Field-Based Site Characterization Technologies Course* (either the short course or the three-day course). The existing course on site characterization offers participants an overview of the operation and performance of individual technologies, while the new course provides information on how the use of field-based technologies and accelerated approaches affects planning and preparing for site characterization activities; such as developing conceptual site models, establishing data quality objectives, preparing sampling and analysis plans, planning field work activities, and evaluating and documenting performance.

AUDIENCE

The new training has been developed jointly with the interagency government representatives of the Site Characterization Subgroup of the Federal Remediation Technologies Roundtable (FRTR). The course provides opportunities for hands-on activities, with participants operating various instruments. In addition, three supplemental "plug-in" modules, addressing the field-based technologies and planning considerations unique to health and safety monitoring, unexploded ordnance (UXO) and detection of explosive compounds, and sites contaminated with radiological materials, will address the needs of specific audiences. There are no tuition costs for this course. The course was designed for an audience of environmental professionals who are involved directly or indirectly in the use or implementation of field-based technologies, data interpretation related to those technologies, or report preparation requiring the consideration or incorporation of the technologies. Individuals registering for the course should have: (1) direct or indirect experience with common sampling

[illegible] (2) a general understanding of conceptual site models (CSM), data quality objectives (DQO), and sampling and analysis plans (SAP); (3) a general science background; and (4) an understanding of common approaches to performing site characterizations, sampling, or monitoring.

CONDENSED OUTLINE ▼

The *Field-Based Site Characterization Technologies Course* will be delivered prior to this training. The outline below shows how the subject matter of the existing course is integrated into the comprehensive training course. In addition, one optional "plug in" module can be offered to specific audiences on the last day.

I. Introduction
II. Overview of Site Characterization
III. Geophysical Characterization Techniques and Data Interpretation
IV. Organic Chemical Characterization Techniques and Data Interpretation
V. Inorganic Chemical Characterization Techniques and Data Interpretation
VI. Sources for Site Characterization Technology Information
VII. Overview of Planning and Process Selection
VIII. Building the Conceptual Site Model
IX. Establishing Data Quality Objectives
X. Developing Sampling and Analysis Plans
XI. Planning for Field Work
XII. Evaluating and Documenting Performance
XIII. Optional "Plug In" Module on UXO/Explosives Issues, Radiological Issues, or Health and Safety Issues

REGISTRATION ▼

PLANNING AND PROCESS SELECTION FOR FIELD-BASED TECHNOLOGIES COURSE

The schedule for course offerings for 1999 is currently under development. Please complete the following information if you are interested in registering for the course in 1999.

Name: _____
Organization/Agency: _____ Mail Code: _____
Address: _____
E-Mail Address: _____ @ _____
Telephone: _____ Fax: _____
Job Title: ☐ OSC ☐ RPM ☐ SAM ☐ CIC Other (specify): _____
Number of Years of Superfund Experience (if applicable): _____
Supervisor's Name: _____ Telephone: _____

Mail To: CERCLA Education Center
Technology Innovation Office
U.S. EPA (5102G)
401 M Street, SW
Washington, DC 20460

Fax To: (301) 589-8487

OR

E-Mail To: register@emsus.com

For more information about the CEC or this course, please call (703) 603-9910

MANAGING REMEDIATION WASTE

United States
Environmental Protection
Agency

Solid Waste and
Emergency Response
(5305W)

EPA530-F-98-026
October 1998
www.epa.gov/osw

Management of Remediation Waste Under RCRA

printed on paper that contains at least 20 percent postconsumer fiber

October 14, 1998

MEMORANDUM

SUBJECT: Management of Remediation Waste Under RCRA

TO: RCRA/CERCLA Senior Policy Managers
Regional Counsels

FROM: Timothy Fields, Jr., Acting Assistant Administrator for
Solid Waste and Emergency Response ***/signed/***

Steven A. Herman, Assistant Administrator for
Enforcement and Compliance Assurance ***/signed/***

Rapid clean up of RCRA corrective action facilities and Superfund sites is one of the Agency's highest priorities. In this context, we often receive questions about management of remediation waste under the Resource Conservation and Recovery Act (RCRA). To assist you in successfully implementing RCRA requirements for remediation waste, this memorandum consolidates existing guidance on the RCRA regulations and policies that most often affect remediation waste management. We encourage you to work with the regulations, policies and approaches outlined in this memorandum to achieve our cleanup goals as quickly and efficiently as possible.

Note that not all remediation wastes are subject to RCRA Subtitle C hazardous waste requirements. As with any other solid waste, remediation wastes are subject to RCRA Subtitle C only if they are listed or identified hazardous waste. Environmental media are subject to RCRA Subtitle C only if they contain listed hazardous waste, or exhibit a characteristic of hazardous waste. These distinctions are discussed more completely below.

The information in this memo is divided into three categories: information on regulations and policies that apply to all remediation waste; information on regulations and policies that apply only to contaminated media; and, information on regulations and policies that apply only to contaminated debris. Most of the references cited in this memo are available over the Internet. The Federal Register notices published after 1994 are available at www.access.gpo.gov/nara; the guidance memos and other EPA documents are available at www.epa.gov/correctiveaction. Federal Register notices and other documents are also available through the RCRA/CERCLA hotline: in Washington D.C., call (703) 412-9810; outside Washington D.C., call (800) 424-9346; and hearing impaired call (800) 553-7672. The hotline's hours are Monday - Friday, excluding

Federal holidays, 8:00 - 5:00, eastern standard time. Many EPA guidance memos and other documents may also be obtained through the RCRA/CERCLA hotline fax-back system. To obtain a list of documents available over the fax-back system, and fax-back system code numbers, call the RCRA/CERCLA hotline at the numbers listed above.

I hope this information will assist you as you continue to make protective, inclusive, and efficient cleanup decisions. If you have additional questions or require more information, please contact Robert Hall or Greg Madden, of our staffs, on (703) 308-8484 or (202) 564-4229 respectively.

Regulations and Policies that Apply to All Remediation Wastes

Area of Contamination Policy. In what is typically referred to as the area of contamination (AOC) policy, EPA interprets RCRA to allow certain discrete areas of generally dispersed contamination to be considered RCRA units (usually landfills). Because an AOC is equated to a RCRA land-based unit, consolidation and *in situ* treatment of hazardous waste within the AOC do not create a new point of hazardous waste generation for purposes of RCRA. This interpretation allows wastes to be consolidated or treated *in situ* within an AOC without triggering land disposal restrictions or minimum technology requirements. The AOC interpretation may be applied to any hazardous remediation waste (including non-media wastes) that is in or on the land. Note that the AOC policy only covers consolidation and other in situ waste management techniques carried out within an AOC. For *ex situ* waste management or transfer of wastes from one area of contamination to another, see discussion of corrective action management units, below.

The AOC policy was first articulated in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). See 53 FR 51444 for detailed discussion in proposed NCP preamble; 55 FR 8758-8760, March 8, 1990 for final NCP preamble discussion. See also, most recent EPA guidance, March 13, 1996 EPA memo, "Use of the Area of Contamination Concept During RCRA Cleanups."

Corrective Action Management Units (CAMUs). The corrective action management unit rule created a new type of RCRA unit – a Corrective Action Management Unit or CAMU -- specifically intended for treatment, storage and disposal of hazardous remediation waste. Under the CAMU rule, EPA and authorized states may develop and impose site-specific design, operating, closure and post-closure requirements for CAMUs in lieu of MTRs for land-based units. Although there is a strong preference for use of CAMUs to facilitate treatment, remediation waste placed in approved CAMUs does not have to meet LDR treatment standards.

The main differences between CAMUs and the AOC policy (discussed above) are that, when a CAMU is used, waste may be treated *ex situ* and then placed in a CAMU, CAMUs may be located in uncontaminated areas at a facility, and wastes may be consolidated into CAMUs from areas that are not contiguously contaminated. None of these activities are allowed under the AOC policy, which, as discussed above, covers only consolidation and *in situ* management techniques carried out within an AOC.

CAMUs must be approved by EPA or an authorized state and designated in a permit or corrective action order. In certain circumstances, EPA and states (including states that are not authorized for the CAMU regulations) may use other mechanisms to approve CAMUs. See, 58 FR 8677, February 16, 1993; appropriate use of RCRA Section 7003 orders and comparable state orders is discussed below and in an EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2. In addition, as appropriate, CAMUs may be approved by EPA as an applicable or relevant and appropriate requirement during a CERCLA cleanup using a record of decision or by an authorized state during a state cleanup using a CERCLA-like authority and a similar state document. See, e.g., 58 FR 8679, February 16, 1993. An opportunity for the public to review and comment on tentative CAMU approvals is required by the regulations when CAMUs are approved using permitting procedures and as a matter of EPA policy when CAMUs are approved using orders. EPA recommends that, whenever possible, remediation project managers combine this public participation with other public involvement activities that are typically part of remediation. For example, public notice of tentative approval of a CAMU could be combined with public notice of a proposed plan under CERCLA.

The CAMU rule is currently subject to litigation; however, the suit has been stayed pending promulgation of the final HWIR-Media regulations. Although EPA proposed to withdraw CAMUs as part of the HWIR-Media proposal, the Agency now intends to retain the CAMU rule. The Agency encourages approval of CAMUs when they are appropriate given the site-specific conditions.

The CAMU regulations are at 40 CFR 264.552, promulgated February 16, 1993 (58 FR 8658). The differences between CAMUs and AOCs are discussed in more detail in the March 13, 1996 EPA guidance memo, "Use of the Area of Contamination Concept During RCRA Cleanups."

Corrective Action Temporary Units (TUs). Temporary units, like corrective action management units, are RCRA units established specifically for management of hazardous remediation waste. The regulations for temporary units (TUs) were promulgated at the same time as the regulations for corrective action management units. The CAMU regulations established land-based units for treatment, storage and disposal of remediation waste; the TU regulations established non-land based units for treatment and storage of hazardous remediation waste. Under the TU regulations, EPA and authorized states may modify existing MTR design, operating and closure standards for temporary tank and container units used to treat and store hazardous remediation waste. Temporary units may operate for one year, with an opportunity for a one year extension.

Like CAMUs, temporary units must be approved by EPA or an authorized state and designated in a permit or corrective action order. In certain circumstances, EPA and states (including states that are not authorized for the TU regulations) may use other mechanisms to approve TUs. See, 58 FR 8677, February 16, 1993; appropriate use of RCRA Section 7003 orders and comparable state orders is discussed below and in an EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2. In addition, as appropriate, TUs may be approved by EPA as an applicable or relevant and appropriate

requirement during a CERCLA cleanup using a record of decision or by an authorized state during a state cleanup using a CERCLA-like authority and a similar state document. Placement of waste in tanks or containers, including temporary units, is not considered land disposal. Therefore, waste does not have to be treated to meet LDR treatment standards prior to being placed in a TU. Of course, LDRs must be met if hazardous remediation wastes are eventually land disposed, for example, after they are removed from the TU; however, if treatment in a TU results in constituent concentrations that comply with applicable land disposal restriction treatment standards, no further treatment prior to land disposal is required as a condition of the LDRs.

An opportunity for the public to review and comment on tentative TU approvals is required by the regulations when TUs are approved using permitting procedures and as a matter of EPA policy when TUs are approved using orders. As with CAMUs, EPA recommends that whenever possible, remediation project managers combine this public participation with other public involvement activities that are typically part of remediation. For example, public notice of tentative approval of a temporary unit could be combined with public notice of a proposed plan under CERCLA.

The TU regulations are at 40 CFR 264.553, promulgated February 16, 1993 (58 FR 8658).

Determination Of When Contamination is Caused by Listed Hazardous Waste. Where a facility owner/operator makes a good faith effort to determine if a material is a listed hazardous waste but cannot make such a determination because documentation regarding a source of contamination, contaminant, or waste is unavailable or inconclusive, EPA has stated that one may assume the source, contaminant or waste is not listed hazardous waste and, therefore, provided the material in question does not exhibit a characteristic of hazardous waste, RCRA requirements do not apply. This approach was first articulated in the Proposed NCP preamble which notes that it is often necessary to know the source of a waste (or contaminant) to determine whether a waste is a listed hazardous waste under RCRA[1] and also notes that, "at many CERCLA sites no information exists on the source of the wastes." The proposed NCP preamble goes on to recommend that the lead agency use available site information such as manifests, storage records and vouchers in an effort to ascertain the sources of wastes or contaminants, but that when this documentation is not available or inconclusive the lead agency may assume that the wastes (or contaminants) are not listed RCRA hazardous wastes. This approach was confirmed in the final NCP preamble. See, 53 FR 51444, December 21, 1988 for proposed NCP preamble discussion; 55 FR 8758, March 13, 1990 for final NCP preamble discussion.

This approach was also discussed in the HWIR-Media proposal preamble, 61 FR 18805, April 29, 1996, where it was expanded to also cover dates of waste disposal – i.e., if, after a good faith effort to determine dates of disposal a facility owner/operator is unable to make such a determination because documentation of dates of disposal is unavailable or inconclusive, one may

[1] Listing determinations are often particularly difficult in the remedial context because the listings are generally identified by the sources of the hazardous wastes rather than the concentrations of various hazardous constituents; therefore, analytical testing alone, without information on a waste's source, will not generally produce information that will conclusively indicate whether a given waste is a listed hazardous waste.

assume disposal occurred prior to the effective date of applicable land disposal restrictions. This is important because, if hazardous waste was originally disposed of before the effective dates of applicable land disposal restrictions and media contaminated by the waste are determined not to contain hazardous waste when first generated (i.e., removed from the land, or area of contamination), the media are not subject to RCRA requirements, including LDRs. See the discussion of the contained-in policy, below.

Site Specific LDR Treatment Variances. The regulations for site-specific LDR treatment variances allow EPA and authorized states to establish a site-specific LDR treatment standard on a case-by-case basis when a nationally applicable treatment standard is unachieveable or inappropriate. Public notice and a reasonable opportunity for public comment must be provided before granting or denying a site-specific LDR treatment variance. EPA recommends that remediation project managers combine this public involvement with other public involvement activities that are typically part of remediation. Regulations governing site-specific LDR treatment variances are at 40 CFR 268.44(h), promulgated August 17, 1988 (53 FR 31199) and clarified December 5, 1997 (62 FR 64504). The most recent EPA guidance on site-specific LDR treatment variances, which includes information on establishing alternative LDR treatment standards, is in the January 8, 1997 guidance memo, "Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups."

In 1996, EPA revised its policy on state authorization for site-specific LDR treatment variances and began encouraging states to become authorized to approve variances. See, HWIR-Media proposal, 61 FR 18828 (April 29, 1996).

On May 26, 1998, EPA promulgated additional site-specific land disposal restriction treatment variance opportunities specific to hazardous contaminated soil. These opportunities are discussed below.

Treatability Studies Exemption. The term "treatability study"as defined at 40 CFR 260.10 refers to a study in which a hazardous waste is subjected to a treatment process to determine: (1) whether the waste is amenable to the treatment process; (2) what pretreatment (if any) is required; (3) the optimal process conditions needed to achieve the desired treatment; (4) the efficiency of a treatment process for a specific waste or wastes; or, (5) the characteristics and volumes of residuals from a particular treatment process. Under regulations at 40 CFR 261.4(e) and (f), hazardous wastes managed during a treatability study are exempt from many RCRA Subtitle C requirements. The regulations limit the amount of waste that may be managed under an exempt treatability study to, generally, 1000 kg of hazardous waste or 1 kg of acutely hazardous waste per study. For contaminated environmental media, the volume limit is, generally, 10,000 kilograms of media that contain non-acutely hazardous waste and 2,500 kilograms of media that contain acutely hazardous waste per study. There are also limits on the types and lengths of studies that may be conducted under the exemption and record keeping and reporting requirements. Regulations governing treatability studies are at 40 CFR 261.4(e) and (f), associated preamble discussions at 52 FR 27290 (July 19, 1988) and 59 FR 8362 (February 18, 1994).

Exemption for Ninety Day Accumulation. Management of hazardous waste in tanks, containers, drip pads and containment buildings does not constitute land disposal. In addition,

EPA has provided an exemption for generators of hazardous waste which allows them to accumulate (i.e., treat or store) hazardous waste at the site of generation in tanks, containers, drip pads or containment buildings for up to ninety days without RCRA interim status or a RCRA permit. Accumulation units must meet applicable design, operating, closure and post-closure standards. Because putting hazardous waste in a tank, container, drip pad or containment building is not considered land disposal, LDR treatment standards do not have to be met before putting waste in such units. LDRs must be met if hazardous wastes are eventually land disposed, for example, after they are removed from the accumulation unit; however, if treatment in an accumulation unit results in constituent concentrations that comply with applicable land disposal restriction treatment standards, no further treatment prior to land disposal is required as a condition of the LDRs. The exemption for ninety-day accumulation is found in regulations at 40 CFR 262.34; associated preamble discussion is at 51 FR at 10168 (March 24, 1986).

Permit Waivers. Under CERCLA Section 121(e), no Federal, state or local permit is required for on-site CERCLA response actions. EPA has interpreted CERCLA Section 121(e) to waive the requirement to obtain a permit and associated administrative and procedural requirements of permits, but not the substantive requirements that would be applied through permits.[2]

In addition, on a case-by-case basis, where there may be an imminent and substantial endangerment to human health or the environment, EPA has broad authority to require corrective action and other appropriate activities under RCRA Section 7003. Under RCRA Section 7003, EPA has the ability to waive both the requirement to obtain a permit and the substantive requirements that would be imposed through permits. When EPA uses RCRA Section 7003, however, the Agency seldom uses RCRA Section 7003 to waive substantive requirements. In rare situations where substantive requirements are waived, the Agency would impose alternative requirements (e.g, waste treatment or storage requirements) as necessary to ensure protection of human health and the environment. EPA may issue RCRA Section 7003 orders at, among other sites, facilities that have been issued RCRA permits and facilities that are authorized to operate under RCRA interim status. In discussing the use of 7003 orders, where other permit authorities are available to abate potential endangerments, EPA generally encourages use of those other permit authorities (e.g., 3005(c)(3) omnibus permitting authority) rather than RCRA Section 7003. Similarly, if RCRA Section 3008(h) or RCRA Section 3013 authority is available, EPA generally encourages use of these authorities rather than RCRA Section 7003. If permit authorities or non-RCRA Section 7003 enforcement authorities are inadequate, cannot be used to address the potential endangerment in a timely manner, or are otherwise inappropriate for the potential endangerment at issue, use of RCRA Section 7003 should be considered. See, "Guidance on the Use of Section 7003 of RCRA," U.S. EPA, Office of Enforcement and Compliance Assurance, October 1997.

In 1987, EPA issued guidance indicating that RCRA-authorized states with state waiver authorities comparable to CERCLA 121(e) or RCRA Section 7003 could use those state waiver authorities to waive RCRA requirements as long as the state did so in a manner no less stringent than that allowed under the corresponding Federal authorities. These waivers are most often

[2] Note that, under certain circumstances, substantive requirements may be waived using CERCLA. See the ARAR waiver provisions at 40 CFR 300.430(f)(1)(ii)(C).

used, as are the Federal waivers, to obviate the need to obtain a RCRA permit, rather than to eliminate substantive requirements. See, EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2.

Exemption from 40 CFR Part 264 Requirements for People Engaged in the Immediate Phase of a Spill Response. Regulations at 40 CFR 264.1(g)(8) provide that people engaged in treatment or containment activities are not subject to the requirements of 40 CFR part 264 if the activities are carried out during immediate response to: (1) a discharge of hazardous waste; (2) an imminent and substantial threat of a discharge of hazardous waste; (3) a discharge of a materials which, when discharged, becomes a hazardous waste; or, (4) an immediate threat to human health, public safety, property or the environment from the known or suspected presence of military munitions, other explosive material, or an explosive device. This means that, during the immediate phase of a spill response, hazardous waste management activities do not require hazardous waste permits (or interim status) and hazardous waste management units used during immediate response actions are not subject to RCRA design, operating, closure or post-closure requirements.

Of course, if hazardous waste treatment activities or other hazardous waste management activities continue after the immediate phase of a spill response is over, all applicable hazardous waste management and permitting requirements would apply. In addition, if spills occur at a facility that is already regulated under 40 CFR part 264, the facility owner/operator must continue to comply with all applicable requirements of 40 CFR Part 264 Subparts C (preparedness and prevention) and D (contingency plan and emergency procedures). See regulations at 40 CFR 260.1(g) and associated preamble discussion at 45 FR 76626 (November 19, 1980). See also, Sept. 29, 1986 memo from J. Winston Porter (EPA Assistant Administrator) to Fred Hansen interpreting the 40 CFR 264.1(g) regulations.

Changes During Interim Status to Comply with Corrective Action Requirements. Under regulations at 40 CFR 270.72(a)(5), an owner or operator of an interim status facility may make changes to provide for treatment, storage and disposal of remediation wastes in accordance with an interim status corrective action order issued by EPA under RCRA Section 3008(h) or other Federal authority, by an authorized state under comparable state authority, or by a court in a judicial action brought by EPA or an authorized state. These changes are limited to treatment, storage and disposal of remediation waste managed as a result of corrective action for releases at the facility in question; however, they are exempt from the reconstruction ban under 40 CFR 270.72(b). Under this provision, for example, EPA could approve a corrective action management unit for treatment of remediation waste using a 3008(h) order (or an authorized state could approve a CAMU using a similar state authority), even if that unit would otherwise amount to "reconstruction." Of course, units added at interim status facilities in accordance with this provision must meet all applicable unit requirements; for example, in the case of a CAMU, the CAMU requirements apply. See, regulations at 40 CFR 270.72(a)(5) promulgated March 7, 1989 and associated preamble discussion at 54 FR 9599.

Emergency Permits. In the event of an imminent and substantial endangerment to human health or the environment, EPA, or an authorized state, may issue a temporary emergency permit for treatment, storage or disposal of hazardous waste. Emergency permits may allow treatment,

storage or disposal of hazardous waste at a non-permitted facility or at a permitted facility for waste not covered by the permit. Emergency permits may be oral or written. (If oral, they must be followed within five days by a written emergency permit.) Emergency permits must specify the hazardous wastes to be received and managed and the manner and location of their treatment, storage and disposal. Emergency permits may apply for up to ninety days, but may be terminated at any point if EPA, or an authorized state, determines that termination is appropriate to protect human health or the environment. Emergency permits must be accompanied by a public notice that meets the requirements of 40 CFR 124.10(b), including the name and address of the office approving the emergency permit, the name and location of the hazardous waste treatment, storage or disposal facility, a brief description of the wastes involved, the actions authorized and the reason for the authorization, and the duration of the emergency permit.

Emergency permits are exempt from all other requirements of 40 CFR part 270 and part 124; however, to the extent possible and not inconsistent with the emergency situation, they must incorporate all otherwise applicable requirements of 40 CFR part 270 and parts 264 and 266.

See, regulations at 40 CFR 270.61, originally promulgated as 40 CFR 122.27 on May 19, 1987 (45 FR 33326). EPA has also written a number of letters interpreting the emergency permit regulations, see, for example, November 3, 1992 letter to Mark Hansen, Environmental Products and Services Inc., from Sylvia Lowrance, Director Office of Solid Waste (available in the RCRA Permit Policy Compendium).

Temporary Authorizations at Permitted Facilities. Under regulations at 40 CFR 270.42(e), EPA, or an authorized state, may temporarily authorize a permittee for an activity that would be the subject of a class two or three permit modification in order to, among other things, facilitate timely implementation of closure or corrective action activities. Activities approved using a temporary authorization must comply with applicable requirements of 40 CFR part 264. Temporary authorizations are limited to 180 days, with an opportunity for an extension of 180 additional days. To obtain an extension of a temporary authorization, a permittee must have requested a class two or three permit modification for the activity covered in the temporary authorization. Public notification of temporary authorizations is accomplished by the permittee sending a notice about the temporary authorization to all persons on the facility mailing list and to appropriate state and local governments. See regulations at 40 CFR 270.42, promulgated on September 28, 1988, and associated preamble at 53 FR 37919.

Regulations and Policies that Apply to Contaminated Environmental Media Only

Contained-in policy. Contaminated environmental media, of itself, is not hazardous waste and, generally, is not subject to regulation under RCRA. Contaminated environmental media can become subject to regulation under RCRA if they “contain” hazardous waste. As discussed more fully below, EPA generally considers contaminated environmental media to contain hazardous waste: (1) when they exhibit a characteristic of hazardous waste; or, (2) when they are contaminated with concentrations of hazardous constituents from listed hazardous waste that are above health-based levels.

If contaminated environmental media contain hazardous waste, they are subject to all applicable RCRA requirements until they no longer contain hazardous waste. EPA considers

contaminated environmental media to no longer contain hazardous waste: (1) when they no longer exhibit a characteristic of hazardous waste; and (2) when concentrations of hazardous constituents from listed hazardous wastes are below health-based levels. Generally, contaminated environmental media that do not (or no longer) contain hazardous waste are not subject to any RCRA requirements; however, as discussed below, in some circumstances, contaminated environmental media that contained hazardous waste when first generated (i.e., first removed from the land, or area of contamination) remain subject to LDR treatment requirements even after they "no longer contain" hazardous waste.

The determination that any given volume of contaminated media does not contain hazardous waste is called a "contained-in determination." In the case of media that exhibit a characteristic of hazardous waste, the media are considered to "contain" hazardous waste for as long as they exhibit a characteristic. Once the characteristic is eliminated (e.g., through treatment), the media are no longer considered to "contain" hazardous waste. Since this determination can be made through relatively straightforward analytical testing, no formal "contained-in" determination by EPA or an authorized state is required. Just like determinations about whether waste has been adequately decharacterized, generators of contaminated media may make independent determinations as to whether the media exhibit a characteristic of hazardous waste. In the case of media that are contaminated by listed hazardous waste, current EPA guidance recommends that contained-in determinations be made based on direct exposure using a reasonable maximum exposure scenario and that conservative, health-based, standards be used to develop the site-specific health-based levels of hazardous constituents below which contaminated environmental media would be considered to no longer contain hazardous waste. Since this determination involves development of site-specific health-based levels, the approval of EPA or an authorized state is required.

In certain circumstances the, RCRA land disposal restrictions will continue to apply to contaminated media that has been determined not to contain hazardous waste. This is the case when contaminated media contain hazardous waste when they are first generated (i.e., removed from the land, or area of contamination) and are subsequently determined to no longer contain hazardous waste (e.g., after treatment), but still contain hazardous constituents at concentrations above land disposal restriction treatment standards. It is also the case when media are contaminated as a result of disposal of untreated (or insufficiently treated) listed hazardous waste after the effective date of an applicable LDR treatment requirement. Of course, if no land disposal will occur (e.g., the media will be legitimately recycled) the LDR treatment standards do not apply. In addition, contaminated environmental media determined not to contain any waste (i.e., it is just media, it does not contain solid or hazardous waste) would not be subject to any RCRA Subtitle C requirements, including the LDRs, regardless of the time of the "contained-in" determination.

The contained-in policy was first articulated in a November 13, 1986 EPA memorandum, "RCRA Regulatory Status of Contaminated Groundwater." It has been updated many times in Federal Register preambles, EPA memos and correspondence, see, e.g., 53 FR 31138, 31142, 31148 (Aug. 17, 1988), 57 FR 21450, 21453 (May 20, 1992), and detailed discussion in HWIR-Media proposal preamble, 61 FR 18795 (April 29, 1996). A detailed discussion of the continuing requirement that some soils which have been determined to no longer contain hazardous waste (but still contain solid waste) comply with land disposal treatment standards can be found in the

HWIR-Media proposal preamble, 61 FR 18804; the September 15, 1996 letter from Michael Shapiro (EPA OSW Director) to Peter C. Wright (Monsanto Company); and the preamble to the LDR Phase IV rule, 63 FR 28617 (May 26, 1998).

Note that the contained-in policy applies only to environmental media (soil, ground water, surface water and sediments) and debris. The contained-in policy for environmental media has not been codified. As discussed below, the contained-in policy for hazardous debris was codified in 1992.

RCRA Section 3020(b) Exemption for Reinjection of Contaminated Ground Water. Under RCRA Section 3020(a), disposal of hazardous waste into or above a formation that contains an underground source of drinking water is generally prohibited. RCRA Section 3020(b) provides an exception for underground injection carried out in connection with certain remediation activities. Under RCRA Section 3020(b), injection of contaminated ground water back into the aquifer from which it was withdrawn is allowed if: (1) such injection is conducted as part of a response action under Section 104 or 106 of CERCLA or a RCRA corrective action intended to clean up such contamination; (2) the contaminated ground water is treated to substantially reduce hazardous constituents prior to reinjection; and, (3) the response action or corrective action will, on completion, be sufficient to protect human health and the environment. Approval of reinjection under RCRA Section 3020(b) can be included in approval of other cleanup activities, for example, as part of approval of a RCRA Statement of Basis or CERCLA Record of Decision. See, RCRA Section 3020(b), established as part of the 1984 HSWA amendments. See also, OSWER Directive 9234.1-06, "Applicable of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26," November 27, 1989.

LDR Treatment Standards for Contaminated Soils. On May 26, 1998, EPA promulgated land disposal restriction treatment standards specific to contaminated soils.[3] These treatment standards require that contaminated soils which will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards (UTS), whichever is greater. (This is typically referred to as 90% capped by 10xUTS.) For contaminated soil that exhibits a characteristic of ignitable, reactive or corrosive hazardous waste, treatment must also eliminate the hazardous characteristic.

The soil treatment standards apply to all underlying hazardous constituents[4] reasonably expected to be present in any given volume of contaminated soil when such constituents are found at initial concentrations greater than ten times the UTS. For soil that exhibits a characteristic of toxic, ignitable, reactive or corrosive hazardous waste, treatment is also required for: (1) in the case of the toxicity characteristic, the characteristic constituent; and, (2) in the case of ignitability,

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[3] This rule, which also addresses a number of non-soil issues, has been challenged by a number of parties. To date, the parties have filed non-binding statements of issues only; however, based on those statements, it appears that, with the exception of the requirement that PCBs be included as an underlying hazardous constituent which has been challenged for both soil and non-soil wastes, the soil treatment standards are not included in the challenges.

[4] Except fluoride, selenium, sulfides, vanadium and zinc.

reactivity or corrosivity, the characteristic property. Although treatment is required for each underlying hazardous constituent, it is not necessary to monitor soil for the entire list of underlying hazardous constituents. Generators of contaminated soil can reasonably apply knowledge of the likely contaminants present and use that knowledge to select appropriate underlying hazardous constituents, or classes of constituents, for monitoring. As with the LDR treatment standards for hazardous debris (discussed below), generators of contaminated soil may use either the applicable universal treatment standards for the contaminating hazardous waste or the soil treatment standards.

See, soil treatment standard regulations at 40 CFR 268.49, promulgated May 26, 1998 and associated preamble discussion at 63 FR 28602-28622.

Note that the soil treatment standards supersede the historic presumption that an LDR treatment variance is appropriate for contaminated soil. LDR treatment variances are still available for contaminated soil, provided the generator can show that an otherwise applicable treatment standard (i.e., the soil treatment standard) is unachieveable or inappropriate, as discussed above, or can show that a site-specific, risk-based treatment variance is proper, as discussed below.

Site-Specific, Risk-Based LDR Treatment Variance for Contaminated Soils. On May 26, 1998, EPA promulgated a new land disposal restriction treatment variance specific to contaminated soil. Under 40 CFR 268.44(h)(3), variances from otherwise applicable LDR treatment standards may be approved if it is determined that compliance with the treatment standards would result in treatment beyond the point at which short- and long-term threats to human health and the environment are minimized. This allows a site-specific, risk-based determination to supersede the technology-based LDR treatment standards under certain circumstances.

Alternative land disposal restriction treatment standards established through site specific, risk-based minimize threat variances should be within the range of values the Agency generally finds acceptable for risk-based cleanup levels. That is, for carcinogens, alternative treatment standards should ensure constituent concentrations that result in the total excess risk to an individual exposed over a lifetime generally falling within a range from 10^{-4} to 10^{-6}, using 10^{-6} as a point of departure and with a preference for achieving the more protective end of the risk range. For non-carcinogenic effects, alternative treatment standards should ensure constituent concentrations that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; in general, the hazard index should not exceed one (1). Constituent concentrations that achieve these levels should be calculated based on a reasonable maximum exposure scenario -- that is, based on an analysis of both the current and reasonable expected future land uses, with exposure parameters chosen based on a reasonable assessment of the maximum exposure that might occur; however, alternative LDR treatment standards may not be based on consideration of post-land disposal controls such as caps or other barriers.

See, regulations at 40 CFR 268.44(h)(4), promulgated May 26, 1998 and associated preamble discussion at 63 FR 28606-28608.

Regulations and Policies that Apply Only to Debris

LDR Treatment Standards for Contaminated Debris. In 1992, EPA established land disposal restriction treatment standards specific to hazardous contaminated debris. The debris-specific treatment standards established by these regulations are based on application of common extraction, destruction, and containment debris treatment technologies and are expressed as specific technologies rather than numeric criteria. As with the contaminated soil treatment standards discussed earlier, generators of hazardous contaminated debris may choose between meeting either the debris treatment standards or the numerical treatment standard promulgated for the contaminating hazardous waste. See, regulations at 40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 57 FR 37194 and 27221.

Interpretation that Debris Treated to the LDR Debris Treatment Standards Using Extraction or Destruction Technologies no Longer Contain Hazardous Waste. With the land disposal restriction treatment standards for hazardous contaminated debris, in 1992, EPA determined that hazardous debris treated to comply with the debris treatment standards using one of the identified extraction or destruction technologies would be considered no longer to contain hazardous waste and would, therefore, no longer be subject to regulation under RCRA, provided the debris do not exhibit any of the hazardous waste characteristics. This "contained-in determination" is automatic; no agency action is needed. Note that this automatic contained-in determination does not apply to debris treated to the debris treatment standards using one of the identified immobilization technologies. See, regulations at 40 CFR 261.3(f) and treatment standards at Table 1 of 40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 51 FR 37225.

cc: Barbara Simcoe, Association of State and Territorial Solid Waste Management Officials

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 15 1998

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Summary Chart of October 14, 1998 Memorandum, "Management of Remediation Waste Under RCRA."

FROM: Stephen F. Heare, Acting Director
Permits and State Programs Division

TO: RCRA Senior Policy Advisors, Regions I - X
Regional Counsels

On October 14, 1998 we issued a guidance memorandum, "Management of Remediation Waste under RCRA" which provides information on the RCRA regulations and policies that most often affect remediation waste. The attached chart summarizes the memo and can be used to quickly identify possible remediation waste management strategies and to compare one remediation waste management approach to another.

I emphasize that the information in the chart significantly simplifies many of the RCRA remediation waste regulations and policies for purposes of summary. For complete information you should continue to refer to the guidance memorandum and the materials referenced therein.

I hope this information in this chart will be helpful as you continue to make protective, inclusive and efficient cleanup decisions.

cc: Barbara Simcoe, Association of State and Territorial Solid Waste Management Officials

Attachment.

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Summary of Regulations and Policies That Often Affect M[illegible]gement of Remediation Waste Under RCRA – October 1998

Regulation / Policy	On-site / Off-site	Wastes Covered	More Information
Area of Contamination – Allows wastes to be consolidated and treated *in situ* within an AOC without triggering land disposal restrictions or minimum technology requirements. For AOC, contamination must be contiguous but does not have to be homogeneous.	On-site, *in situ* only	All RW	53 FR 51444 for detailed discussion in proposed NCP preamble; 55 FR 8758-8760, March 8, 1990 for final NCP preamble discussion. See also, most recent EPA guidance, March 13, 1996 EPA memo, "Use of the Area of Contamination Concept During RCRA Cleanups."
CAMU – Corrective Action Management Units are a type of RCRA unit specifically for RW. RW may be placed into CAMUs and treated in CAMUs without triggering LDRs or MTRs. Prior state or EPA approval and specification of unit standards required.	On-site only	All RW	40 CFR 264.552, promulgated February 16, 1993 (58 FR 8658). The differences between CAMUs and AOCs are discussed in more detail in the March 13, 1996 EPA guidance memo, "Use of the Area of Contamination Concept During RCRA Cleanups."
TU – Corrective Action Temporary Units are a type of RCRA unit specifically for RW. TUs may meet modified design, operating and closure standards instead of the RCRA standards that usually apply to tanks and containers. Prior state or EPA approval and specification of unit standards required. Operation limited to one year with opportunity for one one-year extension.	On-site only	All RW	40 CFR 264.553, promulgated February 16, 1993 (58 FR 8658).
Determination of whether contamination caused by listed hazardous waste – If, after a good faith effort to find information, information about the source of a waste or contamination is unavailable or inconclusive, one may assume waste is not, or the contamination was not caused by, listed RCRA hazardous waste.	Both	All RW	53 FR 51444, December 21, 1988 for proposed NCP preamble discussion; 55 FR 8758, March 13, 1990 for final NCP preamble discussion.
Site-specific LDR treatment variances – EPA and authorized states may establish a site-specific LDR treatment standard on a case-by-case basis when a nationally applicable treatment standard is unachieveable or inappropriate. Public notice and a reasonable opportunity for public comment must be provided before granting or denying a site-specific LDR treatment variance.	Both	All RW	40 CFR 268.44(h), promulgated August 17, 1988 (53 FR 31199) and clarified December 5, 1997 (62 FR 64504). Most recent EPA guidance, January 8, 1997 memo "Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups."
Treatability study exemption – Certain quantities of hazardous waste are exempted from many RCRA requirements during treatability studies.	On-site only	All RW	40 CFR 261.4(e) and (f), associated preamble discussions at 52 FR 27290 (July 19, 1988) and 59 FR 8362 (February 18, 1994).

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

Summary of Regulations and Policies That Often Affect Management of Remediation Waste Under RCRA – October 1998

Regulation / Policy	On-site / *Off-site*	Wastes *Covered*	More Information
Exemption for 90 day accumulation – Generators may accumulate (i.e., treat or store) hazardous waste in tanks, containers, drip pads or containment buildings for up to ninety days without RCRA interim status or a RCRA permit. Placement of waste in accumulation units does not constitute land disposal. Accumulation units must meet applicable design, operating, closure and post-closure standards.	On-site only	All RW	40 CFR 262.34; associated preamble discussion is at 51 FR at 10168 (March 24, 1986).
Permit waivers – No Federal, state or local permit is required for on-site CERCLA response actions. Under RCRA Section 7003, EPA has the ability to waive both the requirement to obtain a permit and the substantive requirements that would be imposed through permits. States with state waiver authorities comparable to CERCLA 121(e) or RCRA Section 7003 may waive RCRA requirements in a manner no less stringent than that allowed under the corresponding Federal waivers.	Both	All RW	CERCLA Section 121(e); "Guidance on the Use of Section 7003 of RCRA," U.S. EPA, Office of Enforcement and Compliance Assurance, October 1997 and EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2.
Exemption from part 264 requirements for people engaged in the immediate phase of a spill response – People engaged in treatment or containment activities are not subject to 40 CFR part 264 during immediate response to discharges or imminent and substantial threats of discharges of hazardous waste and known or suspected military munitions, other explosive materials, or explosive devices.	Both	All RW	40 CFR 260.1(g) and associated preamble discussion at 45 FR 76626 (November 19, 1980) and Sept. 29, 1986 memo from J. Winston Porter (EPA Assistant Administrator) to Fred Hansen interpreting the 40 CFR 264.1(g) regulations.
Changes during interim status to comply with corrective action requirements – An owner or operator of an interim status facility may make changes to provide for treatment, storage and disposal of RW in accordance with an interim status corrective action order issued by EPA under RCRA Section 3008(h) or other Federal authority, by an authorized state under comparable state authority, or by a court in a judicial action brought by EPA or an authorized state.	On-site	All RW	40 CFR 270.72(a)(5) promulgated March 7, 1989 and associated preamble discussion at 54 FR 9599.

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

Regulation / Policy	On-site / Off-site	Wastes Covered	More Information
Emergency permits – If there is an imminent and substantial endangerment to human health or the environment, EPA, or an authorized state, may issue a temporary emergency permit for treatment, storage or disposal of hazardous waste. Emergency permits may allow treatment, storage or disposal of hazardous waste at a non-permitted facility or at a permitted facility for waste not covered by the permit.	Both	All RW	40 CFR 270.61, originally promulgated as 40 CFR 122.27 on May 19, 1987 (45 FR 33326) and November 3, 1992 letter to Mark Hansen, Environmental Products and Services Inc., from Sylvia Lowrance, Director Office of Solid Waste (available in the RCRA Permit Policy Compendium).
Temporary authorizations at permitted facilities – EPA, or an authorized state, may temporarily authorize a permittee for an activity that would be the subject of a class two or three permit modification in order to, among other things, facilitate timely implementation of closure or corrective action.	Both	All RW	40 CFR 270.42, promulgated on September 28, 1988, and associated preamble at 53 FR 37919.
Contained-in policy – *Contaminated environmental media* that does not exhibit a characteristic of hazardous waste and, if contaminated by listed waste, has concentrations of hazardous constituents that are below health-based levels does not need to be managed as hazardous waste.	Both	Media only	Nov. 13, 1986 memo, "RCRA Regulatory Status of Contaminated Groundwater" and 53 FR 31138, 31142, 31148 (Aug. 17, 1988); 57 FR 21450, 21453 (May 20, 1992); 61 FR 18795 (April 29, 1996); September 15, 1996 letter to Monsanto Company; and 63 FR 28617 (May 26, 1998).
RCRA Section 3020(b) exemption for reinjection of contaminated ground water – Injection of contaminated ground water back into the aquifer from which it was withdrawn is allowed if certain requirements are met.	Both	Ground water only	RCRA Section 3020(b). **See also, OSWER Directive 9234.1-06,** "Applicable of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26," November 27, 1989.
LDR treatment standards for contaminated soil – Soil specific treatment standards of 90% reduction in concentrations of hazardous constituents or ten times the universal treatment standard, whichever is less stringent. Treatment required for all underlying hazardous constituents reasonably expected to be present when such constituents are found at initial concentrations greater than 10 X UTS.	Both	Soil only	40 CFR 268.49, promulgated May 26, 1998 and associated preamble discussion at 63 FR 28602-28622.

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

Summary of Regulations and Policies That Often Affect Management of Remediation Waste Under RCRA – October 1998

Regulation / Policy	On-site / Off-site	Wastes Covered	More Information
Site-specific risk-based LDR treatment variance for contaminated soil – EPA, or an authorized state, may approve a variance from an otherwise applicable treatment standard if compliance with that standard would result in treatment beyond the point at which threats are minimized.	Both	Soil only	40 CFR 268.44(h)(4), promulgated May 26, 1998 and associated preamble discussion at 63 FR 28606-28608.
LDR treatment standards for contaminated debris – Debris specific treatment standards expressed as specified treatment methods / technologies.	Both	Debris only	40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 57 FR 37194 and 27221.
Interpretation that debris treated using extraction or destruction technologies no longer contain hazardous waste – Debris treated to comply with the debris treatment standards using one of the identified extraction or destruction technologies would be considered no longer to contain hazardous waste and would, therefore, no longer be subject to regulation under RCRA, provided the debris do not exhibit any of the hazardous waste characteristics.	Both	Debris only	40 CFR 261.3(f) and treatment standards at Table 1 of 40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 51 FR 37225.

Most of the references cited in this chart re available over the Internet. The Federal Register notices published after 1994 are available at www.access.gpo.gov/nara; the guidance memos and other EPA documents are available at www.epa.gov/correctiveaction. Federal Register notices and other documents are also available through the RCRA/CERCLA hotline: in Washington D.C., call (703) 412-9810; outside Washington D.C., call (800) 424-9346; and hearing impaired call (800) 553-7672. The hotline's hours are Monday - Friday, excluding Federal holidays, 8:00 - 5:00, eastern standard time. Many EPA guidance memos and other documents may also be obtained through the RCRA/CERCLA hotline fax-back system. To obtain a list of documents available over the fax-back system, and fax-back system code numbers, call the RCRA/CERCLA hotline at the numbers listed above.

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

United States
Environmental
Protection Agency

Solid Waste and
Emergency Response
(5305W)

EPA530-F-98-029
November 1998
www.epa.gov/osw

Office of Solid Waste

EPA

Environmental Fact Sheet

Final HWIR-MEDIA Rule

What is the HWIR-media rule?

The HWIR-media rule is a final regulation that is part of President Clinton's March 1994 environmental regulatory reform initiative. The rule sets new requirements under the Resource Conservation and Recovery Act (RCRA) for hazardous remediation wastes that are treated, stored, or disposed of during cleanup actions. Specifically, the rule

- Makes permits for treating, storing, and disposing of hazardous remediation wastes faster and easier to obtain
- Provides that obtaining these permits will not subject the owner and/or operator to facility-wide corrective action
- Creates a new kind of unit called a "staging pile" that allows more flexibility in temporarily storing remediation waste during cleanup
- Excludes dredged materials from RCRA Subtitle C if they are managed under an appropriate permit under the Marine Protection, Research and Protection Act or the Clean Water Act.
- Makes it faster and easier for States to receive authorization when they update their RCRA programs to incorporate revisions to the Federal RCRA regulations.

What is the background for this rule?

On April 29, 1996, EPA proposed new regulatory provisions entitled "Requirements for Management of Hazardous Contaminated Media" (61 FR 18780). That proposal, also known as the "Hazardous Waste Identification Rule for Contaminated Media" (or HWIR-media), included a broad range of potential reforms. Among those reforms, EPA proposed options for excluding contaminated media and other remediation wastes from Subtitle C. For the reasons described in the following paragraph, EPA is not finalizing those broad reforms in the HWIR-media final rule, but instead is finalizing only the reforms listed at left. EPA has already finalized the 1996 proposed provisions for standards for hazardous soils. These provisions were in the May 26, 1998, Phase IV final rule (63 FR 28556).

Although EPA conducted a lengthy outreach process before developing the HWIR-media proposal and tried to balance the concerns and interests of various stakeholder groups, it is clear after reviewing public comment on the proposal that stakeholders have fundamental disagreements on many remediation waste management issues. EPA has concluded that pursuing comprehensive regulatory reform would be time- and resource-intensive and would most likely result in a rule that would provoke additional

years of litigation and associated uncertainty. This uncertainty would be detrimental to the program and would have a negative effect on ongoing and future cleanups. Therefore, EPA is withdrawing the proposed options for broad reforms—such as those that exempted remediation wastes from Subtitle C—and is, instead, finalizing only those reforms listed.

One of the 1996 HWIR-media options proposed was the withdrawal of the Corrective Action Management Unit (CAMU) rule because its flexibility would be replaced with the proposed broad reforms. However, because EPA is not finalizing those broad reforms, the CAMU rule will be retained as it currently exists in 40 CFR Section 264.552

Does the HWIR-media rule apply new mandatory requirements?

No. Adoption of the requirements of this rule is optional for authorized state RCRA programs because these requirements are less stringent then the existing requirements. Even after these new regulations are adopted and authorized for state programs, facilities may choose not to take advantage of them and may choose, instead, to comply with the traditional requirements for hazardous waste management.

Is EPA changing policies that currently provide flexibility for remediation waste management?

No. Existing areas of flexibility for the management of hazardous remediation waste such as the "contained-in" and "area of contamination" policies and site-specific land disposal restrictions treatability variances continue to be available.

What impacts does EPA expect the HWIR-media rule to have?

EPA anticipates that the HWIR-media rule will

- Eliminate existing regulatory disincentives to remediation
- Make site cleanup faster and easier

and thus

- Provide increased protection to human health and the environment.

For More Information

The *Federal Register* notice and this fact sheet are available in electronic format on the Internet through the EPA Public Access Server. The notice is available http://www.epa.gov/rules, regulations, and legislation. This fact sheet and other documents related to this rule are available under "EPA Offices and Regions." For additional information or to order paper copies of any documents, call the RCRA Hotline. Callers within the Washington Metropolitan Area must dial 703-412-9810 or TDD 703-412-3323 (hearing impaired). Long-distance callers may call 1-800-424-9346 or TDD 1-800-553-7672. The RCRA Hotline operates weekdays, 9:00 a.m. to 6:00 p.m. Write to the RCRA Information Center (5305W), US EPA, 401 M Street, SW, Washington, DC 20460.

References for Managing Remediation Waste

Module References

! Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Advanced Notice for Proposed Rulemaking (ANPR) May 1, 1996 (61 FR 19432). Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm

! Hazardous Remediation Waste Management Requirements (HWIR-Media); Final Rule, US EPA, Federal Register: Volume 63, Number 229, November 30, 1998. Available over the Internet: http://www.epa.gov/epaoswer/hazwaste/id/hwirmdia.htm

! Corrective Action Management Units and Temporary Units Final Rule 58 FR 8658, February 16, 1993. Available over the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm

! Requirements for Management of Hazardous Contaminated Media (HWIR-Media), 40 CFR Parts 260, 261, 262, 264, 268, 269 and 271, Federal Register: Volume 63, Number 230, December 1, 1998. Available over the Internet: http://frwebgate1.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=3206116830+4+0+0&WAISaction=retrieve

! Requirements for Management of Hazardous Contaminated Media; Proposed Rule, US EPA, Federal Register: April 29, 1996. Available over the Internet: http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/April/Day-29/pr-539.txt.html

! Preamble for Final HWIR-Media Rule, US EPA, October 16, 1998. Available to download from the Internet via: http://www.epa.gov/epaoswer/hazwaste/id/hwirmdia/omb-1016.pdf

! Draft Preamble for Final HWIR-Media Rule, September 8, 1998. Available to download from the Internet via: http://www.epa.gov/epaoswer/hazwaste/id/hwirmdia/omb-0908.pdf

! Draft Regulatory Language for Final HWIR-Media Rule. Available to download from the Internet via: http://www.epa.gov/epaoswer/hazwaste/id/hwirmdia/omb-rule.pdf

! AOC Policy: National Contingency Plan (NCP) Preamble, 53 FR 1444.

! Final National Contingency Plan, 55 FR 8758-8760, March 8, 1990.

! Use of Area of Contamination Concept During RCRA Cleanups, EPA guidance, EPA memo March, 1996.

! Contained-in Policy: RCRA Regulatory Status of Contaminated Groundwater, EPA memorandum, November 13, 1986.

! Contained-in Policy: Federal Register preambles, EPA memos and correspondence, see, e.g., 53 FR 31138, 31142, 31148 (Aug. 17, 1988), 57 FR 21450, 21453 (May 20, 1992), and HWIR-Media preamble, 61 FR 18795 (April 29, 1996).

! EPA guidance memo from J. Winston Porter to EPA Regional Administrators, 58 FR 8679, February, 1993.

References for Managing Remediation Waste

! RCRA Permit Requirements for State Superfund Actions, OSWER Directive 9522.00-2, November, 1987.

Supplemental References and Resources

! Environmental Fact Sheet: Hazardous Waste Identification Rule for Contaminated Media (HWIR-Media), Proposed Rule, US EPA. Available to order via NCEPI. Order Number: EPA530F96010. Fax order to: 703/321-8547.

! Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Proposed Exclusion, Federal Register: Volume 63, Number 134, July 14, 1998. Available over he Internet: http://frwebgate1.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=32546113+32+0+0&WAISaction=retrieve

! Management of Corrective Action Wastes Pursuant to Proposed Subpart S, Department of Energy, February 1995. (DOE Environmental Policy and Guidance Documents: available to download from the Internet: http://www.homer.hsr.ornl.gov/oepa/loadpolicy.html)

! Contained-in Policy, Areas of Contamination (AOC) and Remediation Waste: 12/16/95 Memo from Shapiro to Wright, 9441.1995(32). Available to download from the Internet at http://www.epa.gov/epaoswer/hazwaste/ca/10.txt

! Management of Remediation Waste Under RCRA, October 1998 Memorandum from Fields, EPA, to RCRA/CERCLA Policy Managers.

! Summary Chart of October 14, 1998 Memorandum, 'Management of Remediation Waste Under RCRA', October 15, 1998.

! 53 FR 51444 for detailed discussion in proposed National Contingency Plan (NCP) preamble; 55 FR 8758-8760, March 8, 1990 for final preamble discussion all regarding the Area of Contamination (AOC) Policy. Available over the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/17.txt

! EPA Issues Final Rules for Corrective Action Management Units and Temporary Units, U.S. EPA, 1993, p.4. Available to order via NCEPI. Order Number: EPA/530-F93-001 Fax order to: 703/321-8547.

! Use of the Area of Contamination Concept During RCRA Cleanups, March 13, 1996, EPA Memorandum.

! RCRA Regulatory Status of Contaminated Groundwater, November 13, 1986, EPA Memorandum.

! 53 FR 31138, 31142, 31148 (August 17, 1988), 57 FR 21450, 21453 (May 20, 1992), and detailed discussion in HWIR-Media preamble, 61 FR 18795 (April 29, 1996).

! Letter from Shapiro, EPA OSW Director, to Wright, Monsanto Company, September 15, 1996.

! Preamble to the LDR Phase IV rule, 63 FR 28617 (May 26, 1998).

References for Managing Remediation Waste

- RCRA Permit Requirements for the State Superfund Actions, November 16, 1987 EPA Guidance Memorandum from Porter, EPA, to EPA Regional Administrators (OSWER Directive 9522.00-2).

- CAMU and TU Regulations are a t 40 CFR 264.552, promulgated February 16, 193 (58 FR 8658).

- OSW Guidance on managing media.

- OSW Waste Cleanup Website: http://www.epa.gov/epaoswer/osw/cleanup.htm

- RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction

- Management of Hazardous Contaminated Media (HWIR Media): http://www.epa.gov/epaoswer/hazwaste/id/hwirmdia.htm

- Environmental Fact Sheet: Hazardous Waste Identification Rule for Contaminated Media (HWIR) - Proposed Rule. Available for download from the Internet at http://www.epa.gov/epaoswer/hazwaste/id/hwirmdia/hwirmefs.txt

- RCRA Hotline Phone Number - (800) 424-9346

ADMINISTRATIVE APPROACHES

May 3, 1996

Mr. Mark Levine
Whyco Chromium Company, Inc.
670 Waterbury Road
Thomaston, Connecticut 06787

Re: RCRA Corrective Action at Whyco Chromium Company, Inc.
(CTD001450154)

Dear Levine:

The purpose of this letter is to follow up on our May 1, 1996 telephone conversation. During this conversation we discussed the EPA-New England's (EPA-NE) interest in initiating Corrective Action at in Whyco Chromium Company, Inc. in Thomaston, Connecticut.

EPA-NE has set a goal of achieving stabilization or final remedy at each of the approximately 155 high priority RCRA Treatment, Storage, and Disposal (TSD) Facilities in New England by the year 2000. Whyco Chromium Company, Inc. is ranked as one of these high priority facilities.

EPA-New England considers a facility to be stabilized if it can demonstrate that it has met two environmental indicators: **Human Exposures Controlled** and **Groundwater Releases Controlled**. These two indicators are described in a July 29, 1994 memorandum from Michael Shapiro, EPA Director of Solid Waste. (This memo also serves as our current guidance for determining when the two environmental indicators have been met. A copy of this memorandum is enclosed for your use.) A stabilized facility in general terms is one where migration of releases has been controlled and human exposure pathways controlled or cut off so that the facility poses no unacceptable risk to human health under existing conditions at the facility.

A facility could move from stabilization on to final remediation when steps are taken to characterize and, if necessary, address ecological risks and potential future human health risks posed by releases at or from the facility. Final remedy selection also must include a formal decision making process which incorporates public involvement. (EPA encourages public involvement in all stages and aspects of Corrective Action.)

A facility can work toward the goals of stabilization or final remedy under the terms of a permit or administrative order, under state supervision, through deferral to the Superfund Program, or voluntarily. The voluntary approach may offer a facility considerable flexibility in establishing characterization and remediation goals.

EPA-NE has utilized the National Corrective Action Priority System (NCAPS) model to evaluate the relative priority of the New England TSD universe. The NCAPS model is based on four different exposure pathways: groundwater, surface water, air and on-site (direct contact with hazardous materials or contact with contaminated surface soils). Based upon the NCAPS model, Whyco Chromium Company, Inc. was ranked as a high priority facility. The NCAPS modeling results do not mean that a facility ranked as "high" will, in fact, require large-scale remediation. EPA-NE expects that in some cases, a high-ranked NCAPS facility may need no active remediation at all.

I look forward to setting up a meeting with you at the Whyco Chromium Company, Inc. facility to answer any questions you may have about the Corrective Action process. Additional goals for this meeting are to discuss:

- the EPA-NE Corrective Action goals outlined above (i.e. stabilization and final remedy),
- the mechanisms that Whyco Chromium Company, Inc. can work in accordance with to achieve these goals (e.g. order, permit, voluntary)and the pro's and con's of each,
- up-to-date information about Corrective Action goals previously accomplished at Whyco Chromium Company, Inc.,
- your views as to how Corrective Action can proceed at Whyco Chromium Company, Inc.,
- any possibilities for EPA-NE to assist in any beneficial reuse at Whyco Chromium Company, Inc.,
- any possibilities for EPA-NE to provide assistance with using innovative technologies in any field activities at Whyco Chromium Company, Inc., and
- any other issues that you would like to discuss.

Additionally, I and possibly another person from our program would be interested in touring the facility so that our office can get a first hand understanding of the conditions and challenges at your site.

In the meantime my office strongly encourages that you take a close look at the **Human Exposures Controlled** and **Groundwater Releases Controlled** environmental indicators and begin to assemble any information or take remedial actions wherever possible to demonstrate your having attained these indicators.

Useful information for determining attainment of the environmental indicators may include:

- an outline of the operational history of the facility including all wastes generated at the facility and their management over time,
- a brief description of all areas where hazardous constituents may have been released to soils, groundwater,

surface waters, etc (e.g. Solid Waste Management Units [SWMUs] and Areas of Concern [AOCs]) at the facility,

- a description of known releases and potential releases at each SWMU and AOC,
- a description of exposure pathways for all releases and potential releases,
- a summary of existing investigative information (if extensive please feel free to reference any documents already in EPA's possession),
- a description of all exposure pathway controls and/or release controls instituted at the facility and how these achieve or contribute toward achieving the two environmental indicators.

The analysis of status relative to the two environmental indicators may require a remediation level with which to compare hazardous constituent levels. Please contact EPA-NE for guidance if comparison to a remediation level is needed.

On behalf of EPA-NE, I would like to thank you in advance for your cooperation and your efforts to achieve one of the Corrective Action goals. I plan to contact you within the next few weeks to schedule our meeting. Please contact me at (617) 223-5511 if you have any questions.

Sincerely,

Ernest Waterman, RCRA Facility Manager
Corrective Action Section

ENCLOSURE

NOTES TO THE PROSPECTIVE AUTHORS:

1. This file is in WP "Outline" format.
2. "Company" or the company name refers to people and "facility" refers to the place.
3. **"[Company name]"** can be quickly replaced by the actual company name by using the search function--F2.
4. Everything in bold brackets i.e. [..] needs to be fixed before sending out. Final versions should have no bold brackets left.

[DATE]

[Facility Contact
Company
Address
Town, State Zip Code]

Dear **[Facility Contact]**:

On behalf of the Environmental Protection Agency Region I New England office (EPA-NE) I would like to thank you for meeting on **[Insert Date]** to discuss investigation and remediation at the **[facility]** in **[Town]**, **[State]** in accordance with the federal Resource Conservation and Recovery Act (RCRA) Corrective Action program. The purpose of this letter is to formally outline EPA-NE's expectations of **[company name]** should it choose to pursue Corrective Action on a self-directed basis in advance of, or possibly in lieu of, a federal order or permit. The EPA-NE recognizes that some level of investigation and remediation work have already been undertaken at the facility.

Our expectations of **[company name]** when pursuing Corrective Action include the following:

1. <u>Letter of Commitment</u>

   EPA-NE expects **[company name]** to respond to this letter with a letter of commitment acknowledging **[company name]**'s understanding and acceptance of the broad goals and expectations laid out in this letter. Most importantly, EPA-NE is expecting that **[company name]** will commit to the achievement of specific environmental objectives at the facility (i.e. stabilization or final remedy as explained below) within specific time frames. EPA-NE will treat receipt of the letter of commitment as the initiation of Corrective Action. We would appreciate receiving **[company name]**'s letter of commitment within 30 **[NOTE: this can be flexible based on the circumstances with this facility]** days of your receipt of this letter.

2. <u>Achievement of Performance Standards</u>

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EPA-NE expects the self-directed Corrective Action at your facility to be guided by **[company name]**'s ability to understand and achieve performance standards without the need for in-depth and continuous EPA-NE review and comment of work in progress. The broad performance standards for self-directed Corrective Action at your facility are:

a. **[company name]** will perform an investigation to identify all releases of hazardous waste and/or hazardous constituents at the facility; determine fully the nature and extent of any releases; and determine the significance of these releases. It is imperative that sufficient and representative information be obtained so that **[company name]** can make determinations regarding releases of concern and propose interim measures as necessary. Negative findings of releases and information that is not sufficient and representative (e.g., questionably located soil borings and monitoring wells, samples collected without complete sampling and analysis protocol being followed, and samples that were not analyzed for an adequate list of constituents), may be viewed as inconclusive and further sampling may be required. The investigation shall include:

   i. Characterization of the physical setting (geology, hydrology, meteorology, ecology, land uses, etc) supported by site specific investigation(s) sufficient to understand the transport and fate of known and potential releases and to identify all potential receptors of those releases.

   ii. Documentation of site activity and hazardous waste and/or hazardous constituents used or generated at the facility to provide the basis for focusing sampling efforts on specific hazardous wastes and hazardous constituents and specific areas.

   iii. Collection, in accordance with a Quality Assurance Project Plan, of wastes, groundwater, surface water, soil, sediment and air samples sufficient to identify all releases, encompass the extent of all releases, characterize all releases, and characterize release source areas.

   iv. Performance of any activities necessary to evaluate threats to human health and/or the environment resulting from any releases of hazardous waste or hazardous constituents at or from the facility. This may include modeling of contaminant fate and transport, graphical analyses of collected data, statistical analyses of collected data, and human health and ecological risk assessment.

   v. Technical provisions of Appendices 1, 2, 3, and 4 of Region I's §3008(h) Model Order and the guidance documents referred to therein will be used as guidance in the conduct of investigations, field work, sampling, analyses, data validation, and data interpretation. ***A copy of the Model Order is enclosed.***

b. EPA-NE requests that **[company name]** provide a summary of all previous interim measures including the objectives of each interim measure, the dates each interim measure was started and completed, any confirmatory sampling associated with each

MODEL

interim measure, and whether the interim measure(s) were undertaken voluntarily or in accordance with an enforceable mechanism.

c. Investigation results will be used to identify remediation needs, develop remedial alternatives, and select remedies. As work progresses the need for interim measures, as discussed in point 2.d. below, should be continually reviewed by **[company name]**. When investigation results are available, the goals for the facility (stabilization or final remedy) may need to be revised after discussions between **[company name]** and EPA-NE.

d. The objectives of proposing and implementing interim measures is to address conditions at facilities presenting an immediate threat to human health and/or the environment. As warranted, **[company name]** is expected to implement interim measures to control or abate actual threats, prevent imminent threats from occurring, and keep contamination problems from increasing in scope. The factors to determine the need and appropriateness of a given interim measure (as described in Proposed 40 CFR §264.540) include:

   i. The time to implement the final remedy;

   ii. Actual or possible exposures to nearby populations or environmental receptors;

   iii. The threat of contamination to drinking water;

   iv. Further degradation if the interim measure is not carried out;

   v. The presence of hazardous wastes that pose a threat of release;

   vi. Hazardous wastes in soils that could migrate;

   vii. Weather conditions that may cause releases of hazardous wastes;

   viii. Risks of fire/explosion or exposure to the hazardous wastes; and

   ix. Other situations that may pose threats to human health and the environment.

e. The following performance standards shall be met before the facility can be considered as stabilized:

   i. <u>Human Exposures Controlled Performance Standard</u>

   Based upon guidance specified in the July 29, 1994 U.S. EPA-NE "RCRIS Corrective Action Environmental Indicator Event Codes" memorandum, one of the two following criteria must be met. These are:

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(1) Remedial measures[1] have been implemented with the result that all maximum contaminant concentrations detected or reasonably suspected are less than or equal to their respective action levels (e.g. MCLs for groundwater, a 1×10^{-6} risk level for other contaminants, or any other number designated as the action level) or do not exceed an EPA-NE specified cleanup standard for the facility.

OR

(2) There is no unacceptable human exposure to any contaminant concentration above action levels that has been detected or is reasonably suspected based on current contaminant concentrations and current site conditions. Although contamination remains at the facility that may require further remediation, action has been taken or site conditions are otherwise such that unacceptable threats to human health from actual exposure to the contamination are not plausible based on current uses of the site. Such actions may include the use of physical barriers or institutional controls (e.g. deed restrictions or alternative water supply).

ii. Groundwater Releases Controlled Performance Standard

Based upon guidance specified in the July 29, 1994 U.S. EPA-NE "RCRIS Corrective Action Environmental Indicator Event Codes" memorandum, one of the two following criteria shall be met. These are:

(1) An engineered system has been installed that is designed and operating (including performance monitoring) to effectively control the further migration beyond a designated boundary such as the engineered system, the facility boundary, a line upgradient of receptors, or the leading edge of the plume as defined by levels above EPA-NE established action levels or clean-up standards.

OR

(2) The EPA-NE has determined that the groundwater cleanup objectives can be met without the use of an engineered system through the remedial measures selected, including Facilities where the contamination will naturally attenuate.

f. Media Cleanup Standards are concentration levels of hazardous constituents in the soil, groundwater, air, surface water, and sediments at a facility that will be protective of human health and the environment. Generally, they are based on the risk posed by each contaminant with consideration of the naturally occurring background concentration of the substance, any established regulatory limits, and any technological limitations (e.g. analytical detection limits). For releases which require final remedies, or corrective

[1] Remedial measure is a general term that can refer to interim measures or final remedies.

measures, **[company name]** is expected to contribute to the development of Media Cleanup Standards by proposing standards which reflect the requirements of 1990 Proposed 40 CFR §264.525(d)(1).

g. A necessary complement to Media Cleanup Standards is establishment of the point of compliance where Media Cleanup Standards must be met. As applicable, **[company name]** will make proposals regarding point of compliance which reflect considerations specified in 1990 Proposed 40 CFR §264.525(e).

h. **[company name]** is expected to propose corrective measures as soon as sufficient data exists to do so. Proposed final remedies must reflect the requirements in the 1990 Proposed 40 CFR § 264.525(a) and (b) so that they:

   i. Are protective of human health and the environment;

   ii. Attain media cleanup standards as established by the EPA;

   iii. Control the source(s) of releases so as to reduce or eliminate, to the extent practicable, further releases of hazardous wastes (including hazardous constituents) that may pose a threat to human health and the environment and

   iv. Comply with the applicable standards for proper management of wastes;

   and optimize:

   v. Long-term reliability and effectiveness;

   vi. Reduction of toxicity, mobility or volume;

   vii. Short-term effectiveness;

   viii. Implementability; and

   ix. Cost effectiveness.

i. **[company name]** will be expected to commit to conducting public involvement activities that inform the local community of the Corrective Action activities at the facility.

j. **[company name]** will be expected to develop measurable and attainable objectives by which the effectiveness of selected interim measures and final remedies can be evaluated. These objectives must be developed prior to the implementation of an interim measure or final remedy and they must be developed to evaluate each individual interim measure and

MODEL

final remedy implemented (i.e., the standards are area and remedy specific). Examples are provided as follows:

i. Soil sampling used to confirm that remediation of contaminated soils has been completed to the extent necessary to reduce soil contaminant levels to less than or equal to the site specific media protection standards.

ii. Sampling downgradient of a groundwater plume to measure the effectiveness of a pump and treat system or the effectiveness of a retaining wall in stopping contaminant plume migration.

k. As a benefit of entering into Corrective Action on a self-directed basis, the schedule and number of deliverables largely at the discretion of the participating companies. However, in view of the economy of effort it should provide both parties, EPA-NE expects **[company name]** to structure their efforts to submit the Corrective Measure Study Report three months prior to the scheduled start date for the final remedy proposal public comment period.

l. EPA-NE expects that **[company name]** will set a Corrective Action schedule and inform EPA-NE of that schedule, that **[company name]** will submit all major milestone related reports to EPA-NE and that **[company name]** will submit semi-annual **[NOTE: there is some flexibility here—doesn't have to be semi-annual]** progress reports. In addition to the written form of these reports, both the major milestone related reports and the semi-annual progress reports may be presented to EPA-NE in the form or an oral presentation in order to get immediate feedback.

m. A benefit to EPA-NE of entering an agreement in which a RCRA company responsibly pursues Corrective Action on a self-directed basis is the ability to focus EPA-NE resources on a greater number of facilities that require Corrective Action. As a result, EPA-NE input on investigation plans and results at your facility, should it commit to undertaking self-directed Corrective Action, may be limited. Lack of a formal response to any given document should not be taken as approval of the document or any of the plans, conclusions, or recommendations it might contain. Likewise, formal response on any portion of a document should not be taken to mean that the document has been fully reviewed and all other portions found acceptable. Conversely, **[company name]** should maintain communication with EPA-NE and raise any problems to EPA-NE as they occur. EPA-NE will lend its support and guidance to your facility as resources allow.

n. With regard to Stabilization Determinations, Preliminary Media Cleanup Standards Determinations, Preliminary Media Cleanup Point of Compliance Determinations, and Final Remedy Selection, EPA-NE expects that **[company name]** will evaluate its facility to determine if the relevant performance criteria have been achieved. If in **[company name]**'s opinion stabilization has been achieved, **[company name]** should inform EPA-

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NE in writing of the rationale and assumptions behind its positive determination. If the Stabilization Measures of Success have not been achieved **[company name]** should notify EPA-NE of the specific actions that it will undertake to achieve the Stabilization Measures of Success. EPA-NE expects **[company name]** to submit its first evaluation as to whether the Stabilization Measures of Success have been achieved within 90 days of receipt of this letter. EPA-NE will determine whether Stabilization Measures of Success have been attained when **[company name]** submits documentation in support thereof.

EPA-NE will make preliminary media cleanup standards determinations, preliminary media cleanup point of compliance determinations and final remedy proposals at **[company name]**'s request. These determinations need to take the form of a Statement of Basis with public notice and comment provisions as set out at 40 CFR Part 124 and Part 270. The issuance of a permit or administrative order could possibly occur within the same time frame.

o. EPA-NE will monitor **[company name]**'s progress relative to their work plan schedule and the general performance standards set out in this letter. If EPA-NE perceives that **[company name]** is not achieving the goals set out in this letter, the EPA-NE will consider issuing a legally-binding Corrective Action mechanism. Given the capability and pro-active attitude that **[company name]** has recently demonstrated, the EPA-NE feels confident that no such event should be necessary.

p. In return for the flexibility of working within a voluntary agreement it is anticipated that **[company name]** will meet or exceed all performance standards.

3. <u>Reservation of rights</u>

a. EPA-NE reserves all of its statutory and regulatory powers, authorities, rights, and remedies, both legal and equitable, which may pertain to **[company name]**'s activities at the facility identified in this letter. This Corrective Action agreement shall not be construed as a covenant not to sue, release, waiver, or limitation of any rights, remedies, powers, and/or authorities, civil or criminal, which EPA-NE has under RCRA, CERCLA, or any other statutory, regulatory, or common law authority of the United States.

b. EPA-NE reserves the right to disapprove of work performed by **[company name]** pursuant to this Corrective Action agreement and to request that Respondent perform additional tasks.

c. EPA-NE reserves the right to perform any portion of the work consented to herein or any additional site characterization, feasibility study, and remedial work as it deems necessary to protect human health and/or the environment. EPA-NE may exercise its authority under CERCLA to undertake response actions at any time. EPA-NE reserves its right to seek reimbursement from **[company name]** for costs incurred by the United States.

Notwithstanding compliance with the terms of this Corrective Action agreement, **[company name]** is not released from liability, if any, for the costs of any response actions taken or authorized by EPA.

d. If EPA-NE determines that activities undertaken in compliance with this Corrective Action agreement have caused or may cause a release of hazardous waste or hazardous constituent(s), or a threat to human health and/or the environment, or that **[company name]** is not capable of undertaking the work agreed upon, EPA-NE may order **[company name]** to stop further implementation of activities undertaken pursuant to this Corrective Action agreement for such period of time as EPA-NE determines may be needed to abate any such release or threat and/or to undertake any action which EPA-NE determines is necessary to abate such release or threat.

e. EPA-NE and **[company name]** acknowledge and agree that EPA's approval of any Statements of Work (SOWs) or any final workplan does not constitute a warranty or representation that the SOWs or workplans will achieve the required cleanup or performance standards. Compliance by **[company name]** with the terms of this Corrective Action agreement shall not relieve it of its obligations to comply with RCRA or any other applicable local, state, or federal laws and regulations.

f. Notwithstanding any other provision of this letter, no action or decision by EPA-NE pursuant to this Corrective Action agreement, including without limitation, decisions of the Regional Administrator, the Director of the Office of Site Remediation and Restoration, or any authorized representative of EPA, shall constitute final agency action giving rise to any right of judicial review prior to EPA's initiation of a judicial action to enforce this Corrective Action agreement, including an action for penalties or an action to compel **[company name]**'s compliance with its terms and conditions.

g. Indemnification **[company name]** agrees to indemnify and save and hold harmless the United States government, its agencies, departments, agents, and employees, from any and all claims or causes of action arising [solely] from or on account of acts or omissions of **[company name]** or its officers, employees, agents, independent contractors, receivers, trustees, and assigns in carrying out activities required by this Corrective Action agreement. This indemnification shall not be construed in any way as affecting or limiting the rights or obligations of **[company name]** or the United States under their various contracts. **[company name]** shall not be responsible for indemnifying the EPA-NE for claims or causes of action solely from or on account of acts or omissions of EPA-NE.]

EPA-NE looks forward to the results of your efforts. If you have any questions regarding this letter, please contact **[RFM name]** of my staff at **[phone no.]**.

Sincerely,

Matthew R. Hoagland, Chief
RCRA Corrective Action Section

Enclosures

cc: **[State Agency]**

MODEL

November 4, 1996

Mr. Mark Lavine,
Environmental Protection Superintendent
Whyco Chromium Company, Inc.
670 Waterbury Road
Thomaston, CT 06787

Dear Mr. Lavine:

I would like to thank you and Mr. Hyner for meeting with me on August 5, 1996 to discuss voluntary Corrective Action at Whyco Chromium. The purpose of this letter is to formally outline EPA's expectations of Whyco Chromium in pursuing voluntary Corrective Action.

Our major expectations for the Whyco Chromium voluntary Corrective Action are as follows:

I. Letter of Commitment: EPA expects Whyco Chromium to respond to this letter with a letter of commitment acknowledging Whyco Chromium's understanding and acceptance of the broad goals and expectations laid out in this letter. EPA will treat receipt of the letter of commitment as Whyco Chromium's initiation of voluntary Corrective Action. We would appreciate this letter of commitment from Whyco Chromium within 30 days of your receipt of this letter.

II. Achievement of Performance Standards: EPA expects the voluntary Corrective Action at Whyco Chromium to be guided by Whyco Chromium's ability to understand and achieve performance standards rather than by EPA review and comment of work in progress. The broad performance standards for voluntary Corrective Action at Whyco Chromium are:

A. Whyco Chromium will perform an investigation to identify all releases of hazardous waste and/or hazardous constituents at the Facility; determine fully the nature and extent of any releases; and determine the significance of these releases. It is imperative that **sufficient and representative information/data be** obtained so that Whyco Chromium can make determinations regarding releases of concern and propose interim corrective measures if necessary. Negative findings of releases and data/information that is not sufficient and representative (e.g., questionably located soil borings

and monitoring wells, samples collected without complete sampling and analysis protocol being followed, and samples that were not analyzed for an adequate list of constituents), may be viewed as inconclusive and further sampling may be required. The investigation shall include:

1. Characterization of physical setting (geology, hydrology, meteorology, ecology, land uses, etc) supported by site specific investigation sufficient to understand the transport and fate of known and potential releases and to identify all potential receptors of those releases.

2. Documentation of site activity and hazardous waste and/or hazardous constituents used or generated at the facility to provide the basis for focusing sampling efforts on specific hazardous wastes and hazardous constituents and specific areas.

3. Collection, in accordance with a Quality Assurance Project Plan, of wastes, groundwater, surface water, soil, sediment and air samples sufficient to identify all releases, encompass the extent of all releases, characterize all releases, and characterize release source areas.

4. Performance of any activities necessary to evaluate threats to human health and/or the environment resulting from any releases of hazardous waste or hazardous constituents at or from the Facility. This may include modeling of contaminant fate and transport, graphical analyses of collected data, statistical analyses of collected data, and human health and ecological risk assessment.

5. Technical provisions of Appendices 1, 2, 3, and 4 of Region I's §3008(h) Model Order and the guidance documents referred to therein will be used as guidance in the conduct of investigations, field work, sampling, analyses, data validation, and data interpretation.

B. The EPA requests that Whyco Chromium provide a summary of all previous interim measures including the objectives of each interim measure, the dates each interim measure was started and completed, whether the interim measure(s) were undertaken voluntarily or in accordance with an enforceable mechanism, and any confirmatory sampling associated with each interim measure.

C. Investigation results will be used to identify remediation needs and support a determination of site stabilization. As work progresses the need for interim measures, as discussed in point III below, will be

continually reviewed. It is EPA's understanding that Whyco Chromium is working toward stabilization of the facility. When investigation results are available, the target of activity (stabilization or final remedy) may be reviewed and revised by the mutual agreement of Whyco Chromium and EPA.

D. The objectives of proposing and implementing Interim Measures is to address conditions at facilities presenting an immediate threat to human health and/or the environment. As warranted, Whyco Chromium will implement interim measures to control or abate actual threats, prevent imminent threats from occurring, keep contamination problems from increasing in scope and achieve stabilization.

The factors to determine the need and appropriateness of a given interim measure (as described in Proposed 40 CFR §264.540) include:

1. Time to implement the final remedy;

2. Actual or possible exposures to nearby populations or environmental receptors;

3. The threat of contamination to drinking water;

4. Further degradation if the interim measure is not carried out;

5. The presence of hazardous wastes that pose a threat of release;

6. Hazardous wastes in soils that could migrate;

7. Weather conditions that may cause releases of hazardous wastes;

8. Risks of fire/explosion or exposure to the hazardous wastes; and

9. Other situations that may pose threats to human health and the environment.

E. The following Environmental Indicator performance standards shall be met as the Stabilization Measure of Success:

1. Human Exposures Controlled Performance Standard

Based upon guidance specified in the July 29, 1994 U.S. EPA "RCRIS Corrective Action Environmental Indicator Event Codes" memorandum, one of the two following criteria must be met. These are:

a. Remedial measures have been implemented with the result that all maximum contaminant concentrations detected or reasonably suspected are less than or equal to their respective action levels (e.g. MCLs for groundwater, a 1 x 10^{-6} risk level for other contaminants, or any other number designated as the action level) or do not exceed an EPA specified cleanup standard for the Facility.

OR

b. There is no unacceptable human exposure to any contaminant concentration above action levels that has been detected or is reasonably suspected based on current contaminant concentrations and current site conditions. Although contamination remains at the Facility that may require further remediation, action has been taken or site conditions are otherwise such that unacceptable threats to human health from actual exposure to the contamination are not plausible based on current uses of the site. Such actions may include the use of physical barriers or institutional controls (e.g. deed restrictions or alternative water supply).

2. Groundwater Releases Controlled Performance Standard

Based upon guidance specified in the July 29, 1994 U.S. EPA "RCRIS Corrective Action Environmental Indicator Event Codes" memorandum, one of the two following criteria shall be met. These are:

a. An engineered system has been installed that is designed and operating (including performance monitoring) to effectively control the further migration beyond a designated boundary such as the engineered system, the Facility boundary, a line upgradient of receptors, or the leading edge of the plume as defined by levels above EPA established action levels or clean-up standards.

OR

b. The EPA has determined that the groundwater cleanup objectives can be met without the use of an engineered system through the remedial measures selected, including Facilities where the contamination will naturally attenuate.

F. Environmental Indicator action levels shall be relevant remediation standards under the State of Connecticut Department of Environmental Protection Remediation Standard regulations (The Regulations of Connecticut State Agencies Section 22a-133k-1). Note that where no

exposure pathway exists a consideration of action levels may not be needed. Also note that because the facility is located over an aquifer classified as GB by the State of Connecticut that groundwater action levels must be protective of any existing uses and the surface water receiving groundwater discharge from the facility and are not protective of drinking water use unless an existing drinking water usage exists.

G. Whyco Chromium will conduct public involvement activities that inform the local community of the voluntary corrective action activities at the facility.

H. Whyco Chromium will develop measurable and attainable standards by which the effectiveness of selected interim measures can be evaluated. These standards will be defined as the Measures of Success. Measures of Success must be developed prior to the implementation of an interim measure and they must be developed to evaluate each individual interim measure implemented (i.e., Measures of Success are area and remedy specific). Examples are provided as follows:

1. Soil sampling used to confirm that remediation of contaminated soils has been completed to the extent necessary to reduce soil contaminant levels to less than or equal to the site specific media protection standards.

2. Sampling downgradient of a groundwater plume to measure the effectiveness of a pump and treat system or the effectiveness of a retaining wall in stopping contaminant plume migration.

I. As a benefit of entering into voluntary Corrective Action, the Corrective Action Schedule and number of deliverables will mainly be at the discretion of Whyco Chromium. EPA expects that Whyco Chromium will set a Corrective Action schedule and inform EPA of that schedule, that Whyco Chromium will submit all major milestone related reports to EPA and that Whyco Chromium will submit progress reports. The progress reports may be presented to EPA in the form of an oral presentation. The schedule proposed by Whyco Chromium must achieve stabilization before the year 2000.

J. The benefit to EPA of entering an agreement in which Whyco Chromium pursues voluntary Corrective Action is the ability to focus EPA resources on a greater number of facilities that require Corrective Action. As a result, EPA input on investigation plans and results will be limited. Lack of a formal response to any given document should not be taken as approval of the document or any of the plans, conclusions, or

recommendations it might contain. Likewise, formal response on any portion of a document should not be taken to mean that the document has been fully reviewed and all other portions found acceptable. Conversely, Whyco Chromium should maintain communication with EPA and raise any problems to EPA as they occur. EPA will lend its support and guidance to Whyco Chromium as resources allow.

K. Stabilization Determinations: EPA will determine whether stabilization measures of success have been attained when Whyco Chromium submits documentation in support thereof.

L. The EPA will monitor Whyco Chromium's progress relative to their work plan schedule and the general performance standards set out in this letter. If EPA perceives that the voluntary Corrective Action is not achieving the goals set out in this letter, the EPA will consider issuing a legally-binding Corrective Action mechanism. Given the capability and pro-active attitude that Whyco Chromium has recently demonstrated, the EPA feels confident that no such event should be necessary.

M. In return for the flexibility of working within a voluntary agreement it is anticipated that Whyco Chromium will meet or exceed all performance standards.

III. Reservation of rights:

A. EPA reserves all of its statutory and regulatory powers, authorities, rights, and remedies, both legal and equitable, which may pertain to Whyco Chromium's activities at the facility identified in this letter. This voluntary Corrective Action agreement shall not be construed as a covenant not to sue, release, waiver, or limitation of any rights, remedies, powers, and/or authorities, civil or criminal, which EPA has under RCRA, CERCLA, or any other statutory, regulatory, or common law authority of the United States.

B. EPA reserves the right to disapprove of work performed by Whyco Chromium pursuant to this voluntary Corrective Action agreement and to request that Respondent perform additional tasks.

C. EPA reserves the right to perform any portion of the work consented to herein or any additional site characterization, feasibility study, and remedial work as it deems necessary to protect human health and/or the environment. EPA may exercise its authority under CERCLA to undertake response actions at any time. EPA reserves its right to seek reimbursement from Whyco Chromium for costs incurred by the United States.

Notwithstanding compliance with the terms of this voluntary Corrective Action Agreement, Whyco Chromium is not released from liability, if any, for the costs of any response actions taken or authorized by EPA.

D. If EPA determines that activities undertaken in compliance with this voluntary Corrective Action agreement have caused or may cause a release of hazardous waste or hazardous constituent(s), or a threat to human health and/or the environment, or that Whyco Chromium is not capable of undertaking the work agreed upon, EPA may order Whyco Chromium to stop further implementation of activities undertaken pursuant to this voluntary Corrective Action agreement for such period of time as EPA determines may be needed to abate any such release or threat and/or to undertake any action which EPA determines is necessary to abate such release or threat.

E. EPA and Whyco Chromium acknowledge and agree that EPA's approval of the SOW(s) or any final work plan does not constitute a warranty or representation that the SOW(s) or workplans will achieve the required cleanup or performance standards. Compliance by Whyco Chromium with the terms of this voluntary Corrective Action agreement shall not relieve it of its obligations to comply with RCRA or any other applicable local, state, or federal laws and regulations.

F. Notwithstanding any other provision of this letter, no action or decision by EPA pursuant to this voluntary Corrective Action agreement, including without limitation, decisions of the Regional Administrator, the Director of the Waste Management Division, or any authorized representative of EPA, shall constitute final agency action giving rise to any right of judicial review prior to EPA's initiation of a judicial action to enforce this voluntary Corrective Action agreement, including an action for penalties or an action to compel Whyco Chromium's compliance with its terms and conditions.

G. Indemnification: Whyco Chromium agrees to indemnify and save and hold harmless the United States government, its agencies, departments, agents, and employees, from any and all claims or causes of action arising [solely] from or on account of acts or omissions of Whyco Chromium or its officers, employees, agents, independent contractors, receivers, trustees, and assigns in carrying out activities required by this voluntary Corrective Action agreement. This indemnification shall not be construed in any way as affecting or limiting the rights or obligations of Whyco Chromium or the United States under their various

contracts. [Whyco Chromium shall not be responsible for indemnifying the EPA for claims or causes of action solely from or on account of acts or omissions of EPA.]

EPA looks forward to the results of your efforts. If you have any questions regarding this letter, please contact me at (617) 223-5511.

Sincerely,

Ernest Waterman, C.P.G.
RCRA Corrective Action Section

cc: M. Fracasso, CTDEP
T. Stark, GZA

WHYCO CHROMIUM COMPANY, INC.

January 24, 1997

Mr. Ernie Waterman
USEPA - Region 1
RCRA Corrective Action Section
John F. Kenney Building
Boston, MA 02203-0001

Dear Mr. Waterman:

We are in receipt of your letter of November 4, 1996 in which you describe how the RCRA Voluntary Corrective Action/Stabilization criteria would apply to Whyco Chromium. In general, this letter reflects our discussion with you during our visit to our site on August 5, 1996.

This letter will inform you that Whyco Chromium will proceed with Corrective Action under the voluntary "mechanism" with a short-term "end point" of stabilization as defined in your letter. We understand that EPA's long-term goal as well as your own, is to achieve final remedy.

As previously discussed with you, the southern end of our property contains the majority of the site's AOC's and that previous investigations of the regulated units in this area have defined subsurface conditions in great detail. We remain committed to a philosophy that definitive actions to reduce identified impacts to the environment should be implemented as a first priority. Therefore, our proposed approach, which will be detailed in the work plan, will be to put our initial resource into final evaluation and, if necessary implementation of interim measures in the southern portion of the site.

We believe the best first step following this letter is preparation of an Environmental Indicators Evaluation discussing previous interim measures as requested in your letter and which describes the current status of each AOC and how we believe at this time it will be addressed in the program. As part of this evaluation we will also prepare a detailed analysis of available subsurface data from the southern portion of the site. The EI evaluation will be completed in approximately 3 months and submitted to EPA for their information and comment as time allows. The EI evaluation will form the basis for development of a Work Plan and QAPP.

Please contact Mark LaVine at (860) 283-5826 or Thomas F. Stark at (860) 875-7655 if you have any questions.

Very truly yours,

Mark S. Hyner
President

670 Waterbury Road • Thomaston, CT 06787 • (860) 283-5826 • FAX (860) 283-6153

Image Not Available

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

(DATE)

(FACILITY NAME & ADDRESS)

Re: RCRA Corrective Action at **(FACILITY NAME)**
EPA ID# **(FACILITY ID #)**

Dear Sir/Madam:

The purpose of this letter is to inform you that the United States Environmental Protection Agency (EPA), Region III, will be conducting a site visit in the next couple of months to determine if RCRA Corrective Action is necessary at your facility.

First, let me inform you why EPA is initiating this inspection at your facility. EPA has set a goal of meeting Environmental Indicators or achieving final remediation at each of the approximately 300 high priority RCRA Treatment, Storage, and Disposal (TSD) Facilities in Region III by the year 2005. Your facility is ranked as one of these high priority facilities. EPA Region III utilized the National Corrective Action Priority System (NCAPS) model to evaluate the relative priority of the Region III TSD universe. The NCAPS model is based on four different exposure pathways: groundwater, surface water, air and on-site (direct contact with hazardous materials or contact with contaminated surface soils). Based upon the NCAPS model, your facility was ranked as a high priority facility. The NCAPS modeling results do not mean that a facility ranked as "high" will, in fact, require large-scale remediation. In some cases, remediation may have already taken place under the State’s jurisdiction or as a facility-lead.

EPA Region III is focusing on two interim Environmental Indicators as a result of the Government Performance and Results Act: Human Exposures Controlled and Groundwater Releases Controlled. In general terms, EPA considers the environmental indicators to be met where migration of groundwater releases has been controlled and human exposure pathways controlled or cut off so that the facility poses no unacceptable risk to human health and the environment under existing conditions at the facility. Even if these two Environmental Indicators are met, additional remediation may still be necessary for the final corrective measures.

EPA encourages public involvement in all stages and aspects of the Corrective Action process. Final remedy selection will include a formal decision making process which incorporates public involvement.

EPA Region III recently tasked the U.S. Department of Army, Corps of Engineers, to review file information and conduct a site visit at your facility to gather relevant information for EPA to determine whether the environmental indicators have been achieved. Information which will be discussed at the site visit to determine the status of the environmental indicators may include the following:

- An outline of the operational history of the facility including all wastes generated at the facility and their management;

- A brief description of all areas where hazardous constituents may have been released to the air, soils, groundwater and surface waters (e.g., Solid Waste Management Units [SWMUs] and Areas of Concern [AOCs]);

- A description of known releases and potential releases at each SWMU and AOC;

- A description of exposure pathways for all releases and potential releases;

- A summary of existing investigative information;

- A description of all exposure pathway controls and/or release controls instituted at the facility and how these achieve or contribute toward achieving the two environmental indicators;

- Up-to-date information about Corrective Action goals previously accomplished at your facility;

- Your views as to how Corrective Action can proceed at your facility; and

- Any other issues that you would like to discuss.

EPA or the Corps of Engineers will be contacting you within the next several weeks to set up this site visit.

On behalf of EPA Region III, I thank you in advance for your cooperation during this anticipated site visit. If you have any questions or concerns I encourage you to contact Denis M. Zielinski, RCRA Senior Project Manager, at (215)814-3431.

Sincerely,

(BRANCH CHIEF)

cc: **(STATE CONTACTS)**
(COE CONTACT)

FACILITY LEAD CORRECTIVE ACTION AGREEMENT

I. CORRECTIVE ACTION GOALS

By agreeing to participate in the Facility Lead Corrective Action Program with EPA, the Facility commits to:

A. Determine the extent and sources of all releases of hazardous wastes or hazardous waste constituents at or from the Facility using quality data;

B. Evaluate and meet EPA's Environmental Indicators (see "Environmental Indicator Forms" on EPA Region III's website at www.epa.gov/reg3wcmd/corrective_action.htm);

C. Perform interim measures at the Facility to prevent or mitigate unacceptable threats to human health and the environment by: 1) controlling human exposures, and 2) controlling migration of any groundwater contamination at or from the Facility from releases of hazardous wastes or hazardous constituents;

D. Conduct effective public involvement;

E. Communicate regularly to EPA, the State, and the community on corrective action progress at the Facility.

EPA agrees to provide an appropriate level of oversight to assist the Facility to meet these goals.

II. WORK TO BE PERFORMED

The Facility agrees to demonstrate achievement of the goals listed in Section I by performing the work (as appropriate) described below. These goals may be achieved through a combination of sampling activities, previous work, and documentation of valid historical data.

A. Develop a Workplan

1. Within ninety (90) calendar days of the date of its Commitment Letter, the Facility agrees to submit a Workplan to EPA. The Workplan is subject to approval by EPA and shall include a strategy and schedule to implement pertinent tasks identified in this Agreement, which include, but are not limited to, the following:

   a. Site characterization (Section II.B).
   b. Quality Assurance and Sampling Plan (Section II.B and D).

c. Evaluation of Environmental Indicator goals (Section II.C).
d. Ongoing or planned Interim Measures (Section II.D).
e. Community Relations Plan (Section II.E).
f. Reports to EPA (Section II.F and IV).
g. Selection of a land use scenario (Section II.B).

2. The Facility may also add other tasks to the Workplan.

B. Determine the extent and sources of releases of hazardous wastes or hazardous constituents at or from the Facility using quality data.

1. Site Characterization - The Facility will determine the nature and extent of all releases of hazardous wastes and hazardous constituents at or from the Facility. The characterization will include investigative tasks such as sampling, analyses, data validation and data interpretation and will be conducted in a manner consistent with the provisions of Region III's guidance for a "RCRA Facility Investigation" and "Risk-Based Screening"as well as additional EPA guidance (see "RCRA Facility Investigation" document, "Risk-Based Screening" document and additional "Guidance Documents" on EPA Region III's website at www.epa.gov/reg3wcmd/corrective_action. htm); At a minimum, the Facility shall perform the following:

a. Soil - Identify maximum concentrations and determine the extent of any releases of hazardous wastes and hazardous constituents to soil. Sampling shall continue until concentrations in soil approach Region III's Risk-Based Concentration ("RBC) Table using an appropriate land use scenario approved by EPA (see "Risk-Based Concentration Tables" on EPA Region III's website at www.epa.gov/reg3hwmd/risk/riskmenu. htm). In addition, evaluate the potential of hazardous wastes and hazardous constituents in soil to affect other media through cross media transfer (e.g. screening against Soil Screening Levels "SSLs" for groundwater).

b. Groundwater - Determine maximum concentrations of hazardous wastes and hazardous constituents in groundwater and, to the extent practicable, the source of the groundwater contamination. The horizontal and vertical extent of any releases to groundwater shall be delineated until concentrations of hazardous wastes and hazardous constituents in groundwater approach maximum contaminant levels ("MCLs"), or, where no MCLs have been promulgated, Region III's Risk-Based Concentration (RBC) Table using the tap water column, independent of whether the aquifer is currently utilized as a source of potable water.

c. Surface Water and Sediment - Where contaminated groundwater potentially discharges to a surface water body, determine the maximum concentrations of hazardous wastes and hazardous constituents in surface water and sediment, and assess the extent of impact of

hazardous wastes and hazardous constituents to the surface water body and sediments to levels considering the state-designated use of the surface water body and the potential exposure to human and/or ecological receptors.

d. Air - Where there is the potential for indoor or outdoor air to be contaminated by particulates or vapors through cross-media transfer, determine the maximum concentrations through appropriate methods (e.g. sampling, modeling).

2. Data Quality - The Facility agrees to perform site screening and site characterization through the use of high quality field data collection protocols and appropriate EPA laboratory methods specified in 2.a and 2.b below such that the analytical results accurately represent site characteristics. The data collected must support decisions regarding the applicability and effectiveness of interim measures and/or final remedial decisions. (see "Quality Assurance/Quality Control" document on EPA Region III's website at www.epa.gov/reg3wcmd/corrective_action.htm); In addition the Facility shall:

a. Ensure that all laboratories used by the Facility for analyses perform such analyses according to the EPA methods included in "Test Methods for Evaluating Solid Waste" (SW-846, November 1986) or other methods deemed satisfactory to EPA; and

b. Ensure that all laboratories used by the Facility for analyses participate in a quality assurance/quality control program equivalent to that which is followed by EPA.

c. Ensure that data is reliable by having it data undergo 3rd party data validation.

3. Exposure Assessment - The Facility agrees to identify all potential exposure pathways.

4. Site Screening - The Facility agrees to use the Screening process specified in the Risk-Based Screening document located on EPA Region III's website.

5. Future Land Use - If conditions suggest that a future non-residential land use scenario is applicable to any portion of the Facility, the Facility shall include a schedule in the Workplan for submitting land use information as specified in the OSWER Directive No. 9355.7-04 "Land Use in the CERCLA Remedy Selection Process" and will solicit public input (as specified in the Facility Workplan in Section II.A) on this issue.

C. Evaluate and meet EPA's Environmental Indicators.

1. The Facility agrees to assess current exposures and evaluate potential contaminated groundwater migration pathways as priority activities of the site investigation.

2. The Facility agrees to implement Interim Measures as soon as possible to achieve the Environmental Indicator goals.

D. Perform Interim Measures at the Facility to prevent or mitigate threats to human health and/or the environment.

1. The Facility agrees to implement Interim Measures:

a. When it is necessary to protect human health and/or the environment.

b. To meet the Environmental Indicator goals of eliminating current human exposure to and controlling groundwater contamination from releases of hazardous wastes or hazardous constituents to the extent practicable.

Interim Measures implemented shall be consistent with the long term cleanup objectives at the Facility.

2. The Facility will conduct appropriate monitoring and/or confirmatory sampling of Interim Measures to assess their effectiveness. The quantity, quality, and frequency of the monitoring will be dependent upon the Interim Measures selected.

E. Conduct effective public involvement.

1. The Facility agrees to:

a. Develop a Community Relations Plan which will describe how it will conduct public involvement activities to inform the local community, the State and any other interested parties of activities throughout the corrective action process. EPA guidance for conducting effective public involvement in the RCRA program can be found in the RCRA Public Involvement Manual, EPA530-R-93-006, September 1993.

b. Provide EPA with a fact sheet summarizing the status of the work to date for inclusion on EPA Region III's web page within sixty (60) calendar days of the Letter of Commitment. At a minimum, this fact sheet shall be updated semi-annually.

F. Communicate regularly to EPA, the State, and the community on corrective action progress at the Facility.

1. The Facility agrees to submit:

   a. A Letter of Commitment which shall include a proposed time-frame for a meeting with EPA to discuss the known current conditions and to outline the work necessary to meet EPA's Environmental Indicator objectives. The letter will also identify a Facility Project Coordinator, who will be responsible for the implementation of the corrective action activities and serve as the Facility's point of contact.

   b. An Environmental Indicators report to EPA and the State when the Facility has collected sufficient data, and taken action as necessary, to control current human exposures to contamination and the migration of any groundwater contamination.

   c. A Site Investigation report to EPA and the State when the Facility has identified the nature and extent of all releases of hazardous wastes and/or hazardous constituents at or from the Facility.

   d. Annual Progress Reports to EPA and the State summarizing the work performed (including new interim measures), public involvement activities, proposed schedule changes, and a summary of anticipated activities to be conducted over the next year. The first Annual Progress Report shall be submitted to EPA and the State one year from the date of the Letter of Commitment.

   e. In addition to the written reports identified above, the Facility may choose to present information to EPA in the form of oral presentations and request EPA comment on technical issues or proposed actions.

III. FINAL REMEDIES - COMPLETING CORRECTIVE ACTION

Eliminating human exposure to hazardous wastes and hazardous constituents and controlling migration of contaminated groundwater are short-term corrective action objectives. Interim Measure activities implemented to achieve these short-term objectives are based on reasonably expected human exposures under current land and groundwater use conditions. The RCRA Corrective Action Program's overall mission is to protect human health and the environment. To achieve this goal, final remedies must be based on potential future land and groundwater uses and ecological receptors.

A. At the completion of site characterization activities, EPA will evaluate the need to issue a Corrective Action Permit or Order to the Facility.

B. Under certain circumstances implementation of Interim Measures may achieve the final remedial goals. In that case, EPA will public notice a tentative determination and solicit comment prior to making a final Agency determination regarding final corrective action remedies at the Facility.

IV. CERTIFICATION

Reports specified in Section II. F.1.b, Section II.F.1.c and Section II.F.1.d, when submitted to EPA and the State, shall be certified by a "responsible corporate officer[1]." The Facility agrees to provide the certification in the following form:

> I certify that the information contained in this Report is true, accurate, and complete.
>
> As to [the/those identified portion(s)] of this [type of submission] for which I cannot personally verify [its/their] accuracy, I certify that this Report and all attachments were prepared in accordance with procedures designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, or the immediate supervisor of such person(s), the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.
>
> Name: Title: Signature :

V. SAMPLING AND DATA/DOCUMENT AVAILABILITY AND PRESERVATION

A. The Facility shall submit to EPA the results of all sampling and/or tests or other data generated by, or on behalf of, Facility.

B. At the request of EPA, the Facility shall provide or allow EPA or its authorized representatives to take split or duplicate samples of all samples collected by Facility pursuant to this Agreement**.** The Facility agrees not to limit access to the property or otherwise affect EPA's authority to collect samples pursuant to applicable law, including, but not limited to, RCRA and CERCLA.

C. The Facility may assert a business confidentiality claim covering all or part of any information submitted to EPA pursuant to this Agreement in the manner described in 40 C.F.R. § 2.203(b). The Facility shall not assert any confidentiality claim with regard to any physical, sampling, monitoring, or analytical data.

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[1] A "responsible corporate officer" means: (a) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (b) the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. A person is a "duly authorized representative" only if: (1) the authorization is made in writing by a person described above; and (2) the authorization specifies either an individual or position having responsibility for overall operation of the regulated facility or activity (a duly authorized representative may thus be either a named individual or any individual occupying a named position).

D. Commencing on the date the Letter of Commitment is submitted to EPA, the Facility agrees that it shall preserve and make available to EPA for inspection and copying, all data, records and documents in its possession or in the possession of its divisions, officers, directors, employees, agents, contractors, successors, and assigns which relate in any way to this Agreement or to hazardous waste management and/or disposal at the Facility.

VI. RESERVATION OF RIGHTS

A. EPA reserves all of its statutory and regulatory powers, authorities, rights, and remedies, both legal and equitable, which may pertain to the Facility's activities. This Agreement shall not be construed as a covenant not to sue, release, waiver, or limitation of any rights, remedies, powers, and/or authorities, civil or criminal, which EPA has under RCRA, CERCLA, or any other statutory, regulatory, or common law authority of the United States.

B. EPA reserves the right to disapprove work performed by the Facility pursuant to this Agreement and to request or direct that Facility perform additional tasks.

C. EPA reserves the right to require or to perform any portion of the work consented to herein or any additional site characterization, feasibility study, and remedial work as it deems necessary to protect human health and/or the environment. EPA may exercise its authority under CERCLA to undertake response actions at any time. EPA reserves its right to seek reimbursement from the Facility for costs incurred by the United States. Notwithstanding compliance with the terms of this Agreement, the Facility is not released from liability, if any, for the costs of any response actions taken or authorized by EPA.

D. If EPA determines that activities undertaken pursuant to this Agreement have caused or may cause a release of hazardous waste or hazardous constituent(s), or a threat to human health and/or the environment, or that the Facility is not capable of undertaking the work agreed upon, EPA may order the Facility to stop further implementation of activities undertaken pursuant to this Agreement for such period of time as EPA determines may be needed to abate any such release or threat and/or to undertake any action which EPA determines is necessary to abate such release or threat.

E. EPA and the Facility acknowledge and agree that EPA's approval of any Statements of Work (SOWs) or any workplan submitted pursuant to this Agreement does not constitute a warranty or representation that the SOWs or workplans will achieve the required cleanup or performance standards. Compliance by the Facility with the terms of this Agreement shall not relieve it of its obligations to comply with RCRA or any other applicable local, state, or federal laws and regulations.

F. Notwithstanding any other provision herein, no action or decision by EPA pursuant to this Agreement, including without limitation, decisions of the Regional Administrator, the

Director of the Waste and Chemicals Management Division, or any authorized representative of EPA, shall constitute final agency action giving rise to any right of judicial review prior to EPA's initiation of a judicial action to enforce this Agreement, including an action for penalties or an action to compel the Facility's compliance with its terms and conditions.

G. Notwithstanding any other terms or conditions in this Agreement, EPA may decide to issue a Corrective Action Permit or Order to the Facility at any time.

H. Indemnification: The Facility agrees to indemnify and save and hold harmless the United States government, its agencies, departments, agents, and employees, from any and all claims or causes of action arising from or on account of acts or omissions of the Facility or its officers, employees, agents, independent contractors, receivers, trustees, and assigns in carrying out activities required by this Agreement. This indemnification shall not be construed in any way as affecting or limiting the rights or obligations of the Facility or the United States under their various contracts. The Facility shall not be responsible for indemnifying the EPA for claims or causes of action solely from or on account of acts or omissions of EPA.

VII. OTHER APPLICABLE LAWS

All actions shall be undertaken in accordance with the requirements of all applicable local, state, and federal laws and regulations. The Facility shall obtain or require its authorized representatives to obtain all permits and approvals necessary under such laws and regulations.

VIII. NOTICE OF NON-LIABILITY OF EPA

EPA shall not be deemed a party to any contract involving the Facility and relating to activities at the Facility and shall not be liable for any claim or cause of action arising from or on account of any act, or the omission of the Facility, its officers, employees, contractors, receivers, trustees, agents or assigns, in carrying out the activities required by this Agreement.

IX. EFFECTIVE DATE

The effective date of this Agreement is the date of the Letter of Commitment submitted by the Facility to EPA.

References for Administrative Approaches

Module References

! Sections 3004(u), 3004(v), Subpart F, 3007, 3008(a), 3008(h), 3013, 7003 of the RCRA Statute.

! Guidance on the Use of Section 7003 of RCRA, U.S. EPA, October 1997. Available to download from the Internet: http://es.epa.gov/oeca/osre/rcra.html

! Final RCRA §3008(h) Model Consent Order, U.S. EPA, OSWER Directive #9902.5A, December 15, 1993.

! Interim Final Model 3008(h) Unilateral Order, U.S. EPA, OSWER Directive #9902.5, January 23, 1989.

! Issuance of Administrative Orders Under Section 3013 of the Resource Conservation and Recovery Act, U.S. EPA, September 26, 1984. EPA Memorandum from Courtney M. Price, Assistant Administrator for Enforcement and Compliance Monitoring, and Lee M. Thomas, Assistant Administrator, Office of Solid Waste and Emergency Response.

Supplemental References and Resources

! Letter from Whyco Chromium Company, to Ernie Waterman, EPA Region 1, regarding the implementation of Voluntary Corrective Action at the facility. Letter dated January 24, 1997.

! Model facility agreement and letter outlining EPA's expectations for facilities pursuing self-directed Corrective Action, May 1996.

! Letter from Waterman, EPA, to Lavine, Whyco, outlining EPA's expectations of Whyco Chromium in pursuing voluntary corrective action. Letter dated November 1996.

! RCRA Corrective Action Authorities Hotline Monthly Report Question, February 1995. Available for download from Internet at http://www.epa.gov/epaoswer/hazwaste/ca/6.txt

! OSW Waste Cleanup Website: http://www.epa.gov/epaoswer/osw/cleanup.htm

! RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction

! Comparison of RCRA §7003 to Other Enforcement and Response Authorities Table

! RCRA Hotline Phone Number - (800) 424-9346

! Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Advanced Notice for Proposed Rulemaking (ANPR) May 1, 1996 (61 FR 19432). Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm

! A Summary of Owner/Operator Initiated Agreements

! Example guidance and letters from Regions showing how various concepts related to independent and voluntary corrective actions can be implemented.

References for Administrative Approaches

! Permits Improvement Team. U.S. EPA, March 1998. Available to download from the Internet: http://www.epa.gov/ooaujeag/notebook/pit.htm

! EPA Press Release: EPA Corrective Action Program in New England, U.S. EPA, Region 1, July 2, 1998.

! OSW Waste Cleanup Website: http://www.epa.gov/epaoswer/osw/cleanup.htm

! RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction

! EPA Reinvention Activity Fact Sheets: Permits Improvement Team: http://www.epa.gov/ooaujeag/notebook/pit.htm

FINAL REMEDY SELECTION

EPA 542-F-98-023
November 1998

FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE

REMEDIATION CASE STUDIES: FACT SHEET AND ORDER FORM

INTRODUCTION

Increasing the cost-effectiveness of site remediation is a national priority. The selection and use of more cost-effective remedies requires better access to data on the performance and cost of technologies used in the field. To make data more widely available, member agencies of the Federal Remediation Technologies Roundtable (see footnote) are working jointly to publish case studies of full-scale remediation and demonstration projects. Previously, the Roundtable had published 54 case study reports and a collection of corresponding abstracts. Now, the Roundtable has published 86 additional case study reports and corresponding abstracts. These case studies are based on an important Roundtable Guide for documenting site cleanups.

CONTENTS OF CASE STUDY REPORTS

The 140 case study reports prepared by the federal agencies describe both above-ground and in situ technologies. Remediation case studies are available in 13 separate volumes (Volumes 1-4 were published in March 1995, Volumes 5-6 in July 1997, and Volumes 7-13 in September 1998):

Volume 1: Bioremediation
Volume 2: Groundwater Treatment
Volume 3: Soil Vapor Extraction
Volume 4: Thermal Desorption, Soil Washing, and In Situ Vitrification
Volume 5: Bioremediation and Vitrification
Volume 6: Soil Vapor Extraction and Other In Situ Technologies
Volume 7: Ex Situ Soil Treatment Technologies
Volume 8: In Situ Soil Treatment Technologies
Volume 9: Groundwater Pump and Treat
Volume 10: Groundwater Pump and Treat
Volume 11: Innovative Groundwater Treatment Technologies
Volume 12: On-Site Incineration
Volume 13: Debris and Surface Cleaning Technologies, and Other Miscellaneous Technologies

Exhibit 1 lists the case studies contained in each report with the technology and type of contaminants treated. Case studies average 20 pages long and document project design, operation, performance, cost, and lessons learned. Graphics include concentration distribution, site stratigraphy, and treatment schematics.

ABSTRACTS OF REMEDIATION CASE STUDIES

Three volumes of case study abstracts have been prepared; Volume 1 covers the 37 reports published in March 1995, Volume 2 the 17 published in July 1997, and Volume 3 the 86 published in September 1998. Each 2-page abstract summarizes information about the site and waste treated, waste source, technology, period of operation, technology vendor, technology description, contaminants and media treated, regulatory requirements, summary of performance and cost, points of contact, and the significance of the application.

GUIDE TO DOCUMENTING AND MANAGING COST AND PERFORMANCE INFORMATION FOR REMEDIATION PROJECTS

The Roundtable has revised this Guide to better capture federal agency cleanup experience. The Guide provides recommended procedures for documenting the matrix characteristics and technology operation, performance, and cost for the following conventional and innovative cleanup technologies:

In Situ Soil Remediation

- Bioventing
- Capping
- In situ heating
- Phytoremediation
- Soil flushing
- Soil vapor extraction
- Vitrification

Ex Situ Soil Remediation

- Composting
- Incineration
- Land treatment
- Slurry-phase bioremediation
- Soil washing
- Stabilization
- Thermal desorption

Groundwater Remediation

- Air sparging
- Bioremediation
- Bioslurping
- Circulating wells (UVB)
- Cosolvents and surfactants
- Dual-phase extraction
- Dynamic underground stripping
- In situ oxidation (Fenton's reagent)
- Natural attenuation (chlorinated compounds)
- Natural attenuation (nonchlorinated hydrocarbons)
- Permeable reactive barriers
- Phytoremediation
- Pump and treat systems
- Steam flushing
- Vertical barrier walls

ORDERING INFORMATION

Ordering instructions are provided at the end of this Fact Sheet and Order Form.

ON-LINE ACCESS

The case studies and case study abstracts are available on the Internet through the Roundtable home page at *http://www.frtr.gov*. The home page provides links to individual Roundtable members' home pages, and includes a search function.

The Federal Remediation Technologies Roundtable consists of senior executives from eight agencies with an interest in site remediation technology. The Roundtable meets twice each year to coordinate the exchange of information on remediation technologies and to consider cooperative efforts. Primary members include the U.S. Departments of Defense, Energy, and Interior, and the U.S. Environmental Protection Agency. Other participants include the Nuclear Regulatory Commission, National Aeronautics and Space Administration, Tennessee Valley Authority, and the U.S. Coast Guard.

EXHIBIT 1. SUMMARY OF REMEDIATION CASE STUDIES

Site Name, State	Technology	Contaminants
Remediation Case Studies (Volume 1): Bioremediation		
Brown Wood Preserving Superfund Site, FL	Land Treatment	PAHs
Eielson Air Force Base, AK	Bioventing	BTEX/TPH
French Ltd. Superfund Site, TX	Slurry-Phase Bioremediation	BTEX, PAHs, Chlorinated Solvents
Hill Air Force Base, Site 280, UT	Bioventing	BTEX/TPH
Hill Air Force Base, Site 914, UT	Bioventing preceded by SVE (one report covers both technologies)	BTEX/TPH
Lowry Air Force Base, CO	Bioventing	BTEX/TPH
Lowry Air Force Base, CO	Land Treatment	BTEX/TPH
Scott Lumber Company Superfund Site, MO	Land Treatment	PAHs
Umatilla Army Depot Activity, OR	Composting	TNT/RDX/HMX
Remediation Case Studies (Volume 2): Groundwater Treatment		
Amcor Precast, UT	In Situ Density-Driven Sparging	BTEX/TPH
Amoco Petroleum Pipeline, MI	GW Extraction w/GAC	BTEX/TPH
Commencement Bay, South Tacoma Channel Well 12A Superfund Site, WA	GW Extraction w/GAC	Chlorinated Solvents
Ft. Drum, Fuel Dispensing Area 1595, NY	GW Extraction w/Air Stripping and GAC	BTEX/TPH
Langley Air Force Base, IRP Site 4, VA	GW Extraction w/Air Stripping	BTEX/TPH
Lawrence Livermore National Laboratory Gasoline Spill Site, CA	In Situ Dynamic Underground Stripping	BTEX/TPH
McClellan Air Force Base, Operable Unit B/C, CA	GW Extraction w/Air Stripping	Chlorinated Solvents
McClellan Air Force Base, Operable Unit D, CA	GW Extraction w/Air Stripping	Chlorinated Solvents
Twin Cities Army Ammunition Plant, MN	GW Extraction w/Air Stripping	Chlorinated Solvents
U.S. Department of Energy Kansas City Plant, MO	GW Extraction w/Advanced Oxidation Processes	Chlorinated Solvents
U.S. Department of Energy Savannah River Site, A/M Area, SC	GW Extraction w/Air Stripping	Chlorinated Solvents
U.S. Department of Energy Savannah River Site, A/M Area, SC	In Situ Air Stripping	Chlorinated Solvents
Remediation Case Studies (Volume 3): Soil Vapor Extraction		
Commencement Bay, South Tacoma Channel Well 12A Superfund Site, WA	SVE w/Product Recovery	Chlorinated Solvents
Fairchild Semiconductor Corporation Superfund Site, CA	SVE w/GAC	Chlorinated Solvents
Hastings Groundwater Contamination Superfund Site, Well Number 3 Subsite, NE	SVE w/GAC	Chlorinated Solvents
Hill Air Force Base, Site 914, UT	SVE w/Catalytic Oxidation followed by Bioventing (one report covers both technologies)	BTEX/TPH
Luke Air Force Base, North Fire Training Area, AZ	SVE w/Thermal Oxidizer	BTEX/TPH
McClellan Air Force Base, Operable Unit D, Site S, CA	SVE w/Catalytic Oxidizer and Scrubber	Chlorinated Solvents
Rocky Mountain Arsenal Superfund Site (Motor Pool Area - Operable Unit #18), CO	SVE w/Product Recovery and GAC	Chlorinated Solvents
Sacramento Army Depot Superfund Site, Tank 2 (Operable Unit #3), CA	SVE w/GAC	Chlorinated and Non-Chlorinated Solvents
SMS Instruments Superfund Site, NY	SVE w/Catalytic Incineration and Scrubbing	Chlorinated and Non-Chlorinated Solvents
Verona Well Field Superfund Site (Thomas Solvent Raymond Road - Operable Unit #1), MI	SVE w/Catalytic Oxidation and GAC	Chlorinated and Non-Chlorinated Solvents
Remediation Case Studies (Volume 4): Thermal Desorption, Soil Washing, and In Situ Vitrification		
Anderson Development Company Superfund Site, MI	Thermal Desorption	MBOCA, PAHs
King of Prussia Technical Corporation Superfund Site, NJ	Soil Washing	Heavy Metals
McKin Superfund Site, ME	Thermal Desorption	BTEX/TPH, PAHs
Outboard Marine Corporation Superfund Site, OH	Thermal Desorption	PCBs
Parsons Chemical/ETM Enterprises Superfund Site, MI	In Situ Vitrification	Pesticides, Heavy Metals, Dioxins
Pristine, Inc. Superfund Site, OH	Thermal Desorption	BTEX, PAHs, Pesticides, Dioxins, Chlorinated Solvents

Site Name, State	Technology	Contaminants
TH Agriculture & Nutrition Company Superfund Site, GA	Thermal Desorption	Pesticides
Wide Beach Development Superfund Site, NY	Thermal Desorption w/Dehalogenation	PCBs
Remediation Case Studies (Volume 5): Bioremediation and Vitrification		
Burlington Northern Superfund Site, MN	Land Treatment	PAHs, Methylene Chloride Extractable Hydrocarbons
Dubose Oil Products Co. Superfund Site, FL	Composting	PAHs, Toluene, TCE
Southeastern Wood Preserving Superfund Site, MS	Slurry-Phase Bioremediation	Naphthalene, Benzo(a)pyrene
Umatilla Army Depot Activity, OR	Windrow Composting	TNT, RDX, HMX
U.S. Department of Energy Savannah River Site, SC	In Situ Bioremediation	TCE, PCE
U.S. Department of Energy Paducah Gaseous Diffusion Plant, KY	Lasagna™ Soil Remediation	TCE
Parsons Chemical/ETM Enterprises Superfund Site, MI	In Situ Vitrification	Pesticides, Metals, Dioxins
U.S. Department of Energy Hanford Site, WA, Oak Ridge (TN) and Others	In Situ Vitrification	Pesticides, Metals, Dioxin/Furan, PCBs
Remediation Case Studies (Volume 6): Soil Vapor Extraction and Other In Situ Technologies		
Basket Creek Surface Impoundment Site, GA	SVE	Toluene, MIBK
Sacramento Army Depot Superfund Site, Burn Pits Operable Unit, CA	SVE	TCE, PCE, DCE
Sand Creek Industrial Superfund Site, Operable Unit 1, CO	SVE	PCE, TCE
U.S. Department of Energy, Portsmouth Gaseous Diffusion Plant, OH	In Situ Enhanced Soil Mixing	TCE, TCA, DCE
U.S. Department of Energy, Savannah River Site, SC	Flameless Thermal Oxidation	TCE, PCE, TCA
U.S. Department of Energy, Savannah River Site, SC, and Hanford Site, WA	Six Phase Soil Heating	TCE, PCE
U.S. Department of Energy, Portsmouth Gaseous Diffusion Plant, OH and Other Sites	Hydraulic and Pneumatic Fracturing	VOCs, DNAPLs
U.S. Department of Energy, SEG Facilities, TN	Frozen Soil Barrier Technology	Not Applicable (not a contaminated site)
U.S. Department of Energy, Multiple Sites	Resonant Sonic Drilling	Not Applicable (not a contaminated site)
Remediation Case Studies (Volume 7): Ex Situ Soil Treatment Technologies (Bioremediation, Solvent Extraction, Thermal Desorption)		
Bioremediation		
Bonneville Power Administration Ross Complex, Operable Unit A, WA	Land Treatment	PAHs
Fort Greely, UST Soil Pile, AK	Land Treatment	BTEX/TPH
Novartis Site, Ontario, Canada	Land Treatment	Pesticides/Herbicides
Solvent Extraction		
Sparrevohn Long Range Radar Station, AK	Solvent Extraction	PCBs
Thermal Desorption		
FCX Washington Superfund Site, NC	Thermal Desorption	Pesticides/Herbicides
Fort Lewis, Solvent Refined Coal Pilot Plant (SRCPP), WA	Thermal Desorption	PAHs
Naval Air Station Cecil Field, Site 17, OU 2, FL	Thermal Desorption	BTEX/TPH, PAHs
Port Moller Radio Relay Station, AK	Thermal Desorption	BTEX/TPH
Re-Solve, Inc. Superfund Site, MA	Thermal Desorption	PCBs
Waldick Aerospaces Devices Superfund Site, NJ	Thermal Desorption	Chlorinated Solvents, BTEX/TPH, Metals
Remediation Case Studies (Volume 8): In Situ Soil Treatment Technologies (Soil Vapor Extraction, Thermal Processes)		
Soil Vapor Extraction		
Camp Lejeune Military Reservation, Site 82, Area A, NC	SVE	Chlorinated Solvents
Davis-Monthan AFB, Site ST-35, AZ	SVE	BTEX/TPH
Defense Supply Center Richmond, OU 5, VA	SVE	Chlorinated Solvents
Fort Greely, Texas Tower Site, AK	Air Sparging, In Situ Bioremediation, and SVE	BTEX/TPH
Fort Lewis, Landfill 4, WA	SVE and Air Sparging	Chlorinated Solvents, Metals
Fort Richardson, Building 908 South, AK	SVE	BTEX/TPH
Holloman AFB, Sites 2 and 5, NM	SVE	BTEX/TPH
Intersil/Siemens Superfund Site, CA	SVE	Chlorinated Solvents

EXHIBIT 1. SUMMARY OF REMEDIATION CASE STUDIES (continued)

Site Name, State	Technology	Contaminants
NAS North Island, Site 9, CA	Photolytic Destruction	Chlorinated Solvents
Seymour Recycling Corporation Superfund Site, IN	SVE	Chlorinated Solvents
Shaw AFB, OU 1, SC	SVE and Groundwater Containment	BTEX/TPH
Tyson's Dump Superfund Site, PA	SVE	Chlorinated Solvents
Thermal Processes		
Brodhead Creek Superfund Site, PA	Contained Recovery of Oily Waste	PAHs, Metals
Missouri Electric Works Superfund Site, MO	In Situ Thermal Desorption	PCBs
Remediation Case Studies (Volume 9): Groundwater Pump and Treat (Chlorinated Solvents)		
Des Moines TCE Superfund Site, OU 1, IA	Pump and Treat with Air Stripping	Chlorinated Solvents
Former Firestone Facility Superfund Site, CA	Pump and Treat with Air Stripping, Carbon Adsorption, and Oil/Water Separation	Chlorinated Solvents
JMT Facility RCRA Site (formerly Black & Decker RCRA Site), NY	Pump and Treat with Air Stripping	Chlorinated Solvents
Keefe Environmental Services Superfund Site, NH	Pump and Treat with Air Stripping and Coagulation/Flocculation	Chlorinated Solvents
Lawrence Livermore National Laboratory (LLNL) Site 300 - General Services Area (GSA) Operable Unit, CA	Pump and Treat with Air Stripping and Carbon Adsorption; SVE	Chlorinated Solvents
Mystery Bridge at Hwy 20 Superfund Site, Dow/DSI Facility - Volatile Halogenated Organic (VHO) Plume, WY	Pump and Treat with Air Stripping; SVE	Chlorinated Solvents
Offutt AFB, Site LF-12, NE	Pump and Treat with Air Stripping	Chlorinated Solvents
Old Mill Superfund Site, OH	Pump and Treat with Air Stripping and Carbon Adsorption	Chlorinated Solvents
SCRDI Dixiana Superfund Site, SC	Pump and Treat with Air Stripping	Chlorinated Solvents
Shaw AFB, Site OT-16B, SC	Hydraulic Containment Through Active Pumping	Chlorinated Solvents
Shaw AFB, Sites SD-29 and ST-30, SC	Free Product Recovery with Air Stripping	Chlorinated Solvents, BTEX/TPH
Solid State Circuits Superfund Site, MO	Pump and Treat with Air Stripping	Chlorinated Solvents
Sol Lynn/Industrial Transformers Superfund Site, TX	Pump and Treat with Air Stripping, Carbon Adsorption, and Filtration	Chlorinated Solvents
Solvent Recovery Services of New England, Inc. Superfund Site, CT	Pump and Treat with Carbon Adsorption, Chemical Treatment, Filtration, and UV/Oxidation; Vertical Barrier Wall	Chlorinated Solvents, Metals
Remediation Case Studies (Volume 10): Groundwater Pump and Treat (Nonchlorinated Contaminants)		
Baird and McGuire Superfund Site, MA	Pump and Treat with Aeration, Air Stripping, Chemical Treatment, Clarification, and Filtration	BTEX/TPH, PAHs, Pesticides/Herbicides, Metals
Bofors Nobel Superfund Site, OU 1, MI	Pump and Treat with Air Stripping, Carbon Adsorption, Chemical Treatment, Filtration, and UV/Oxidation	Chlorinated Solvents, SVOCs
City Industries Superfund Site, FL	Pump and Treat with Air Stripping	Chlorinated Solvents, BTEX/TPH
King of Prussia Technical Corporation Superfund Site, NJ	Pump and Treat with Air Stripping, Carbon Adsorption, and Electrochemical Treatment	Chlorinated Solvents, BTEX/TPH, Metals
LaSalle Electrical Superfund Site, IL	Pump and Treat with Air Stripping, Carbon Adsorption, and Oil/Water Separation	Chlorinated Solvents, PCBs
Mid-South Wood Products Superfund Site, AR	Pump and Treat with Carbon Adsorption, Filtration, and Oil/Water Separation	PAHs, Metals
Odessa Chromium I Superfund Site, OU 2, TX	Pump and Treat with Chemical Treatment, Flocculation, Multimedia Filtration, pH Adjustment, and Precipitation	Metals
Odessa Chromium IIS Superfund Site, OU 2, TX	Pump and Treat with Chemical Treatment, Flocculation, Multimedia and Cartridge Filtration, pH Adjustment, and Precipitation	Metals
Pope AFB, Site FT-01, NC	Free Product Recovery	BTEX/TPH
Pope AFB, Site SS-07, Blue Ramp Spill Site, NC	Free Product Recovery	BTEX/TPH
Sylvester/Gilson Road Superfund Site, NH	Pump and Treat with Air Stripping, Biological Treatment, Chemical Treatment, Clarification, Flocculation, and Mixed-media Pressure Filtration; Cap; SVE; Vertical Barrier Wall	Chlorinated Solvents, Metals
United Chrome Superfund Site, OR	Pump and Treat with Reduction and Precipitation	Metals
U.S. Avtex Superfund Site, MI	Pump and Treat with Air Stripping	Chlorinated Solvents, Diethyl Ether
Western Processing Superfund Site, WA	Pump and Treat with Air Stripping and Filtration; Vertical Barrier Wall	Chlorinated Solvents, PAHs, Metals

Site Name, State	Technology	Contaminants
Remediation Case Studies (Volume 11): Innovative Groundwater Treatment Technologies		
Balfour Road Site, CA; Fourth Plain Service Station Site, WA; Steve's Standard and Golden Belt 66 Site, KS	Enhanced Bioremediation of Groundwater	BTEX/TPH
Coastal Systems Station, AOC 1, FL	Chemical Reaction and Flocculation, and Dissolved Air Flotation	BTEX/TPH, Metals
Former Intersil, Inc. Site, CA	Pump and Treat with Air Stripping; Permeable Reactive Barrier	Chlorinated Solvents
French Ltd. Superfund Site, TX	Pump and Treat with Activated Sludge for Extracted Groundwater; In Situ Bioremediation	Chlorinated Solvents
Gold Coast Superfund Site, FL	Pump and Treat with Air Sparging	Chlorinated Solvents
Libby Groundwater Superfund Site, MT	Pump and Treat; In Situ Bioremediation	PAHs
Moffett Federal Airfield, CA	Permeable Reactive Barrier	Chlorinated Solvents
Pinellas Northeast Site, FL	In Situ Air and Steam Stripping -Dual Auger Rotary Steam Stripping	Chlorinated Solvents
Pinellas Northeast Site, FL	In Situ Anaerobic Bioremediation	Chlorinated Solvents
Pinellas Northeast Site, FL	Membrane Filtration - PerVap™	Chlorinated Solvents
Site A (actual name confidential), NY	Pump and Treat with Air Stripping; In Situ Bioremediation; Air Sparging; SVE	BTEX/TPH
U.S. Coast Guard Support Center, NC	Permeable Reactive Barrier	Chlorinated Solvents, Metals
Remediation Case Studies (Volume 12): On-Site Incineration		
Baird and McGuire, MA	Rotary Kiln Incinerator	PAHs, Pesticides/Herbicides, Metals, Dioxin, PCBs
Bayou Bonfouca, LA	Rotary Kiln Incinerator	PAHs
Bridgeport Refinery and Oil Services, NJ	Rotary Kiln Incinerator	BTEX/TPH, Metals, Dioxin, PCBs
Celanese Corporation Shelby Fiber Operations, NC	Rotary Kiln Incinerator	Chlorinated Solvents, PAHs, Metals
Coal Creek, WA	Rotary Kiln Incinerator	Metals, Dioxin, PCBs
FMC Corporation - Yakima, WA	Rotary Kiln Incinerator	Pesticides/Herbicides, Metals
Former Nebraska Ordnance Plant - OU 1, NE	Rotary Kiln Incinerator	Explosives/Propellants, TNT, RDX, HMX
MOTCO, TX	Rotary Kiln Incinerator	Chlorinated Solvents, Metals, Dioxin, PCBs
Old Midland Products, AR	Rotary Kiln Incinerator	PAHs
Petro Processors, LA	Horizontal Liquid Injection Incinerator	Chlorinated Solvents, BTEX/TPH, PAHs, Metals
Rocky Mountain Arsenal, CO	Submerged Quench Incinerator	Pesticides/Herbicides, Metals
Rose Disposal Pit, MA	Rotary Kiln Incinerator	Chlorinated Solvents, Dioxin, PCBs
Rose Township Dump, MI	Infrared Incinerator	BTEX/TPH, Dioxin, PCBs
Sikes Disposal Pits, TX	Rotary Kiln Incinerator	Chlorinated Solvents, PAHs
Times Beach, MO	Rotary Kiln Incinerator	Dioxin, PCBs
Vertac Chemical Corporation, AR	Rotary Kiln Incinerator	Pesticides/Herbicides, Dioxin, PCBs
Remediation Case Studies (Volume 13): Debris and Surface Cleaning Technologies, and Other Miscellaneous Technologies		
Alabama Army Ammunition Plant, AL	Transportable Hot-Gas Decontamination	Explosives
Chicago Pile 5 (CP-5) Research Reactor, Argonne National Laboratory, IL	Centrifugal Shot Blast	Radioactivity
Chicago Pile 5 (CP-5) Research Reactor, Argonne National Laboratory, IL	Rotary Peening with Captive Shot	Radioactivity
Chicago Pile 5 (CP-5) Research Reactor, Argonne National Laboratory, IL	Roto Peen Scaler with VAC-PAC® System	Radioactivity
Envirocare of Utah, UT	Polyethylene Macroencapsulation	Radioactivity
Lawrence Livermore National Laboratory (LLNL) Site 300 - Pit 6 Landfill OU, CA	Cap	Chlorinated Solvents, Radioactivity

Key:

DNAPLs = Dense Non-Aqueous Phase Liquids
SVOCs = Semi-Volatile Organic Compounds
GAC = Granular Activated Carbon
SVE = Soil Vapor Extraction
BTEX = Benzene, Toluene, Ethylbenzene, and Xylene
TPH = Total Petroleum Hydrocarbons
PAHs = Polycyclic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
TCA = 1,1,1-Trichloroethane
TCE = Trichloroethene
PCE = Tetrachloroethene
DCE = Dichloroethene
TNT = 2,4,6-Trinitrotoluene
RDX = Hexahydro-1,3,5-trinitro-1,3,5 triazine
HMX = Octahydro-1,3,5,7-tetranitro 1,3,5,7-tetrazocine
MBOCA = 4,4-methylene bis(2-chloroaniline)
MIBK = Methyl isobutyl ketone

Remediation Case Studies and Abstract Volumes
Ordering Instructions and Form

The following documents are available free-of-charge from the U.S. EPA/National Center for Environmental Publications and Information (NCEPI). To order, mail this completed form to: U.S. EPA/National Center for Environmental Publications and Information, P.O. Box 42419, Cincinnati, OH 45242, or FAX to (513) 489-8695. Also, telephone orders may be placed at (800) 490-9198 or (513) 489-8190.

Title	Number	Please Send
Previous Publications		
Abstracts of Remediation Case Studies, Volume 1	EPA-542-R-95-001; March 1995	☐
Remediation Case Studies, Volume 1: Bioremediation	EPA-542-R-95-002; March 1995	☐
Remediation Case Studies, Volume 2: Groundwater Treatment	EPA-542-R-95-003; March 1995	☐
Remediation Case Studies, Volume 3: Soil Vapor Extraction	EPA-542-R-95-004; March 1995	☐
Remediation Case Studies, Volume 4: Thermal Desorption, Soil Washing, and In Situ Vitrification	EPA-542-R-95-005; March 1995	☐
Abstracts of Remediation Case Studies, Volume 2	EPA-542-R-97-010; July 1997	☐
Remediation Case Studies, Volume 5: Bioremediation and Vitrification	EPA-542-R-97-008; July 1997	☐
Remediation Case Studies, Volume 6: Soil Vapor Extraction and Other In Situ Technologies	EPA-542-R-97-009; July 1997	☐
New Publications		
Abstracts of Remediation Case Studies, Volume 3	EPA-542-R-98-010; September 1998	☐
Remediation Case Studies, Volume 7: Ex Situ Soil Treatment Technologies (Bioremediation, Solvent Extraction, Thermal Desorption)	EPA-542-R-98-011; September 1998	☐
Remediation Case Studies, Volume 8: In Situ Soil Treatment Technologies (Soil Vapor Extraction, Thermal Processes)	EPA-542-R-98-012; September 1998	☐
Remediation Case Studies, Volume 9: Groundwater Pump and Treat (Chlorinated Solvents)	EPA-542-R-98-013; September 1998	☐
Remediation Case Studies, Volume 10: Groundwater Pump and Treat (Nonchlorinated Contaminants)	EPA-542-R-98-014; September 1998	☐
Remediation Case Studies, Volume 11: Innovative Groundwater Treatment Technologies	EPA-542-R-98-015; September 1998	☐
Remediation Case Studies, Volume 12: On-Site Incineration	EPA-542-R-98-016; September 1998	☐
Remediation Case Studies, Volume 13: Debris and Surface Cleaning Technologies, and Other Miscellaneous Technologies	EPA-542-R-98-017; September 1998	☐
Guide to Documenting and Managing Cost and Performance Information for Remediation Projects, Revised Version	EPA-542-B-98-007; October 1998	☐

Name: _____ Date: _____

Organization: _____

Address: _____

City/State/Zip: _____ Telephone: _____

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Individual remediation case studies and abstracts also are available on the Internet at ***http://www.frtr.gov.***

Federal Remediation Technologies Roundtable
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Title	Number	Please Send
Guide to Documenting and Managing Cost and Performance Information for Remediation Projects, Revised Version	EPA-542-B-98-007; October 1998	☐
Site Remediation Technology InfoBase: A Guide to Federal Programs, Information Resources, and Publications on Contaminated Site Cleanup Technologies, First Edition	EPA-542-B-98-006; August 1998	☐
Field Sampling and Analysis Technologies Matrix And Reference Guide, First Edition	EPA-542-B-98-002; March 1998	☐
Field Sampling and Analysis Technologies Matrix - Poster	EPA-542-B-98-002A; March 1998	☐
Remediation Technologies Screening Matrix And Reference Guide, Third Edition	Viewable at *http://www.frtr.gov*; November 1997	☐
Remediation Technologies Screening Matrix - Poster*	November 1998	☐

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Organization: _____

Address: _____

City/State/Zip: _____ Telephone: _____

E-mail Address: _____

Documents also are available on the Internet at ***http://www.frtr.gov.***

* To order a copy of the Remediation Technologies Screening Matrix Poster: send your name, organization, and address to the technology transfer hotline at t2hotline@aec.apgea.army.mil.

EPA

United States
Environmental Protection Agency
(5102 G)
Washington, DC 20460

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Federal Remediation Technologies Roundtable
<www.frtr.gov>

Remediation Case Studies:

Fact Sheet and Order Form

United States Environmental Protection Agency | Solid Waste and Emergency Response | EPA 542-F-96-013 February 1997

Citizens' Guides to Understanding Innovative Treatment Technologies

A Citizen's Guide to Innovative Treatment Technologies for Contaminated Soils, Sludges, Sediments and Debris
(EPA 542-F-96-001)

A Citizen's Guide to Solvent Extraction
(EPA 542-F-96-002)

A Citizen's Guide to Soil Washing
(EPA 542-F-96-003)

A Citizen's Guide to Chemical Dehalogenation
(EPA 542-F-96-004)

A Citizen's Guide to Thermal Desorption
(EPA 542-F-96-005)

A Citizen's Guide to In Situ Soil Flushing
(EPA 542-F-96-006)

A Citizen's Guide to Bioremediation
(EPA 542-F-96-007)

A Citizen's Guide to Soil Vapor Extraction and Air Sparging
(EPA 542-F-96-008)

A Citizen's Guide to Phytoremediation
(EPA 542-F-96-014)

A Citizen's Guide to Natural Attenuation
(EPA 542-F-96-015)

A Citizen's Guide to Treatment Walls
(EPA 542-F-96-016)

The Citizens' Guides have been developed by the EPA Superfund program. Superfund is on the forefront of developing new technologies to meet the nation's clean-up needs better and faster. EPA is committed to helping citizens better understand the clean-up process and the new technologies available to address sites.

prepared by
United States Environmental Protection Agency
Technology Innovation Office
Office of Solid Waste and Emergency Response
Washington, DC 20460

Printed on recycled paper

Organismo para la Protección del Medio Ambiente (Estados Unidos) | Desecho Sólidos y Respuesta de Emergencia | EPA 542-F-96-013 Febrero 1997

Guías del ciudadano para entender las técnicas innovadoras de tratamiento

Guía del ciudadano: Técnicas de tratamiento innovadoras para suelos contaminados, fango residual, sedimentos y detritos
(EPA 542-F-96-017)

Guía del ciudadano: El lavado del suelo
(EPA 542-F-96-018)

Guía del ciudadano: La extracción con solventes
(EPA 542-F-96-019)

Guía del ciudadano: La deshalogenación química
(EPA 542-F-96-020)

Guía del ciudadano: La desorción térmica
(EPA 542-F-96-021)

Guía del ciudadano: El enjuague de suelos in situ
(EPA 542-F-96-022)

Guía del ciudadano: Medidas biocorrectivas
(EPA 542-F-96-023)

Guía del ciudadano: La extracción de vapores del suelo y la aspersión de aire
(EPA 542-F-96-024)

Guía del ciudadano: Medidas fitocorrectivas
(EPA 542-F-96-025)

Guía del ciudadano: Atenuación natural
(EPA 542-F-96-026)

Guía del ciudadano: Muros do tratamiento
(EPA 542-F-96-027)

Estas guías forman parte de una serie producida por el Programa *Superfund* de la EPA (Organismo para la Protección del Medio Ambiente en español). El *Superfund* es líder en el desarrollo de nuevas tecnologías para responder a las necesidades de descontaminación a nivel nacional en forma rápida y eficiente. Es compromiso de la EPA llevar a la población un mejor entendimiento de los medios de limpieza ambiental y de las nuevas técnicas disponibles para este fin.

producidas por
Organismo para la Protección del Medio Ambiente (Estados Unidos)
Oficina de Innovación Tecnológica
Oficina de Desechos Sólidos y Respuesta de Emergencia
Washington, DC 20460

Questions about Innovative Technologies for Clean-up at Contaminated Sites?

Get Answers

For free copies of *Citizens' Guides*

Write:
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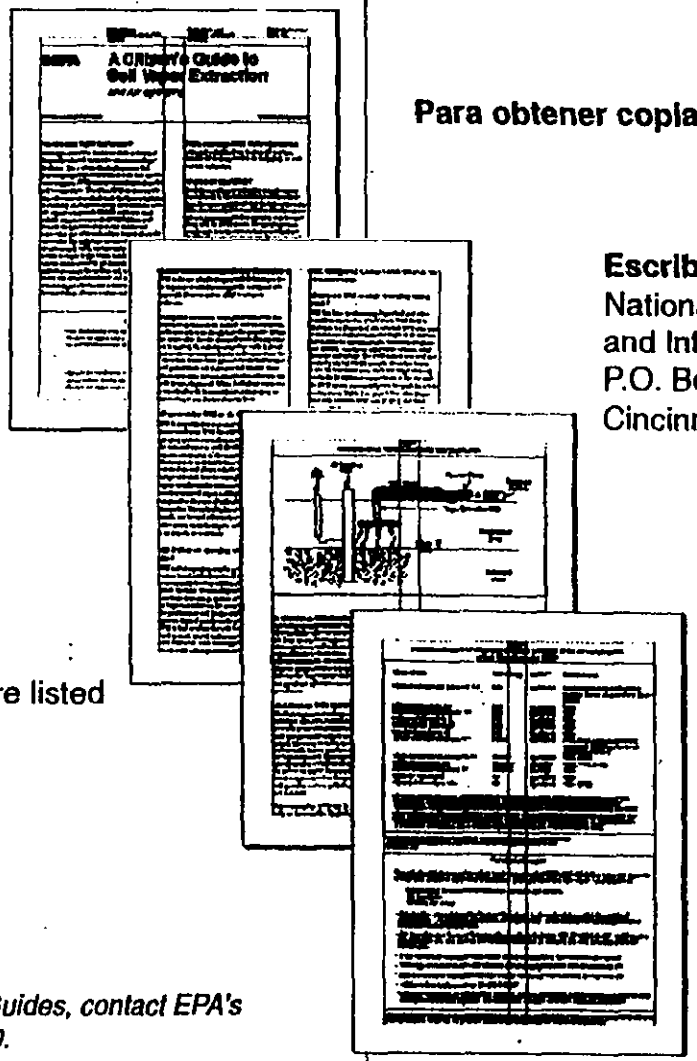
(513) 489-8695

Publication titles and order numbers are listed on the reverse of this page.

For more information on any of the Citizens' Guides, contact EPA's Technology Innovation Office at 703-603-9910.



¿Dudas en cuanto al uso de las técnicas innovadoras para el tratamiento de sitios contaminados?

He aquí la respuesta

Para obtener copias gratis de las *Guías del ciudadano*

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Los títulos de las publicaciones y los números para solicitarlas se enlistan al reverso de este folleto.

Para mayor información en cuanto a las Guías del ciudadano, llame a la Oficina de Innovación Technológica de la EPA (Organismo para la Protección del Medio Ambiente en español) al 703-603-9910.

The Latest Information on Cleanup Technologies is Here!

The Federal Remediation Technologies Roundtable (FRTR), in a cooperative effort led by the U.S. Army Environmental Center, has updated its comprehensive guide to environmental cleanup technologies. The *Remediation Technologies Screening Matrix and Reference Guide, 3rd Edition* provides critical information on commercially available, alternative treatment technologies — and combines the best features of many Environmental Protection Agency, Department of Defense and Department of Energy publications.

Access the Guide at http://www.frtr.gov

Web Links

Available only on the World Wide Web, the Guide offers "links" to more than 230 government and corporate Websites. Its Reference List of technology information sources includes more than 1,200 reports — many with links to electronic copies! The number of links will increase as the Guide is updated periodically.

For More Information

Check out the 3rd Edition of the Remediation Technologies Screening Matrix and Reference Guide today! Visit www.frtr.gov.

For more information, contact any of these FRTR member agencies:

U.S. Army Environmental Center
USAEC Environmental Hotline: 1-800-USA-3845
E-mail: t2hotline@aec.apgea.army.mil
Website: aec-www.apgea.army.mil:8080

U.S. Army Corps of Engineers
Missouri River District
HTRW: 402-697-2556
Website:
www.mrd.usace.army.mil/mrded-h/mrded-h.html

Naval Facilities Engineering Service Center
NFESC Hotline: 1-888-484-3372
E-mail: help@nfesc.navy.mil
Website: www.nfesc.navy.mil

Air Force Center for Environmental Excellence
Website: www.afcee.brooks.af.mil

EPA Technology Innovation Office
TIO: 703-603-9910
Website: www.clu-in.com

EPA National Risk Management Reduction Laboratory
NRMRL: 513-569-7562
Website: www.epa.gov/ORD/NRMRL/

Department of Energy
EM Hotline: 1-800-736-3282
Website: www.em.doe.gov

U.S. Geological Survey
USGS: 703-648-4000
Website: www.usgs.gov

The Federal Remediation Technologies Roundtable announces the release of the

Remediation Technologies Screening Matrix and Reference Guide, 3rd Edition

at

WWW.FRTR.GOV

Contaminant and Technology Perspectives

Learn More about Contaminant Classes!

What are the most common chemicals found on contaminated sites? The Guide's Contaminant Perspectives section describes eight classes of chemical contaminants:

- Halogenated Volatile Organic Compounds
- Nonhalogenated Volatile Organic Compounds
- Halogenated Semivolatile Organic Compounds
- Nonhalogenated Semivolatile Organic Compounds
- Fuels (Petroleum, Oils, and Lubricants)
- Inorganics
- Radionuclides
- Explosives

Descriptions include properties and behaviors of each contaminant group, typical contaminants in each group, common available treatment technologies, typical treatment trains, and an abbreviated contaminant screening matrix. Each matrix highlights the development status, use rating, cleanup time, applicability rating and treatment function.

Three primary strategies that may be used separately or as components of a remediation treatment train include: destruction or alteration of contaminants; extraction or separation from environmental media; and immobilization of contaminants.

Treatment Technologies Screening Matrix

Screen for Available Treatment Technologies!

The Treatment Technologies Screening Matrix is the Guide's "focal point," providing information summaries and relative rating codes to help remediation specialists compare technologies. The Matrix's 64 treatment technologies are separated into 15 technology groups. Rating codes — developed by technology experts from FRTR member agencies — cover these key data points:

- Development Status
- Residuals Produced
- Treatment Train Indicator
- O&M or Capital Intensive
- Availability
- System Reliability/Maintainability
- Cleanup Time
- Overall Cost
- Chemical Class

The Treatment Technologies Screening Matrix is also available as a wall poster.

Technology Profiles

The Latest on Proven and Innovative Technologies!

The Technology Profiles include basic information linked to multiple Websites that contain detailed product descriptions. Grouped into 64 technology categories — and more than 200 technology variations — the profiled technologies range from conventional (such as incineration) to innovative (like phytoremediation). Each profile contains:

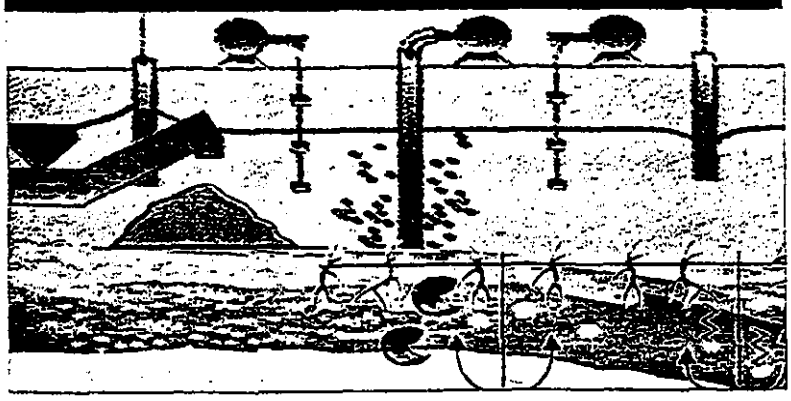
- Technology Description
- Synonyms and DSERTS Code
- Typical Process Diagram
- Applicability Discussion
- Limitations Listing
- Data Needs/Requirements
- Performance Data
- Cost Information
- References
- Site Information
- Points of Contact
- Vendor Listing from EPA's VISITT
- Links to Health and Safety Reports

Innovative Treatment Technologies Short Course

THE CERCLA EDUCATION CENTER

The CERCLA Education Center (CEC) is a unique training forum implemented by the U.S. Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response (OSWER) Technology Innovation Office (TIO). CEC courses have been developed cooperatively by TIO, the Office of Emergency and Remedial Response (OERR), the Office of Acquisition Management (OAM), the Office of Enforcement and Compliance Assurance (OECA), and the Office of Research and Development (ORD). The CEC's structured curriculum, designed for EPA hazardous waste site managers and other environmental professionals, enables participants to schedule training that is of particular interest to them and most appropriate for their projects and workload.

COURSE DESCRIPTION



The CEC is pleased to offer the *Innovative Treatment Technologies Short Course*, one of several advanced courses designed to meet the needs of experienced remedial project managers (RPM), on-scene coordinators (OSC), site assessment managers (SAM), and other environmental professionals. This one-day course provides a comprehensive overview of a number of innovative technologies, including: bioremediation (various types), soil vapor extraction enhancements, thermal desorption, soil washing, air sparging, passive treatment walls, base-catalyzed dechlorination, surfactant flushing, and thermally enhanced extraction. Instructors experienced in using innovative treatment technologies provide participants with a description and review of the operating principles and discuss the advantages and limitations of each technology. Instructors also discuss practical considerations related to the selection of innovative technologies and provide cost and performance data.

Participants receive a comprehensive manual and numerous publications and handouts on innovative treatment technologies, as well as diskette copies of computer databases that aid in decision making and a comprehensive list of reference materials used in developing the short course.

AUDIENCE

There are no tuition costs for this course, which is intended only for personnel of federal, state, and local agencies and tribes. This advanced course is designed to provide an interactive learning experience for EPA site managers who have a minimum of one year of experience in the Superfund program. Other participants from EPA, other federal agencies, and state agencies should have a minimum of three years experience in a hazardous waste program.

CONDENSED OUTLINE ▼

The registered participants are surveyed in advance to determine which technologies are of the greatest interest. The technologies they choose are presented during the course; however, participants receive manuals containing information on all of the technologies.

I. Introduction
II. Treatability and Procurement Overview
III. Thermal, Physical, and Chemical Technologies
   A. Introduction
   B. Thermal Desorption
   C. Soil Vapor Extraction (SVE) with Enhancements
   D. Vitrification
   E. Soil Flushing and Surfactant Enhancements
   F. Soil Washing
   G. Solvent Extraction
   H. Dechlorination: Base-Catalyzed Decomposition
   I. Electrokinetic Remediation
   J. Passive Treatment Walls
IV. Bioremediation
   A. Introduction
   B. Solid-Phase
   C. White Rot Fungus
   D. Slurry-Phase
   E. Bioventing and Bioslurping
   F. Enhanced *In Situ* Groundwater
   G. Phytoremediation
V. Monitored Natural Attenuation
VI. Sources for Innovative Treatment Technology Information

REGISTRATION ▼

INNOVATIVE TREATMENT TECHNOLOGIES SHORT COURSE

The next scheduled delivery date is [INSERT DATE]. Please complete the following information if you would like to register.

Name: _____

Organization/Agency: _____ Mail Code: _____

Address: _____

E-Mail Address: _____ @ _____

Telephone: _____ Fax: _____

Job Title: ❑ OSC ❑ RPM ❑ SAM ❑ CIC Other (specify): _____

Number of Years of Superfund Experience (if applicable): _____

Supervisor's Name: _____ Telephone: _____

Mail To: CERCLA Education Center
Technology Innovation Office
U.S. EPA (5102G)
401 M Street, SW
Washington, DC 20460

Fax To: (301) 589-8487

OR

E-Mail To: register@emsus.com

For more information about the CEC or this course, please call (703) 603-9910

Innovative Treatment Technologies Course

THE CERCLA EDUCATION CENTER

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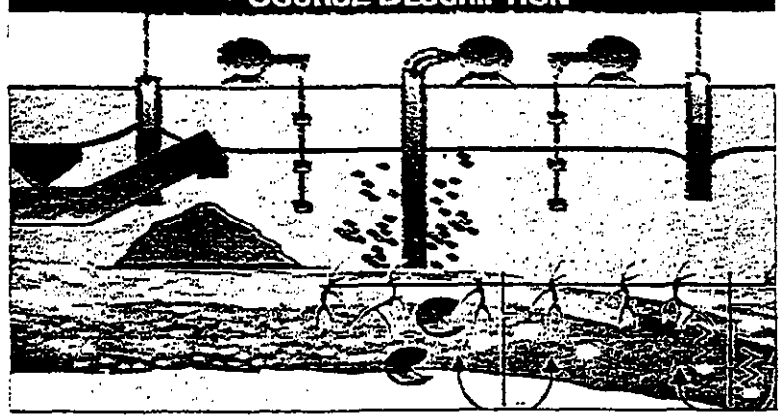

The CEC is pleased to offer the *Innovative Treatment Technologies Course*, a three-day course that provides in-depth information about technical, financial, and practical considerations for several technologies. The information, taught by experienced scientists and EPA site managers, will assist participants in determining when an innovative treatment technology might be appropriate for a cleanup action. Participants also receive up-to-date information about resources that will help them consider, select, and implement innovative treatment technologies—including specific information about access to and use of several computerized information management systems.

Participants receive a manual, numerous publications, and handouts on innovative treatment technologies. The course addresses such topics as treatability studies and procuring innovative treatment technologies. Throughout the course, participants work through examples and case studies that are based on Superfund sites at which innovative treatment technologies have been implemented. The course is designed to be interactive, encouraging the sharing of instructors' and participants' experiences with and knowledge of the topics covered.

AUDIENCE

There are no tuition costs for this course, which is intended only for personnel of federal, state, and local agencies and tribes. This advanced course is designed for remedial project managers (RPM), on-scene coordinators (OSC), site assessment managers (SAM), and other environmental professionals who have a minimum of one year of experience in the Superfund program.

CONDENSED OUTLINE ▼

I. Introduction
II. Treatability and Procurement Overview
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   A. Introduction
   B. Thermal Desorption
   C. Soil Vapor Extraction (SVE) with Enhancements
   D. Vitrification
   E. Soil Flushing and Surfactant Enhancements
   F. Soil Washing
   G. Solvent Extraction
   H. Dechlorination: Base-Catalyzed Decomposition
   I. Electrokinetic Remediation
   J. Passive Treatment Walls
IV. Bioremediation
   A. Introduction
   B. Solid-Phase
   C. White Rot Fungus
   D. Slurry-Phase
   E. Bioventing and Bioslurping
   F. Enhanced *In Situ* Groundwater
   G. Phytoremediation
V. Monitored Natural Attenuation
VI. Sources for Innovative Treatment Technology Information

REGISTRATION ▼

INNOVATIVE TREATMENT TECHNOLOGIES COURSE

The next scheduled delivery date is October 27-29, 1998 in Denver, CO. Please complete the following information if you would like to register.

Date and location of course you would like to attend: _____

Name: _____

Organization/Agency: _____ Mail Code: _____

Address: _____

E-Mail Address: _____ @ _____

Telephone: _____ Fax: _____

Job Title: ❑ OSC ❑ RPM ❑ SAM ❑ CIC Other (specify): _____

Number of Years of Superfund Experience (if applicable): _____

Supervisor's Name: _____ Telephone: _____

Mail To: CERCLA Education Center
Technology Innovation Office
U.S. EPA (5102G)
401 M Street, SW
Washington, DC 20460

Fax To: (301) 589-8487

OR

E-Mail To: register@emsus.com

For more information about the CEC or this course, please call (703) 603-9910

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Expediting Cleanup Through Contingent Removal Actions

Office of Environmental Management
Office of Environment, Safety & Health

March 1997

This guidance is primarily intended for personnel with line management responsibility for Department of Energy (DOE) environmental restoration projects conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). It provides a concise description of the components and application of contingent removal actions to streamline remediation of recurrent site problems. "Contingent Removal" is a DOE-specific term consistent with the removal action process as defined in the National Contingency Plan (NCP), 40 CFR 300. Additional written guidance is available in DOE's *Phased Response/Early Action Guidance*, Module 2 (DOE/EH-0256, November 1995).

Although a number of DOE's waste sites are sufficiently complex and unique to warrant extensive pre-response characterization, many do not. In fact, the time and costs to evaluate waste sites and document individual response actions can be reduced significantly by focusing on the similarities between sites, and constructing a pre-determined set of responses based on those similarities. This concept of utilizing similarities between sites to streamline remedial planning and implementation is embodied in EPA's presumptive remedy policy (OSWER Fact Sheet 9355.[illegible]-[illegible]FS, September, 1993, EPA 540-F-93-047) and serves as the basis for implementing generic approaches[1].

Analogous to this concept of pre-determined responses, the contingent removal action approach is designed to address anticipated recurrent site problems more efficiently and consistently. Contingent removal actions are intended to streamline the remediation process by establishing a standardized, pre-approved response strategy (e.g., excavate and dispose off-site in a permitted cell) for a site-specifically defined condition (e.g., thorium hot spots above *x* pCi/g in the top *y* inches of soil) thus reducing approval and documentation delays and expediting response.

Developing Contingent Removal Actions

Close coordination and teamwork between DOE, EPA, and State RPMs is essential to the development of a contingent removal approach. This "core" team, with assistance from the extended project team (e.g., support contractors and technical experts assisting in the scoping and implementation of the project) must reach consensus on:

- Appropriate site problems for contingent removals
- Appropriate criteria to trigger removals
- Removal implementation procedures
- Strategy for integrating contingent removals into the overall site remediation strategy

[1] Generic approaches are facility specific remedial strategies which use the knowledge gained from previous experience at waste sites within a facility to serve as the basis and justification for subsequent responses at similar sites in that facility.

Without this common understanding and consensus, response times will be lengthened, negating potential gains from the up-front planning which characterizes this approach.

This approach is potentially applicable to a range of problem types (e.g., soil hot spots, buried drums/tanks) varying in potential scope and scale of cleanup (i.e., volumes of materials addressed). However, as with any innovative approach, the core team may want to limit initial application to problem types where response action logistics currently fit within existing constraints (e.g., necessary equipment and personnel are available on-site). As experience is gained, broader application involving additional resources (i.e., placement of new contracts) can be pursued.

Step One: Identify Appropriate Site Problems for Contingent Removals

The core team should use their site conceptual model developed during the scoping phase to identify specific types of problems amenable to a contingent removal action approach. Factors to consider when evaluating candidates for contingent removals are discussed below:

- Frequency of problem type: The greatest potential savings from this approach will be directly correlated with the frequency in which conditions triggering the agreed to response are encountered (i.e., economies of scale increase each time a problem is more efficiently addressed through a contingent removal).
- Cost of taking action: Any fiscal constraints on the scope of a contingent removal should be identified (e.g., conducting a removal(s) will not exceed $X00,000 within the fiscal year or impede progress on other projects currently scheduled or ongoing and funded under the existing baseline).
- Health and safety issues: Any health and safety concerns with implementing a pre-approved response strategy to ensure protection for workers must be identified and resolved (e.g., necessary H&S personnel are available and an adequate H&S plan is currently in place to address the problem).

- Availability of technology and waste management capability: Necessary equipment, waste management facilities, and regulatory approvals (e.g., permits) must be available to provide a reasonable assurance of success (e.g., workers trained in emergency response are on-site and compliant storage capacity is available for approximately X,000 yd^3 of material).

Step Two: Establish Criteria For Triggering Action

Once the core team agrees on which types of site problems will be addressed through contingent removals, facility specific criteria to trigger action (and also delineate the boundaries of the response) must be established. To ensure resources are being expended on substantive cleanup, *specified concentration or dose levels to trigger response should be set where there is a clear potential for risk.* Setting trigger levels at concentrations for which an action is clearly needed also allows for a more rapid response, i.e., sites with concentrations below the trigger levels can then be assessed on a separate (slower) track to determine whether a no-further-action finding is appropriate, or whether additional data are needed to determine if a response is required.

[NOTE: Establishing facility-specific trigger levels as part of a contingent removal approach does not limit in any way the agencies' authority to initiate a removal action whenever they determine it is appropriate to do so (e.g., threat of hazardous substance release, threat of fire and / or explosion, etc).]

Potential sources for trigger levels include: 1) regulatory standards, 2) risk-based methodologies, equations, or guidelines, or 3) exposure levels exceeding health and safety requirements in DOE Orders[2]. Use of trigger levels is conceptually consistent with the use of action levels[3] in the RCRA corrective action program.

Step Three: Establish Removal/Implementation Procedures

Once the core team designates a type of site problem as a candidate for a contingent removal action (i.e., trigger criteria have been met), specific implementation procedures must be developed. Decision rules (see Highlight 1) are useful for linking the site problem, the criteria used to trigger response, and the implementing procedures to effectively communicate the basis for action to the public and the remedial contractor performing the work. Factors to consider when establishing implementation procedures include:

- Responsibilities and authorities: The core team needs to agree on which organizations will conduct the action to expedite field mobilization and avoid delays.
- Contracting mechanisms: Proposed contracting mechanisms to conduct the removals should be reviewed to avoid unforeseen delays and accelerate the start of field activities (e.g., no procurement is required due to available on-site equipment and labor force).
- Monitoring strategy for terminating a removal: A monitoring plan indicating when action may stop (e.g. all soils above *x* pCi/g have been removed) or scope limits have been reached should be established before actual excavation begins.
- Generic design and technical procedures: Use of existing procedures, plans, and design documentation (e.g., protocols for using radiological detection instruments) should be emphasized to streamline design and conserve resources.

HIGHLIGHT 1: Example Decision Rules to Communicate Facility-Specific Basis for Action

If thorium is found above *x* pCi/g in the top *y* inches of soil in any 100 ft^2 area measured using the Soil Screening Facility Methodology, and the total estimated volume is less than 100 yd^3, then that volume will be excavated using onsite personnel and equipment, and stored in disposal boxes until offsite waste acceptance criteria can be verified.

If concentrations of TCE in any off-site monitoring well exceed twice the maximum contaminant level in two consecutive quarterly samples, then alternative drinking water will be supplied to local residents using potable groundwater supplies within an *x* mile radius of the monitoring well.

Step Four: Integrate Contingent Removal Actions Into Overall Site Remediation Strategy

The objective of an effective site remediation strategy is to determine which site problems are best addressed through either removal or remedial action and optimize the sequence and timing of those actions. Therefore, once a contingent removal action approach has been proposed and the public has had an opportunity to comment, it needs to be integrated into the overall site remediation strategy (e.g., incorporated into the existing Federal Facility Agreement). Thus, each time a situation is encountered which meets the trigger criteria, a response can be implemented immediately. Each time a response is initiated, the agencies should prepare an information brief to communicate to the public what remediation has been (or is being) conducted to keep them informed of the progress being made.

Please refer any questions concerning this material to:

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[2] DOE Orders are internal established requirements for which full compliance is mandated for all affected activities, including CERCLA remedial and removal actions.

[3] Corrective action for releases from solid waste management units at hazardous waste management facilities; Proposed rule 61 FR 19432, May 1, 1996

References for Final Remedy Selection

Module References

! RCRA Corrective Action Decision Documents: the Statement of Basis and Response to Comments (Part of: Public Participation in RCRA Corrective Action Under Permits and Section 3008(h) Orders), Directive No. 9902.6, April 29, 1991. Available over the Internet: http://www.epa.gov/epaoswer/hazwaste/permit/pubpart/chp_4.pdf

! Land Use in the CERCLA Remedy Selection Process, OSWER Directive No. 9355-7.04, May 25, 1995.

! RCRA Corrective Action Plan, May 1994 (EPA 520-R-94-004, OSWER Directive No. 9902.3-2A). Available to order via NCEIP. Fax order to 703/321-8547.

Supplemental References and Resources

! Institutional Controls: A Reference Manual, US EPA Workgroup on Institutional Controls, Draft, March 1998.

! Remediation Technologies Screening Matrix and Reference Guide, Third Edition, Federal Remediation Technologies Roundtable, http://www.frtr.gov/matrix2

! Remediation Case Studies: Fact Sheet and Order Form, EPA542-F-98-023, Federal Remediation Technologies Roundtable, Searchable database of case studies at http://www.frtr.gov

! EPA Remediation Characterization Innovative Technologies (EPA REACHIT) Fact Sheet, USEPA, 1998, On-line database at http://www.epareachit.com

! Innovative Treatment Technologies (Short) Course. Offered through the CERCLA Education Center Technology Innovation Office. For more information call 703/603-9910.

! Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Advanced Notice for Proposed Rulemaking (ANPR) May 1, 1996 (61 FR 19432). Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm

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! Best Management Practices for Soil Treatment Technologies, May 1997 Available for download from the Internet at: http://www.epa.gov/epaoswer/hazwaste/ca/index.htm#p&g

! OSW Waste Cleanup Website: http://www.epa.gov/epaoswer/osw/cleanup.htm

! RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction

! List of Web Sites Related to Remediation Technologies: http://www.clu-in.com/resourc1.htm

! Environmental Technology Verification Program Web Site: http://www.epa.gov/etv

! Remedy Selection, Implementation, and Performance Monitoring

! Remedy selection guidance, policies, and matrices

! RCRA Hotline Phone Number - (800) 424-9346

REMEDY COMPLETION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 24 1996

available at www.epa.gov/swerffrr/doc/924memo.htm

MEMORANDUM

SUBJECT: Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities

FROM: Steven A. Herman
Assistant Administrator
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Elliott P. Laws
Assistant Administrator
Office of Solid Waste and Emergency Response

TO: RCRA/CERCLA National Policy Managers
Regions I-X

Good RCRA/CERCLA coordination has become increasingly important as our offices have reorganized and programs have assumed new organizational relationships. We believe that, in general, coordination of site cleanup activities among EPA RCRA, EPA CERCLA and state/tribal cleanup programs has improved greatly; however, we are aware of examples of some remaining coordination difficulties. In this memo, we discuss three areas: acceptance of decisions made by other remedial programs; deferral of activities and coordination among EPA RCRA, EPA CERCLA and state/tribal cleanup programs; and coordination of the specific standards and administrative requirements for closure of RCRA regulated units with other cleanup activities. We also announce a revision to the Agency's policy on the use of fate and transport calculations to meet the "clean closure" performance standard under RCRA. We hope the guidance offered here will assist in your continuing efforts to eliminate duplication of effort, streamline cleanup processes, and build effective relationships with the states and tribes.

This memorandum focuses on coordination between CERCLA and RCRA cleanup programs; however, we believe the approaches outlined here are also applicable to coordination between either of these programs and certain state or tribal cleanup programs that meet appropriate criteria. For example, over half of the states have "Superfund-like"

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authorities. In some cases, these state authorities are substantially equivalent in scope and effect to the federal CERCLA program and to the state or federal RCRA corrective action program. In accordance with the 1984 Indian Policy, EPA recognizes tribes as sovereign nations, and will work with them on a government-to-government basis when coordinating cleanup efforts on lands under tribal jurisdiction.

In addition to the guidance provided in this memorandum, two other on-going initiatives address coordination of RCRA and CERCLA. First, EPA is currently coordinating an inter-agency and state "Lead Regulator Workgroup." This workgroup intends to provide guidance where overlapping cleanup authorities apply at federal facilities that identifies options for coordinating oversight and deferring cleanup from one program to another. We intend for today's memorandum and the pending guidance from the Lead Regulator Workgroup to work in concert to improve RCRA/CERCLA integration and coordination. Second, EPA has also requested comment on RCRA/CERCLA integration issues in the May 1, 1996 Advanced Notice of Proposed Rulemaking--Corrective Action for Releases From Solid Waste Management Units at Hazardous Waste Management Facilities (61 FR 19432; commonly referred to as the RCRA "Subpart S" ANPR). We intend to coordinate all of these efforts as we develop further policy on integration issues.

Acceptance of Decisions Made by Other Remedial Programs

Generally, cleanups under RCRA corrective action or CERCLA will substantively satisfy the requirements of both programs.[1] We believe that, in most situations, EPA RCRA and CERCLA site managers can defer cleanup activities for all or part of a site from one program to another with the expectation that no further cleanup will be required under the deferring program. For example, when investigations or studies have been completed under one program, there should be no need to review or repeat those investigations or studies under another program. Similarly, a remedy that is acceptable under one program should be presumed to meet the standards of the other.

It has been our experience that, given the level of site-specific decision-making required for cleaning up sites, differences among the implementation approaches of the various remedial programs primarily reflect differences in professional judgement rather than structural inconsistencies in the programs themselves. Where there are differences in approaches among remedial programs, but not in their fundamental purposes or objectives (e.g., differences in analytical QA/QC procedures), these differences should not necessarily

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[1] In a few, limited cases, program differences may be sufficiently great to prevent deferral to the other program (e.g., the inability of CERCLA to address petroleum releases or RCRA to address certain radioactive materials). In these instances we encourage remedial programs to coordinate closely with each other to minimize duplication of effort, including oversight.

prevent deferral. We encourage program implementors to focus on whether the end results of the remedial activities are substantively similar when making deferral decisions and to make every effort to resolve differences in professional judgement to avoid imposing two regulatory programs.

We are committed to the principle of parity between the RCRA corrective action and CERCLA programs and to the idea that the programs should yield similar remedies in similar circumstances. To further this goal, we have developed and continue to develop a number of joint (RCRA/CERCLA) guidance documents. For example, the several "Presumptive Remedies," which are preferred technologies for common categories of sites, and the Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration (OSWER Directive 9234.2-25, September 1993), which recognizes the impracticability of achieving groundwater restoration at certain sites, are applicable to both RCRA and CERCLA cleanups. For more information on the concept of parity between the RCRA and CERCLA programs see: 54 FR 41000, esp. 41006-41009 (October 4, 1989), RCRA deferral policy; 54 FR 10520 (March 13, 1989), National Priorities List for Uncontrolled Hazardous Waste Sites Listing Policy for Federal Facilities; 55 FR, 30798, esp. 30852-30853 (July 27, 1990), Proposed Rule for Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; 60 FR 14641 (March 20, 1995), Deletion Policy for RCRA Facilities; and, 61 FR 19432 (May 1, 1996), Corrective Action for Releases From Solid Waste Management Units at Hazardous Waste Management Facilities, Advanced Notice of Proposed Rulemaking.

Program Deferral

The concept of deferral from one program to another is already in general use at EPA. For example, it has long been EPA's policy to defer facilities that may be eligible for inclusion on the National Priorities List (NPL) to the RCRA program if they are subject to RCRA corrective action (unless they fall within certain exceptions, such as federal facilities). Recently, EPA expanded on this policy by issuing criteria for deleting sites that are on the NPL and deferring their cleanup to RCRA corrective action (attached).[2] When a site is deleted from the NPL and deferred to RCRA, problems of jurisdictional overlap and duplication of effort are eliminated, because the site will be handled solely under RCRA authority. Corrective action permits or orders should address all releases at a CERCLA site being deferred to RCRA; some RCRA permits or orders may need to be modified to address all releases before a site is deleted from the NPL.

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[2] Currently, the RCRA deletion policy does not pertain to federal facilities, even if such facilities are also subject to Subtitle C of RCRA. Site Managers are encouraged to use interagency agreements to eliminate duplication of effort at federal facilities; the Lead Regulator Workgroup intends to provide additional guidance on coordinating oversight and deferring cleanup from one program to another at federal facilities.

While EPA's general policy is for facilities subject to both CERCLA and RCRA to be cleaned up under RCRA, in some cases, it may be more appropriate for the federal CERCLA program or a state/tribal "Superfund-like" cleanup program to take the lead. In these cases, the RCRA permit/order should defer corrective action at all of the facility to CERCLA or a state/tribal cleanup program. For example, where program priorities differ, and a cleanup under CERCLA has already been completed or is underway at a RCRA facility, corrective action conditions in the RCRA permit/order could state that the existence of a CERCLA action makes separate RCRA action unnecessary. In this case, there would be no need for the RCRA program to revisit the remedy at some later point in time. Where the CERCLA program has already selected a remedy, the RCRA permit could cite the CERCLA decision document (e.g., ROD), but would not necessarily have to incorporate that document by reference. RCRA permits/orders can also defer corrective action in a similar way for cleanups undertaken under state/tribal programs provided the state/tribal action protects human health and the environment to a degree at least equivalent to that required under the RCRA program.

Superfund policy on deferral of CERCLA sites for listing on the NPL while states and tribes oversee response actions is detailed in the May 3, 1995 OSWER Directive 9375.6-11 ("Guidance on Deferral of NPL Listing Determinations While States Oversee Response Actions"). The intent of this policy is to accelerate the rate of response actions by encouraging a greater state or tribal role, while maintaining protective cleanups and ensuring full public participation in the decision-making process. Once a deferral response is complete, EPA will remove the site from CERCLIS and will not consider the site for the NPL unless the Agency receives new information of a release or potential release that poses a significant threat to human health or the environment. The state and tribal deferral policy is available for sites not listed on the NPL; deferral of final NPL sites must be addressed under the Agency's deletion policy, as described above.

Coordination Between Programs

While deferral from one program to another is typically the most efficient and desirable way to address overlapping cleanup requirements, in some cases, full deferral will not be appropriate and coordination between programs will be required. The goal of any approach to coordination of remedial requirements should be to avoid duplication of effort (including oversight) and second-guessing of remedial decisions. We encourage you to be creative and focus on the most efficient path to the desired environmental result as you craft strategies for coordination of cleanup requirements under RCRA and CERCLA and between federal and state/tribal cleanup programs.

Several approaches for coordination between programs at facilities subject to both RCRA and CERCLA are currently in use. It is important to note that options for coordination at federal facilities subject to CERCLA §120 may differ from those at non-federal facilities

because of certain prescriptive requirements under §120. EPA anticipates issuing further guidance on coordination options specific to federal facilities through the interagency Lead Regulator Workgroup. Current approaches that are in use include:

Craft CERCLA or RCRA decision documents so that cleanup responsibilities are divided. CERCLA and RCRA decision documents do not have to require that the entire facility be cleaned up under one or the other program. For example, at some facilities being cleaned up under CERCLA, the RCRA units (regulated or solid waste) are physically distinct and could be addressed under RCRA. In these cases, the CERCLA decision documents can focus CERCLA activities on certain units or areas, and designate others for action under RCRA. When units or areas are deferred from CERCLA to RCRA, the CERCLA program should include a statement (e.g., in a ROD or memorandum submitted to the administrative record) that successful completion of these activities would eliminate the need for further cleanup under CERCLA at those units and minimal review would be necessary to delete the site from the NPL. Similarly, when units or areas are deferred from RCRA to CERCLA, RCRA permits or orders can reference the CERCLA cleanup process and state that complying with the terms of the CERCLA requirements would satisfy the requirements of RCRA.

Establish timing sequences in RCRA and CERCLA decision documents. RCRA and CERCLA decision documents can establish schedules according to which the requirements for cleanup at all or part of a facility under one authority would be determined only after completion of an action under the other authority. For example, RCRA permits/orders can establish schedules of compliance which allow decisions as to whether corrective action is required to be made after completion of a CERCLA cleanup or a cleanup under a state/tribal authority. After the state or CERCLA response is carried out, there should be no need for further cleanup under RCRA and the RCRA permit/order could simply make that finding. Similarly, CERCLA or state/tribal cleanup program decision documents could delay review of units or areas that are being addressed under RCRA, with the expectation that no additional cleanup will need to be undertaken pending successful completion of the RCRA activities, although CERCLA would have to go through the administrative step of deleting the site from the NPL.

A disadvantage of this approach is that it contemplates subsequent review of cleanup by the deferring program and creates uncertainty by raising the possibility that a second round of cleanup may be necessary. Therefore, we recommend that program implementers look first to approaches that divide responsibilities, as described above. A timing approach, however, may be most appropriate in certain circumstances, for example, where two different regulatory agencies are involved. Whenever a timing approach is used, the final review by the deferring program will generally be very

streamlined. In conducting this review, there should be a strong presumption that the cleanup under the other program is adequate and that reconsidering the remedy should rarely be necessary.

The examples included in this memo demonstrate several possible approaches to deferring action from one cleanup program to another. For example, under RCRA, situations are described where the RCRA corrective action program would make a finding that no action is required under RCRA because the hazard is already being addressed under the CERCLA program, which EPA believes affords equivalent protection. In other examples, the RCRA program defers not to the CERCLA program per se, but either defers to a particular CERCLA ROD or actually incorporates such ROD by reference into a RCRA permit or order. In addition, there are examples where the Agency commits to revisit a deferral decision once the activity to which RCRA action is being deferred is completed; in other situations, reevaluation is not contemplated. As discussed in this memorandum, no single approach is recommended, because the decision of whether to defer action under one program to another and how to structure such a deferral is highly dependant on site-specific and community circumstances. In addition, the type of deferral chosen may raise issues concerning, for example, the type of supporting documentation that should be included in the administrative record for the decision, as well as issues concerning availability and scope of administrative and judicial review.

Agreements on coordination of cleanup programs should be fashioned to prevent revisiting of decisions and should be clearly incorporated and cross-referenced into existing or new agreements, permits or orders. We recognize that this up-front coordination requires significant resources. Our expectation is that, over the long-term, duplicative Agency oversight will be reduced and cleanup efficiency will be enhanced.

RCRA Closure and Post-Closure

Some of the most significant RCRA/CERCLA integration issues are associated with coordination of requirements for closure of RCRA regulated units[3] with other cleanup activities. Currently, there are regulatory distinctions between requirements for closure of RCRA regulated units and other cleanup requirements (e.g., RCRA corrective action requirements). RCRA regulated units are subject to specific standards for operation, characterization of releases, ground water corrective action and closure. Coordination of these standards with other remedial activities can be challenging. In the November 8, 1994 proposed Post-Closure Rule (59 FR 55778), EPA requested comment on an approach that

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[3] In this document, the term "regulated unit" refers to any surface impoundment, waste pile, land treatment unit or landfill that receives (or has received) hazardous waste after July 26, 1982 or that certified closure after January 26, 1983.

would reduce or eliminate the regulatory distinction between cleanup of releases from closed or closing regulated units and cleanup of non-regulated unit releases under RCRA corrective action. The Office of Solid Waste will address this issue further in the final Post-Closure and Subpart S rules.

At the present time, however, the dual regulatory structure for RCRA closure and other cleanup activities remains in place. There are several approaches program implementors can use to reduce inconsistency and duplication of effort when implementing RCRA closure requirements during CERCLA cleanups or RCRA corrective actions. These approaches are analogous to the options discussed above for coordination between cleanup programs. For example, a clean-up plan for a CERCLA operable unit that physically encompasses a RCRA regulated unit could be structured to provide for concurrent compliance with CERCLA and the RCRA closure and post-closure requirements. In this example, the RCRA permit/order could cite the ongoing CERCLA cleanup, and incorporate the CERCLA requirements by reference. RCRA public participation requirements would have to be met for the permit/order to be issued; however, at many sites it may be possible to use a single process to meet this need under RCRA and CERCLA.

At some sites, inconsistent cleanup levels have been applied for removal and decontamination ("clean closure") of regulated units and for site-wide remediation under CERCLA or RCRA corrective action. Where this has happened, clean closure levels have been generally set at background levels while, at the same site, cleanup levels have been at higher, risk-based concentrations. To avoid this inconsistency and to better coordinate between different regulatory programs, we encourage you to use risk-based levels when developing clean-closure standards. The Agency has previously presented its position on the use of background and risk-based levels as clean closure standards (52 FR 8704-8709, March 19, 1987; attached). This notice states that clean closure levels are to be based on health-based levels approved by the Agency. If no Agency-approved level exists, then background concentrations may be used or a site owner may submit sufficient data on toxicity to allow EPA to determine what the health-based level should be.

EPA continues to believe, as stated in the March 19,1987 notice, that risk-based approaches are protective and appropriate for clean-closure determinations. In EPA's view, a regulatory agency could reasonably conclude that a regulated unit was clean-closed under RCRA if it was cleaned up under Superfund, RCRA corrective action, or certain state/tribal cleanup programs to the performance standard for clean closure. This performance standard can be met with the use of risk-based levels. RCRA units that did not achieve the closure performance standard under a cleanup would remain subject to RCRA capping and post-closure care requirements.

The 1987 federal register notice described EPA's policy that the use of fate and transport models to establish risk levels would be inappropriate for clean closure determinations. This discussion, however, also included the statement that, after additional experience with clean closures, "the Agency may decide that a less stringent approach is

sufficiently reliable to assure that closures based on such analyses are fully protective of human health and the environment." After nine years of further experience, EPA believes that, consistent with the use of risk-based standards in its remedial programs, use of fate and transport models to establish risk levels can be appropriate to establish clean closure determinations. EPA today announces that it is changing its 1987 policy on evaluating clean closure under RCRA to allow use of fate and transport models to support clean closure demonstrations. EPA intends to publish this change in the Federal Register in the near future.

We encourage you to consider risk-based approaches when developing cleanup levels for RCRA regulated units and to give consideration to levels set by state/tribal programs which use risk-based approaches. EPA is developing guidance on risk-based clean closure and on the use of models to meet the clean closure performance standard.

Since almost all states oversee the closure/post-closure process and more than half implement RCRA corrective action, coordination of RCRA corrective action and closure will often be solely a state issue. However, if a state is not authorized for corrective action, or if a facility is subject to CERCLA as well as RCRA corrective action, close coordination between federal and state agencies will be necessary. As discussed above, actual approaches to coordination or deferral at any site should be developed in consideration of site-specific and community concerns.

Summary

We encourage you to continue your efforts to coordinate activities between the RCRA and CERCLA programs and between state, tribal and federal cleanup programs. We are aware that several of the EPA Regions are considering developing formal mechanisms to ensure that coordination will occur among these programs. We endorse these efforts and encourage all Regions, states and tribes to consider the adoption of mechanisms or policies to ensure coordination. If you have any questions on the issues discussed in this memorandum, or on other RCRA/CERCLA issues, please call Hugh Davis at (703) 308-8633.

attachments

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 16 1998

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Risk-Based Clean Closure

FROM: Elizabeth Cotsworth, Acting Director
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TO: RCRA Senior Policy Advisors
Regions I - X

The purpose of this memorandum is to provide guidance on risk-based clean closure and to confirm that, under current regulations, RCRA regulated units may be clean closed to protective, risk-based media cleanup levels.

Closure Requirements and Regulations

Closure is the term used to describe taking a RCRA regulated unit out of service. During closure, facility owners/operators must comply with the closure performance standard at 40 CFR 264.111 or 40 CFR 265.111. According to 40 CFR 264.111 and 40 CFR 265.111, closure must be completed in a manner that (a) minimizes the need for further maintenance; (b) controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to ground or surface waters or to the atmosphere; and, (c) complies with the unit-specific closure requirements of 40 CFR Part 264 or 265. Generally, two types of closure are allowed - closure by removal or decontamination (referred to here as "clean closure") and closure with waste in place.[1]

The premise of clean closure is that all hazardous wastes have been removed from a given RCRA regulated unit and any releases at or from the unit have been remediated so that further regulatory control under RCRA Subtitle C is not necessary to protect human health and the environment. As part of meeting the closure performance standard referenced above, for clean

[1] On November 8, 1994 EPA requested comment on an approach that would reduce or eliminate the regulatory distinction between cleanup of releases from closed or closing regulated units and cleanup of releases from non-regulated units under the RCRA corrective action program. 59 FR 55778. If promulgated, this approach would essentially create a third type of closure by allowing some closing units to take advantage of the additional flexibility provided by the corrective action program. The Office of Solid Waste plans to address this issue further in the final post-closure rule.

closure, facility owners/operators must remove all wastes from the closing unit and remove or decontaminate all waste residues, contaminated containment system components, contaminated soils (including ground water and any other environmental media contaminated by releases from the closing unit), and structures and equipment contaminated with hazardous waste and hazardous waste leachate. (See, for example, 40 CFR Sections 264.178, 264.197, 264.228, 264.258 and 264.575 and corresponding interim status closure standards in 40 CFR Part 265.)

EPA's expectation is that, with the exception of landfills and most land treatment units, well designed and well operated RCRA units (i.e., units that comply with the unit-specific minimum technical requirements) will generally be clean closed. Units that are not clean closed remain subject to the requirements for post-closure care, including post-closure permitting.

Reaffirming Risk-Based Clean Closure Standards

Since 1987, EPA has interpreted the regulations governing closure by removal and the term "remove or decontaminate" to require complete removal of all hazardous waste and liners and removal or decontamination of leachate and other materials contaminated with hazardous waste or hazardous constituents to the extent necessary to protect human health and the environment. (52 FR 8704, March 19, 1987.) As the Agency explained in the 1987 notice, this interpretation means that, except for hazardous waste and liners, for clean closure, the regulations do not require one to completely remove all contamination, i.e., to background, at or from a closing unit. Rather, some limited quantity of hazardous constituents might remain in environmental media after clean closure provided they are at concentrations below levels that may pose a risk to human health and the environment. In the 1987 notice, EPA took the position that the amount of hazardous constituents that might remain in environmental media after clean closure should be identified through appropriate application of risk information either by using available constituent-specific limits or factors that had undergone Agency review (e.g., MCLs or health-based limits calculated using a verified reference dose), or, when such limits or factors were not available, by using toxicity information submitted by a facility owner/operator and approved by EPA, or by using background concentrations.

EPA continues to interpret the regulations governing closure by removal and the "remove or decontaminate" standard as described above. In addition, EPA today is providing additional guidance on identifying the amount of hazardous constituents that might remain in environmental media after clean closure.

Since the 1987 notice, EPA and the states have gained considerable experience in making protective, risk-based cleanup decisions under the RCRA corrective action and CERCLA cleanup programs. EPA's position is that the procedures and guidance generally used to develop protective, risk-based media cleanup standards for the RCRA corrective action and CERCLA cleanup programs are also appropriate to define the amount of hazardous constituents that may remain in environmental media after clean closure. In other words, site-specific, risk-based media cleanup levels developed under the RCRA corrective action and CERCLA cleanup

programs are appropriate levels at which to define clean closure.

EPA has published numerous documents offering guidance on developing site-specific, risk-based media cleanup levels. As discussed in the May 1, 1996 Advance Notice of Proposed Rulemaking for RCRA corrective action, EPA's goal continues to be to clean up sites in a manner consistent with established, protective, risk-based media cleanup levels (e.g., MCLs and many state cleanup standards) or, when such levels do not exist to clean up to protective, risk-based media cleanup levels developed for the site in question (e.g., through a site-specific risk assessment). Both approaches require a site-specific risk-based decision since established media cleanup levels are appropriate only when all exposure assumptions are consistent with site-specific conditions at the facility in question.

EPA generally considers protective media cleanup standards for human health to mean constituent concentrations that result in the total residual risk from any medium to an individual exposed over a lifetime falling within a range from 10^{-4} to 10^{-6}, with the cumulative carcinogenic risk not to exceed 10^{-4} and a preference for cleanup standards at the more protective end of the risk range. For non-carcinogenic effects, EPA generally interprets protective cleanup standards to mean constituent concentrations that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; the hazard index generally should not exceed one (1). See, e.g., the National Contingency Plan (55 FR 8666, March 8, 1990) the 1990 Subpart S Proposal (55 FR 30798, July 27, 1990), and the 1996 Subpart S ANPR (61 FR 19432, May 1, 1196). Cleanup to standards that are consistent with these risk-reduction goals (e.g., most Federally promulgated standards such as MCLs and many state cleanup standards) will generally be adequate to satisfy the closure performance standard and the "remove or decontaminate" standard.

In the March 19, 1987 notice, EPA also interpreted the regulations governing closure by removal and the "remove or decontaminate" standard to require consideration of the possibility of cross-media contamination so that, for example, facility owners/operators would have to show that remaining levels of hazardous constituents in soil would not migrate from the soil to air, surface, or ground water in excess of Agency-approved concentrations. EPA reaffirms that interpretation today. In addition, although not emphasized in the 1987 notice, EPA reminds program implementors and facility owners/operators that closures must protect both human health and the environment. During clean closure, ecological concerns may sometimes require more aggressive decontamination than might be necessary strictly to protect human health.

Clarification of Acceptability of Fate and Transport Modeling

In the 1987 Notice, EPA required that demonstrations of compliance with the regulations governing closure by removal and the "remove or decontaminate" standard be conservative in the sense that they eliminate the uncertainties associated with contaminant fate and transport. (50 FR 8707, March 19, 1987.) EPA recently revised its interpretation of the "remove or decontaminate" standard in a memo from Elliott Laws and Steven Herman to RCRA/CERCLA

National Policy Managers (September 24, 1996) to allow limited use of fate and transport modeling during closure. This revision was based on the experience EPA has gained using fate and transport modeling since 1987. Under the new Agency interpretation, fate and transport models may be used to support clean closure determinations by modeling the potential for residual contamination in one medium to migrate to and contaminate other media. For example, under the new interpretation, fate and transport modeling might be used to model the potential for residual contamination in soil to migrate to and contaminate ground water.

Some individuals were confused by EPA's new interpretation. The Agency takes this opportunity to clarify that, when supporting demonstrations of compliance with the "remove or decontaminate" standard, fate and transport modeling is appropriate only for modeling the potential for residual contamination (not waste) to migrate from one medium to another. EPA continues to interpret the closure regulations and the remove or decontaminate standard to require removal of all hazardous waste and liners. As discussed earlier in this memo, following removal of all hazardous waste and liners, media throughout a closing unit and any areas affected by releases from the closing unit must be decontaminated. Decontamination levels must protect human health and the environment and must ensure that remaining levels of hazardous constituents in soil will not migrate from soil and contaminate air, surface, or ground water in excess of Agency-approved concentrations. It is only when identifying the appropriate level of decontamination, by, in part, considering the potential for cross media transfer, that fate and transport modeling may be used.

New Interpretation Regarding Non-Residential Exposure Assumptions

In an effort to promote redevelopment of industrial properties, many states have recently developed programs which allow them to consider reasonably expected future land use during cleanups and, in certain situations, apply non-residential exposure assumptions to development of cleanup standards. These programs primarily provide for continued maintenance of non-residential land use and any necessary additional cleanup should land use change through institutional controls such as deed restrictions.[2] EPA did not explicitly consider these types of programs when interpreting the closure regulations and the remove or decontaminate standard in the March 1987 notice.

EPA now interprets current closure regulations to allow appropriate use of non-residential exposure assumptions when identifying the amount of decontamination necessary to satisfy the "remove or decontaminate" standard. Using non-residential exposure assumptions to identify the amount of decontamination necessary to satisfy the "remove or decontaminate" standard does not affect any other closure requirement. This means, for clean closure, facility owners/operators must still remove all hazardous wastes and liners. In addition, just like for any other clean

[2] Some states are also developing systems for ground water classification using the comprehensive state ground water protective plan (CSGWPP) process.

closure, a decontamination level based on non-residential exposure assumptions must be achieved throughout the closing unit and any areas affected by releases from the closing unit. It also must ensure that environmental receptors are adequately protected and that no unacceptable transfer of contamination from one medium to another (e.g., soil to ground water) will occur. Issues associated with protecting environmental receptors and preventing unacceptable cross-media transfer may prohibit approval of clean closure based on non-residential exposure assumptions when such closure might otherwise be appropriate. Moreover, although some additional increment of contamination may be allowed to remain in media through application of non-residential exposure assumptions, as during any other clean closure, owners and operators may not rely on physical barriers (such as fences or slurry walls) to ensure protection of human health and the environment. When a facility is also undergoing RCRA corrective action or another type of site-wide cleanup, non-residential exposure assumptions used during clean closure must be consistent with the exposure assumptions being applied in the corrective action (or other) cleanup.

The Agency emphasizes that non-residential exposure assumptions should not be used unless there is a reasonable degree of confidence that future land use will conform to those assumptions. EPA believes this confidence would typically be based on the existence of long-term controls over land use. For example, in some cases, a local authority may have imposed zoning restrictions. In other cases a land owner may have agreed to convey an easement to another party and the easement may impose limits on how the land owner can use the property. When non-residential exposure assumptions are used, the area covered by the non-residential land use assumptions should be clearly delineated and procedures established to alert future users to the presence of contamination and risks presented and to provide for periodic evaluations of actual land use. EPA is currently developing additional guidance on land use controls and restrictions. When completed, this guidance may be used to implement the policies in this memorandum.

Program implementors and facility owners/operators should be careful to distinguish clean closures based on non-residential exposure assumptions from other clean closures, by, for example, referring to them as "non-residential clean closure"or "closure by removal and decontamination based-on non-residential exposure assumptions." Care should especially be taken to ensure that the public is aware of the exposure assumptions which are being applied and the associated land use restrictions which must be maintained in order for the assumptions to remain valid. At a minimum this information should be clearly included in public notices of tentative closure decisions. EPA's current guidance on incorporating considerations of reasonably anticipated future land use in remedial decision making is entitled, "Land Use in the CERCLA Remedy Selection Process" (OSWER Direction No. 9355.7-04, May 25, 1995).

All but a few states are currently authorized to implement the RCRA closure requirements in lieu of EPA; therefore, implementation of this policy will largely be at the discretion of state RCRA program managers. EPA does not view this change in policy to allow appropriate use of non-residential exposure assumptions during clean closures as requiring re-

authorization, or re-evaluation, of authorized state programs. If EPA were asked to evaluate an individual clean closure decision made using non-residential exposure assumptions, the Agency would likely consider factors such as: the methods used to identify the reasonably expected future land use; the amount of community involvement in the land use decision; the probability that the covered property will be actively used (as opposed to abandoned) ; the enforceability of a land use control (with more weight given to programs that have a mechanism in place to review and ensure continued validity of non-residential exposure assumptions); the specific non-residential exposure assumptions which are applied; the potential for trespassers, especially children; and, the range of circumstances under which a state could compel further cleanup if land use were to change.

EPA notes that in situations where, because of a change in land use, additional cleanup is needed after clean closure, EPA would retain authority to take action, under appropriate circumstances, using RCRA Section 7003, CERCLA Section 106, and other authorities. In addition, of course, until clean closed facilities undergo final administrative disposition of a RCRA permit application (i.e., through permit issuance or permit denial) they would remain subject to corrective action under RCRA Section 3008(h).

Additional Information

Reliance on risk-based approaches during clean closure will complement EPA's other ongoing efforts to encourage coordination of cleanup requirements and eliminate duplication of effort. Guidance on coordination of RCRA closure requirements with other cleanup activities was provided in the September 26, 1996 memo on RCRA/CERCLA integration, referenced above.

I encourage you to use risk-based approaches to develop site-specific clean closure requirements and to continue in your efforts to eliminate duplication of effort among cleanup programs. For additional information please contact Elizabeth McManus, of my staff, on (703) 308-8657.

cc Barry Breen, Office of Site Remediation Enforcement
Stephen Luftig, Office of Emergency and Remedial Response
Eric Schaeffer, Office of Regulatory Enforcement
Barb Simcoe, Association of State and Territorial Solid Waste Management Officials

References for Remedy Completion

Supplemental References and Resources

- Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities; Advanced Notice for Proposed Rulemaking (ANPR), May 1, 1996 (61 FR 19432). Available to download from the Internet: http://www.epa.gov/epaoswer/hazwaste/ca/subparts.htm

- Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities, September 24, 1996. Available to download at: http://www.epa.gov/swerffrr/doc/924memo.htm

- Risk-Based Clean Closure, March 16, 1998.

- RCRA Corrective Action Internet Homepage: http://www.epa.gov/correctiveaction

- RCRA Hotline Phone Number - (800) 424-9346

RECENT DEVELOPMENTS IN INNOVATIVE TREATMENT TECHNOLOGIES

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

EPA

DIRECTIVE NUMBER: 9200.4-17P

TITLE: Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites

APPROVAL DATE: April 21, 1999

EFFECTIVE DATE: April 21, 1999

ORIGINATING OFFICE: OSWER

[X] **FINAL**

[ ] **DRAFT**

STATUS:

REFERENCE (other documents):

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United States Environmental Protection Agency
Washington, DC 20460

OSWER Directive Initiation Request

1. Directive Number
9200.4-17P

2. Originator Information

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3. Title
Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites

4. Summary of Directive (include brief statement of purpose)
The purpose of this Directive is to clarify EPA's policy regarding the use of monitored natural attenuation (MNA) for the remediation of contaminated soil and groundwater at sites administered by EPA's Office of Solid Waste and Emergency Response (OSWER).

5. Keywords
natural attenuation, remediation, soil, groundwater, contamination

6a. Does This Directive Supersede Previous Directive(s)?

☒ No ☐ Yes What Directive (number, title)

b. Does It Supplement Previous Directive(s)?

☒ No ☐ Yes What Directive (number, title)

7. Draft Level

☒ A - Signed by AA/DAA ☐ B - Signed by Office Director ☐ C -For Review and Comment ☐ D - In Development

8. Document to be distributed to States by Headquarters? ☒ Yes ☐ No

This Requests Meets OSWER Directives System Format Standards

9. Signature of Lead Office Directives Coordinator	Date
Shushona Clark	3/29/99
10. Name and Title of Approving Official	**Date**
Timothy Fields, Jr., Acting AA/OSWER	4/21/99

EPA Form 1315-17 (Rev 5-87) Previous editions are obsolete

OSWER DIRECTIVE OSWER DIRECTIVE OSWER DIRECTIVE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 21 1999

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Final OSWER Directive "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (OSWER Directive Number 9200.4-17P)

FROM: Elizabeth Cotsworth, Acting Director
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TO: Addressees

Purpose

This memorandum accompanies a copy of the Final OSWER Directive regarding the use of monitored natural attenuation for the remediation of contaminated soil and groundwater at sites regulated under all Office of Solid Waste and Emergency Response (OSWER) programs. A draft Interim Final version of this Directive was released on December 1, 1997 for use, and for general public review and comment. In response to comments received on that draft, EPA has incorporated several changes in this final version dealing with topics such as contaminants of concern, cross-media transfer, plume migration, and remediation time frame.

Implementation

This Directive is being issued in Final form and should be used immediately as guidance for proposing, evaluating, and approving Monitored Natural Attenuation remedies. This Final Directive will be available from the Superfund, RCRA, and OUST dockets and through the RCRA, Superfund & EPCRA Hotline (800-424-9346 or 703-412-9810). The directive will also be available in electronic format from EPA's home page on the Internet (the address is http://www.epa.gov/swerust1/directiv/d9200417.htm).

Questions/Comments

If you need more information about the Directive please feel free to contact any of the appropriate EPA staff listed on the attachment.

Addressees: Federal Facility Forum
Federal Facilities Leadership Council
Other Federal Facility Contacts
OSWER Natural Attenuation Workgroup
RCRA Corrective Action EPA Regional and State Program Managers
State LUST Fund Administrators
State LUST Program Managers
UST/LUST Regional Program Managers
UST/LUST Regional Branch Chiefs
State Superfund Program Managers
Superfund Regional Policy Managers

attachment

Attachment
EPA Contacts
January 1999

If you have any questions regarding this policy, please first call the RCRA/Superfund Hotline at (800) 424-9346. If you require further assistance, please contact the appropriate staff from the list below:

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USE OF MONITORED NATURAL ATTENUATION AT SUPERFUND, RCRA CORRECTIVE ACTION, AND UNDERGROUND STORAGE TANK SITES

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Directive 9200.4-17P

April 1999

USE OF MONITORED NATURAL ATTENUATION AT SUPERFUND, RCRA CORRECTIVE ACTION, AND UNDERGROUND STORAGE TANK SITES

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NOTICE: This document provides guidance to EPA and state staff. It also provides guidance to the public and to the regulated community on how EPA intends to exercise its discretion in implementing its regulations. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future, as appropriate.

PURPOSE AND OVERVIEW

The purpose of this Directive is to clarify EPA's policy regarding the use of monitored natural attenuation (MNA) for the cleanup of contaminated soil and groundwater[1] in the Superfund, RCRA Corrective Action, and Underground Storage Tank programs. These programs are administered by EPA's Office of Solid Waste and Emergency Response (OSWER) which include the Office of Emergency and Remedial Response (OERR), Office of Solid Waste (OSW), Office of Underground Storage Tanks (OUST), and the Federal Facilities Restoration and Reuse Office (FFRRO). Statutory authority for these remediation programs is provided under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA).

EPA remains fully committed to its goals of protecting human health and the environment by remediating contaminated soils, restoring contaminated groundwaters to their beneficial uses, preventing migration of contaminant plumes[2], and protecting groundwaters and other environmental resources[3]. EPA advocates using the most appropriate technology for a given site. EPA does not consider MNA to be a "presumptive" or "default" remedy—it is merely one option that should be evaluated with other applicable remedies. EPA does not view MNA to be a "no action[4]" or "walk-away" approach, but rather

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[1] Although this Directive does not address remediation of contaminated sediments, many of the same principles would be applicable. Fundamental issues such as having source control, developing lines of evidence, monitoring and contingency plans are also appropriate for sediments. However, the Agency is developing the policy and technical aspects for sediments, specifically.

[2] The outer limits of contaminant plumes are typically defined for each contaminant of concern based on chemical concentrations above which the overseeing regulatory authority has determined represent an actual or potential threat to human health or the environment.

[3] Environmental resources to be protected include groundwater, drinking water supplies, surface waters, ecosystems and other media (air, soil and sediments) that could be impacted by site contamination.

[4] For the Superfund program, Section 300.430(e)(6) of the National Contingency Plan (NCP) directs that a "no action alternative" (or no further action) "shall be developed" for all feasibility studies (USEPA, 1990a, p. 8849). The "no action" alternative can include monitoring but generally not other remedial actions, where such actions are defined in Section 300.5 of the NCP. In general, the "no action" alternative is selected when there is no current or potential threat to human health or the environment or when CERCLA exclusions preclude taking an action (USEPA, 1991a). As explained in this Directive, a remedial alternative that relies on monitored natural attenuation to attain site-specific remediation objectives is **not** the same as the "no action" alternative.

considers it to be an alternative means of achieving remediation objectives[5] that may be appropriate for specific, well-documented site circumstances where its use meets the applicable statutory and regulatory requirements. As there is often a variety of methods available for achieving remediation objectives at any given site, MNA may be evaluated and compared to other viable remediation methods (including innovative technologies) during the study phases leading to the selection of a remedy. As with any other remedial alternative, MNA should be selected only where it meets all relevant remedy selection criteria, and where it will meet site remediation objectives within a timeframe that is reasonable compared to that offered by other methods. In the majority of cases where MNA is proposed as a remedy, its use may be appropriate as one component of the total remedy, that is, either in conjunction with active remediation or as a follow-up measure. MNA should be used very cautiously as the sole remedy at contaminated sites. Furthermore, the availability of MNA as a potential remediation tool does not imply any lessening of EPA's longstanding commitment to pollution prevention. Waste minimization, pollution prevention programs, and minimal technical requirements to prevent and detect releases remain fundamental parts of EPA waste management and remediation programs.

Use of MNA does not signify a change in OSWER's remediation objectives. These objectives (discussed in greater detail under the heading "Implementation") include control of source materials[6], prevention of plume migration, and restoration of contaminated groundwaters, where appropriate. Thus, EPA expects that source control measures (see section on "Remediation of Sources") will be evaluated for all sites under consideration for any proposed remedy. As with other remediation methods, selection of MNA as a remediation method should be supported by detailed site-specific information that demonstrates the efficacy of this remediation approach. In addition, the progress of MNA toward a site's remediation objectives should be carefully monitored and compared with expectations. Where MNA's ability to meet these expectations is uncertain and based predominantly on predictive analyses, decision makers should incorporate contingency measures into the remedy.

The scientific understanding of natural attenuation processes continues to evolve. EPA recognizes that significant advances have been made in recent years, but there is still a great deal to be learned regarding the mechanisms governing natural attenuation processes and their ability to address different types of contamination problems. Therefore, while EPA believes MNA may

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[5] In this Directive, remediation objectives are the overall objectives that remedial actions are intended to accomplish and are not the same as chemical-specific cleanup levels. Remediation objectives could include preventing exposure to contaminants, preventing further migration of contaminants from source areas, preventing further migration of the groundwater contaminant plume, reducing contamination in soil or groundwater to specified cleanup levels appropriate for current or potential future uses, or other objectives. The term "remediation" as used in this Directive is not limited to "remedial actions" defined in CERCLA §101(24), and includes CERCLA "removal actions", for example.

[6] "**Source material** is defined as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir [either stationary or mobile] for migration of contamination to the ground water, to surface water, to air, [or other environmental media,] or acts as a source for direct exposure. Contaminated ground water generally is not considered to be a source material although non-aqueous phase liquids (NAPLS [occurring either as residual- or free-phase]) may be viewed as source materials." (USEPA, 1991b).

be used where circumstances are appropriate, it should be used with caution commensurate with the uncertainties associated with the particular application. Furthermore, largely due to the uncertainty associated with the potential effectiveness of MNA to meet remediation objectives that are protective of human health and the environment, EPA expects that **source control and long-term performance monitoring will be fundamental components of any MNA remedy**.

This Directive is a policy document and as such is not intended to provide detailed technical guidance on evaluating MNA remedies. EPA recognizes that at present there are relatively few EPA guidance documents concerning appropriate implementation of MNA remedies. Chapter IX of OUST's alternative cleanup technologies manual (USEPA, 1995a) addresses the use of natural attenuation at leaking UST sites. The Office of Research and Development (ORD) has recently published a protocol for evaluating MNA at chlorinated solvent sites (USEPA, 1998a). Additional technical resource documents for evaluating MNA in groundwater, soils, and sediments are being developed by ORD. Supporting technical information regarding the evaluation of MNA as a remediation alternative is available from a variety of other sources, including those listed at the end of this Directive. "References Cited" lists those EPA documents that were specifically cited within this Directive. The list of "Additional References" includes documents produced by EPA as well as non-EPA entities. Finally, "Other Sources of Information" lists sites on the World Wide Web (Internet) where additional information can be obtained. Non-EPA documents may provide regional and state site managers, as well as the regulated community, with useful technical information. However, these non-EPA guidances are not officially endorsed by EPA, EPA does not necessarily agree with all their conclusions, and all parties involved should clearly understand that such guidances do not in any way replace current EPA or OSWER guidances or policies addressing the remedy selection process in the Superfund, RCRA, or UST programs.

BACKGROUND

The term "monitored natural attenuation", as used in this Directive, refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These *in-situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants. When relying on natural attenuation processes for site remediation, EPA prefers those processes that degrade or destroy contaminants. Also, EPA generally expects that MNA will only be appropriate for sites that have a low potential for contaminant migration. Additional discussion of criteria for "Sites Where Monitored Natural Attenuation May Be Appropriate" may be found later in this Directive. Other terms associated with natural attenuation in the literature include "intrinsic remediation", "intrinsic bioremediation", "passive bioremediation", "natural

recovery", and "natural assimilation". While some of these terms are synonymous with "natural attenuation," others refer strictly to biological processes, excluding chemical and physical processes. Therefore, it is recommended that for clarity and consistency, the term "monitored natural attenuation" be used throughout OSWER remediation programs unless a specific process (*e.g.*, reductive dehalogenation) is being referenced.

Natural attenuation processes are typically occurring at all sites, but to varying degrees of effectiveness depending on the types and concentrations of contaminants present and the physical, chemical, and biological characteristics of the soil and groundwater. Natural attenuation processes may reduce the potential risk posed by site contaminants in three ways:

(1) Transformation of contaminant(s) to a less toxic form through destructive processes such as biodegradation or abiotic transformations;

(2) Reduction of contaminant concentrations whereby potential exposure levels may be reduced; and

(3) Reduction of contaminant mobility and bioavailability through sorption onto the soil or rock matrix.

Where conditions are favorable, natural attenuation processes may reduce contaminant mass or concentration at sufficiently rapid rates to be integrated into a site's soil or groundwater remedy. Following source control measures, natural attenuation may be sufficiently effective to achieve remediation objectives at some sites without the aid of other (active) remedial measures. Typically, however, MNA will be used in conjunction with active remediation measures. For example, active remedial measures could be applied in areas with high concentrations of contaminants while MNA is used for low concentration areas; or MNA could be used as a follow-up to active remedial measures. EPA also encourages the consideration of innovative technologies for source control or "active" components of the remedy, which may offer greater confidence and reduced remediation time frames at modest additional cost.

While MNA is often dubbed "passive" remediation because natural attenuation processes occur without human intervention, its use at a site does **not** preclude the use of "active" remediation or the application of enhancers of biological activity (*e.g.*, electron acceptors, nutrients, and electron donors). However, by definition, a remedy that includes the introduction of an enhancer of any type is no longer considered to be "natural" attenuation. Use of MNA does not imply that activities (and costs) associated with investigating the site or selecting the remedy (*e.g.*, site characterization, risk assessment, comparison of remedial alternatives, performance monitoring, and contingency measures) have been eliminated. These elements of the

investigation and cleanup must still be addressed as required under the particular OSWER program, regardless of the remedial approach selected.

Contaminants of Concern

It is common practice in conducting remedial actions to focus on the most obvious contaminants of concern, but other contaminants may also be of significant concern in the context of MNA remedies. In general, since engineering controls are not used to control plume migration in an MNA remedy, decision makers need to ensure that MNA is appropriate to address **all contaminants** that represent an actual or potential threat to human health or the environment. Several examples are provided below to illustrate the need to assess both the obvious as well as the less obvious contaminants of concern when evaluating an MNA remedial option.

- Mixtures of contaminants released into the environment often include some which may be amenable to MNA, and others which are not addressed sufficiently by natural attenuation processes to achieve remediation objectives. For example, Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) associated with gasoline have been shown in many circumstances to be effectively remediated by natural attenuation processes. However, a common additive to gasoline (*i.e.*, methyl tertiary-butyl ether [MTBE]) has been found to migrate large distances and threaten downgradient water supplies at the same sites where the BTEX component of a plume has either stabilized or diminished due to natural attenuation. In general, compounds that tend not to degrade readily in the subsurface (*e.g.*, MTBE and 1,4-dioxane) and that represent an actual or potential threat should be assessed when evaluating the appropriateness of MNA remedies.

- Analyses of contaminated media often report chemicals which are identified with a high degree of certainty, as well other chemicals labeled as "tentatively identified compounds" (TICs). It is often assumed that TICs will be addressed by a remedial action along with the primary contaminants of concern. This may be a reasonable assumption for an active remediation system (*e.g.*, pump and treat) which is capturing all contaminated groundwater, but might not be acceptable for an MNA remedy that is relying on natural processes to prevent contaminant migration. Where MNA is being proposed for sites with TICs, it may be prudent to identify the TICs and evaluate whether they too will be sufficiently mitigated by MNA.

- At some sites the same geochemical conditions and processes that lead to biodegradation of chlorinated solvents and petroleum hydrocarbons can chemically transform naturally occurring minerals (*e.g.*, arsenic and manganese compounds) in the aquifer matrix to forms that are more mobile and/or more toxic than the original materials (USEPA, 1998). A

comprehensive assessment of an MNA remedial option should include evaluation of whether naturally occurring metals will become contaminants of concern.

Addressing the above concerns does not necessarily require sampling and analysis of extensive lists of parameters at every monitoring location in all situations. The location and number of samples collected and analyzed for this purpose should be determined on a site-specific basis to ensure adequate characterization and protection of human health and the environment.

Transformation Products

It also should be noted that some natural attenuation processes may result in the creation of transformation products[7] that are more toxic and/or mobile than the parent contaminant (*e.g.*, degradation of trichloroethylene to vinyl chloride). The potential for creation of toxic transformation products is more likely to occur at non-petroleum release sites (*e.g.*, chlorinated solvents or other volatile organic spill sites) and should be evaluated to determine if implementation of a MNA remedy is appropriate and protective in the long term.

Cross-Media Transfer

Natural attenuation processes may often result in transfer of some contaminants from one medium to another (*e.g.*, from soil to groundwater, from soil to air or surface water, and from groundwater to surface water). Processes that result in degradation of contaminants are preferable to those which rely predominantly on the transfer of contamination from one medium to another. MNA remedies involving cross-media transfer of contamination should include a site-specific evaluation of the potential risk posed by the contaminant(s) once transferred to a particular medium. Additionally, long-term monitoring should address the media to which contaminants are being transferred.

[7] The term "transformation products" in the Directive includes intermediate products resulting from biotic or abiotic processes (*e.g.*, TCE, DCE, vinyl chloride), decay chain daughter products from radioactive decay, and inorganic elements that become methylated compounds (*e.g.*, methyl mercury) in soil or sediment. Some transformation products are quickly transformed to other products while others are longer lived.

Petroleum-Related Contaminants

Natural attenuation processes, particularly biological degradation, are currently best documented at petroleum fuel spill sites. Under appropriate field conditions, the regulated compounds benzene, toluene, ethylbenzene, and xylene (BTEX) may naturally degrade through microbial activity and ultimately produce non-toxic end products (*e.g.*, carbon dioxide and water). Where microbial activity is sufficiently rapid, the dissolved BTEX contaminant plume may stabilize (*i.e.*, stop expanding), and contaminant concentrations in both groundwater and soil may eventually decrease to levels below regulatory standards. Following degradation of a dissolved BTEX plume, a residue consisting of heavier petroleum hydrocarbons of relatively low solubility and volatility will typically be left behind in the original source (spill) area. Although this residual contamination may have relatively low potential for further migration, it still may pose a threat to human health or the environment either from direct contact with soils in the source area or by continuing to slowly leach contaminants to groundwater. For these reasons, MNA alone is generally not sufficient to remediate petroleum release sites. Implementation of source control measures in conjunction with MNA is almost always necessary. Other controls (*e.g.*, institutional controls[8]), in accordance with applicable state and federal requirements, may also be necessary to ensure protection of human health and the environment.

Chlorinated Solvents

Chlorinated solvents[9], such as trichloroethylene, represent another class of common contaminants. These compounds are more dense than water and are referred to as DNAPLs (dense non-aqueous phase liquids). Recent research has identified some of the mechanisms potentially responsible for degrading these solvents, furthering the development of methods for estimating biodegradation rates of these chlorinated compounds. However, the hydrologic and geochemical conditions favoring significant biodegradation of chlorinated solvents sufficient to achieve remediation objectives within a reasonable timeframe are anticipated to occur only in limited circumstances. DNAPLs tend to sink through the groundwater column toward the bottom of the aquifer. However, they can also occur as mixtures with other less dense contaminants. Because of the varied nature and distribution of chlorinated compounds, they are typically difficult to locate, delineate, and remediate even with active measures. In the subsurface, chlorinated solvents represent source materials that can continue to contaminate groundwater for decades or longer. Cleanup of solvent spills is also complicated by the fact that a typical spill includes

[8] The term "institutional controls" refers to non-engineering measures—usually, but not always, legal controls—intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances. Examples of institutional controls cited in the National Contingency Plan (USEPA, 1990a, p.8706) include land and resource (*e.g.*, water) use and deed restrictions, well-drilling prohibitions, building permits, well use advisories, and deed notices.

[9] Chlorinated solvents are only one type of halogenated compound. Chlorinated solvents are specifically referenced in this Directive because they are commonly found at contaminated sites. The discussion in this Directive regarding chlorinated solvents may also apply to other halogenated compounds to be remediated.

multiple contaminants, including some that tend not to degrade readily in the subsurface.[10] Extremely long dissolved solvent plumes have been documented that may be due to the existence of subsurface conditions that are not conducive to natural attenuation.

Inorganics

MNA may, under certain conditions (*e.g.*, through sorption or oxidation-reduction reactions), effectively reduce the dissolved concentrations and/or toxic forms of inorganic contaminants in groundwater and soil. Both metals and non-metals (including radionuclides) may be attenuated by sorption[11] reactions such as precipitation, adsorption on the surfaces of soil minerals, absorption into the matrix of soil minerals, or partitioning into organic matter. Oxidation-reduction (redox) reactions can transform the valence states of some inorganic contaminants to less soluble and thus less mobile forms (*e.g.*, hexavalent uranium to tetravalent uranium) and/or to less toxic forms (*e.g.*, hexavalent chromium to trivalent chromium). Sorption and redox reactions are the dominant mechanisms responsible for the reduction of mobility, toxicity, or bioavailability of inorganic contaminants. It is necessary to know what specific mechanism (type of sorption or redox reaction) is responsible for the attenuation of inorganics so that the stability of the mechanism can be evaluated. For example, precipitation reactions and absorption into a soil's solid structure (*e.g.*, cesium into specific clay minerals) are generally stable, whereas surface adsorption (*e.g.*, uranium on iron-oxide minerals) and organic partitioning (complexation reactions) are more reversible. Complexation of metals or radionuclides with carrier (chelating) agents (*e.g.*, trivalent chromium with EDTA) may increase their concentrations in water and thus enhance their mobility. Changes in a contaminant's concentration, pH, redox potential, and chemical speciation may reduce a contaminant's stability at a site and release it into the environment. Determining the existence, and demonstrating the irreversibility, of these mechanisms is important to show that a MNA remedy is sufficiently protective.

In addition to sorption and redox reactions, radionuclides exhibit radioactive decay and, for some, a parent-daughter radioactive decay series. For example, the dominant attenuating mechanism of tritium (a radioactive isotopic form of hydrogen with a short half-life) is radioactive decay rather than sorption. Although tritium does not generate radioactive daughter products, those generated by some radionulides (*e.g.*, Am-241 and Np-237 from Pu-241) may be more toxic, have longer half-lives, and/or be more mobile than the parent in the decay series. Also, it is

[10] For example, 1,4-dioxane, which is used as a stabilizer for some chlorinated solvents, is more highly toxic, less likely to sorb to aquifer solids, and less biodegradable than some other solvent constituents under the same environmental conditions.

[11] When a contaminant is associated with a solid phase, it is usually not known if the contaminant is precipitated as a three-dimensional molecular coating on the surface of the solid, adsorbed onto the surface of the solid, absorbed into the structure of the solid, or partitioned into organic matter. "Sorption" will be used in this Directive to describe, in a generic sense (*i.e.*, without regard to the precise mechanism) the partitioning of aqueous phase constituents to a solid phase.

important that the near surface or surface soil pathways be carefully evaluated and eliminated as potential sources of external direct radiation exposure[12].

Inorganic contaminants persist in the subsurface because, except for radioactive decay, they are not degraded by the other natural attenuation processes. Often, however, they may exist in forms that have low mobility, toxicity, or bioavailability such that they pose a relatively low level of risk. Therefore, natural attenuation of inorganic contaminants is most applicable to sites where immobilization or radioactive decay is demonstrated to be in effect and the process/mechanism is irreversible.

Advantages and Disadvantages of Monitored Natural Attenuation

MNA has several potential advantages and disadvantages, and the factors listed below should be carefully considered during site characterization and evaluation of remediation alternatives before selecting MNA as the remedial alternative. **Potential advantages** of MNA include:

- As with any *in situ* process, generation of lesser volume of remediation wastes, reduced potential for cross-media transfer of contaminants commonly associated with *ex situ* treatment, and reduced risk of human exposure to contaminants, contaminated media, and other hazards, and reduced disturbances to ecological receptors;

- Some natural attenuation processes may result in *in-situ* destruction of contaminants;

- Less intrusion as few surface structures are required;

- Potential for application to all or part of a given site, depending on site conditions and remediation objectives;

- Use in conjunction with, or as a follow-up to, other (active) remedial measures; and

- Potentially lower overall remediation costs than those associated with active remediation.

[12] External direct radiation exposure refers to the penetrating radiation (*i.e.,* primarily gamma radiation and x-rays) that may be an important exposure pathway for certain radionuclides in near surface soils. Unlike chemicals, radionuclides can have deleterious effects on humans without being taken into or brought in contact with the body due to high energy particles emitted from near surface soils. Even though the radionuclides that emit penetrating radiation may be immobilized due to sorption or redox reactions, the resulting contaminated near surface soil may not be a candidate for a MNA remedy as a result of this exposure risk.

The **potential disadvantages** of MNA include:

- Longer time frames may be required to achieve remediation objectives, compared to active remediation measures at a given site;
- Site characterization is expected to be more complex and costly;
- Toxicity and/or mobility of transformation products may exceed that of the parent compound;
- Long-term performance monitoring will generally be more extensive and for a longer time;
- Institutional controls may be necessary to ensure long term protectiveness;
- Potential exists for continued contamination migration, and/or cross-media transfer of contaminants;
- Hydrologic and geochemical conditions amenable to natural attenuation may change over time and could result in renewed mobility of previously stabilized contaminants (or naturally occurring metals), adversely impacting remedial effectiveness; and
- More extensive education and outreach efforts may be required in order to gain public acceptance of MNA.

IMPLEMENTATION

The use of MNA is not new in OSWER programs. For example, in the Superfund program, use of natural attenuation as an element in a site's groundwater remedy is discussed in "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites" (USEPA, 1988a). Use of MNA in OSWER programs has slowly increased over time with greater program experience and scientific understanding of the processes involved. Recent advances in the scientific understanding of the processes contributing to natural attenuation have resulted in a heightened interest in this approach as a potential means of achieving remediation objectives for soil and groundwater. However, EPA expects that reliance on MNA as the sole remedy will only be appropriate at relatively few contaminated sites. This Directive is intended to clarify OSWER program policies regarding the use of MNA and ensure that MNA remedies are selected and implemented appropriately. Topics addressed include the role of MNA in OSWER remediation programs, site characterization, the types of sites where MNA may be appropriate, reasonable remediation timeframes, source control, performance monitoring, and contingency remedies where MNA will be employed.

Role of Monitored Natural Attenuation in OSWER Remediation Programs

Under OSWER programs, remedies selected for contaminated media (such as contaminated soil and groundwater) must protect human health and the environment. Remedies may achieve this level of protection using a variety of methods, including treatment, containment, engineering controls, and other means identified during the remedy selection process.

The regulatory and policy frameworks for corrective actions under the UST, RCRA, and Superfund programs have been established to implement their respective statutory mandates and to promote the selection of technically defensible, nationally consistent, and cost effective solutions for the cleanup of contaminated media. EPA recognizes that MNA may be an appropriate remediation option for contaminated soil and groundwater under certain circumstances. However, determining the appropriate mix of remediation methods at a given site, including when and how to use MNA, can be a complex process. Therefore, MNA should be carefully evaluated along with other viable remedial approaches or technologies (including innovative technologies) within the applicable remedy selection framework. **MNA should not be considered a default or presumptive remedy at any contaminated site.**

Each OSWER program has developed regulations and policies to address the particular types of contaminants and facilities within its purview[13]. Although there are differences among

[13] Existing program guidance and policy regarding MNA can be obtained from the following sources: For Superfund, see "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites," (USEPA, 1988a; pp. 5-7 and 5-8); the Preamble to the 1990 National Contingency Plan (USEPA, 1990a, pp.8733-34); and "Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites, Final Guidance" (USEPA, 1996a; p. 18). For the RCRA program, see the Subpart S Proposed Rule (USEPA, 1990b, pp.30825 and 30829), and the Advance Notice of Proposed Rulemaking (USEPA, 1996b, pp.19451-52). For the UST program, refer to Chapter IX in "How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers;" (USEPA, 1995a).

these programs, they share several key principles that should generally be considered during selection of remedial measures, including:

- Source control measures should use treatment to address "principal threat" wastes (or products) wherever practicable, and engineering controls such as containment for waste (or products) that pose a relatively low long-term threat, or where treatment is impracticable.[14]

- Contaminated groundwaters should be returned to "their beneficial uses[15] wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site." When restoration of groundwater is not practicable, EPA "expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction."[16]

- Contaminated soil should be remediated to achieve an acceptable level of risk to human and environmental receptors, and to prevent any transfer of contaminants to other media (*e.g.*, surface or groundwater, air, sediments) that would result in an unacceptable risk or exceed required cleanup levels.

- Remedial actions in general should include opportunity(ies) for public involvement that serve to both educate interested parties and to solicit feedback concerning the decision making process.

Consideration or selection of MNA as a remedy or remedy component does not in any way change or displace these (or other) remedy selection principles. Nor does use of MNA

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[14] Principal threat wastes are those **source materials** that are "highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. They include liquids and other highly mobile materials (*e.g.*, solvents) or materials having high concentrations of toxic compounds." (USEPA, 1991b). Low level threat wastes are "source materials that generally can be reliably contained and that would present only a low risk in the event of release." (USEPA, 1991b). Since contaminated groundwater is not source material, it is neither a principal nor a low-level threat waste.

[15] **Beneficial uses** of groundwater could include uses for which water quality standards have been promulgated, (*e.g.*, drinking water supply, discharge to surface water), or where groundwater serves as a source of recharge to either surface water or adjacent aquifers, or other uses. These or other types of beneficial uses may be identified as part of a Comprehensive State Groundwater Protection Program (CSGWPP). For more information on CSGWPPs, see USEPA, 1992a and USEPA, 1997b, or contact your state implementing agency.

[16] This is a general expectation for remedy selection in the Superfund program, as stated in §300.430 (a)(1)(iii)(F) of the National Contingency Plan (USEPA, 1990a, p.8846). The NCP Preamble also specifies that cleanup levels appropriate for the expected beneficial use (*e.g.*, MCLs for drinking water) "should generally be attained throughout the contaminated plume, or at and beyond the edge of the waste management area when waste is left in place" (USEPA, 1990a, p.8713). The RCRA Corrective Action program has similar expectations (see USEPA, 1996b, pp.19448-19450).

diminish EPA's or the regulated party's responsibility to achieve protectiveness or to satisfy long-term site remediation objectives. EPA expects that **MNA will be an appropriate remediation method only where its use will be protective of human health and the environment and it will be capable of achieving site-specific remediation objectives within a timeframe that is reasonable compared to other alternatives.** The effectiveness of MNA in both near-term and long-term timeframes should be demonstrated to EPA (or other overseeing regulatory authority) through: 1) sound technical analyses which provide confidence in natural attenuation's ability to achieve remediation objectives; 2) performance monitoring; and 3) contingency (or backup) remedies where appropriate. **In summary, use of MNA does not imply that EPA or the responsible parties are "walking away" from the cleanup or financial responsibility at a site.**

It also should be emphasized that the selection of MNA as a remedy does **not** imply that active remediation measures are infeasible, or are "technically impracticable" from an engineering perspective. Technical impracticability (TI) determinations are used to justify a departure from cleanup levels that would otherwise be required at a Superfund site or RCRA facility based on the inability to achieve such cleanup levels using available remedial technologies (USEPA, 1993a). Such a TI determination does not imply that there will be no active remediation at the site, nor that MNA will be used at the site. Rather, such a TI determination simply indicates that the cleanup levels and objectives which would otherwise be required cannot practicably be attained using available remediation technologies. In such cases, an alternative cleanup strategy that is fully protective of human health and the environment must be identified. Such an alternative strategy may still include engineered remediation components, such as recovery of free phase NAPLs and containment of residual contaminants, in addition to approaches intended to restore some portion of the contaminated groundwater to beneficial uses. Several remedial approaches could be appropriate to address the dissolved plume, one of which could be MNA under suitable conditions. However, the evaluation of natural attenuation processes and the decision to rely upon MNA for the dissolved plume should be distinct from the recognition that restoration of a portion of the plume is technically impracticable (*i.e.*, MNA should **not** be viewed as a direct or presumptive outcome of a technical impracticability determination.)

Demonstrating the Efficacy of Natural Attenuation Through Site Characterization

Decisions to employ MNA as a remedy or remedy component should be thoroughly and adequately supported with site-specific characterization data and analysis. In general, the level of site characterization necessary to support a comprehensive evaluation of MNA is more detailed than that needed to support active remediation. Site characterizations for natural attenuation generally warrant a quantitative understanding of source mass; groundwater flow (including preferential pathways); contaminant phase distribution and partitioning between soil, groundwater, and soil gas; rates of biological and non-biological transformation; and an understanding of how all of these factors are likely to vary with time. This information is generally necessary since contaminant behavior is governed by dynamic processes which must be well understood before MNA can be appropriately applied at a site. Demonstrating the efficacy of

MNA may require analytical or numerical simulation of complex attenuation processes. Such analyses, which are critical to demonstrate natural attenuation's ability to meet remediation objectives, generally require a detailed conceptual site model[17] as a foundation.

EPA recommends the use of conceptual site models to integrate data and guide both investigative and remedial actions. However, program implementors should be cautious and collect sufficient field data to test conceptual hypotheses and not "force-fit" site data into a pre-conceived, and possibly inaccurate, conceptual representation. For example, a common mechanism for transport of contaminants is advection-dispersion, by which contaminants dissolved in groundwater migrate away from a source area. An alternative mechanism of contaminant transport (*i.e.*, NAPL migration) could be associated with a relatively large release of NAPL into the subsurface such that the NAPL itself has the potential to migrate significant distances along preferential pathways. Since NAPL migration pathways are often difficult to locate in the subsurface, one may incorrectly conclude that only the dissolved transport model applies to a site, when a combined NAPL and dissolved phase migration model would be more accurate. Applying a wrong conceptual model, in the context of evaluating an MNA (or any other) remedy, could result in a deficient site characterization (*e.g.*, did not use tools and approaches designed to find NAPLs or NAPL migration pathways), and inappropriate selection of an MNA remedy where long-term sources were not identified nor considered during remedy selection. NAPL present as either free- or residual phase represents a significant mass of contamination that will serve as a long-term source. Sources of contamination are more appropriately addressed by engineered removal, treatment or containment technologies, as discussed later in this Directive. Where the sources of contamination have been controlled, dissolved plumes may be amenable to MNA because of the relatively small mass of contaminants present in the plume.

Site characterization should include collecting data to define (in three spatial dimensions over time) the nature and distribution of contaminants of concern and contaminant sources as well as potential impacts on receptors (see "Background" section for further discussion pertaining to "Contaminants of Concern"). However, where MNA will be considered as a remedial approach, certain aspects of site characterization may require more detail or additional elements. For

[17] A conceptual site model (CSM) is a three-dimensional representation that conveys what is known or suspected about contamination sources, release mechanisms, and the transport and fate of those contaminants. The conceptual model provides the basis for assessing potential remedial technologies at the site. "Conceptual site model" is **not** synonymous with "computer model"; however, a computer model may be helpful for understanding and visualizing current site conditions or for predictive simulations of potential future conditions. Computer models, which simulate site processes mathematically, should in turn be based upon sound conceptual site models to provide meaningful information. Computer models typically require a lot of data, and the quality of the output from computer models is directly related to the quality of the input data. Because of the complexity of natural systems, models necessarily rely on simplifying assumptions that may or may not accurately represent the dynamics of the natural system. Calibration and sensitivity analyses are important steps in appropriate use of models. Even so, the results of computer models should be carefully interpreted and continuously verified with adequate field data. Numerous EPA references on models are listed in the "Additional References" section at the end of this Directive.

example, to assess the contributions of sorption, dilution, and dispersion to natural attenuation of contaminated groundwater, a very detailed understanding of aquifer hydraulics, recharge and discharge areas and volumes, and chemical properties is necessary. Where biodegradation will be assessed, characterization also should include evaluation of the nutrients and electron donors and acceptors present in the groundwater, the concentrations of co-metabolites and metabolic by-products, and perhaps specific analyses to identify the microbial populations present. The findings of these, and any other analyses pertinent to characterizing natural attenuation processes, should be incorporated into the conceptual model of contaminant fate and transport developed for the site.

MNA may not be appropriate as a remedial option at many sites for technological or economic reasons. For example, in some complex geologic systems, technological limitations may preclude adequate monitoring of a natural attenuation remedy to ensure with a high degree of confidence that potential receptors will not be impacted. This situation typically occurs in many karstic, structured, and/or fractured rock aquifers where groundwater moves preferentially through discrete pathways (*e.g.*, solution channels, fractures, joints, foliations). The direction of groundwater flow through such heterogeneous (and often anisotropic) materials can not be predicted directly from the hydraulic gradient, and existing techniques may not be capable of identifying the pathway along which contaminated groundwater moves through the subsurface. MNA will not generally be appropriate where site complexities preclude adequate monitoring. In some other situations where it may be technically feasible to monitor the progress of natural attenuation, the cost of site characterization and long-term monitoring required for the implementation of MNA may be higher than the cost of other remedial alternatives. Under such circumstances, MNA may not be less costly than other alternatives.

A related consideration for site characterization is how other remedial activities at the site could affect natural attenuation. For example, the capping of contaminated soil could alter both the type of contaminants leached to groundwater, as well as their rate of transport and degradation. Another example could be where there is co-mingled petroleum and chlorinated solvent contamination. In such cases, degradation of the chlorinated solvents is achieved, in part, through the action of microbes that derive their energy from the carbon in the petroleum. Recovery of the petroleum removes some of the source of food for these microbes and the rate of degradation of the chlorinated solvents is decreased. Therefore, the impacts of any ongoing or proposed remedial actions should be factored into the analysis of the effectiveness of MNA.

Once site characterization data have been collected and a conceptual model developed, the next step is to evaluate the potential efficacy of MNA as a remedial alternative. This involves collection of site-specific data sufficient to estimate with an acceptable level of confidence both the rate of attenuation processes and the anticipated time required to achieve remediation objectives. A three-tiered approach to such an evaluation is becoming more widely practiced and accepted. In this approach, successively more detailed information is collected as necessary to provide a specified level of confidence on the estimates of attenuation rates and remediation timeframe. These three tiers of site-specific information, or “lines of evidence”, are:

(1) Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend[18] of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. (In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. In the case of inorganic contaminants, the primary attenuating mechanism should also be understood.)

(2) Hydrogeologic and geochemical data that can be used to demonstrate **indirectly** the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.

(3) Data from field or microcosm studies (conducted in or with actual contaminated site media) which **directly** demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

Unless EPA or the overseeing regulatory authority determines that historical data (Number 1 above) are of sufficient quality and duration to support a decision to use MNA, data characterizing the nature and rates of natural attenuation processes at the site (Number 2 above) should be provided. Where the latter are also inadequate or inconclusive, data from microcosm studies (Number 3 above) may also be necessary. In general, more supporting information may be required to demonstrate the efficacy of MNA at those sites with contaminants which do not readily degrade through biological processes (*e.g.*, most non-petroleum compounds, inorganics), or that transform into more toxic and/or mobile forms than the parent contaminant, or where monitoring has been performed for a relatively short period of time. The amount and type of information needed for such a demonstration will depend upon a number of site-specific factors, such as the size and nature of the contamination problem, the proximity of receptors and the potential risk to those receptors, and other characteristics of the environmental setting (*e.g.*, hydrogeology, ground cover, climatic conditions).

Note that those parties responsible for site characterization and remediation should ensure that all data and analyses needed to demonstrate the efficacy of MNA are collected and evaluated by capable technical specialists with expertise in the relevant sciences. Furthermore, EPA expects that documenting the level of confidence on attenuation rates will provide more technically defensible predictions of remedial timeframes and form the basis for more effective performance monitoring programs.

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[18] For guidance on statistical analysis of environmental data, please see USEPA, 1989, USEPA, 1993b, USEPA, 1993d, and Gilbert, 1987, listed in the "References Cited" section at the end of this Directive.

Sites Where Monitored Natural Attenuation May Be Appropriate

MNA is appropriate as a remedial approach where it can be demonstrated capable of achieving a site's remediation objectives within a timeframe that is reasonable compared to that offered by other methods and where it meets the applicable remedy selection criteria (if any) for the particular OSWER program. **EPA expects that MNA will be most appropriate when used in conjunction with other remediation measures (*e.g.*, source control, groundwater extraction), or as a follow-up to active remediation measures that have already been implemented**.

In determining whether MNA is an appropriate remedy for soil or groundwater at a given site, EPA or other regulatory authorities should consider the following:

- Whether the contaminants present in soil or groundwater can be effectively remediated by natural attenuation processes;

- Whether or not the contaminant plume is stable and the potential for the environmental conditions that influence plume stability to change over time;

- Whether human health, drinking water supplies, other groundwaters, surface waters, ecosystems, sediments, air, or other environmental resources could be adversely impacted as a consequence of selecting MNA as the remediation option;

- Current and projected demand for the affected resource over the time period that the remedy will remain in effect;

- Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources;

- Whether the estimated timeframe of remediation is reasonable (see section on "Reasonable Timeframe for Remediation") compared to timeframes required for other more active methods (including the anticipated

effectiveness of various remedial approaches on different portions of the contaminated soil and/or groundwater);

- The nature and distribution of sources of contamination and whether these sources have been, or can be, adequately controlled;

- Whether the resulting transformation products present a greater risk, due to increased toxicity and/or mobility, than do the parent contaminants;

- The impact of existing and proposed active remediation measures upon the MNA component of the remedy, or the impact of remediation measures or other operations/activities (*e.g.*, pumping wells) in close proximity to the site; and

- Whether reliable site-specific mechanisms for implementing institutional controls (*e.g.*, zoning ordinances) are available, and if an institution responsible for their monitoring and enforcement can be identified.

Of the above factors, the most important considerations regarding the suitability of MNA as a remedy include: whether the contaminants are likely to be effectively addressed by natural attenuation processes, the stability of the groundwater contaminant plume and its potential for migration, and the potential for unacceptable risks to human health or environmental resources by the contamination. MNA should not be used where such an approach would result in either plume migration[19] or impacts to environmental resources that would be unacceptable to the overseeing regulatory authority. **Therefore, sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be the most appropriate candidates for MNA remedies.**

An example of a situation where MNA may be appropriate is a remedy that includes source control, a pump-and-treat system to mitigate the highly-contaminated plume areas, and MNA in the lower concentration portions of the plume. In combination, these methods would maximize groundwater restored to beneficial use in a timeframe consistent with future demand on the aquifer, while utilizing natural attenuation processes to reduce the reliance on active remediation methods and reduce remedy cost. If, at such a site, the plume was either expanding

[19] In determining whether a plume is stable or migrating, users of this Directive should consider the **uncertainty** associated with defining the limits of contaminant plumes. For example, a plume is typically delineated for each contaminant of concern as a 2- or 3-dimensional feature. Plumes are commonly drawn by computer contouring programs which estimate concentrations between actual data points. EPA recognizes that a plume boundary is more realistically defined by a zone rather than a line. Fluctuations within this zone are likely to occur due to a number of factors (*e.g.*, analytical, seasonal, spatial, etc.) which may or may not be indicative of a trend in plume migration. Therefore, site characterization activities and performance monitoring should focus on collection of data of sufficient quality to enable decisions to be made with a high level of confidence. See USEPA, 1993b, USEPA, 1993c, USEPA, 1994b, and USEPA, 1998b, for additional guidance.

or threatening downgradient wells or other environmental resources, then MNA would **not** be an appropriate remedy.

Reasonable Timeframe for Remediation

EPA recognizes that determination of what timeframe is "reasonable" for **attaining remediation objectives** is a site-specific determination. The NCP preamble suggests that a "reasonable" timeframe for a remedy relying on natural attenuation is generally a "...timeframe **comparable** to that which could be achieved through active restoration" (USEPA, 1990a, p.8734; emphasis added). The NCP preamble further states that "[t]he most appropriate timeframe must, however, be determined through an analysis of alternatives" (USEPA, 1990a, p.8732). To ensure that these estimates are comparable, assumptions should be consistently applied for each alternative considered. Thus, determination of the most appropriate timeframe is achieved through a comparison of estimates of remediation timeframe for **all** appropriate remedy alternatives.

If **restoring groundwaters to beneficial uses** is a remediation objective, a comparison of restoration alternatives from most aggressive to passive (*i.e.*, MNA) will provide information concerning the approximate range of time periods needed to attain groundwater cleanup levels. An excessively long restoration timeframe, using the most aggressive restoration method, **may** indicate that groundwater restoration is technically impracticable from an engineering perspective (USEPA, 1993a). Where restoration **is** technically **practicable** using either aggressive or passive methods, the longer restoration timeframe required by the passive alternative may be reasonable in comparison with the timeframe needed for more aggressive restoration alternatives (USEPA, 1996a).

The advantages and disadvantages of each remedy alternative, including the timeframe, should be evaluated in accordance with the remedy selection criteria used by each OSWER program. Whether a particular remediation timeframe is appropriate and reasonable for a given site is determined by balancing tradeoffs among many factors which include:

- Classification of the affected resource (*e.g.*, drinking water source, agricultural water source) and value of the resource[20];

[20] In determining whether an extended remediation timeframe may be appropriate for the site, EPA and other regulatory authorities should consider state groundwater resource classifications, priorities and/or valuations where available, in addition to relevant federal guidelines. Individual states may provide information and guidance relevant to groundwater classifications or use designations as part of a Comprehensive State Groundwater Protection Program (CSGWPP). (See USEPA, 1992a and USEPA, 1997b).

- Relative timeframe in which the affected portions of the aquifer might be needed for future water supply (including the availability of alternate supplies);

- Subsurface conditions and plume stability which can change over an extended timeframe;

- Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources;

- **Uncertainties** regarding the mass of contaminants in the subsurface and predictive analyses (*e.g.*, remediation timeframe, timing of future demand, and travel time for contaminants to reach points of exposure appropriate for the site);

- Reliability of monitoring and of institutional controls over long time periods;

- Public acceptance of the timeframe required to reach remediation objectives; and

- Provisions by the responsible party for adequate funding of monitoring and performance evaluation over the time period required for remediation.

It should be noted that the timeframe required for MNA remedies is often longer than that required for more active remedies. **As a consequence, the uncertainty associated with the above factors increases dramatically. Adequate performance monitoring and contingency remedies (both discussed in later sections of this Directive) should be utilized because of this higher level of uncertainty.** When determining reasonable timeframes, the uncertainty in estimated timeframes should be considered, as well as the ability to establish performance monitoring programs capable of verifying the performance expected from natural attenuation in a timely manner (*e.g.*, as would be required in a Superfund five-year remedy review).

A decision on whether or not MNA is an appropriate remedy for a given site is usually based on estimates of the rates of natural attenuation processes. Site characterization (and monitoring) data are typically used for estimating attenuation rates. These calculated rates may be expressed with respect to either time or distance from the source. Time-based estimates are

used to predict the time required for MNA to achieve remediation objectives and distance-based estimates provide an evaluation of whether a plume will expand, remain stable, or shrink. For environmental decision-making, EPA requires that the data used be of "adequate quality and usability for their intended purpose." (USEPA, 1998b). Therefore, where these rates are used to evaluate MNA, or predict the future behavior of contamination, they must also be of "adequate quality and usability." Statistical confidence intervals should be estimated for calculated attenuation rate constants (including those based on methods such as historical trend data analysis, analysis of attenuation along a flow path in groundwater, and microcosm studies). When predicting remedial timeframes, sensitivity analyses should also be performed to indicate the dependence of the calculated remedial timeframes on uncertainties in rate constants and other factors (McNab and Dooher, 1998). A statistical evaluation of the rate constants estimated from site characterization studies of natural attenuation of groundwater contamination often reveals that the estimated rate constants contain considerable uncertainty. For additional guidance on data quality, see USEPA, 1993c, 1994c, 1995b, and 1995c.

As an example, analysis of natural attenuation rates from many sites indicates that a measured decrease in contaminant concentrations of at least one order of magnitude is necessary to determine the appropriate rate law to describe the rate of attenuation, and to demonstrate that the estimated rate is statistically different from zero at a 95% level of confidence (Wilson, 1998). Due to variability resulting from sampling and analysis, as well as plume variability over time, smaller apparent reductions are often insufficient to demonstrate (with 95% level of confidence) that attenuation has in fact occurred at all.

Thus, EPA or other regulatory authorities should consider a number of factors when evaluating reasonable timeframes for MNA at a given site. These factors, on the whole, should allow the overseeing regulatory authority to determine whether a natural attenuation remedy (including institutional controls where applicable) will fully protect potential human and environmental receptors, and whether the site remediation objectives and the time needed to meet them are consistent with the regulatory expectation that contaminated groundwaters will be restored to beneficial uses within a reasonable timeframe. **When these conditions cannot be met using MNA, a remedial alternative that more likely would meet these expectations should be selected.**

Remediation of Sources

Source control measures should be evaluated as part of the remedy decision process at **all** sites, particularly where MNA is under consideration as the remedy or as a remedy component. Source control measures include removal, treatment, or containment, or a combination of these approaches. EPA prefers remedial options which remove free-phase NAPLs and treat those source materials determined to constitute "principal threat wastes" (see Footnote 13).

Contaminant sources that are not adequately addressed complicate the long-term cleanup effort. For example, following free product recovery, residual contamination from a petroleum

fuel release may continue to leach significant quantities of contaminants into the groundwater as well as itself posing unacceptable risks to humans or environmental resources. Such a lingering source often unacceptably extends the time necessary to reach remediation objectives. This leaching can occur even while contaminants are being naturally attenuated in other parts of the plume. If the rate of attenuation is lower than the rate of replenishment of contaminants to the groundwater, the plume can continue to expand thus contaminating additional groundwater and potentially posing a threat to downgradient receptors.

Control of source materials is the most effective means of ensuring the timely attainment of remediation objectives. **EPA, therefore, expects that source control measures will be evaluated for all contaminated sites and that source control measures will be taken at most sites where practicable.** At many sites it will be appropriate to implement source control measures during the initial stages of site remediation ("phased remedial approach"), while collecting additional data to determine the most appropriate groundwater remedy.

Performance Monitoring and Evaluation

Performance monitoring to evaluate remedy effectiveness and to ensure protection of human health and the environment is a critical element of all response actions. Performance monitoring is of even greater importance for MNA than for other types of remedies due to the potentially longer remediation timeframes, potential for ongoing contaminant migration, and other uncertainties associated with using MNA. This emphasis is underscored by EPA's reference to "monitored natural attenuation".

The monitoring program developed for each site should specify the location, frequency, and type of samples and measurements necessary to evaluate whether the remedy is performing as expected and is capable of attaining remediation objectives. In addition, all monitoring programs should be designed to accomplish the following:

- Demonstrate that natural attenuation is occurring according to expectations;
- Detect changes in environmental conditions (*e.g.*, hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of any of the natural attenuation processes[21];
- Identify any potentially toxic and/or mobile transformation products;
- Verify that the plume(s) is not expanding (either downgradient, laterally or vertically);

[21] Detection of changes will depend on the proper siting and construction of monitoring wells/points. Although the siting of monitoring wells is a concern for any remediation technology, it is of even greater concern with MNA because of the lack of engineering controls to control contaminant migration.

- Verify no unacceptable impact to downgradient receptors;
- Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy;
- Demonstrate the efficacy of institutional controls that were put in place to protect potential receptors; and
- Verify attainment of remediation objectives.

The frequency of monitoring should be adequate to detect, in a timely manner, the potential changes in site conditions listed above. At a minimum, the monitoring program should be sufficient to enable a determination of the rate(s) of attenuation and how that rate is changing with time. When determining attenuation rates, the uncertainty in these estimates and the associated implications should be evaluated (see McNab and Dooher, 1998). Flexibility for adjusting the monitoring frequency over the life of the remedy should also be included in the monitoring plan. For example, it may be appropriate to decrease the monitoring frequency at some point in time, once it has been determined that natural attenuation is progressing as expected and very little change is observed from one sampling round to the next. In contrast, the monitoring frequency may need to be increased if unexpected conditions (*e.g.*, plume migration) are observed.

Performance monitoring should continue until remediation objectives have been achieved, and longer if necessary to verify that the site no longer poses a threat to human health or the environment. Typically, monitoring is continued for a specified period (*e.g.*, one to three years) after remediation objectives have been achieved to ensure that concentration levels are stable and remain below target levels. The institutional and financial mechanisms for maintaining the monitoring program should be clearly established in the remedy decision or other site documents, as appropriate.

Details of the monitoring program should be provided to EPA or the overseeing regulatory authority as part of any proposed MNA remedy. Further information on the types of data useful for monitoring natural attenuation performance can be found in the ORD publications (*e.g.*, USEPA, 1997a, USEPA, 1994a) listed in the “References Cited” section of this Directive. Also, USEPA (1994b) published a detailed document on collection and evaluation of performance monitoring data for pump-and-treat remediation systems.

Contingency Remedies

A contingency remedy is a cleanup technology or approach specified in the site remedy decision document that functions as a "backup" remedy in the event that the "selected" remedy fails to perform as anticipated. A contingency remedy may specify a technology (or technologies) that is (are) different from the selected remedy, or it may simply call for modification of the selected technology, if needed. Contingency remedies should generally be flexible—allowing for the incorporation of new information about site risks and technologies.

Contingency remedies are not new to OSWER programs. Contingency remedies should be included in the decision document where the selected technology is not proven for the specific site application, where there is significant uncertainty regarding the nature and extent of contamination at the time the remedy is selected, or where there is uncertainty regarding whether a proven technology will perform as anticipated under the particular circumstances of the site (USEPA, 1990c).

It is also recommended that one or more criteria ("triggers") be established, as appropriate, in the remedy decision document that will signal unacceptable performance of the selected remedy and indicate when to implement contingency remedies. Such criteria should generally include, but not be limited to, the following:

- Contaminant concentrations in soil or groundwater at specified locations exhibit an increasing trend not originally predicted during remedy selection;
- Near-source wells exhibit large concentration increases indicative of a new or renewed release;
- Contaminants are identified in monitoring wells located outside of the original plume boundary;
- Contaminant concentrations are not decreasing at a sufficiently rapid rate to meet the remediation objectives; and
- Changes in land and/or groundwater use will adversely affect the protectiveness of the MNA remedy.

In establishing triggers or contingency remedies, however, care is needed to ensure that sampling variability or seasonal fluctuations do not unnecessarily trigger a contingency. For example, an anomalous spike in dissolved concentration(s) at a well(s) might not be a true indication of a change in trend.

EPA recommends that remedies employing MNA be evaluated to determine the need for including one or more contingency measures that would be capable of achieving remediation objectives. EPA believes that contingency remedies should generally be included as part of a MNA remedy which has been selected based primarily on predictive analyses rather than documented trends of decreasing contaminant concentrations.

SUMMARY

EPA remains fully committed to its goals of protecting human health and the environment by remediating contaminated soils, restoring contaminated groundwaters to their beneficial uses, preventing migration of contaminant plumes, and protecting groundwaters and other environmental resources. EPA does not view MNA to be a "no action" remedy, but rather considers it to be a means of addressing contamination under a limited set of site circumstances where its use meets the applicable statutory and regulatory requirements. MNA is not a "presumptive" or "default" remediation alternative, but rather should be evaluated and compared to other viable remediation methods (including innovative technologies) during the study phases leading to the selection of a remedy. The decision to implement MNA should include a comprehensive site characterization, risk assessment where appropriate, and measures to control sources. In addition, the progress of natural attenuation towards a site's remediation objectives should be carefully monitored and compared with expectations to ensure that it will meet site remediation objectives within a timeframe that is reasonable compared to timeframes associated with other methods. Where MNA's ability to meet these expectations is uncertain and based predominantly on predictive analyses, decision-makers should incorporate contingency measures into the remedy.

EPA is confident that MNA will be, at many sites, a reasonable and protective component of a broader remediation strategy. However, EPA believes that there will be many other sites where either the uncertainties are too great or there is a need for a more rapid remediation that will preclude the use of MNA as a stand-alone remedy. This Directive should help promote consistency in how MNA remedies are proposed, evaluated, and approved.

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EPA Federal Facilities Restoration and Reuse Office, fact sheet on natural attenuation of chlorinated solvents

http://www.epa.gov/swerffrr/petrol.htm
EPA Federal Facilities Restoration and Reuse Office, Fact sheet on natural attenuation of petroleum contaminated sites

http://www.epa.gov/hazwaste/ca/subparts.htm
EPA Office of Solid Waste, information on RCRA Subpart S

http://www.epa.gov/swerosps/bf/
EPA Office of Outreach Programs, Special Projects, and Initiatives, information on Brownfields

http://www.epa.gov/oerrpage/superfnd/web/programs/clp/quality.htm
EPA Office of Emergency and Remedial Response, information on data quality

http://es.epa.gov/ncerqa/qa/qatools.html
EPA Office of Research and Development, National Center for Environmental Research and Quality Assurance, information on data quality, quality assurance and quality control

http://clu-in.com
EPA Technology Innovation Office, information on hazardous site cleanups

POST-CLOSURE

federal register

Thursday
October 22, 1998

Part II

Environmental Protection Agency

40 CFR Parts 264, 265, 270, and 271

Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities: Post-Closure Permit Requirement and Closure Process; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 264, 265, 270, and 271

[FRL–6178–7]

RIN 2050–AD55

Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities; Post-Closure Permit Requirement; Closure Process

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is amending the regulations under the Resource Conservation and Recovery Act (RCRA) in two areas. First, the Agency is modifying the requirement for a post-closure permit, to allow EPA and the authorized States to use a variety of authorities to impose requirements on non-permitted land disposal units requiring post-closure care. As a result of this rule, regulators have the flexibility to use alternate mechanisms under a variety of authorities to address these requirements, based on the particular needs at the facility.

Second, for all facilities, the Agency is amending the regulations governing closure of land-based units that have released hazardous constituents, to allow certain units to be addressed through the corrective action program. As a result of this rule, EPA and the authorized States will have discretion to use corrective action requirements, rather than closure requirements, to address the regulated units. This flexibility will reduce the potential for confusion and inefficiency created by the application of two different regulatory requirements.

Finally, the Agency is specifying the Part B information submission requirements for facilities that receive post-closure permits.

DATES: This rule is effective October 22, 1998.

ADDRESSES: Supporting materials are available for viewing in the RCRA Information Center (RIC), located at Crystal Gateway I, First Floor, 1235 Jefferson Davis Highway, Arlington, VA. The Docket Identification Number is F–98–PCPF–FFFFF. The RIC is open from 9 a.m. to 4 p.m., Monday through Friday, excluding Federal holidays. To review docket materials, it is recommended that the public make an appointment by calling (703) 603–9230. The public may copy a maximum of 100 pages from any regulatory docket at no charge. Additional copies cost $0.15/page. The index and some supporting materials are available electronically. See the Supplementary Information section for information on accessing them.

FOR FURTHER INFORMATION CONTACT: For general information, contact the RCRA Hotline at (800) 424–9346 or TDD (800) 553–7672 (hearing impaired). In the Washington, DC metropolitan area, call (703) 412–9810 or TDD (703) 412–3323.

For more detailed information on specific aspects of this rulemaking, contact Barbara Foster, Office of Solid Waste, Mail Code 5303W, U.S. Environmental Protection Agency, 401 M St. SW, Washington DC 20460, (703–308–7057), foster.barbara@epamail.epa.gov

SUPPLEMENTARY INFORMATION: The index and the following supporting materials are available on the Internet: Economic Assessment. Follow these instructions to access the information electronically:

WWW: http://www.epa.gov/epaoswer/osw/hazwaste.htm#closure
FTP: ftp.epa.gov
Login: anonymous
Password: *foster.barbara@epamail.epa.gov*
Files are located in /pub/epaoswer

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I. Authority

These regulations are promulgated under the authority of sections 2002(a), 3004, 3005, and 3006 of the Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6912(a), 6924, 6925, and 6926.

II. Background Information

A. Overview of RCRA Permit Authorities

Section 3004 of the Resource Conservation Recovery Act (RCRA) requires the Administrator of EPA to

develop regulations applicable to owners and operators of hazardous waste treatment, storage, or disposal facilities, as necessary to protect human health and the environment. Section 3005 requires the EPA Administrator to promulgate regulations requiring each person owning or operating a treatment, storage, or disposal facility to have a permit, and to establish requirements for permit applications. Recognizing that the Agency would require a period of time to issue permits to all facilities, Congress provided, under section 3005(e) of RCRA, that qualifying owners and operators could obtain ''interim status'' and be treated as having been issued permits until EPA takes final administrative action on their permit applications. The privilege of continuing hazardous waste management operations during interim status carries with it the responsibility of complying with appropriate portions of the section 3004 standards.

EPA has issued numerous regulations to implement RCRA requirements for hazardous waste management facilities. These include the standards of 40 CFR Part 264 (which apply to hazardous waste management units at facilities that have been issued RCRA permits), Part 265 (which apply to hazardous waste management units at interim status facilities), and Part 270 (which provide standards for permit issuance).

1. Closure and Post-Closure Care

The closure regulations at 40 CFR Parts 264 and 265 Subpart G require owners and operators of hazardous waste management units to close these units in a manner that is protective of human health and the environment and that minimizes the post-closure releases to the environment. These regulations also establish procedures for closure: they require owners and operators to submit closure plans to the Agency for their hazardous waste management units, and they require Agency approval of those closure plans.

In addition, Parts 264 and 265 establish specific requirements for closure of different types of units. Under Parts 264 and 265 Subpart N, owners and operators of landfills are required to cover the unit with an impermeable cap designed to minimize infiltration of liquid into the unit; then owners or operators must conduct post-closure care (including maintenance of the cap and groundwater monitoring). Under Subparts K and L of Parts 264 and 265, owners and operators of surface impoundments and waste piles must either remove or decontaminate all hazardous waste and constituents from the unit, or leave waste in place, install a final cover over the unit, and conduct post-closure care. Closure of land treatment facilities must be conducted in accordance with closure and post-closure care procedures of §§ 264.280 and 265.280. As part of the closure plan approval process, the Agency has the authority to require owners and operators to remove some or all of the waste from any type of unit at the time of closure, if doing so is necessary for the closure to meet the performance standard of § 264.111 or § 265.111.

Under Subparts I and J of Parts 264 and 265, owners and operators of non-land based units (e.g., tanks and containers) are required to remove or decontaminate all soils, structures, and equipment at closure. Owners and operators of tanks who are unable to do so must close the unit as a landfill and conduct post-closure care (see, for example, § 265.197(b)).

Where post-closure care is required, owners and operators must comply with the requirements of §§ 264.117–120 or §§ 265.117–120. These provisions establish a post-closure plan approval process, similar to the closure plan approval process, and requirements for maintenance of the RCRA cap during the post-closure care period. Facilities also must comply with the groundwater requirements of Part 264 or Part 265 Subpart F during the same period.

2. Subpart F

The requirements of Parts 264 and 265, Subpart F apply to ''regulated units,'' defined in § 264.90(a)(2) as any landfill, surface impoundment, waste pile, or land treatment unit that received hazardous waste after July 26, 1982 or that certified closure after July 26, 1983. While the standards of Parts 264 and 265, Subparts G (closure and post-closure care) and H (financial assurance) are equivalent for permitted and interim status facilities, Part 265 groundwater monitoring requirements for interim status land disposal units are less comprehensive than those established under the Part 264, Subpart F standards for permitted facilities. Whereas Part 265 sets minimum standards for the installation of detection monitoring wells (e.g., one upgradient and three downgradient wells), Part 264 establishes broader standards for establishing a more comprehensive monitoring system to ensure early detection of any releases of hazardous constituents. The specific details of the system are worked out through the permitting process. Consequently, compliance with Part 264 standards usually results in a more extensive network of monitoring wells. Similarly, Part 265 specifies a limited set of indicator parameters that must be monitored, while Part 264 establishes a more comprehensive approach under which the owner or operator is required to design a monitoring program around site-specific indicator parameters. As a result, monitoring systems designed in accordance with Part 264 standards are specifically tailored to the constituents of concern at each individual site. Additionally, Part 264 compliance monitoring standards are more comprehensive than Part 265 standards both in terms of monitoring frequency and the range of constituents that must be monitored. Finally, the Part 264, Subpart F regulations provide for corrective action for releases to groundwater whereas the Part 265, Subpart F regulations do not.

B. Overview of HSWA Corrective Action Authorities

In the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA, Congress expanded EPA's authority to address releases from all solid waste management units (SWMUs) at hazardous waste management facilities. Section 3004(u) of HSWA required that any permit issued under section 3005(c) of RCRA to a treatment, storage, or disposal facility after November 8, 1984, address corrective action for releases of hazardous wastes or hazardous constituents from any SWMU at the facility. Section 3004(v) authorized EPA to require corrective action beyond the facility boundary where appropriate. Section 3008(h) provided EPA with authority to issue administrative orders or bring court action to require corrective action or other measures, as appropriate, when there is or has been a release of hazardous waste or, (under EPA's interpretation) of hazardous constituents from a facility authorized to operate under section 3005(e).

In a December 16, 1985 memorandum entitled *Interpretation of Section 3008(h) of the Solid Waste Disposal Act,* EPA interpreted section 3008(h) to apply not only to facilities that met the requirement for obtaining interim status, but also to facilities that were subject to but did not fully comply with the requirements for interim status, as well as to facilities that lost interim status pursuant to 40 CFR Part 124 or sections 3005(c) or 3005(e)(2) of RCRA. Later, in an August 10, 1989 memorandum entitled *Coordination of Corrective Action Through Permits and Orders* (OSWER Directive 9502.1989(04)), EPA clarified that interpretation by stating that a section 3008(h) order cannot be issued to a facility after final disposition of the permit application.

In practice, the corrective action process is highly site-specific, and involves direct oversight by the reviewing Agency. Unlike the closure process, which provides two options (closure with waste in place and closure by complete removal and decontamination), the corrective action process provides considerable flexibility to the Agency to decide on remedies that reflect the conditions and the complexities of each facility. For example, depending on the site-specific circumstances, remedies may attain media cleanup standards through various combinations of removal, treatment, engineering, and institutional controls.

EPA has codified corrective action requirements at §§ 264.101, 264.552, and 264.553, and currently implements these requirements through the permitting process. EPA also implements corrective action by issuing corrective action orders under section 3008(h) of RCRA. In addition, to facilitate the corrective action process, EPA proposed more extensive corrective action regulations on July 27, 1990, under a new Part 264 Subpart S (*see* 55 FR 30798). The July 27, 1990 Subpart S proposal set forth EPA's interpretation of the statutory requirements at that time. Later, EPA promulgated several sections of that proposal related to temporary units, corrective action management units, and the definition of ''facility'' (*see* 58 FR 8658, February 16, 1993).

On May 1, 1996, the Agency issued a Federal Register notice (61 FR 19432) defining the goals of the corrective action program, and providing guidance on its implementation. The notice also announced the Agency's Corrective Action Initiative and soliciting comment on issues related to the corrective action program. This initiative is a reevaluation effort to identify and implement improvements to the corrective action program, and to focus that program more clearly on environmental results. The notice specified five goals of the Corrective Action Initiative: (1) to create a consistent, holistic approach to cleanup at RCRA facilities; (2) to establish protective, practical cleanup expectations; (3) to shift more of the responsibilities for achieving cleanup goals to the regulated community; (4) to focus on opportunities to streamline and reduce costs; and (5) to enhance opportunities for timely, meaningful public participation.

C. Overview of Proposed Rule

1. Elements of the Proposal That Are Promulgated in This Final Rule

a. Post-closure care under alternatives to permits. The regulations promulgated in this rule were proposed by the Agency on November 8, 1994 (see Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities; Post-Closure Permit Requirement; Closure Process; State Corrective Action Authority (59 FR 55778)). That proposal was designed to give EPA and the authorized States greater flexibility in remediating RCRA facilities by modifying the regulations in several areas.

First, EPA proposed to allow EPA and authorized States to use a variety of legal authorities when addressing facilities that require post-closure care. Under the proposal, the Agency would continue to impose the same substantive groundwater, post-closure care, and corrective action requirements as it would under a permit, and would provide for adequate public participation.

The Agency proposed this change to provide regulators the necessary flexibility to use the best regulatory approach in addressing these sites. Prior to today's rule, section 270.1 required owners and operators of landfills, waste piles, surface impoundments, or land treatment units that received waste after July 26, 1982, or that ceased the receipt of wastes prior to July 26, 1982, but did not certify closure until after January 26, 1983, to obtain post-closure permits (unless they demonstrated that they met the § 270.1 requirements for closure by removal).

In the case of operating land disposal facilities, the RCRA permit, when first issued, incorporates the closure plan and applicable post-closure provisions. These post-closure conditions become effective after the facility ceases to manage hazardous waste and the closure plan has been implemented. The permit, when issued, also requires compliance with Part 264 Subpart F groundwater monitoring standards. Permits issued after November, 1984 also would impose the facility-wide corrective action requirements of RCRA section 3004(u), if necessary.

For interim status facilities that close without obtaining an operating permit, the requirement for a post-closure permit (typically issued after completion of closure) performed an important regulatory function. First, to secure a permit, the facility had to meet the permit application requirements of Part 270, which require extensive information on the hydrogeologic characteristics of the site and extent of any groundwater contamination. Second, once the post-closure permit was issued, the facility became subject to the standards of Part 264 rather than Part 265, most significantly to the site-specific groundwater monitoring requirements of Part 264 Subpart F. Third, the post-closure permit imposed facility-wide corrective action to satisfy the requirements of section 3004(u). Finally, the public involvement procedures of the permitting process assure that the public is informed of and has an opportunity to comment on permit conditions.

The requirement for post-closure permits was promulgated in 1982. At the time, the Agency believed that permits would be the most effective means to develop site-specific groundwater monitoring programs tailored to individual waste management facilities (see 47 FR 32366, July 26, 1982). Since that time, the Agency and the authorized States have issued hundreds of permits to closed and closing interim status facilities. In the course of issuing these permits, EPA and the States have encountered many facilities where post-closure permit issuance proved difficult or, in some cases, impossible. Generally, the Regions and States have encountered two major difficulties when issuing post-closure permits. First, some facilities chose to close, or are forced to close, because they cannot comply with Part 265 standards—particularly, groundwater monitoring and financial assurance. If a facility cannot meet these requirements, EPA cannot issue a permit to it because section 3005(c) of RCRA requires facilities to be in compliance with applicable requirements at the time of permit issuance. Second, owners or operators often have little incentive to seek a post-closure permit. Without a strong incentive on the part of the facility owner or operator to provide a complete application, the permitting process can be significantly protracted.

To address environmental risk at facilities such as those described above, Regions and States have frequently utilized legal authorities other than permits. Use of enforcement actions enables the Agency to place these facilities on a schedule of compliance for meeting financial assurance and/or groundwater monitoring requirements over a period of time. And, even where enforcement actions cannot bring about full regulatory compliance (e.g., where the owner or operator cannot secure financial assurance), they enable the

Agency to prescribe actions to address the most significant environmental risks at the facility. For example, EPA has often issued corrective action orders under the authority of section 3008(h) to address releases from regulated units and/or other SWMUs at these facilities. In other cases, Federal or State Superfund authorities have been used to address cleanup at sites. However, prior to this rule, EPA or the State was still required to issue a post-closure permit even where the environmental risks associated with the facility were addressed through other authorities.

EPA is promulgating, with minor revisions, those provisions of the November 8, 1994 proposal that remove the requirement to issue post-closure permits at each facility, and allow post-closure care requirements to be imposed using either permits or approved alternate authorities. Those provisions are promulgated in this rule in §§ 265.121, 270.1(c), and 271.16, and are discussed in sections III.A. and III.B. below.

b. Remediation requirements for land-based units with releases to the environment. The November 8, 1994 proposal also solicited comment on several issues related to the regulatory distinction between regulated units and SWMUs.

In 1982, when the regulatory structure for closure was established, the Agency had little experience with closure of RCRA regulated units. Since 1982, the Agency and authorized States have approved hundreds of closure plans, and overseen the closure activities taking place under those plans. It has become evident that closure of these units is frequently more complex than EPA envisioned in 1982. In many cases, particularly with unlined land-based units, the unit has released hazardous waste and constituents into the surrounding soils and groundwater. In some cases, the unit may be located near SWMUs or areas of concern that also have released hazardous constituents to the environment. As a result, the cleanup of similar releases may be subject to two different sets of standards and two different sets of procedures. EPA is concerned that this dual regulatory structure may unnecessarily impede cleanups.

In the November 8, 1994 proposal, the Agency addressed this issue by requesting comment on giving discretion to the Agency or the authorized State to impose requirements developed for corrective action in lieu of the requirements of Subparts F (groundwater), G (closure and post-closure), and H (financial assurance) at certain regulated units. After reviewing the comments, which largely supported the concept, EPA has decided to promulgate provisions providing that discretion for certain regulated units, both permitted and interim status, that appear to have released to the environment, if SWMUs also appear to have contributed to the same release. Those provisions are promulgated in this rule in §§ 264.90(f), 264.110(c), 264.140(d), 265.90(f), 265.110(d), and 265.140(d), and are discussed in sections III.A. and III.C. below.

c. Post-closure permit information submission requirements. In the November 8, 1994 rule, EPA proposed to add a new § 270.27 to identify that subset of the Part B application information that must be submitted for post-closure permits. Under that provision, an owner or operator seeking a post-closure permit would have to submit only that information specifically required for post-closure permits under that section, unless otherwise directed by the Regional Administrator. Under the proposal, the information required under § 270.27 would be submitted upon request by the Regional Administrator.

Proposed § 270.27 is promulgated in § 270.28 of this final rule.

2. Elements of the Proposal That Are not Promulgated in This Final Rule

a. State equivalent—corrective action enforcement authority for interim status facilities. The November 8, 1994 proposal also would have required States to adopt enforcement authority equivalent to section 3008(h) corrective action authority as part of their authorized program. Though many commenters supported this portion of the proposal, many State commenters strongly objected to it for several reasons.

Although EPA has the authority to require authorized States to have adequate enforcement programs, the Agency, after considering public comment, has decided not to proceed at this time with the requirement that States adopt section 3008(h)-equivalent authority as part of their authorized enforcement program. EPA believes the States raised significant issues that would need to be resolved prior to promulgation. This is not a final decision on this issue—the Agency may determine at a future date to adopt such a requirement.

EPA notes that States seeking authorization to issue enforceable documents in lieu of post-closure permits will need to submit their alternative legal authorities to EPA for review. As part of that review, EPA will determine whether the State authorities are broad enough to impose facility-wide corrective action at interim status facilities. Submission of these alternative authorities will be required only for States seeking authorization for this rule. It will not be required of all States.

b. Timeframes for closure. The November 8, 1994 proposal requested comment on whether the Agency should make modifications to the closure process, in particular, to the timeframes for closure. The Agency recognized that the current timeframes may, in some cases, not be adequate where the closure is really a cleanup activity, rather than the more straightforward capping or waste removal activities contemplated in 1982.

Though public comment generally agreed that the closure timeframes are not adequate, the Agency is not promulgating this provision of the November 8, 1994 proposal at this time. EPA, however, is promulgating a rule that will allow overseeing agencies to replace closure requirements—including closure timeframes—with requirements developed under corrective action, at some facilities. EPA expects that these revisions will allow site-specific flexibility for timeframes for some of the complex closures, thereby providing, in part, the relief intended by the proposal.

III. Section-by-Section Analysis and Response to Comment

A. Overview of Final Rule

1. Post-Closure Care Under Alternatives to Permits

This final rule creates an optional, new procedural mechanism for imposing requirements on units or facilities that closed without obtaining a permit. It ensures that these units have to meet the same substantive requirements that apply to units receiving post-closure permits.

The post-closure requirements for permitted facilities in Part 264 are more extensive than the analogous Part 265 interim status requirements in three areas: (1) the requirements for submission of information under Part 270; (2) Part 264 Subpart F requirements for groundwater management and corrective action for releases to groundwater; and (3) facility-wide corrective action requirements for releases from SWMUs under § 264.101. To impose equivalent requirements at interim status facilities, EPA or an authorized State must issue an enforceable document that performs many of the functions of a permit. Thus, the enforceable document must impose: (1) the requirements of new

§ 265.121(a)(1), which imposes information requirements that are relevant to closed facilities needing permits only for post-closure care; (2) the requirements of new § 265.121(a)(3), which applies Part 264 groundwater standards to the regulated unit; and (3) the requirements of new § 265.121(a)(2), which imposes facility-wide corrective action consistent with § 264.101.

The remaining requirements that apply during the post-closure care period relate to the maintenance of the closed unit and financial responsibility. The permitting and interim status standards for these requirements are virtually identical. Consequently, these requirements need not be addressed in the enforceable alternative to the permit—rather, the relevant portions of Part 265 Subparts G and H will continue to apply. Post-closure care requirements will normally continue to be set out in the facility's approved closure plan. Financial responsibility requirements are self-implementing. (Of course, EPA or an authorized State may chose to incorporate the Part 265 requirements for post-closure care and financial responsibility into an enforceable document, if they wish.)

The new, non-permit mechanisms provide opportunities for public participation, which differ somewhat from those set out in the permit issuance and modification procedures of Parts 124 and 270. EPA's new requirements reflect the Agency's efforts to provide as much public participation as possible, but also reflect the Agency's awareness that most of the alternate mechanisms used to address corrective action will be enforcement orders.

The current procedures for issuing post-closure permits first provide an opportunity for public comment at the time the permit is issued. This typically means that the public is able to comment on the plan for investigating suspected releases at the facility. Permit modification procedures then provide opportunities to comment at the time the permit authority selects a remedy for the facility. They also provide an opportunity to comment when the permit authority concludes that corrective action is complete. Under the Federal rules used by EPA, opportunities to file administrative appeals are available after each of these steps. (EPA, however, does not require States to provide for administrative appeals of permits).

The new public participation requirements for enforceable documents are codified at § 265.121(b). They require the overseeing agency to provide public notice and an opportunity to comment: (1) when the Agency becomes involved in a remediation at the facility as a regulatory or enforcement matter; (2) on the proposed remedy and the assumptions upon which the remedy is based; and (3) prior to making the final decision that remedial action is complete at the facility. They do not require either EPA or the States to provide opportunities for administrative appeals. EPA recognizes that, at least at the Federal level, this changes the opportunities for public involvement in the requirements that will govern closed hazardous waste facilities. EPA believes these requirements equal, and in some respect exceed, the current permitting requirements for public participation. On the other hand, the new requirements do not require an opportunity for administrative appeal. While this approach to a certain extent lessens the public's opportunity to challenge a decision, EPA believes that rights to administrative appeals (which can be exercised by a regulated facility as well as the public) are inappropriate in an enforcement context.

The final rule defines ''enforceable document'' at § 270.1(c)(7). Generally, Federal orders under section 3008(h) of RCRA and section 106 of CERCLA will fall within this definition and be eligible, as well as State orders issued under authorities reviewed and approved by EPA. Fund-financed actions under section 104 of CERCLA also will be eligible. Closure and post-closure plans, and State enforcement authorities analogous to RCRA section 3008(a) enforcement authority also will be appropriate mechanisms.

Table 1 summarizes these requirements.

TABLE 1.—ENFORCEABLE DOCUMENTS IN LIEU OF POST-CLOSURE PERMITS

Subject	Regulations for permits	Regulations for enforceable documents
Facility Information	§ 270.28	§ 270.28 (*see* § 265.121)
Groundwater Protection	Part 264, Subpart F*	Part 264, Subpart F (*see* § 265.121)*
Corrective Action	§ 264.101	§ 264.101 (*see* § 265.121)
Public Participation	Parts 124 and 270	§ 265.121
Financial Responsibility	Part 264, Subpart H*	Part 265, Subpart H*
Post-Closure Care of Regulated Unit	Part 264, Subpart G*	Part 265, Subpart G*

*For certain land-based units suspected of contributing to releases to the environment, these requirements may be replaced by site-specific requirements developed under corrective action. *See* new §§ 264.90(f), 264,110(c), 264.140(d), 265.90(f), 265.110(d), and 265.140(d) of this final rule.

2. Remediation Requirements for Land-Based Units With Releases to the Environment

The second portion of this final rule provides flexibility to regulators in another area of the RCRA regulations. As described above, two different sets of RCRA requirements arguably apply to a single release if both regulated units and SWMUs have contributed to the release. This rule provides flexibility to harmonize the two sets of requirements by substituting corrective action requirements for requirements for regulated units set out in Part 264 (for permitted facilities) or Part 265 (for interim status facilities). These optional, new provisions are available to regulators at a broad range of RCRA facilities, including, but not limited to, those covered by the change to post-closure permitting described above.

This portion of the rule provides EPA and authorized States with discretion to prescribe alternative groundwater monitoring, closure and post-closure, and financial responsibility standards at both operating and closed facilities, where EPA (or a State) finds that a release of hazardous waste or hazardous constituents has occurred, and both a regulated unit and one or more SWMUs

(or areas of concern [1]) are likely to have contributed to the release.

For permitted facilities, the alternative standards will be issued in the permit (or issued in an enforceable document (as defined in § 270.1(c)(7))), which is referenced in the permit). EPA and authorized States may develop the cleanup requirements for the regulated unit and SWMUs under non-permit authorities, such as CERCLA or a State superfund statute, but they must incorporate them into the permit, or incorporate them into an enforceable document, which is referenced in the permit.

For interim status facilities, EPA or States authorized to implement this portion of this final rule must impose alternative closure, groundwater monitoring, and/or financial responsibility standards for interim status facilities in an enforceable document. ''Enforceable documents'' for this rule include RCRA section 3008(h) orders, actions under sections 104 or 106 of CERCLA, or State actions under authorities reviewed and approved by EPA as described below. If EPA or an authorized State issues alternative closure standards, the facility's closure plan and/or post-closure plan must be amended to set forth the alternative provisions, or to reference the enforceable document that sets forth those provision.

3. Post-Closure Part B Permit Information Submission Requirements

To ensure substantive equivalency of authorities used in lieu of post-closure permits, this final rule requires owners and operators to submit the same information specifically required for post-closure permits, upon request by the Agency, when an alternative authority is used in lieu of a post-closure permit. Section 265.121(a)(1) requires owners and operators obtaining enforceable documents in lieu of post-closure permits to submit the information required in § 270.28.

Section 270.28,[2] which is promulgated in this final rule, establishes information submission requirements for post-closure permits. As is discussed in detail in section III.D. of this preamble, § 270.28 specifies information that the Regional Administrator will request to issue a post-closure permit, and requires owners and operators to submit that information. It includes information the Agency believes will be important for all post-closure permits, that is, groundwater characterization and monitoring data, information related to long-term care of the regulated unit and monitoring systems, and information on SWMUs and possible releases. In addition, recognizing that additional information may be needed on a site-specific basis, § 270.28 also allows the Regional Administrator to require any of the Part B information specified in §§ 270.17, 270.18, 270.20, and 270.21. Section 265.121(a)(1) adopts this approach for alternative mechanisms as well.

B. Post-Closure Care Under Alternatives to Permits

1. Use of Alternative Mechanisms To Address Post-Closure Care (§ 270.1(c))

a. Detailed discussion of final rule. Section 270.1(c), amended by this rule, requires owners and operators closing unpermitted regulated units with waste in place either to: (1) obtain a post-closure permit, or (2) comply with the alternative post-closure requirements of § 270.1(c)(7). Prior to this rule, owners and operators of regulated units requiring post-closure care had to obtain permits for the post-closure period. This rule, by allowing another alternative to post-closure permitting, provides regulators with flexibility to address the post-closure period at RCRA facilities using a variety of legal authorities, including enforcement mechanisms.

Facilities that close with waste in place, without obtaining a permit, and then use non-permit mechanisms in lieu of a permit to address post-closure responsibilities, will have to meet three important requirements that apply to facilities that receive permits: (1) the more extensive groundwater monitoring required under Part 264, as they apply to regulated units; (2) certain requirements for information about the facility found in Part 270 that enable the overseeing agency to implement the Part 264 monitoring requirements; and (3) facility-wide corrective action for SWMUs as required under § 264.101. These requirements are set out in new § 265.121, which applies to interim status facilities requiring post-closure care.

EPA and States authorized for this rule must impose these requirements in enforceable documents, as defined in § 270.1(c)(7) of this rule, if they are being issued in lieu of permits. Federal enforcement orders issued under sections 3008(a) and 3008(h) qualify as enforceable documents. Post-closure plans issued by EPA under § 265.118, which are enforceable under section 3008(a), also will qualify. Orders issued under section 106 of CERCLA will also be eligible, as will decision documents describing response actions under CERCLA section 104. Although response actions under section 104 are often carried out by EPA using monies from the Superfund, rather than by responsible parties under orders, it is reasonable to rely on them because EPA is responsible for carrying out the cleanup work. EPA does not intend this rule to revise the existing policy to defer from listing on Superfund's National Priorities List (NPL) those facilities that are subject to RCRA corrective action. However, since the policy permits the listing of some RCRA facilities on the NPL (such as bankrupt or recalcitrant facilities), some of the facilities subject to this rule may also be eligible for cleanup under CERCLA section 104, and EPA (or an authorized State) may wish to rely on the CERCLA action to discharge the facility's cleanup responsibilities.

States obtaining authorization for this rule will be able to use enforceable cleanup orders similar to EPA's section 3008(h) orders, as well as State superfund authorities. EPA has not yet formally reviewed these State cleanup authorities, so it will require States that wish to use them to submit them for review as part of the State authorization process. EPA will determine whether they provide: (1) the substantive requirement of adequate authority to compel cleanup of all releases from SWMUs within a facility's boundary, as needed to protect human health and the environment (*see* new § 265.121(a)(2)), and (2) procedural requirements to ensure compliance (i.e., adequate penalty and injunctive authority to address failures to comply)(*see* new § 271.16(e)). EPA does not anticipate that plans for truly ''voluntary'' cleanups will meet the enforceability requirement, although it is willing to look at mechanisms called ''voluntary'' plans or agreements to determine whether the State has adequate authority to compel compliance. (EPA emphasizes that this rule does not preclude the use of State ''voluntary'' authorities to address cleanup at RCRA facilities and, indeed, EPA encourages their use under the appropriate circumstances. Nor does it affect the ability of EPA Regions to enter into memoranda of agreement or other mechanisms promoting the use of State voluntary programs at RCRA facilities, where appropriate. This rule only

[1] Area of concern means any area of a facility under the control or ownership of an owner or operator where a release to the environment of hazardous wastes or hazardous constituents has occurred, is suspected to have occurred, or may occur, regardless of the frequency or duration (*see* final RCRA section 3008(h) Model Consent Order, December 15, 1993).

[2] This provision was promulgated as § 270.72.

addresses the question of whether the State uses these authorities to satisfy the post-closure permit obligation.)

EPA expects that, in some cases, the overseeing agency or agencies will choose to use more than one mechanism to ensure that the substantive post-closure requirements in new § 265.121 are imposed. For example, if EPA were addressing a facility with releases at SWMUs and a regulated unit with no release, it could issue a section 3008(h) order to address the releases from the SWMUs. EPA, however, might decide that such an order would not be the most effective means of imposing long-term groundwater monitoring requirements for the non-leaking regulated unit. The new requirements could be imposed on the regulated unit in a revised interim status post-closure plan. Alternatively, EPA could issue a section 3008(a) order to enforce the new requirements (codified in this rule at § 265.121). Sometimes, multiple agencies may be involved. For example, a State that does not have a cleanup order authority could revise an interim status post-closure plan (or issue a State enforcement order analogous to section 3008(a)) to address a regulated unit, and rely on an EPA section 3008(h) order to address any releases from SWMUs.

Facilities subject to the new § 265.121 will remain subject to all other applicable interim status requirements, including requirements for financial assurance. These remaining interim status requirements are virtually identical to permit requirements, so there is no need to address them in the new alternatives to post-closure permits. These interim status requirements will continue to be enforceable under section 3008(a) and analogous State authorities.

Facilities subject to the new § 265.121 also will remain subject to section 3008(h) authority unless or until EPA or the authorized State issues a final disposition of a permit application under § 270.73, thereby terminating interim status at the facility. It should be noted that in a Federal Register notice dated May 1, 1996 (61 FR 19432, at 19453–4) EPA erroneously stated that facilities at which the regulated units clean closed under interim status no longer have interim status. EPA corrects that statement in this rule and restates the Agency's longstanding position that interim status is terminated only by a final disposition of a permit application, or by the methods outlined in § 270.73, which do not include clean closure. The May 1, 1996, Federal Register notice correctly stated that section 3008(h) continues to apply at clean closed facilities where there has been no final disposition of a permit application. Similarly, section 3008(h) continues to apply at facilities addressed through an approved alternate authority until final disposition of a permit application under § 270.73. Issuance of an alternate mechanism does not terminate interim status authorities.

b. Response to comment. Commenters on the proposed rule largely supported the provisions that would remove the permit requirement. Many commenters agreed with the Agency that the rule allows flexibility to regulators, yet maintains protection of human health and the environment.

Some commenters objected that the Agency should have the authority to issue an order or a permit, but should not be able to issue an order, and later to issue a permit to the facility. EPA disagrees. The Agency currently has the authority to issue a permit after the facility is addressed through an alternate authority, such as an enforcement order. This rule does not modify the Agency's authority to issue permits in this situation. Rather, it takes away the permitting obligation in cases where the facility is addressed through an alternate mechanism, by making the permit one of several options to address the facility. EPA believes this approach makes sense, and allows EPA to chose the best available mechanism, while retaining authority to use whatever authority is necessary to protect human health and the environment. EPA notes, however, that it is not likely to issue a permit to impose requirements that a facility has already satisfied under an alternate, enforceable document. Rather, it would limit a permit to requirements that, for some reason, had not been fully satisfied.

Several commenters expressed concern over discussion in the preamble of the November 8, 1994 proposal related to uncooperative facilities. The preamble explained that where the owner or operator is financially incapable of meeting the threshold requirements for permit issuance, such as compliance with the financial assurance requirements, or where the owner or operator may be uncooperative and an enforcement action is necessary, the post-closure permit is likely not the best mechanism to use. The preamble further explained that a post-closure permit will generally be the preferable mechanism for cooperative facilities capable of meeting financial assurance requirements.

Several commenters interpreted this discussion to limit the use of alternate mechanisms to uncooperative facilities not in compliance with applicable financial assurance and groundwater requirements. Commenters objected that facilities should not be rewarded for non-compliance, and that the proposal was making the post-closure care process more burdensome for compliant facilities. Other commenters thought the Agency was proposing to exempt non-compliant facilities from certain requirements.

The Agency did not intend to limit the use of alternate authorities to facilities not in compliance with applicable RCRA requirements. EPA only identified these facilities as examples of where an enforcement mechanism was more appropriate than a permit. Furthermore, EPA does not consider the imposition of alternative enforcement authorities to be a ''reward,'' since such authorities might often include stipulated penalties and, in any case, would impose the same substantive standards as a permit. EPA will retain section 3008(a) authority to enforce against closed interim status facilities that have failed to meet Part 265 financial assurance requirements. As to groundwater monitoring, this rule will substitute the stricter Part 264 requirements for the original Part 265 requirements. EPA will retain authority to use section 3008(a) to enforce past violations of the Part 265 monitoring requirements and to assure that the facility complies with Part 264 requirements once they are put in place by a revised interim status post-closure plan (or other enforceable mechanism). The rule will also require facility-wide corrective action as required under permits. More important, EPA notes that the new authority to use alternatives to post-closure permits is not limited to facilities that are out of compliance with Part 265 requirements. All facilities that have closed (or that, in the future, will close) with waste in place without obtaining a permit are eligible.

Many commenters objected that this preamble discussion appeared to remove the interim status groundwater and financial assurance requirements at facilities not in compliance with the regulations. However, the Agency did not eliminate interim status financial assurance requirements. Facilities addressed through alternate mechanisms remain subject to the financial assurance requirements of Part 265 Subpart H. They become subject to the more prescriptive groundwater requirements of Part 264 Subpart F. Rather than waive requirements at non-compliant facilities, as commenters believe, this rule continues to require compliance with upgraded requirements.

Some commenters believed that the choice of mechanism should be left to the facility, or that the options should

be discussed at length to achieve consensus. These commenters believed that an otherwise reluctant owner or operator is more likely to commit resources to meet agency goals if regulatory alternatives and consequences are clearly discussed and understood up-front.

Other commenters believed that the regulations should specify when an alternative authority would be used in lieu of a permit, and remove some of the Agency's discretion.

EPA did not take either approach suggested by these commenters. EPA agrees with commenters that the owner or operator generally should be involved in discussions related to the selection of mechanisms. This is particularly true of cooperative facilities in compliance with applicable requirements and eligible for post-closure permits. EPA intends to take into consideration the preference of facility owners and operators in deciding how to address these facilities, and it encourages authorized States to do so as well. However, EPA believes that it is important to provide the Agency and authorized States flexibility to consider all factors when deciding what authority to use to address a site. These factors will include conditions at the site, the availability of alternate State authorities, availability of resources, preference of the owner or operator and the local public, and the compliance status of the owner or operator. The Agency believes that by attempting to establish criteria in this rule, it would unnecessarily limit the flexibility to make the decision that best ensures protection of human health and the environment at each site.

Some commenters believed the owner or operator should have opportunity to challenge the Agency's or authorized State's choice of mechanism. EPA disagrees, and believes that the choice of mechanism to use to address a facility is an inherently governmental decision that should not be subject to challenge. EPA believes this approach is consistent with longstanding policy on enforcement discretion, and is vital to an effective enforcement program.

This rule limits the use of alternate mechanisms to facilities that have not received permits. Some commenters believed that the Agency should modify the rule to allow permits to be converted to orders and allow owners or operators of permitted facilities to address the post-closure period through another mechanism.

EPA has not adopted the commenter's suggestion, as this rulemaking deals only with alternative mechanisms for closed facilities that have not yet received post-closure permits. It should be noted that existing §§ 264.117(a)(2)(i) and 265.117(a)(2)(i) address commenters' concern to some extent by allowing the Agency to shorten the post-closure period upon a determination that the shortened period is protective of human health and the environment.

Another commenter suggested that EPA should be allowed to use alternative authorities at closed facilities, needing post-closure permits, that have submitted a Part B permit application. The Agency agrees that it should not be precluded from using alternative mechanisms at these facilities so long as it has not issued a Part B permit.

Some commenters objected to the provisions of the rule that would remove the requirement that EPA use the post-closure permit as the vehicle to impose Part 264 requirements for post-closure care. One commenter believed that the Agency should use enforcement orders to overcome the obstacles to permitting it described (such as non-compliance with financial assurance requirements). This commenter believed that post-closure permitting is protracted because EPA has not used its enforcement authority to move facilities through the permitting process, and has not made issuing post-closure permits a priority.

EPA disagrees with this commenter. There are many facilities in the RCRA universe that are not able to meet the financial assurance requirements of Subpart H. While EPA can take enforcement actions against these facilities to bring them into compliance to the extent possible, there are some facilities that never will be able to meet those requirements, despite an enforcement order. As was explained above, EPA will not be able to issue permits to such facilities. Further, the Agency believes that the flexibility provided by this rule is important, not only to address non-compliant facilities, but to allow regulators to use the most appropriate authority available to them at all facilities. This choice may be based on many factors, including the specific conditions at the facility, availability of approved alternate State cleanup authorities, and recalcitrance of the facility. Thus, while the Agency agrees with the commenter that it is important to take enforcement actions against facilities to bring them into compliance whenever possible, and that enforcement authorities should be used to expedite the permitting process, it does not agree that post-closure permits should or can be issued to all facilities. Further, EPA is more interested in obtaining environmental results than in the choice of mechanism used, and in eliminating redundant processes.

Other commenters believed that the Agency remains subject to the permit deadline for land disposal facilities in RCRA section 3005(c)(2)(A)(i). Those commenters believed that revisions to the rules that reduce the existence of or scope of this mandatory duty to issue post-closure permits in a timely manner violate section 3005(c) of RCRA, and that Congress enacted the permit deadlines based upon the rules then in effect.

EPA agrees that section 3005(c) of RCRA required the Administrator to issue or deny a final permit for each applicant for a land disposal permit by November, 1988. EPA also agrees that, so long as its regulations require it to issue post-closure permits to land disposal facilities, those post-closure permits are subject to the statutory deadline. EPA, however, does not agree that section 3005(c) deprives it of authority to determine whether post-closure permits are necessary or desirable means of imposing post-closure care requirements. Section 3005(c) imposes a deadline for permitting, but does not define the scope of the permitting requirement.

In 1982, when EPA promulgated the post-closure permit requirement, it had discretion under the statute to choose a procedural mechanism for imposing post-closure care requirements on facilities that closed while in interim status. It selected permits rather than interim status closure plans or other alternatives. The fact that Congress enacted a deadline for issuing permits to land disposal facilities in 1984 did not change that discretion. Nothing in the statute or the legislative history of the section 3005(c) indicates that Congress was aware of or concerned about EPA's use of permits to impose post-closure care requirements at facilities closing under interim status. The legislative history of other portions of the 1984 amendments suggests that Congress was concerned that EPA's 1984 regulations for land disposal facilities imposed more stringent requirements for ground-water monitoring and closure on permitted facilities than on interim status facilities. EPA, however, has eliminated this discrepancy, amending the rules for closure on March 19, 1987 (*see* 52 FR 8704), and the rules for groundwater monitoring today.

Essentially, this commenter argues that Congress ''ratified'' EPA's 1982 post-closure permit rule, making it part of the statute so that EPA could no longer revisit it. EPA does not agree with this interpretation of section 3005(c). Nothing in the statute or the

legislative history suggests that Congress wanted to prohibit EPA from revising this part—or, indeed, any part—of the rules defining the scope of the permit requirement. The same is true for the requirement for public participation in permitting set out in section 7004(b)(1) of RCRA. There is no evidence that Congress intended the public participation requirements to create a statutory duty to issue post-closure permits.

EPA acknowledges that it could deny post-closure permits for all of the land disposal facilities that obtain enforceable documents in lieu of post-closure permits. Permit denials would satisfy the requirement of section 3005(c) to issue or deny final permits. EPA, however, does not believe that Congress intended it to impose a deadline on the denial of permits for facilities no longer obligated to have them. The Agency believes it is simply not reasonable to interpret the statute to require EPA to spend scarce resources on actions with so little environmental significance.

Other commenters questioned whether issuance of an alternate mechanism would terminate interim status. This rule does not modify the requirements to terminate interim status, which are outlined in § 270.73. Thus, facilities that have units that closed with waste in place under interim status, and do not receive a post-closure permit as a result of this rule, will remain in interim status until there is final disposition of a permit application (in the case of these closed facilities, a permit denial) under § 270.73(a). EPA recognizes that owners and operators may want to terminate interim status when all RCRA activities are complete at a facility to bring finality to those activities, and that this is an important issue not only to facilities subject to post-closure requirements, but to all facilities that closed without obtaining a RCRA permit. EPA plans to issue guidance related to denial of permit applications for purposes of terminating interim status at closed facilities that have completed all RCRA activities, including facility-wide corrective action.

The Agency agrees that some integration of the closure and facility-wide corrective action requirements is warranted. The Agency has taken steps in this final rule to address the situation where two units are involved in the same remedy and there is potential for the two sets of requirements to conflict.

Other commenters raised concerns that the rule would affect EPA's current policy of using only one authority—CERCLA or RCRA—at a site. Another commenter conditioned support for the proposal on EPA clarifying that it does not intend to modify its current Superfund policy that defers remediation activities to RCRA corrective action authority. On June 10, 1986, EPA published a final policy that allowed the Agency to defer listing RCRA-related sites on Superfund's National Priorities List (*see* 51 FR 21054). This commenter is concerned that if the Agency adopts the rule as proposed, which would allow use of Superfund orders as an alternative mechanism for RCRA post-closure permits, then the Agency would begin to deviate from that policy. The commenter believes that the reasons for deferral to RCRA authority cited in the deferral policy are still valid.

This rule does not modify the Agency's current policies related to the applicability of CERCLA and RCRA at hazardous waste sites. For example, the rule does not affect CERCLA listing policy. The Agency expects that RCRA facilities will, generally, continue to be handled under RCRA, rather than CERCLA. Rather, the result of this rule is that once the Agency decides to address a site under CERCLA authority, EPA is no longer required to issue a post-closure permit at the site, as long as the CERCLA cleanup has the same scope as a corrective action cleanup would have.

2. Requirements for Alternative Mechanisms

Under the provisions of this rule that remove the requirement for post-closure permits, regulated units that do not obtain a post-closure permit generally will remain subject to the requirements for interim status units throughout the post-closure care period. However, because the interim status post-closure care requirements are in some respects less stringent than post-closure permit requirements, the Agency is promulgating § 265.121. This section recognizes the difference in substantive requirements applicable to permitted and interim status post-closure units, and assures that this rule will not result in less stringent requirements at units addressed through alternate mechanisms.

Specifically, § 265.121 requires owners and operators of regulated units addressed through an alternate mechanism to comply with the groundwater requirements of Part 264 Subpart F (with respect to that unit), to submit information required under Part 270, and to address facility-wide corrective action. EPA will review State order authorities to ensure that they are capable of imposing these requirements before authorizing States to use them.

a. Part B Information Submission Requirements (§ 265.121(a)(1)). i. *Overview.* To ensure substantive equivalency of authorities used in lieu of post-closure permits, this rule requires owners and operators to submit the Part 270 information specifically required for post-closure permits, upon request by the Agency, when an enforceable document is issued in lieu of a post-closure permit. The information submission requirements for post-closure permits are promulgated in this final rule in § 270.28, and are discussed in detail in section III.D. of this preamble. Section 270.28 specifies information the Agency believes will be important for all post-closure permits, and, in turn, for all enforceable documents issued in lieu of post-closure permits, that is, groundwater characterization and monitoring data, information related to long-term care of the regulated unit and monitoring systems, and information on SWMUs and possible releases.

In addition, recognizing that additional information may be needed on a site-specific basis, § 270.28 also allows the Regional Administrator to require any of the Part B information specified in §§ 270.17, 270.18, 270.20, and 270.21. Section 265.121(a)(1) adopts this approach for enforceable documents issued in lieu of post-closure permits as well.

ii. *Response to Comment.* One commenter asked EPA to state explicitly in the rule that facilities pursuing the alternative approach would not be required to submit the information required in § 265.121(a)(1) any earlier than they would otherwise be required to submit a Part B application. EPA agrees with the commenter that the information would not be required earlier in the case of an alternate authority than it would be in the case of a permit. In the case of post-closure permits, the Agency typically calls in Part B information when it is ready to begin working on the permit application. This has become the Agency's practice because the Agency recognizes that, if information is submitted earlier, it can become outdated and have to be replaced when it is time to work on the permit. The Agency is extending this practice to instances where a non-permit mechanism is used to address post-closure care. As in the case of the post-closure permit, the information required by § 265.121(a)(1) for non-permitted facilities need not be submitted to the Agency until the Agency requests it.

b. Subpart F Groundwater Monitoring and Corrective Action Program (§§ 265.121(c)(3) and 264.90—264.100). i. *Overview.* This rule requires owners and operators of facilities with regulated units addressed through a non-permit mechanism under § 270.1(c)(7) to meet the requirements of Part 264, Subpart F. Section 265.118(c)(4) requires that the post-closure plan include provisions that implement the Part 264 Subpart F requirements.[3] This approach is designed to ensure equivalent protection of human health and the environment at all facilities, regardless of which legal authority used to address post-closure care. Commenters generally supported this approach, and the Agency is promulgating this provision as proposed.

ii. *Response to Comment.* Though many commenters supported the proposed provision, others argued that it was an illegal expansion of the Agency's statutory authority. EPA disagrees. The statute does not limit EPA's ability to impose more stringent groundwater monitoring requirements on interim status facilities. EPA developed the current regulations based on the premise that facilities would remain in interim status only temporarily and ultimately would receive permits and become subject to the requirements of Part 264 for groundwater. As a result of this rule, however, some facilities that closed while still under interim status standards will not receive a permit. EPA believes it is within the Agency's statutory authority to modify the regulations and assure that those facilities ultimately comply with the more stringent requirements of Part 264, whether a permit is issued or an alternate authority is used to address post-closure care.

One commenter conditioned support for the proposal on EPA removing Part 264 groundwater requirements for regulated units, and requiring instead that they have a groundwater monitoring and response program that is necessary to protect human health and the environment.

In the second part of this rule, EPA is providing discretion to waive Part 264 groundwater monitoring only in cases where corrective action will provide opportunities for oversight by the implementing Agency. In other cases, the Agency continues to believe that it needs the detailed requirements of Part 264, with interaction with the overseeing agency, to ensure protection of human health and the environment. In proposing to modify the requirement for post-closure permits, the Agency did not intend to remove or modify the groundwater requirements applicable to regulated units under post-closure permits—only to allow regulators to use a variety of mechanisms to impose those requirements. Thus, EPA believes that commenter's request extends to issues that are outside the scope of this rulemaking.

c. *Facility-Wide Corrective Action (§ 265.121(a)(2)).* i. *Overview.* This rule requires that authorities used at post-closure facilities as alternatives to post-closure permits impose corrective action requirements consistent with the statute and § 264.101 of the regulations. The rule does not specify the authorities that EPA or a State could use to impose corrective action as an alternative to a post-closure permit—only that the authority must be consistent with RCRA corrective action requirements. Certainly, RCRA section 3008(h) orders are appropriate, but EPA has not limited alternative authorities to this section. State enforcement authorities analogous to section 3008(h) or State cleanup or superfund authorities also would be appropriate, if they were used consistently with the requirements of § 265.121 (*see* requirements for State authorization in section IV.D.1. of this preamble).

In requiring facility-wide corrective action consistent with RCRA section 3004(u) and (v) provisions, EPA does not intend to require that cleanup programs relying on alternative authorities use the procedures of EPA's Subpart S proposal (which the Agency significantly revised in its May, 1996 ANPR) or permit requirements. Rather, the authorities must be broad enough to meet the performance standards of § 264.101. For example, compliance with the National Contingency Plan (NCP) procedures for remedy selection would satisfy these proposed requirements. EPA wishes to emphasize, however, that an alternative approach to corrective action at a facility, used in lieu of a permit, must include a facility-wide assessment, must address releases of hazardous wastes or constituents to all media from all SWMUs within the facility boundary (as well as off-site releases to the extent required under section 3004(v)—as necessary to protect human health and the environment), and must be protective of human health and the environment. Anything less than that, in EPA's view, would not meet the basic requirements of RCRA sections 3004(u) and (v) or § 264.101. EPA believes that this proposed approach is appropriate because it provides reasonable flexibility for regulatory agencies using available authorities to address environmental problems at RCRA sites.

ii. *Response to Comment.* Commenters generally supported this provision, and many commenters agreed that the Agency should not require corrective action procedures identical to those in EPA's Subpart S proposal.

Some commenters objected to the principle that corrective action be consistent with the Subpart S proposal. These commenters believe that because the Subpart S requirements and procedures are not final, it is legally indefensible to base a rule on them. Another commenter believed that until Subpart S regulations are codified and adopted, corrective action clean-up standards should meet the RCRA closure performance standard.

EPA agrees that alternative authorities used to address corrective action should be consistent with promulgated standards and with the statute. EPA did not intend this rule to require compliance with portions of the Subpart S proposal that have not yet been made final. Rather, this rule requires that the authorities must be consistent with promulgated § 264.101. It should be noted that authorities consistent with § 264.101 include provisions originally proposed under Subpart S, that is, provisions allowing designation and use of corrective action management units (§ 264.552) and temporary units (§ 264.553).

3. Public Involvement (§ 265.121(b))

a. Overview. The public involvement provisions proposed in the November 8, 1994 rule are modified in this final rule. In the November 8, 1994 rule, the Agency proposed to require a minimum level of mandatory public participation for all facilities where alternate authorities were used in lieu of post-closure permits. Proposed § 262.121(b) would have established the following requirements at the point of remedy selection: (1) public notification of the proposed remedy through a local newspaper; (2) opportunity for public comment (at least 30 days); (3) availability of a transcript of the public meeting; (4) availability of a written summary of significant comments and information submitted, and the EPA or State response; and, (5) if the remedy is significantly revised during the public participation process, a written summary of significant changes or opportunity to comment on a revised remedy selection. The Agency proposed an exception to these requirements in

[3] Note that §§ 264.90(f) and 265.90(f) of this rule amend the requirements of Subpart F to allow the Regional Administrator to replace Subpart F requirements at regulated units with requirements developed through a corrective action process, in some cases (*see* section III.B. of this preamble).

§ 265.121(b)(2), whereby if a delay in the implementation of the remedy would adversely affect human health or the environment, EPA could delay the implementation of the public involvement requirements.

This final rule requires the Regional Administrator to assure that a meaningful opportunity for public involvement occurs, which includes, at a minimum, public notice and opportunity for comment, at three key stages—when EPA or the authorized State agency first becomes involved in the cleanup process as a regulatory or enforcement matter, when EPA or the authorized State Agency is ready to approve a remedy for the site (this opportunity must include a chance to comment on the assumptions on which the remedy is based), and when EPA or the authorized State is ready to decide that remedial action is complete at a facility. The rule does not limit public involvement to these stages of cleanup; rather, it encourages early, open, and continuous involvement of the public when alternate authorities are used at a facility in lieu of post-closure permits, similar to the public involvement provided by the permitting process. In addition to notifying the public at these three key stages, EPA believes meaningful public involvement includes regular updating of the community on the progress made cleaning up the facility.

Additionally, it is the Agency's expectation that owners and operators conducting cleanups prior to the Agency's or authorized State's involvement will involve the public in decisions throughout the remediation process. Owners and operators should provide notice and opportunity to comment prior to selecting a remedy if they wish to later rely on that remedy as part of an enforceable document issued in lieu of a post-closure permit. The Agency took this approach based on several considerations.

First, it is EPA's policy to encourage public involvement early and often in the permitting process, in its remediation programs, as well as in other Agency actions. EPA wanted this rule to be consistent with that policy.

Second, EPA recognized that the post-closure permit process assures opportunity for public involvement at the time of permit issuance, and through the permit modification procedures. EPA wanted this rule to provide similar opportunities when an alternate authority is used to address a facility.

Third, EPA recognized that existing State and Federal authorities provide for public involvement through widely varying processes. EPA wanted to provide sufficient procedural flexibility to minimize the likelihood that States would have to modify the public involvement provisions of their existing cleanup programs to qualify for authorization, yet EPA wanted to assure, at the same time, that those programs provided for meaningful public participation at key stages of the remediation process.

Fourth, EPA recognizes that many cleanup activities have taken place prior to promulgation of this rule and others will take place prior to the adoption of the State's program for this rule through Federal, State, and facility-initiated actions, and EPA recognizes that those cleanups may or may not have involved the public in the way specified in the final rule. In cases where the cleanup began prior to the effective date of the rule, EPA did not want to require post-closure permits to be issued simply because the early stages of public involvement procedures of this rule were not met.

Finally, EPA recognized that in some cases, where delay in a cleanup might have an impact on human health and the environment, public involvement may not be possible prior to implementation of the remedy. EPA did not want to delay cleanup in those cases, but wanted to assure that the public was involved in the process as promptly as possible after the emergency was addressed. EPA wanted this rule to allow cleanups to take place immediately in these cases, but assure that public involvement would follow at the earliest opportunity. As explained below, the final rule authorizes EPA or the authorized State to modify public involvement requirements in those circumstances.

This rule encourages early public involvement by requiring public involvement (which at a minimum includes public notice and opportunity for comment) as soon as the authorized regulatory agency becomes involved in the cleanup process as a regulatory or enforcement matter (unless this might lead to a delay in the cleanup that would adversely affect human health and the environment). In most cases, the Agency anticipates, this will be very early in the process, prior to remedy selection—certainly before any Agency-prescribed remedies occur (except in cases of emergency). For example, the affected community should be notified and given an opportunity to comment prior to the initiation of any activity to assess contamination or prior to the implementation of any interim measure. By requiring early public notice of activities at a site, the Agency intends this rule to encourage involvement of the public throughout the cleanup process.

EPA proposed to require public involvement during the remedy selection process. EPA is retaining this requirement in the final rule. EPA has, however, made the requirement more specific by requiring public notice and comment on both the proposed remedy and the assumptions upon which it is based, including site characterization and land use.

The Agency understands ''remedy selection'' as a term of art in the RCRA corrective action or in the Superfund process, where the regulatory agency either selects or approves a remedy proposed by the owner or operator. In some cases an owner or operator may implement an action that could be considered a ''remedy'' prior to the Agency or State's involvement or oversight. The owner or operator should provide notice and opportunity to comment on the prospective remedy and its underlying assumptions, otherwise, any enforceable document developed later may not be eligible to substitute for a post-closure permit. In those cases, the owner or operator may have to follow the permit process to obtain a post-closure permit or to obtain a permit denial (if no further action is necessary).

This rule also requires public involvement to assure that notice and opportunity to comment take place prior to the Agency or authorized State deciding that remedial action is complete at a facility. When additional corrective action is no longer needed, the Agency could terminate an enforcement order or terminate interim status at the facility through the permit denial process in Part 124. Either process would ensure full opportunity for public participation, including permit appeal provisions. The rule, however, would allow alternative mechanisms, as long as the Agency or the authorized State provided public notice of its actions, and opportunity to comment prior to making the final decision that remedial action is complete at the facility.

This rule also requires that all public involvement be meaningful. Meaningful public participation is achieved when all impacted and affected parties have ample time to participate in the facility cleanup decisions. In many cases meaningful public involvement will require careful planning and more than notice and opportunity for comment. In some cases, meaningful public notice may require bilingual notifications or publication of legal notices in city or community newspapers (or other media, such as radio, church organizations and

community newsletters). EPA recommends that parties responsible for involving the public provide information at all key milestones in the remediation process, and site fact sheets. Existing forums of community communication such as regular community meetings and electronic bulletin boards can be used to provide regular progress reports on the facility cleanup. Additionally, EPA recommends that parties responsible for involving the public update the community regularly on the progress made cleaning up the facility.

Often, the level of public involvement will depend on the significance of the action—for example, the Agency may simply notify the public of a decision to remove a small quantity of waste, but higher levels of involvement would be called for at remedy selection in a major remedial action, or when a decision is made that may impose significant restrictions on land use. For these reasons, EPA believes that public involvement should be tailored to the needs at the site, and has provided flexibility in this rule.

EPA has long recognized that the level of public involvement should be determined by the significance of the action taking place. For example, in a final rule dated May 24, 1993 (*see* 58 FR 29886), EPA promulgated regulations to govern modification of permits. Those regulations established different levels of public involvement depending on the significance of the permit modification. Class 1 modifications require minimal public involvement—the permittee must send a notice of the permit modification to all persons on the facility mailing list, and to the appropriate units of State and local government. Persons may request review of the permit modifications. Class 3 modifications, on the other hand, require far more extensive involvement of the public—publication in a local newspaper, a public meeting, and a public comment period. To assist owners and operators in implementing the rule, in Appendix 1 to § 270.42, EPA classified different activities as class 1, 2, or 3 modifications, based on the significance of the action.

EPA also issued guidance on public involvement which complements the approach in this rule (*see* the RCRA Public Participation Manual, September, 1996, EPA 530–R–96–007). This manual provides guidance on addressing public participation in the permit process, including permitting and enforcement remedial action activities. It emphasizes the importance of cooperation and communication, and highlights the public's role in providing valuable input. It stresses the importance of early and meaningful involvement of the public in Agency activities, and of open access to information. In addition to the manual, EPA fully endorses The Model Plan for Public Participation, developed by the Public Participation and Accountability Subcommittee of the National Environmental Justice Advisory Council (a Federal Advisory Council to the U.S. Environmental Protection Agency). The Model Plan encourages public participation in all aspects of environmental decisionmaking. It emphasizes that communities, including all types of stakeholders, and regulatory agencies should be seen as equal partners in any dialogue on environmental justice issues. The model also recognizes the importance of maintaining honesty and integrity in the process by clearly articulating goals, expectations and limitations. EPA encourages regulators and owners and operators implementing the provisions of this final rule to refer to these guidances.

It should be noted that the Agency proposed in § 265.121(b)(2) to allow the Regional Administrator to delay or waive the public participation requirements upon a determination that even a short delay in the implementation of the remedy would adversely affect human health or the environment. EPA believes this flexibility is important to assure protection of human health and the environment, and has promulgated that provision, with minor revisions, in this final rule.

It also should be noted that the Agency proposed a § 265.121(b)(3), which would have allowed EPA to address a facility using an approved alternate authority where cleanup activities were conducted prior to the effective date of this rule, but the public involvement procedures of this rule were not met. That provision would have required the Agency to conduct public involvement before considering the facility fully addressed under § 270.1(c)(7)(ii). The Agency has retained this provision.

b. Response to Comment. EPA received a variety of comments on the public involvement provisions of this rule. Some commenters believed the Agency had not gone far enough to assure public participation when alternate authorities are used in lieu of permits; others agreed with the Agency's approach; and others believed the public participation provisions of the proposal were too stringent. EPA considered those comments in developing the public involvement provisions of this final rule. Those comments are discussed below.

i. *The proposed rule did not preserve public involvement procedures when an alternate mechanism is used.* Many commenters believed that, despite statements in the preamble to the contrary, the Agency had not gone far enough in the proposed rule to preserve the public involvement procedures when alternate authorities are used in lieu of post-closure permits. These commenters believed that if the Agency allows alternate authorities to replace post-closure permits, it should assure that the public involvement procedures of the alternate authority are equivalent to that of a permit. These commenters believed that the proposal failed to do so in several respects.

First, these commenters noted that public participation was required by the proposal only at the time of remedy selection. Commenters pointed out that remedy selection occurs at a later stage of the remedial action process, following the development of schedules of compliance, and the preparation and evaluation of plans, reports, and remedial investigations. They pointed out that many decisions have already been made by the point of remedy selection, and that earlier public involvement allows more meaningful opportunity to affect those decisions. Commenters noted that when remedial action is implemented through a permit, these steps are subject to public participation requirements, through either permit issuance or permit modification procedures.

EPA agrees with the concerns raised by these commenters and that the public should be included in the decisionmaking process as early as possible. EPA agrees that early public participation provides the community a more meaningful role in the process.

To address these concerns, this rule requires public involvement to begin when the authorized agency first becomes involved in the cleanup process as a regulatory or enforcement matter. The Agency anticipates that, in most cases, this will be very early in the cleanup process, prior to proposed remedy selection.

Second, several commenters objected that no rights of appeal are provided or guaranteed when an alternative mechanism is used in lieu of a permit, even though such rights are provided in the permitting process. These commenters believed that these appeal rights must be preserved as part of the final rule for alternative mechanisms to be as protective as the post-closure permit. These commenters pointed out that under existing procedures, a hearing is available under Part 124 procedures to challenge a permit, while

EPA hearing procedures established for the respondent only under section 3008(h), Part 24 are less formal and comprehensive. Also, no pre-enforcement review is available for CERCLA 106 orders. These commenters believe that an alternate authority used in lieu of a post-closure permit should be reviewable under Part 124.

EPA recognizes that this rule does not guarantee pre-enforcement review of remedies implemented through alternate authorities. However, neither RCRA nor the Administrative Procedure Act require EPA to provide opportunities for the public to obtain judicial review of enforcement orders. For example, no such review is required under section 3008(h). Further, EPA believes that the ability to require prompt cleanup is important to assuring protection of human health and the environment. The new rule will make it easier to require cleanup at facilities where permit issuance would have been difficult or impossible. Thus, on balance, the rule promotes environmental protection. Finally, issuance of these alternatives orders does not terminate interim status. To terminate interim status, the Agency must make a final permit determination under the procedures of Part 124, and that decision, like a decision to issue a permit, is reviewable. Members of the public who believe that additional cleanup is required to meet the requirements of § 264.101 can raise that issue at that time.

One commenter objected that the proposal is at odds with Executive Order 12898, which instructs EPA to ensure greater public participation by minority and low-income populations at hazardous waste sites. This commenter expressed concern that the rule as proposed would further isolate vulnerable populations from the decisionmaking process.

EPA disagrees with commenter that the effect of this rule will be to isolate minority and low-income populations from the decisionmaking process. EPA has promulgated requirements in this final rule that assure meaningful involvement of the public in cleanups at post-closure facilities regardless of the mechanism used. These requirements will apply to all post-closure facilities, and will benefit all populations, including minority and low-income. In addition, EPA emphasizes that it will implement the rule in full compliance with Executive Order 12898. Other commenters pointed out that Part 124 requires a 45-day public comment period, while the proposal required only 30 days. Some commenters believed that the procedures associated with alternative post-closure mechanisms should follow the public participation procedures associated with permit issuance to make sure coverage is adequate and consistent. One commenter suggested that the rule specify a minimum comment period, and allow a longer period, at the Regional Administrator's discretion. Another commenter believed that since EPA has not demonstrated that public involvement procedures are hindering cleanups, there is no justification for lesser procedures.

EPA disagrees with the commenters that minimum comment period times or specific procedures are necessary, and did not establish detailed procedural requirements for public involvement in this final rule. However, EPA does expect the public to be given an opportunity to get involved early in the process and ample time to participate in the facility cleanup decisions. EPA took this approach because it recognizes that many different approaches to public participation have proved successful, and it did not wish to restrict existing State or Federal programs unnecessarily. The approach in this rule allows States to implement their own established procedures—as long as they provide for public notice and comment at the key stages in the process required by this rule.

ii. *The public involvement procedures of the proposed rule were adequate.* Other commenters believed that the level of public participation proposed by the Agency was adequate, and would provide an effective mechanism for adequately informing the public with regard to proposed remedies, and allowing public comment and public involvement in the remedy selection process.

Other commenters who generally agreed with the Agency's approach, requested some modifications in the final rule. One such commenter supported the requirement for public participation during the remedy selection process, but believed that the rule should also include a requirement for a brief description of the scope of the contamination to be remediated, if any, and a requirement for the placement of supporting documents in a local information repository. Another commenter believed that the rule must explicitly require that public access to information submitted for alternative mechanisms should be provided as if the information were contained in the Part B permit application.

EPA agrees that this type of information should be made available to the public, and anticipates that it will, where appropriate. However, as discussed above, the Agency is not prescribing detailed procedural requirements for public involvement in this final rule. The Agency intends this rule to provide meaningful public involvement while, at the same time, provide maximum flexibility to States to implement their cleanup programs. The Agency recognizes that, clearly, public involvement cannot be meaningful if there is not adequate access to information and, therefore, the Agency encourages regulators and owners or operators to make information regarding the site available to the public. At the same time, the Agency does not want to prescribe in detail in this final rule when and how the regulatory agency should provide information to the public. By requiring meaningful involvement of the public, the Agency believes that this final rule addresses commenter's concerns by requiring meaningful public involvement, which includes adequate access to information, and that detailed regulations prescribing access to specific information are not necessary.

One commenter agreed with the provision of the proposal that would allow EPA to waive public involvement procedures where immediate action is necessary to protect human health or the environment, but believed that public involvement should not be waived for long-term actions. EPA agrees with this commenter and the rule reflects this approach. In proposing the waiver provision of § 265.121(b), EPA intended to allow regulatory agencies to delay public involvement and get cleanup underway immediately, where necessary to protect human health and the environment, but not to remove the requirement for public participation. In response to this comment, EPA has modified the regulatory language of § 265.121(b) in this final rule to clarify the Agency's intent.

iii. *The public involvement procedures of the proposed rule were too stringent.* A third group of commenters believed that the public involvement requirements of the proposal were too stringent, and did not provide enough flexibility to the States. For example, one commenter stated that the proposed public participation requirements for alternative mechanisms were excessive, unnecessary, and inconsistent with existing public participation requirements. Another stated that there is no need for public participation for remedial action orders and closure plan approval to be equivalent to the requirements of Part 124 and Part 270, and that alternate, less stringent procedures would suffice.

EPA believes that public involvement is important in all agency actions, including enforcement orders. Consequently, EPA is requiring public participation at three key stages.

Some commenters believed that EPA should defer to State programs for public involvement as long as they provide basic due process and reasonable public input. These commenters believed that States should have reasonable flexibility to make site-specific determinations regarding the level of public participation that is appropriate at a site, and to adopt public involvement procedures that meet the needs of their own State. They believed that the benefits of public comment are preserved by requiring the States to provide public notice, and that specific differences in process are of differences of degree, and not substance.

EPA agrees that many States have developed cleanup programs with appropriate public involvement, and has tried to balance the need to ensure adequate public participation against requirements that constrain States. EPA believes the approach in the final rule strikes an appropriate balance. EPA, for example, allows States to decide how much notice must be given, and how long comment periods must last.

Some commenters believed that the proposal would expand the current requirements for public involvement. According to these commenters, when post-closure permits are modified to incorporate a proposed remedy, the current requirements for permit modification require publication in a newspaper for seven days, a public hearing, and a 60-day public comment period, regardless of how the action is changed based on public comment. The proposal would require much more at remedy selection, thus would be more expansive than the existing regulations. To maintain consistency, commenters believed the rule should mirror the public involvement procedures of § 270.41.

EPA acknowledges the commenter's concern, and believes that it has addressed them by leaving the details of the notification process and the length of the comment period to the discretion of the overseeing agency.

Some commenters did not agree that public involvement procedures should apply to actions taken under section 3008(h), because public comment on an enforcement proceeding would be inappropriate and would unnecessarily complicate and confuse the process, while increasing costs and delaying the process. One commenter pointed out that the public currently has no assurance it will have opportunity to participate in the remedial action process when remedial action is implemented through an enforcement order, as the Agency's enforcement programs have discretion to limit public participation, yet there is no evidence that the lack of public participation in enforcement orders has been detrimental to the process.

EPA disagrees with this commenter that public involvement unnecessarily complicates and confuses the cleanup process—in fact, the Agency believes that the public is an important contributor to the cleanup process. It helps ensure that remediation does, in fact, protect human health and the environment, and that remedies are based upon reasonable assumptions, including assumptions of future land use. EPA is committed to public involvement in its oversight of cleanup decisions, and the Agency's policy is to provide for meaningful public notice and comment with every section 3008(h) order. The requirements promulgated in this final rule are consistent with current EPA guidance on section 3008(h) orders.

Another commenter believed that EPA should recognize the wide array of actions that may occur, from small to significant, and the increasing tendency to accomplish remedial action through a series of interim measures, rather than a single major action. This commenter believed that the Agency should tailor public participation measures to ensure participation during significant actions without slowing the conduct of the program by requiring extensive administrative procedures for each and every small action that may be taken. The commenter believed that the public participation measures should be flexible enough to ensure adequate public involvement and avoid serving as yet another brake on the system.

EPA believes that the approach to public involvement in this final rule addresses this commenter's concern. The rule requires public involvement when the Agency becomes involved in a remediation at the facility as a regulatory or enforcement matter; on the proposed preferred remedy and the assumptions upon which the remedy is based, in particular those related to land use and site characterization; and prior to making the final decision that remedial action is complete at the facility. EPA expects that these requirements will be applied flexibly, and it does not expect ''extensive administrative procedures for each and every action.'' For example, in some cases, public comment might be provided on a general strategy, which included interim measures as well as specific final cleanup standards. In other cases, the public might prefer monthly or quarterly updates to activity-by-activity notice. The point is that the public must have early involvement and must have an opportunity to comment before the regulatory agency commits itself to a final remedy or decides final remedial action is complete at the facility. Within this framework, EPA believes the regulatory agency has opportunity to structure a reasonable approach based on the needs at the site. At the same time, the public is put on notice early in the process that activities are taking place.

4. Enforceable Documents Issued Prior to the Effective Date of This Rule (§ 265.121(b)(3))

a. Overview. It is likely that, prior to final promulgation of this rule EPA and authorized States will have required site assessments or cleanup under a variety of authorities, other than post-closure permits, at facilities currently subject to post-closure permit requirements. Most of these actions, if taken after promulgation, would have satisfied the requirements of this rule. EPA proposed and is taking final action to provide a means to give credit to such prior cleanup actions by soliciting public comment on the activities conducted before the effective date of the rule.

Under § 265.121(b)(3), EPA must provide an opportunity for public comment if the enforceable document imposing those remedies is intended to be used in lieu of a permit. Depending on public comment, EPA may impose additional requirements either by amending the existing order, issuing a new order, modifying the post-closure plan, or requiring a post-closure permit.

b. Response to Comment. Several commenters objected to this provision of the rule.

According to one commenter, the proposed approach, if designed to provide finality to owners or operators, was a good idea in that it could provide them with early assurance that they would not have to repeat closure, post-closure, cleanup or investigations at a later date. However, this commenter strongly opposed this provision to the extent that it contemplates any such *post hoc* adequacy determinations would be the impetus to reinvestigate and/or require additional remedial actions with respect to prior closure/post-closure activities. In addition, the commenter believed that when an owner or operator receives an adequacy determination under proposed § 265.121(c) for prior closure/post-closure activities under an alternative legal authority, these activities should

be expressly recognized as adequate in any subsequently-issued permit to assure the finality of any prior closure/post-closure determinations.

Another commenter opposed any effort to retroactively apply new, more restrictive standards (for public involvement or selection of remedies) to past remedial actions, and to approved closures. According to the commenter, actions undertaken in good faith by the owner or operator with Agency approval should be done with reasonable assurance that they will be considered completed. The commenter believed that uncertainty would discourage remedial actions.

Another commenter believed that this provision is beyond EPA's statutory authority. This commenter believed that EPA cannot conveniently ignore agreements entered into by it or States that were presumably within their authority. This issuance of a new regulation does not allow EPA to void binding agreements. Owners that have encouraged the Agency to use an order or consent agreement to oversee remedial action could be required to implement different remedial actions simply because EPA promulgates a new regulation. The commenter believed that this provision would impose more onerous requirements for responsible owners and operators of facilities that are currently implementing remedial action.

Another commenter suggested that before reopening an action, EPA should be required to demonstrate that the cleanup was not protective of human health and the environment. Another commenter expressed concern that any action undertaken in the past would be unlikely to meet current regulatory requirements, yet was likely taken by a cooperative facility aggressive in fulfilling its regulatory obligations at the time. According to the commenter, to reevaluate these facilities without any indication of potential environmental harm would create a costly administrative burden to both the Agency and the owner or operator, without any benefit to human health and the environment.

EPA agrees with the commenters that expressed concern about any uncertainty that might arise for owners and operators due to this provision. However, EPA disagrees that this is the effect of this provision. This provision does not impose new requirements on owners and operators retroactively, since owners and operators were subject to RCRA permit requirements (including section 3004(u)) prior to this rule. Instead, § 265.121(e) would extend the benefits of this rule to post-closure activities or cleanups conducted under enforceable documents issued before the rule was in effect even where these documents had not included public involvement. (Where the public had already had an opportunity to comment on the mechanism, there would be no need to invoke this provision.) EPA does not intend this provision to result in duplicative regulatory action, or to allow reopening of decisions that had already been made. Instead, it would simply ensure the public's opportunity to comment on a mechanism being used in lieu of a permit, if the public had not had an opportunity up to that point.

EPA can understand the commenter's concerns about re-opening past cleanups. EPA and authorized States certainly do not expect to re-open acceptable remedies where they are already underway. EPA believes that, in most situations, the public would have been involved in the remedy selection. In cases where the public was involved, the Agency does not intend this provision to provide an opportunity to revisit issues that already were raised and addressed. Rather, the provision is designed to make this final rule available to facilities that may have begun cleanup prior to the effective date, while, at the same time, assuring that the public has had opportunity to raise issues prior to the Agency's final decision that corrective action is not needed or is no longer need at the site. Even under the current corrective action process, remedies undertaken before the permit is issued are typically incorporated into the permit through the permit procedures. Owners and operators of closed interim status facilities or non-RCRA State programs currently may conduct cleanups outside the post-closure permit process. When EPA or a State issues a post-closure permit, it must determine that any prior cleanup meets the requirements of RCRA section 3004(u). If it does not—that is, if the cleanup is not protective of human health and the environment, or there are significant areas it does not address—EPA or the State may impose permit requirements requiring additional remediation work. Citizens may also raise the same issues in comment periods on draft post-closure permits and in challenges to permits that are issued. Thus, facilities face these issues regardless of whether or not EPA allows older cleanups to be recognized under this new alternative to post-closure permits.

In any case, EPA expects owners and operators conducting cleanups without involving EPA to involve the public at an early stage. EPA strongly discourages owners and operators from waiting until the end of the process to involve the public. If concerns are raised by the public regarding the actions taken under the alternative mechanism, EPA may require additional action through an order or permit. Therefore, EPA is promulgating § 265.121(b)(3).

C. Remediation Requirements for Land-Based Units With Releases to the Environment

1. Overview

In the 1994 notice, EPA requested comment on the possibility of allowing the Regional Administrator to establish groundwater monitoring, closure and post-closure, and financial assurance requirements on a site-specific basis at regulated units addressed through the corrective action process (*see* 59 FR 55778 at 55787–88). EPA specifically requested comment on this prospect for regulated units clustered with non-regulated units, all of which were releasing hazardous constituents to the environment, because of the concern that two different regulatory regimes would apply—for example, the regulated units could be subject to the detailed requirements of Part 264 (which were developed as a preventive requirement), while the non-regulated units could be subject to the more flexible remedial requirements for corrective action under § 264.101 and associated guidance.

EPA is promulgating in this notice final rules that will provide flexibility where a regulated unit is situated among SWMUs (or areas of concern), a release has occurred, and both the regulated unit and one or more SWMUs (or areas of concern) are suspected of contributing to the release. The final rule described in this section allows EPA and the authorized States to replace the regulatory requirements of Subparts F, G, and H at certain regulated units with alternative requirements developed under a remediation authority. This portion of the rule is designed to eliminate some of the problems Regions and States have encountered where two sets of requirements apply at a cleanup site—requirements for closure at the regulated unit, and corrective action requirements at the SWMUs. It applies to both permitted and interim status units. It also applies to both operating and closed facilities. Further, it can be used at closed facilities using alternative authorities in lieu of post-closure permits.

The closure process in Parts 264 and 265 was promulgated in 1982, before the Agency had much experience with closure of RCRA units. Since that time,

EPA has learned that, when a unit has released hazardous waste or constituents into surrounding soils and groundwater, closure is not simply a matter of capping the unit, or removing the waste, but instead may require a significant undertaking to clean up contaminated soil and groundwater. The procedures established in the closure regulations were not designed to address the complexity and variety of issues involved in remediation. Most remediation processes, on the other hand, were designed to allow site-specific remedy selection, because of the complexity of and variation among sites.

Similarly, the groundwater monitoring requirements designed for regulated units do not provide sufficient flexibility for complex cleanups. The requirement to place wells at the downgradient edge of a regulated unit often would not make sense if there are SWMUs further downgradient. Also, the Part 264 regulations contain specific requirements for the selection of cleanup levels for hazardous constituents released to groundwater, and do not provide for considerations of technical practicability, which are critical in a remediation context. Corrective action and other remediation authorities provide more flexible (yet protective) regimes for selecting cleanup levels.

Financial responsibility for closure or post-closure care may also work at cross purposes with financial responsibility for corrective action. It makes sense to allow a facility with funds set aside for closure of a regulated unit to spend those funds on a broader corrective action, when the regulated unit is being addressed in that corrective action.

This portion of this rule revises the requirements of Parts 264 and 265 Subparts F, G, and H, by adding new §§ 264.90(f), 264.110(c), 264.140(d), 265.90(f), 265.110(d), and 265.140(d). Those provisions allow EPA to address environmental needs at certain closing regulated units with more flexible, but protective, site-specific requirements developed through a remediation process. EPA is providing flexibility where a Regional Administrator (or State Director) finds that a regulated unit is situated among SWMUs (or areas of concern), a release has occurred, and the regulated unit and one or more of the SWMUs (or areas of concern) are likely to have contributed to the release.

To provide greater flexibility for the cleanup of regulated units in this situation, EPA is giving the Regional Administrator (or State Director) discretion to replace the requirements for closure, groundwater monitoring, and financial responsibility set out in Parts 264 and 265 with standards tailored specifically for the cleanup. For closure, the new ''generalized'' standard is protecting human health and the environment by meeting the closure performance standard in either § 264.111(a) and (b) or § 265.111(a) and (b). For groundwater monitoring and financial responsibility, the new standard is protection of human health and the environment. The Regional Administrator can use these new standards to integrate the cleanup requirements for the regulated unit into the requirements for the SWMUs developed under remediation authorities. In addition, to reduce duplicative administrative processes, EPA is not requiring that the alternative requirements be incorporated into the permit, closure plan, and/or post-closure plan in all cases. In the case of permitted facilities, alternative requirements for a regulated unit might be included in the permit where related SWMUs were being addressed under RCRA section 3004(u), the permitting corrective action authority. EPA, however, wants the Regional Administrator to be able to use other authorities to develop the requirements for regulated units and related SWMUs, such as RCRA section 3008(h), CERCLA, and approved State remediation authorities. This rule, therefore, allows the Regional Administrator (or an authorized State) to determine that there is no need to impose the unit-specific requirements of Part 264 or Part 265 because alternative requirements developed under an approved remediation authority will protect human health and the environment. The requirements for the regulated unit and the SWMUs developed under that authority can be set out in the permit or in an approved closure plan and/or post-closure plan, or can be set out in another enforceable document (as defined in § 270.1(c)(7)), and referenced in the permit or approved closure plan and/or post-closure plan.

For permitted facilities, EPA is modifying the requirements for content of the closure plan and closure plan modification by adding new § 264.112(b)(8) and (c)(2)(iv), and post-closure plan content and post-closure plan modification at § 264.118(b)(4) and (d)(2)(iv) to require owners and operators to incorporate the alternative requirements into the closure plan and/or post-closure plan, or to incorporate into those plans a reference to the enforceable document (or permit section) that sets forth those requirements. To do so, the owner or operator would use the existing procedures for closure plan and post-closure plan approval and modification in Part 264, and for permit modifications in Part 270. EPA expects that any such decision would be a ''class 3'' modification.

For interim status facilities, EPA is similarly adding new §§ 265.112(b)(8) and (c)(2)(iv) and 265.118 (c)(5) and (d)(1)(iv)to require owners and operators to incorporate alternative requirements into the closure plan and/or post-closure plan, or to incorporate into those plans a reference to the enforceable document that sets forth those requirements. To do so, the owner or operator would use the existing procedures for closure plan and post-closure plan approval and modification in Part 265.

Members of the public may also utilize current procedures to challenge either the specifics of how EPA is addressing a regulated unit as part of corrective action (for example, if the corrective action is imposed through a RCRA permit), or the decision by EPA or the State to address the regulated unit under alternative requirements set out in an enforceable document. Under EPA's federal rules, members of the public may file administrative appeals for permits; they may challenge closure or post-closure plans in court.

The Regional Administrator (or State Director) may use existing procedures for modifying permits or closure plans to revisit corrective action requirements for regulated units set out in permits or to revisit cleanups under alternative enforceable documents. EPA's rules allow permits, closure plans, and post-closure plans to be modified when significant new information arises after the issuance of the plan or permit. Some developments during remediation may justify use of this authority. For example, if a non-RCRA agency in charge of an alternate authority selected a very different remedy which, in the RCRA authority's judgement, would not adequately protect human health and the environment, the RCRA authority might consider this to be new information warranting reconsideration of the decision to defer existing RCRA requirements for regulated units.

Because the concept of deferring closure, groundwater monitoring, and financial responsibility requirements is new, EPA is limiting the range of authorities that can be used to craft alternate requirements. First, a Regional Administrator (or State Director) may defer regulated unit requirements in favor of requirements crafted under corrective action for permits under RCRA section 3004(u) and corrective

action orders for interim status facilities under RCRA section 3008(h). The Regional Administrator (or State Director) may also defer to requirements established in actions under CERCLA section 104 and 106. EPA is familiar with the scope of these legal authorities and the enforcement mechanisms that accompany them. Any Regional Administrator (or State Director) wishing to defer to regulated unit requirements developed under these authorities need only consider whether the requirements will, in fact, protect human health and the environment.

EPA also wants State Directors to be able to defer to State remedial authorities outside of RCRA. EPA, however, is less familiar with these authorities and their enforcement mechanisms. EPA, therefore, is requiring any State that wishes to use a non-RCRA authority to craft alternative regulatory requirements to submit that authority to EPA for review in the State authorization process. EPA will review the scope of the legal authority. It will determine for example, whether the authority can provide for cleanup of releases from a regulated unit to all media, as required under §§ 264.111(b) and 265.111(b). EPA will also review the State's mechanisms for enforcing the alternative requirements. Where a State will not be incorporating the new regulated unit requirements directly into a permit or closure plan enforceable under RCRA, EPA needs to have some assurance that it will be able to enforce them, if necessary. EPA is, in this notice, amending the existing requirements for enforcement of State programs in § 271.16 to add a new requirement regarding the enforceability of these new, alternative regulated unit requirements. Recognizing that effective enforcement mechanisms may vary greatly from State to State, EPA is promulgating a general standard, rather than a list of specific enforcement requirements.

This rule also allows the Agency to transfer the financial assurance requirements of Part 264 or Part 265 Subpart H to the corrective action process, when the regulated unit is addressed through corrective action. This provision does not allow the Agency to waive the requirements for financial assurance at a regulated unit. Owners and operators of regulated units remain subject to the requirement to provide financial assurance to address cleanup at the unit—however, this rule allows EPA or the authorized States to develop site-specific financial assurance requirements for corrective action at the unit, and transfer funds set aside under Subpart H for closure, post-closure, and third-party liability requirements to address corrective action. This provision may be invoked by EPA or by a State authorized for this rule only in cases where the alternative cleanup authority requires financial assurance for the corrective action.

In addition to the financial assurance requirements for closure and post-closure care, Parts 264 and 265 Subpart H require owners and operators to provide assurances that they can pay claims for damages to third-parties arising from accidental occurrences at the facility. The Agency, however, typically has not required third-party liability coverage as part of financial assurance for corrective action. (The general third-party funds required by Parts 264 and 265 would, of course, apply to accidents involving hazardous waste management occurring during corrective action.) This rule allows the Regional Administrators and authorized States to release funded third-party liability assurances, or to relieve owners and operators from the obligation to provide third-party liability assurance, where all regulated units at the facility are being addressed under §§ 264.90(f), 264.110(c), 264.140(d), 265.90(f), 265.110(d) or 265.140(d). EPA expects this action would be warranted under limited circumstances—for example, it might be warranted where all regulated units at the facility are being addressed through corrective action, and the Regional Administrator finds that it is necessary to use the third-party liability funds to pay for the cleanup. It should be noted that where a facility is subject to third-party liability requirements because of regulated units other than those being addressed under §§ 264.90(f), 264.110(c), 264.140(d), 265.90(f), 265.110(d) or 265.140(d), the facility remains subject to the requirement for third-party liability coverage.

2. Response to Comment

In the preamble of the proposed rule (*see* 59 FR 55778 at 55787 and 55688), EPA requested comment on the need for provisions allowing regulated units to be addressed through a remediation process. The Agency described a situation where a collection of adjacent SWMUs and a regulated unit are releasing hazardous constituents to the environment. Prior to this rule, EPA would have been required to impose the requirements of Part 264 or Part 265 for financial assurance, closure, and groundwater monitoring and remediation of the regulated unit, and to select remedies for the SWMUs through the RCRA corrective action process. This situation was inconsistent with a major objective of EPA's Subpart S initiative discussed above, that is, to create a consistent, holistic approach to cleanup at RCRA facilities.

Many commenters supported the approach described by EPA in the preamble to the proposal. Commenters on the proposed rule agreed with EPA that regulated units and non-regulated SWMUs are often indistinguishable in terms of risk, and most supported integration of the closure and corrective action programs.

Many commenters had encountered situations similar to those described by the Agency, and believed that the closure process prevented the best remedy at those sites. Several commenters agreed that it is often difficult to identify the source of contamination, particularly when many SWMUs are located near each other. Commenters cited situations where the boundaries of regulated units and non-regulated units overlap, or where contaminant plumes have commingled as situations where the regulatory distinction between regulated and non-regulated SWMUs is particularly troublesome.

Some commenters believed that the corrective action process, which was specifically designed to address remediation, rather than the closure process, which has preventative goals, should be used to address all units at a facility.

EPA does not believe that the closure process is inappropriate for all regulated units with releases. However, it does believe that it does not make sense to have two separate remedial processes working to clean up a single release, so it is providing relief where a regulated unit and one or more SWMUs appear to have contributed to the same release. EPA believes the Regional Administrator should be able to choose, on a case-by-case basis, whether to apply the current Part 264 and 265 requirements to the SWMUs or the more flexible remediation requirements to the regulated unit. This final rule provides the Regional Administrator with the discretion needed to make this choice.

Several commenters mentioned that having two regulatory programs for RCRA units is complicated by State authorization issues—some States are authorized for the base RCRA program, thus are responsible for closure, but are not authorized for corrective action. In these States, two agencies are responsible for reviewing plans, and making decisions. Another commenter's regulatory agency has taken the position that any detectable levels of organics left in soil or groundwater during closure will require capping and post-closure

monitoring of the unit, whereas the corrective action program uses risk-based cleanup standards. Thus, there is potential for different areas of a facility to be cleaned up to different sets of standards, even if the areas are adjacent to each other, and exposure patterns are identical. Commenters believed that a single, uniform set of cleanup standards should be established for all units regardless of the time the waste or contaminant was placed in the unit, and regardless of the regulatory program that has jurisdiction.

EPA cannot eliminate all of the complexities caused by the State authorization requirements. However, States that are authorized for the base program will be able to request authorization for this rule. They may request authority to address regulated units as part of corrective action. EPA also notes that there is no Federal requirement that facilities cap any detectable levels of organics left in soil or groundwater during closure.

Other commenters raised concerns about EPA's proposal that closure and cleanup standards be integrated. Some commenters expressed concern that the Agency's proposal might be an attempt to extend the closure requirements to non-regulated units, rather than to address all SWMUs through the corrective action process. Some commenters said that they have had to close non-regulated units as regulated units because they could not identify the source of contamination at a site. These commenters believe that the corrective action process, not closure requirements, should be the applicable requirements at SWMUs requiring remediation.

The Agency agrees that regulated unit standards were not designed for SWMUs subject to corrective action. The Agency intends this rule to provide Regional Administrators and State Directors with discretion to choose whether to apply current Part 264 and 265 standards to regulated units closed as part of a broader corrective action, or to address them through cleanup requirements. This rule is not intended as a way to bring SWMUs under Part 264 or Part 265 unit-specific standards.

A few commenters supported retaining the distinction between regulated units and other SWMUs. One commenter believed the Agency should retain the closure process at all regulated units because the regulatory timeframes of that process result in a quicker remedy selection than the open-ended corrective action process. This commenter feared that removing closure requirements at regulated units would delay cleanups. Another commenter objected that site-specific determinations delay any process because they are an open door to extended negotiations, disputes, and litigation, and allow inconsistent decisions. This commenter believed that the closure regulations provide consistent requirements.

The Agency agrees with the commenter that the closure requirements, including the timeframes incorporated in the closure process, are generally appropriate where a release has not occurred. EPA, however, does not agree that these procedures are well-suited to remediation of environmental releases. EPA believes that, where a regulated unit is located among SWMUs (or areas of concern), and releases have or are likely to have occurred, applying two sets of regulatory requirements can slow, rather than hasten the cleanup. Thus, in this final rule, EPA is allowing regulators discretion to apply alternate requirements to the closing regulated unit developed under a remediation authority.

Another commenter suggested retaining the closure requirements if the regulated unit is a landfill, because, according to commenter, landfills typically are large and isolated. The commenter also suggested the closure requirements be retained in situations where routine monitoring is necessary, or in situations where waste in the regulated unit is very hazardous. This commenter suggested that the closure standards be retained where the units contain similar wastes, but were used at different times, and where there are multiple adjacent sources of contamination with overlapping parameters of concern.

This rule retains the closure requirements for isolated units. This final rule allows the Regional Administrator to replace the requirements of Subparts F, G, and H with alternative requirements developed for corrective action only where a regulated unit is situated among SWMUs (or areas of concern), a release has occurred, and both the regulated unit and one or more SWMUs (or areas of concern) are likely to have contributed to the release.

EPA disagrees that the type of waste involved or the need for monitoring should determine which set of regulatory requirements must be used to address the unit, or that routine monitoring can be imposed only through the closure process. EPA believes that remediation processes can be used to provide protective cleanups for all types of wastes, and can be used to impose sufficient groundwater monitoring requirements.

Another commenter suggested that the timeframes for initiating corrective action (§ 264.99(h)(2)) and other administrative and reporting requirements of Part 264 Subpart F be retained in all cases. However, EPA disagrees with this commenter and has chosen to allow greater flexibility provided by alternate remedial authorities for regulated units surrounded by SWMUs that are both suspected to have released to the environment.

One commenter conditioned its approval of this change on due process rights of owner or operator being maintained. EPA believes the existing rights available to an owner or operator in federal enforcement actions appropriately address due process rights and this rule does not modify these rights.

Some commenters asked for clarification of how integration of closure and corrective action would work administratively. EPA has provided this information in the preamble discussion above.

Another commenter stated that the proposal contradicted itself by first claiming that protections imposed through alternative mechanisms would be equivalent to those of a post-closure permit, and then proposing that closure standards be developed on a site-specific basis under the corrective action process. The commenter requested EPA to clarify its intention in this regard, and to ensure that the regulatory requirements were truly the same for closure and post-closure activities conducted with or without a permit.

In response to this comment, EPA clarifies that it intends for the closure of regulated units to be subject to consistent substantive standards, regardless of whether that closure is addressed under a permit or under an alternate authority. EPA believes the requirements of § 265.121 make this point clearly. The commenter's concern derives from EPA's proposal (and decision in this final rule) to amend the closure standards to allow the integration of closure and corrective action at certain specified closed or closing units. These new standards apply equally to all eligible regulated units, regardless of whether they are subject to permits or interim status. Thus, while EPA has amended the closure standards as they apply to certain regulated units, it has retained a consistent approach to closure under the permit process and under alternate authorities. To the extent that the commenter is objecting to EPA's decision to allow use of alternative, site-

specific requirements in lieu of the generic requirements of Subparts F, G, and H, EPA, as explained above, believes that the need to coordinate the cleanup of ''mingled'' releases outweighs any perceived benefits of the more specific requirements for regulated units.

In the preamble of the proposed rule, the Agency described a second remedial situation where the closure standards might not be appropriate—where waste has been removed from a unit but contaminated soils remain, and the remedy that might best prevent future releases from the unit would be precluded by the requirement for a RCRA cap.

Many commenters agreed with the Agency that the requirement for a RCRA cap may impede remedies. Several commenters agreed that the closure regulations do not consider remediation as an alternative to capping the unit, yet many currently available remedial technologies are more protective to human health and the environment in the long term than is capping, and that the Agency should provide flexibility to pursue such options in the closure of regulated units. Many commenters also agreed that required RCRA caps are very expensive and often provide little additional environmental protection where most waste has been removed from the unit.

However, the Agency is not proceeding with revisions to the closure requirements that would modify the requirement for a RCRA cap (or other closure, groundwater, or financial assurance requirements) beyond the situations outlined in §§ 264.90(f), 264.110(c), 264.140(d), 265.90(f), 265.110(d), and 265.140(d). Thus, the unit described by commenters could be addressed under corrective action procedures only if it was situated among SWMUs or areas of concern, and was part of a broader corrective action. EPA was not prepared, at the time this rule was made final, to make a final decision on this issue. EPA will consider additional action in this area if, in implementing this final rule, the Agency identifies further opportunities for integrating closure and corrective action.

D. Post-Closure Permit Part B Information Submission Requirements (§ 270.28)

1. Overview

EPA is promulgating § 270.28, which establishes information submission requirements for post-closure permits. Prior to this rule, the information submission requirements of Part 270 did not distinguish between operating permits and post-closure permits, and facilities seeking post-closure permits were generally expected to provide EPA, as part of their Part B permit applications, the facility-level information specified in § 270.14 as well as relevant unit-specific information required in §§ 270.16, 270.17, 270.18, 270.20, and 270.21.

However, EPA recognized that certain of the Part 270 information requirements are important to ensuring proper post-closure care, while others are generally less relevant to post-closure. The Agency believes the most important information for setting long-term post-closure conditions are groundwater characterization and monitoring data, long-term care of the regulated unit and monitoring systems (e.g., inspections and systems maintenance), and information on SWMUs and possible releases. Therefore, EPA is adding a new § 270.28 to identify that subset of the Part B application information that must be submitted for post-closure permits.

As a result of this provision, an owner or operator seeking a post-closure permit must submit only that information specifically required for such permits under newly added § 270.28, unless otherwise specified by the Regional Administrator. The specific items required in post-closure permit applications are:

—A general description of the facility;
—A description of security procedures and equipment;
—A copy of the general inspection schedule;
—Justification for any request for waiver of preparedness and prevention requirements;
—Facility location information;
—A copy of the post-closure plan;
—Documentation that required post-closure notices have been filed;
—The post-closure cost estimate for the facility;
—Proof of financial assurance;
—A topographic map; and
—Information regarding protection of groundwater (e.g., monitoring data, groundwater monitoring system design, site characterization information)
—Information regarding SWMUs at the facility.

In many cases, this information will be sufficient for the permitting agency to develop a draft permit. However, since RCRA permits are site-specific, EPA believes it is important that the Regional Administrator have the ability to specify additional information needs on a case-by-case basis. Accordingly, to ensure availability of any information needed to address post-closure care at surface impoundments (§ 270.17), waste piles (§ 270.18), land treatment facilities (§ 270.20) and landfills (§ 270.21), § 270.28 of this rule authorizes the Regional Administrator to require any of the Part B information specified in these sections in addition to that already required for post-closure permits at these types of units. This approach enables the Regional Administrator to require additional information as needed, but does not otherwise compel the owner or operator to submit information that is irrelevant to post-closure care determinations.

2. Response to Comment

Commenters generally supported the provisions of the proposed rule related to information submission requirements, and EPA is promulgating the provisions as proposed. Some commenters suggested that additional information be required by § 270.28 (e.g., one commenter suggested the Agency require the chemical and physical analysis of § 270.14(b)(2), and the training plan information required by § 270.14(b)(12)). However, after considering these comments, EPA is promulgating the proposed requirements because the Agency believes they will provide the Agency with the information it needs to address post-closure care in most instances. The information suggested by commenter is not, in the Agency's experience, routinely needed for post-closure permits. For example, § 270.14(b)(2), suggested by commenter, requires a chemical and physical analysis of waste to be handled at the facility—but, in the case of post-closure permits, the regulated unit is closed, and will not be handling wastes. Similarly, § 270.14(b)(12) requires the owner or operator to train persons who will be operating the facility—but, in the case of a post-closure permit, the facility will not be operating.

If for some reason this information is needed by the Agency, this rule does not preclude the Agency from requiring it. As was discussed above, this rule provides the Agency authority to obtain additional information on a case-by-case basis, as needed, but, for most situations, requires only the minimum information necessary for all post-closure situations. This approach, the Agency believes, provides sufficient information to the overseeing agency to ensure adequate post-closure care, while minimizing the information submission requirements for all owners and operators. However, as a result of this final rule, EPA will request information

for post-closure permit applications beyond the information specified in § 270.28 only when necessary on a case-by-case basis.

IV. State Authorization

A. Authorization of State Programs

Under section 3006 of RCRA, EPA may authorize qualified States to administer and enforce the RCRA program within the State (*See* 40 CFR Part 271 for the standards and requirements for state authorization).

Prior to the Hazardous and Solid Waste Amendments of 1984 (HSWA), a State with final authorization administered its hazardous waste program entirely in lieu of the Federal program. The Federal requirements no longer applied in the authorized State, and EPA could not issue permits for any facilities in a State where the State was authorized to permit. When new, more stringent Federal requirements were promulgated or enacted, the State was obligated to enact equivalent authority within specified timeframes. New Federal requirements did not take effect in an authorized State until the State adopted the requirements as State law.

In contrast, under section 3006(g) of RCRA, the new requirements and prohibitions of HSWA take effect in authorized States at the same time they take effect in unauthorized States. EPA is directed to carry out those requirements and prohibitions in authorized States, including issuance of permits, until the State is granted authorization to do so. While States must still adopt more stringent HSWA-related provisions as State law to retain final authorization, the HSWA requirements apply in authorized States in the interim. In general, § 271.21(e)(2) requires States that have final authorization to modify their programs to reflect Federal program changes and to subsequently submit the modifications to EPA for approval. It should be noted, however, that authorized States are only required to modify their programs when EPA promulgates Federal standards that are more stringent or broader in scope than the existing Federal standards. For those Federal program changes that are not more stringent or reduce the scope of the Federal program, States are not required to modify their programs (*see* § 271.1(i)). Section 3009 of RCRA allows States to impose standards more stringent than those in the Federal program.

B. Enforcement Authorities

Since 1980, certification of adequate enforcement authority has been a condition of State authorization. EPA's authority to use its own enforcement authorities, however, does not terminate when it authorizes a State's enforcement program. Following authorization, EPA retains the enforcement authorities of sections 3008, 7003, and 3013 of RCRA, although authorized States have primary enforcement responsibility.

C. Effect of this Rule on State Authorizations

This rule promulgates revisions to the post-closure requirements under HSWA and non-HSWA authorities. The requirements in §§ 264.90(e), 265.110(c), 265.118(c)(4), 265.121 (except for paragraph 265.121(a)(2)), 270.1, 270.14(a), and 270.28, which remove the post-closure permit requirement and allow the use of alternate mechanisms, are promulgated under non-HSWA authority. Thus, those requirements are immediately effective only in States that do not have final authorization for the base RCRA program, and are not applicable in authorized States unless and until the State revises its program to adopt equivalent requirements. These new standards are not more stringent than current requirements and, therefore, States are not required to adopt them.

Sections 264.90(f), 264.110(c), 264.140(d), 265.90(f), 265.110(d), 265.140(d), and 271.16(e), which allow the Agency to address closing regulated units through the corrective action program, are promulgated under HSWA authority. Except for § 271.16(e) these provisions provide additional options to regulators, and, therefore, are not more stringent than the current base RCRA program requiring closure of all regulated units. Authorized States are required to modify their programs only if the new Federal provisions are more stringent.

Further, because these HSWA provisions in this rule are not more stringent, they are immediately effective only in those States not authorized for the base RCRA program. In States authorized for the RCRA base program, these HSWA provisions cannot be enforced until and unless the State adopts them. Once a State adopts these provisions, they can be implemented by EPA before the State is authorized for the regulation change because they are promulgated pursuant to HSWA authority, and are thus immediately effective in the State.

D. Review of State Program Applications

1. Post-Closure Care Under Alternatives to Permits

Sections 264.90(e), 265.110(c), 265.118(c)(4), 265.121, and 270.1 of this final rule remove the requirement for post-closure permits, and allow EPA and the authorized States to address facilities needing post-closure care using alternate authorities. All States seeking authorization for the above provisions of this rule must submit an application that includes regulations at least as stringent as these provisions, as well as the information required under § 271.21. In all States, this information will include copies of State statutes and regulations demonstrating that the State program includes the provisions promulgated in this rule in the sections listed above. EPA will review this information to determine that the State has adopted provisions to assure that authorities used in lieu of post-closure permits are as stringent as the Federal program.

In addition, States must submit an application that includes copies of the statutes and regulations the State plans to use in lieu of the section 3004(u) provisions of a post-closure permit to address corrective action at interim status facilities. For example, many States authorized for corrective action have cleanup authorities, which they apply at interim status facilities. EPA will review those statutes and regulations to determine whether the alternate authority is sufficient to impose requirements consistent with § 264.101. At a minimum, that authority must be sufficiently broad to allow the authorized authority to: (1) require facility-wide assessments; (2) address all releases of hazardous wastes or constituents to all media from all SWMUs within the facility boundary as well as off-site releases to the extent required under section 3004(v) (to the extent that releases pose a threat to human health and the environment); and (3) impose remedies that are protective of human health and the environment. This review by EPA will assure that actions taken at closed facilities under an alternate authority are as protective as those that would be taken under a post-closure permit. In addition, EPA is promulgating in this final rule a revision to § 271.16 to ensure that these alternate authorities are adequately enforceable. EPA will review the State's authority to determine whether it includes the authority to sue in court, and to assess penalties.

2. Remediation Requirements for Land-Based Units With Releases to the Environment

Sections 264.90(f), 264.110(c), 264.140(d), 265.90(f), 265.110(d), and 265.140(d) of this rule allow EPA or the authorized State to replace requirements of Part 264 or 265 Subpart F and G with analogous requirements developed through the corrective action process. When regulated units are addressed through the corrective action process, these provisions allow the Agency to transfer financial assurance requirements to corrective action as well. Sections 264.112(b) and (c), 264.118(b) and (d), 265.112(b) and (c), and 265.118(c) and (d) contain procedures for owners and operators to implement this flexibility.

To obtain authorization for §§ 264.90(f), 264.110(c), and 264.140(d), which apply at permitted facilities, States must be authorized for section 3004(u) or submit an application that includes copies of the statutes and regulations the State plans to use to develop a remedy at regulated units. To obtain authorization for §§ 265.90(f), 265.110(d), and 265.140(d), which apply at interim status facilities, States must submit an application that includes copies of the statutes and regulations the State plans to use to develop a remedy at regulated units. As in the case of alternate authorities submitted for approval to be used in lieu of post-closure permits, authorities to be used to implement §§ 265.90(f), 265.110(d), and 265.140(d) must impose corrective action consistent with § 264.101, and must be sufficiently broad to impose minimum requirements. They must allow the regulatory authority to: (1) include facility-wide assessments; (2) address all releases of hazardous wastes or constituents to all media from all SWMUs within the facility boundary as well as off-site releases to the extent required under section 3004(v) (to the extent necessary to protect human health and the environment); and (3) be protective of human health and the environment. Further, they must include authority to sue in court, and to assess penalties, consistent with § 271.16. For § 265.90(f), the authority must allow the State to require financial assurance.

3. Post-Closure Permit Part B Information Submission Requirements

Section 270.28, which specifies information that must be submitted for post-closure permits, is promulgated under non-HSWA authority and is not more stringent than the current RCRA program. Therefore, § 270.28 does not become effective in an authorized State until and unless the State obtains authorization for that provision. Further, authorized States are not required to modify their programs to adopt § 270.28.

V. Effective Date

This final rule is effective immediately. Section 3010(b)(1) of RCRA allows EPA to promulgate an immediately effective rule where the Administrator finds that the regulated community does not need additional time to come into compliance with the rule. Similarly, the Administrative Procedures Act (APA) provides for an immediate effective date for rules that relieve a restriction (*see* 5 U.S.C. 553(d)(1)).

This rule does not impose any requirements on the regulated community; rather, the rule provides flexibility in the regulations with which the regulated community is required to comply. The Agency finds that the regulated community does not need six months to come into compliance.

VI. Regulatory Assessments

A. Executive Order 12866

Under Executive Order 12866, which was published in the Federal Register on October 4, 1993 (*see* 58 FR 51735), the Agency must determine whether a regulatory action is ''significant'' and, therefore, subject to OMB review and the requirements of the Executive Order. The Order defines ''significant regulatory action'' as one that is likely to result in a rule that may:

(1) have an annual effect on the economy of $100 million or more, or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) materially alter the budgetary impact of entitlement, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Under the terms of Executive Order 12866, OMB has notified EPA that it considers this a ''significant regulatory action'' on the basis of (4) within the meaning of the Executive Order. EPA has submitted this action to OMB for review. Changes made in response to OMB suggestions or recommendations are documented in the public record for this rulemaking (*see* Docket # F–94–PCPP–FFFFF).

This final rule establishes two main changes to the procedures required for closure and post-closure care. First, it allows EPA and the authorized States the option of either issuing post-closure permits or using alternative mechanisms for ensuring the proper management and care of facilities after their closure. Second, it amends the regulations governing closure of regulated units to allow, under certain circumstances, the regulatory agency to address regulated units through Federal or State cleanup programs, instead of applying Part 264 and 265 standards for closure.

The first provision benefits the regulated community by providing a potential avoidance of the permit process for post-closure, as well as eliminating duplication of effort in cases, where EPA and the States have already issued enforcement orders to ensure expeditious action by facility operators. The cost savings for this change are estimated to be a total of $507,000, and are discussed in further detail in the Economic Impact Analysis background document, which has been placed in the docket. The second gives EPA and States discretion to replace regulatory requirements applying to closed regulated units with site-specific requirements developed through cleanup authorities. It does not affect any authority EPA and authorized States have to impose the closure requirements. Further, the requirements for corrective action are not more stringent than those required for closure under Parts 264 and 265. Consequently, no cost assessment was prepared for the second main provision of the rule.

B. Regulatory Flexibility Act

Under the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*, as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996), at the time the Agency publishes a proposed or final rule, it must prepare and make available for public comment a Regulatory Flexibility Analysis that describes the effect of the rule on small entities. However, no regulatory flexibility analysis is required if the Administrator certifies that the rule will not have significant adverse impact on a substantial number of small entities.

SBREFA amended the Regulatory Flexibility Act to require Federal agencies to provide a statement of the factual basis for certifying that a rule will not have a significant economic impact on a substantial number of small entities. The following discussion explains EPA's determination.

The first portion of this final rule would provide regulatory relief by expanding the options available to address post-closure care so that a permit would not be required in every case. No new requirements would be imposed on owners and operators in addition to those already in effect. The Agency estimates a cost savings of $500,000 as a result of this portion of the rule. Additional details related to this cost savings are included in the Economic Impact Analysis, which can be found in the docket. The second part of the final rule makes available more flexible standards regarding closure, groundwater monitoring, and financial assurance for some facilities. It also imposes no new requirements. Therefore, pursuant to 5 U.S.C. 601b, I certify that this regulation will not have significant economic impact on a substantial number of small entities.

C. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), P.L. 104–4, establishes requirements for Federal Agencies to assess the effects of their regulatory actions on State, local, and tribal governments, and on the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with ''Federal mandates'' that may result in expenditures by local, and tribal governments, in the aggregate, or by private sector, of $100 million or more in any one year. Before promulgating an EPA rule for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost-effective, or least burdensome alternative if the Administrator publishes with the final rule an explanation why that alternative was not adopted. Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

EPA has determined that this rule does not include a Federal mandate that may result in estimated costs of $100 million or more to either State, local, or tribal governments in the aggregate, or the private sector in any one year. Neither portion of this rule is more stringent than the current Federal program, therefore, States are not required to adopt them (see section V of this preamble). In addition, this rule imposes no new requirements on owners and operators, but, rather, allows flexibility to regulators to implement requirements already in place. As stated above, EPA estimates a cost savings of $500,000 for the provisions of the final rule. EPA also has concluded that this rule will not significantly or uniquely affect small governments. Small governments will not be responsible for implementing the rule. Although they may be owners or operators of facilities regulated by the rule, the rule does not impose any new requirements.

D. Paperwork Reduction Act

The Office of Management and Budget (OMB) has approved the information collection requirements contained in this rule under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* and has assigned OMB control number 2050–0009 (EPA ICR Number 1573.05).

EPA believes the changes to the information collection do not constitute a substantive or material modification. The recordkeeping and reporting requirements of this rule would replace or reduce similar requirements already promulgated and covered under the existing Information Collection Request (ICR). There is no net increase in recordkeeping and reporting requirements. As a result, the reporting, notification, or recordkeeping (information) provisions of this rule will not need to be submitted for approval to the Office of Management and Budget (OMB) under section 3504(b) of the Paperwork Reduction Act, 44 U.S.C. 3501 et. seq..

The current ICR expires on December 31, 1999. During the ICR renewal process, EPA will prepare an ICR document with an estimate of the burden reduction resulting from the decreased reporting provisions of this rule, and will publish in the Federal Register a Notice announcing the availability of that ICR and soliciting public comments.

Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR Part 9 and 48 CFR Chapter 15.

E. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

Executive Order 13045, entitled ''Protection of Children from Environmental Health Risks and Safety Risks'' (*see* 62 FR 19885, April 23, 1997) applies to any rule that EPA determines: (1) is ''economically significant'' as defined under Executive Order 12866, and (2) the environmental health or safety risk addressed by the rule has a disproportionate effect on children. If the regulatory action meets both criteria, the Agency must evaluate the environmental health or safety effects of the planned rule on children, and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This final rule is not subject to E.O. 13045 because this is not an ''economically significant'' regulatory action as defined by E.O. 12866. In addition, the rule does not involve decisions based on environmental health or safety risks.

F. National Technology Transfer and Advancement Act

Under section 12(d) of the National Technology Transfer and Advancement Act, the Agency is directed to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications,

test methods, sampling procedures, business practices, etc.) that are developed or adopted by voluntary consensus standard bodies. Where available and potentially applicable voluntary consensus standards are not used by EPA, the Act requires the Agency to provide Congress, through the Office of Management and Budget, an explanation of the reasons for not using such standards.

EPA is not promulgating technical standards as part of today's final rule. Thus, the Agency has not considered the use of voluntary consensus standards in developing this rule.

G. Executive Order 12898: Environmental Justice

Under Executive Order 12898, ''Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,'' as well as through EPA's April 1995, ''Environmental Justice Strategy, OSWER Environmental Justice Task Force Action Agenda Report,'' and National Environmental Justice Advisory Council, EPA has undertaken to incorporate environmental justice into its policies and programs. EPA is committed to addressing environmental justice concerns, and is assuming a leadership role in environmental justice initiatives to enhance environmental quality for all residents of the United States. The Agency's goals are to ensure that no segment of the population, regardless of race, color, national origin, or income, bears disproportionately high and adverse human health and environmental effects as a result of EPA's policies, programs, and activities, and all people live in clean and sustainable communities. To address this goal, EPA considered the impacts of this final rule on low-income populations and minority populations and concluded that this final rule will potentially advance environmental justice causes. The process for public involvement set forth in this final rule encourages all potentially affected segments of the population to participate in public hearings and/or to provide comment on health and environmental concerns that may arise pursuant to a proposed Agency action under the rule. EPA believes that public involvement should include regular updating of the community on the progress made cleaning up the facility. Public participation should provide all impacted and affected parties ample time to participate in the facility cleanup decisions. In many cases, public involvement should include bilingual notifications or publication of legal notices in community newspapers.

H. Executive Order 12875: Enhancing Intergovernmental Partnerships

Under Executive Order 12875, EPA may not issue a regulation that is not required by statute and that creates a mandate upon a State, local or tribal government, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by those governments. If EPA complies by consulting, Executive Order 12875 requires EPA to provide to the Office of Management and Budget a description of the extent of EPA's prior consultation with representatives of affected State, local and tribal governments, the nature of their concerns, copies of any written communications from the governments, and a statement supporting the need to issue the regulation. In addition, Executive Order 12875 requires EPA to develop an effective process permitting elected officials and other representatives of State, local and tribal governments ''to provide meaningful and timely input in the development of regulatory proposals containing significant unfunded mandates.''

This rule does not create a mandate on State, local or tribal governments. The rule does not impose any enforceable duties on these entities. It provides more flexibility for States and tribes to implement already-existing requirements. Accordingly, the requirements of section 1(a) of Executive Order 12875 do not apply to this rule.

I. Executive Order 13084: Consultation and Coordination With Indian Tribal Governments

Under Executive Order 13084, EPA may not issue a regulation that is not required by statute, that significantly or uniquely affects the communities of Indian tribal governments, and that imposes substantial direct compliance costs on those communities, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by the tribal governments. If EPA complies by consulting, Executive Order 13084 requires EPA to provide to the Office of Management and Budget, in a separately identified section of the preamble to the rule, a description of the extent of EPA's prior consultation with representatives of affected tribal governments, a summary of the nature of their concerns, and a statement supporting the need to issue the regulation. In addition, Executive Order 13084 requires EPA to develop an effective process permitting elected and other representatives of Indian tribal governments ''to provide meaningful and timely input in the development of regulatory policies on matters that significantly or uniquely affect their communities.''

This rule does not significantly or uniquely affect the communities of Indian tribal governments. In addition, this rule imposes no new requirements on owners and operators, but, rather, allows flexibility to regulators to implement requirements already in place. Accordingly, the requirements of section 3(b) of Executive Order 13084 do not apply to this rule.

J. Submission to Congress and the General Accounting Office

The Congressional Review Act, 5 U.S.C. 801(a)(1)(A), as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the General Accounting Office prior to publication of the rule in this Federal Register. A major rule cannot take effect until 60 days after it is published in the Federal Register. This rule is not a ''major rule'' as defined by 5 U.S.C 804(2).

VII. Brownfields

In February 1995, EPA announced its Brownfields Action Agenda, launching the first Federal effort of its kind designed to empower States, Tribes, communities, and other parties to safely cleanup, reuse, and return brownfields to productive use. To broaden the mandate of the original agenda, in 1997 EPA initiated the Brownfields National Partnership Agenda, involving nearly twenty other Federal agencies in brownfields cleanup and reuse. Since the 1995 announcement, EPA has funded brownfields pilots, reduced barriers to cleanup and redevelopment by clarifying environmental liability issues, developed partnerships with interested stakeholders, and stressed the importance of environmental workforce training. In implementing the Agenda, EPA, to date, has focused primarily on issues associated with CERCLA. Representatives from cities, industries, and other stakeholders, however, have recently begun emphasizing the importance of looking beyond CERCLA and addressing issues at brownfield sites in a more comprehensive manner.

This final rule furthers the Administration's brownfields work by

removing barriers posed by RCRA regulations. Modifying the post-closure permit requirement and allowing the use of an alternative authority to clean up regulated and solid waste management units, expedites the clean up of RCRA facilities and makes such property available for reuse.

List of Subjects

40 CFR Part 264

Environmental protection, Hazardous waste, Closure, Corrective action, Post-closure, Permitting.

40 CFR Part 265

Hazardous waste, Closure, Corrective action, Post-closure, Permitting.

40 CFR Part 270

Hazardous waste, Post-closure, Permitting.

40 CFR Part 271

State authorization, Enforcement authority.

Dated: October 15, 1998.

Carol M. Browner,

Administrator.

For the reasons set out in the preamble, Chapter 1 Title 40 of the Code of Federal Regulations is amended as follows:

PART 264—STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

1. The authority citation for part 264 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6924, and 6925.

2. Section 264.90 is amended by adding new paragraphs (e) and (f) to read as follows:

§ 264.90 Applicability.

* * * * *

(e) The regulations of this subpart apply to all owners and operators subject to the requirements of 40 CFR 270.1(c)(7), when the Agency issues either a post-closure permit or an enforceable document (as defined in 40 CFR 270.1(c)(7)) at the facility. When the Agency issues an enforceable document, references in this subpart to ''in the permit'' mean ''in the enforceable document.''

(f) The Regional Administrator may replace all or part of the requirements of §§ 264.91 through 264.100 applying to a regulated unit with alternative requirements for groundwater monitoring and corrective action for releases to groundwater set out in the permit (or in an enforceable document) (as defined in 40 CFR 270.1(c)(7)) where the Regional Administrator determines that:

(1) The regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and

(2) It is not necessary to apply the groundwater monitoring and corrective action requirements of §§ 264.91 through 264.100 because alternative requirements will protect human health and the environment.

3. Section 264.110 is amended by adding a new paragraph (c) to read as follows:

§ 264.110 Applicability.

* * * * *

(c) The Regional Administrator may replace all or part of the requirements of this subpart (and the unit-specific standards referenced in § 264.111(c) applying to a regulated unit), with alternative requirements set out in a permit or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator determines that:

(1) The regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and

(2) It is not necessary to apply the closure requirements of this subpart (and those referenced herein) because the alternative requirements will protect human health and the environment and will satisfy the closure performance standard of § 264.111 (a) and (b).

4. Section 264.112 is amended by adding new paragraphs (b)(8) and (c)(2)(iv) to read as follows:

§ 264.112 Closure plan; amendment of plan.

* * * * *

(b) * * *

(8) For facilities where the Regional Administrator has applied alternative requirements at a regulated unit under §§ 264.90(f), 264.110(d), and/or § 264.140(d), either the alternative requirements applying to the regulated unit, or a reference to the enforceable document containing those alternative requirements.

(c) * * *

(2) * * *

(iv) the owner or operator requests the Regional Administrator to apply alternative requirements to a regulated unit under §§ 264.90(f), 264.110(c), and/or § 264.140(d).

* * * * *

5. Section 264.118 is amended by adding new paragraphs (b)(4) and (d)(2)(iv) to read as follows:

* * * * *

§ 264.118 Post-closure plan; amendment of plan.

(b) * * *

(4) For facilities where the Regional Administrator has applied alternative requirements at a regulated unit under §§ 264.90(f), 264.110(c), and/or §§ 264.140(d), either the alternative requirements that apply to the regulated unit, or a reference to the enforceable document containing those requirements.

* * * * *

(d) * * *

(2) * * *

(iv) The owner or operator requests the Regional Administrator to apply alternative requirements to a regulated unit under §§ 264.90(f), 264.110(c), and/or § 264.140(d).

* * * * *

6. Section 264.140 is amended by adding a new paragraph (d) to read as follows:

§ 264.140 Applicability.

* * * * *

(d) The Regional Administrator may replace all or part of the requirements of this subpart applying to a regulated unit with alternative requirements for financial assurance set out in the permit or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator:

(1) Prescribes alternative requirements for the regulated unit under § 264.90(f) and/or § 264.110(d); and

(2) Determines that it is not necessary to apply the requirements of this subpart because the alternative financial assurance requirements will protect human health and the environment.

PART 265—INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

1. The authority citation for part 265 continues to read as follows:

Authority: 42 U.S.C. 6905, 6906, 6912, 6922, 6923, 6924, 6925, 6935, 6936, and 6937.

2. Section 265.90 is amended by adding new paragraph (f) to read as follows:

§ 265.90 Applicability.

* * * * *

(f) The Regional Administrator may replace all or part of the requirements of this subpart applying to a regulated unit (as defined in 40 CFR 264.90), with alternative requirements developed for groundwater monitoring set out in an approved closure or post-closure plan or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator determines that:

(1) A regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and

(2) It is not necessary to apply the requirements of this subpart because the alternative requirements will protect human health and the environment. The alternative standards for the regulated unit must meet the requirements of 40 CFR 264.101(a).

3. Section 265.110 is amended by adding new paragraphs (c) and (d) to read as follows:

§ 265.110 Applicability.

* * * * *

(c) Section 265.121 applies to owners and operators of units that are subject to the requirements of 40 CFR 270.1(c)(7) and are regulated under an enforceable document (as defined in 40 CFR 270.1(c)(7)).

(d) The Regional Administrator may replace all or part of the requirements of this subpart (and the unit-specific standards in § 265.111(c)) applying to a regulated unit (as defined in 40 CFR 264.90), with alternative requirements for closure set out in an approved closure or post-closure plan, or in an enforceable document (as defined in 40 CFR 270.1(c)(7)), where the Regional Administrator determines that:

(1) A regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release, and

(2) It is not necessary to apply the closure requirements of this subpart (and/or those referenced herein) because the alternative requirements will protect human health and the environment, and will satisfy the closure performance standard of § 265.111 (a) and (b).

4. Section 265.112 is amended by adding new paragraphs (b)(8) and (c)(1)(iv) to read as follows:

§ 265.112 Closure plan; amendment of plan.

* * * * *

(b) * * *

(8) For facilities where the Regional Administrator has applied alternative requirements at a regulated unit under §§ 265.90(f), 265.110(d), and/or 265.140(d), either the alternative requirements applying to the regulated unit, or a reference to the enforceable document containing those alternative requirements.

(c) * * *

(1) * * *

(iv) The owner or operator requests the Regional Administrator to apply alternative requirements to a regulated unit under §§ 265.90(f), 265.110(d), and/or 265.140(d).

* * * * *

5. § 265.118 is amended by adding new paragraphs (c) (4) and (5), and (d)(1)(iii) to read as follows:

§ 265.118 Post-closure plan; amendment of plan.

* * * * *

(c) * * *

(4) For facilities subject to § 265.121, provisions that satisfy the requirements of § 265.121(a)(1) and (3).

(5) For facilities where the Regional Administrator has applied alternative requirements at a regulated unit under §§ 265.90(f), 265.110(d), and/or 265.140(d), either the alternative requirements that apply to the regulated unit, or a reference to the enforceable document containing those requirements.

(d) * * *

(1) * * *

(iii) The owner or operator requests the Regional Administrator to apply alternative requirements to a regulated unit under §§ 265.90(f), 265.110(d), and/or 265.140(d).

* * * * *

5. A new § 265.121 is added to Subpart G to read as follows:

§ 265.121 Post-closure requirements for facilities that obtain enforceable documents in lieu of post-closure permits.

(a) Owners and operators who are subject to the requirement to obtain a post-closure permit under 40 CFR 270.1(c), but who obtain enforceable documents in lieu of post-closure permits, as provided under 40 CFR 270.1(c)(7), must comply with the following requirements:

(1) The requirements to submit information about the facility in 40 CFR 270.28;

(2) The requirements for facility-wide corrective action in § 264.101 of this chapter;

(3) The requirements of 40 CFR 264.91 through 264.100.

(b)(1) The Regional Administrator, in issuing enforceable documents under § 265.121 in lieu of permits, will assure a meaningful opportunity for public involvement which, at a minimum, includes public notice and opportunity for public comment:

(i) When the Agency becomes involved in a remediation at the facility as a regulatory or enforcement matter;

(ii) On the proposed preferred remedy and the assumptions upon which the remedy is based, in particular those related to land use and site characterization; and

(iii) At the time of a proposed decision that remedial action is complete at the facility. These requirements must be met before the Regional Administrator may consider that the facility has met the requirements of 40 CFR 270.1(c)(7), unless the facility qualifies for a modification to these public involvement procedures under paragraph (b)(2) or (3) of this section.

(2) If the Regional Administrator determines that even a short delay in the implementation of a remedy would adversely affect human health or the environment, the Regional Administrator may delay compliance with the requirements of paragraph (b)(1) of this section and implement the remedy immediately. However, the Regional Administrator must assure involvement of the public at the earliest opportunity, and, in all cases, upon making the decision that additional remedial action is not needed at the facility.

(3) The Regional Administrator may allow a remediation initiated prior to October 22, 1998 to substitute for corrective action required under a post-closure permit even if the public involvement requirements of paragraph (b)(1) of this section have not been met so long as the Regional Administrator assures that notice and comment on the decision that no further remediation is necessary to protect human health and the environment takes place at the earliest reasonable opportunity after October 22, 1998.

6. Section 265.140 is amended by adding a new paragraph (d) to read as follows:

§ 265.140 Applicability.

* * * * *

(d) The Regional Administrator may replace all or part of the requirements of this subpart applying to a regulated unit with alternative requirements for financial assurance set out in the permit or in an enforceable document (as

defined in 40 CFR 270.1(c)(7)), where the Regional Administrator:

(1) Prescribes alternative requirements for the regulated unit under § 265.90(f) and/or 265.110(d), and

(2) Determines that it is not necessary to apply the requirements of this subpart because the alternative financial assurance requirements will protect human health and the environment.

PART 270—EPA ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT PROGRAM

1. The authority citation for part 270 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912, 6924, 6925, 6927, 6939, and 6974.

2. Section 270.l is amended by revising paragraph (c) introductory text and adding a new paragraph (c)(7) to read as follows:

§ 270.1 Purpose and scope of these regulations.

* * * * *

(c) *Scope of the RCRA permit requirement.* RCRA requires a permit for the ''treatment,'' ''storage,'' and ''disposal'' of any ''hazardous waste'' as identified or listed in 40 CFR part 261. The terms ''treatment,'' ''storage,'' ''disposal,'' and ''hazardous waste'' are defined in § 270.2. Owners and operators of hazardous waste management units must have permits during the active life (including the closure period) of the unit. Owners and operators of surface impoundments, landfills, land treatment units, and waste pile units that received waste after July 26, 1982, or that certified closure (according to § 265.115 of this chapter) after January 26, 1983, must have post-closure permits, unless they demonstrate closure by removal or decontamination as provided under § 270.1(c)(5) and (6), or obtain an enforceable document in lieu of a post-closure permit, as provided under paragraph (c)(7) of this section. If a post-closure permit is required, the permit must address applicable 40 CFR part 264 groundwater monitoring, unsaturated zone monitoring, corrective action, and post-closure care requirements of this chapter. The denial of a permit for the active life of a hazardous waste management facility or unit does not affect the requirement to obtain a post-closure permit under this section.

* * * * *

(7) *Enforceable documents for post-closure care.* At the discretion of the Regional Administrator, an owner or operator may obtain, in lieu of a post-closure permit, an enforceable document imposing the requirements of 40 CFR 265.121. ''Enforceable document'' means an order, a plan, or other document issued by EPA or by an authorized State under an authority that meets the requirements of 40 CFR 271.16(e) including, but not limited to, a corrective action order issued by EPA under section 3008(h), a CERCLA remedial action, or a closure or post-closure plan.

3. Section 270.14 is amended by adding a sentence to the end of paragraph (a) to read as follows:

§ 270.14 Contents of part B: General requirements.

(a) * * * For post-closure permits, only the information specified in § 270.28 is required in Part B of the permit application.

* * * * *

4. A new § 270.28 is added to Subpart B to read as follows:

§ 270.28 Part B information requirements for post-closure permits.

For post-closure permits, the owner or operator is required to submit only the information specified in §§ 270.14(b)(1), (4), (5), (6), (11), (13), (14), (16), (18) and (19), (c), and (d), unless the Regional Administrator determines that additional information from §§ 270.14, 270.16, 270.17, 270.18, 270.20, or 270.21 is necessary. The owner or operator is required to submit the same information when an alternative authority is used in lieu of a post-closure permit as provided in § 270.1(c)(7).

PART 271—REQUIREMENTS FOR AUTHORIZATION OF STATE HAZARDOUS WASTE PROGRAMS

1. The authority citation for part 271 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a) and 6926.

2. Section 271.16 is amended by adding a new paragraph (e) to read as follows:

§ 271.16 Requirements for enforcement authority.

* * * * *

(e) Any State authority used to issue an enforceable document either in lieu of a post-closure permit as provided in 40 CFR 270.1(c)(7), or as a source of alternative requirements for regulated units, as provided under 40 CFR 264.90(f), 264.110(c), 264.140(d), 265.90(d), 265.110(d), and 265.140(d), shall have available the following remedies:

(1) Authority to sue in courts of competent jurisdiction to enjoin any threatened or continuing violation of the requirements of such documents, as well as authority to compel compliance with requirements for corrective action or other emergency response measures deemed necessary to protect human health and the environment; and

(2) Authority to access or sue to recover in court civil penalties, including fines, for violations of requirements in such documents.

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Office of Solid Waste

EPA

Environmental Fact Sheet

Post-Closure Permit Amendment Addresses Corrective Action

To remove impediments to cleanup at hazardous waste facilities, the Environmental Protection Agency (EPA) is amending closure and post-closure care requirements to expand regulatory options available to EPA and authorized states. This rule facilitates cleanup of hazardous and solid waste management units that may be similarly situated, but were previously subject to two different requirements.

Background

Under Subtitle C of the Resource Conservation and Recovery Act (RCRA), Congress gives EPA the authority to regulate the permitting of hazardous waste treatment, storage, and disposal facilities. In 1982, EPA promulgated rules applicable to regulated land disposal units, including rules governing closure of those units, and rules requiring owners and operators of land disposal units to obtain a post-closure permit if they leave hazardous waste in place after closure.

In the 1984 Hazardous and Solid Waste Amendments, Congress expanded EPA's authority to implement corrective action for releases from all solid waste management units (SWMUs) located at hazardous waste facilities. As a result, EPA's closure and post-closure requirements applied to regulated units, while other SWMUs at the same facilities were addressed under the Agency's new corrective action authority.

After implementing this dual regulatory structure for several years, EPA recognized a need for flexibility in its regulations. As a result, EPA has promulgated revisions to its regulations to coordinate the implementation of RCRA closure, post-closure care, and corrective action requirements.

Action

Post-Closure Permits

This rule allows regulators flexibility to issue a post-closure permit to a facility or to impose the same regulatory requirements in an enforceable document issued under an alternate non-permit authority in lieu of a post-closure permit. Facilities that receive enforceable documents in lieu of post-

closure permits must continue to meet all requirements of the regulations applicable to non-permitted facilities and must meet the additional requirements outlined in this rule--that is, they must submit information about the facility upon request by EPA, conduct facility-wide corrective action, and comply with the groundwater requirements applicable under permits. In addition, the Agency must provide for meaningful public involvement at three key stages--when it becomes involved in the corrective action activities at the facility, during remedy selection, and prior to making a decision that corrective action is complete at the facility. These requirements assure that facilities addressed under alternate authorities are subject to the same level of environmental protection as facilities regulated under post-closure permits, while allowing regulators flexibility to use the best tool available to address the facility.

This rule also adds a new section to 40 CFR Part 270, identifying specific RCRA Part B permit application information that must be submitted when post-closure permit is issued. This provision clarifies information submission requirements for owners and operators, but does not modify existing requirements.

Closure of Regulated Units

This rule allows EPA to replace the closure and groundwater requirements at certain hazardous waste units with similar, site-specific requirements developed through the corrective action process. This flexibility is available under the following conditions:

- When a hazardous waste unit is situated among SWMUs (or areas of concern), a release has occurred, and both the unit and the SWMU(s) are likely contributors to the release.
- When EPA determines that applying the hazardous waste closure and groundwater monitoring requirements for post-closure care is not necessary because the cleanup remedy developed through the corrective action process is deemed protective.
- When the remedy selected will satisfy the RCRA closure performance standards.

When the closure and groundwater requirements are developed through corrective action, the rule also allows regulators to develop site-specific financial assurance requirements.

Applicability

The post-closure provisions of this rule affect all non-permitted land disposal facilities that close with waste in place. The provisions regarding closure of regulated units apply to all land disposal units, at permitted and non-permitted facilities, that meet the conditions of the rule.

Conclusion

EPA believes that this final rule will facilitate the regions' and states' implementation of RCRA post-closure care and corrective action requirements in two areas. First, it will expand the regulatory options available to EPA and the authorized states to address environmental needs at facilities undergoing post-closure care. Second, it will allow EPA and the authorized states to address certain hazardous waste units under the corrective action process rather than closure, thus removing impediments to cleanup that have been encountered where two similarly situated units have been subject to two different regulatory requirements.

For More Information

This fact sheet is available in electronic format on the Internet at <www.epa.gov/epaoswer/osw/cleanup.htm>. For additional information or to order copies of this or any other document, call the RCRA Hotline. Callers within the Washington Metropolitan Area must dial 703-412-9810 or TDD 703-412-3323 (hearing impaired). Long-distance callers may call 1-800-424-9346 or TDD 1-800-553-7672. The RCRA Hotline operates weekdays, 9:00 a.m. to 6:00 p.m. Write to the RCRA Information Center (5305W), US EPA, 401 M Street SW, Washington, DC 20460. Address e-mail to rcra-docket@epamail.epa.gov.

Post- Closure Rule

This document is part of the training materials for the RCRA Corrective Action Workshop on Results-Based Project Management. It contains summaries of EPA statutory authorities, regulations, and guidance materials. This document does not substitute for any of these authorities or materials. In addition, this document is not an EPA regulation and therefore cannot impose legally binding requirements on EPA, States, or the regulated community. EPA may change this document in the future, as appropriate.

Basic Elements of the Post-Closure Rule

- Post-closure care under alternatives to permits
- Remediation requirements for land-based units with releases to the environment

2

Notes:

Post-closure care under alternatives to permits:

These provisions allow post-closure care, normally imposed through a post - closure permit, to be imposed through alternate enforceable documents.

Remediation requirements for land-based units with releases to the environment:

These provisions provide flexibility to harmonize potentially conflicting requirements where releases from regulated units and other releases commingle.

Post-Closure Care Under Alternatives to Permits

- These provisions apply to units that:
  - Close with waste in place
  - Close prior to obtaining a final permit status
- These units must either:
  - Obtain a post-closure permit; or
  - Obtain an enforceable document in lieu of a post-closure permit

Notes:

The choice between the two options is at the discretion of the Regional Administrator (or authorized State).

What Constitutes an "Enforceable Document?"

- May be an order, plan or other document issued under an alternative authority
- May be issued by EPA or authorized States

5

Notes:

An alternative authority must have the following attributes:

1. Authority to sue in courts for injunctive relief, and to compel compliance with corrective action or other response actions; and
2. Authority to access or recover civil penalties.

Examples of enforceable documents:

1. Enforceable orders under §3008(h) of RCRA
2. Orders under §106 of CERCLA
3. Fund-lead actions under §104 of CERCLA
4. State orders issued under authorities reviewed and approved by EPA
5. Closure and post-closure plans
6. State enforcement orders analogous to §3008(h) of RCRA.

In some cases, combinations of authorities might be used, such as a §3008(h) order to cover SWMUs, and a closure plan for regulated units.

Key Differences Between Parts 264 and 265

- Key differences between Parts 264 and 265 that apply to affected units subject to post-closure permits:
  - Information submission requirements
  - Subpart F requirements for groundwater monitoring and corrective action for releases to groundwater
  - Site-wide Corrective Acton

Notes:

Alternative mechanisms must ensure affected interim-status units meet the same substantive requirements that apply to units receiving post-closure permits.

References: "40 CFR Parts 264, 265, 270, and 271 Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities," US EPA, Federal Register, October 1998.

Requirements for Alternate Enforceable Documents

- Requirements of §265.121(a)(1)
- Requirements of §265.121(a)(3)
- Requirements of §265.121(a)(2)

Notes:

Requirements of §265.121(a)(1):

Imposes information submission requirements relevant to closed facilities needing permits only for post-closure care.

Information submission need not occur any earlier under an alternative mechanism than if a traditional post-closure permit were being used. That is, facilities do not need to submit this information until requested to do so by the implementing agency.

Requirements of §265.121(a)(3):

Imposes Part 264 Subpart F groundwater standards.

Requirements of §265.121(a)(2):

Imposes facility-wide corrective action consistent with §264.101.

Corrective action need not use the procedures of proposed Subpart S. Rather, it must meet the more general performance standards of §264.101 and §3004(u)(v).

Notes (cont.):

Units closing under alternative mechanisms remain subject to requirements covering maintenance of the closed unit and financial assurance.

Interim and final status requirements are virtually identical - thus, Part 265 Subpart G and H continue to apply and do not need to be addressed by the alternative mechanism.

Public Notice and Comment - §265.121(b)

- Public Notice is required as follows:
  - When EPA becomes involved in remediation at a facility through rules or enforcement
  - At the point of a proposed remedy
  - Prior to final decision that a remedy is complete

Notes:

Public involvement is not limited to these instances - EPA encourages early, open, and continuous public involvement.

Public involvement may be modified where necessary to avoid delays in implementing cleanup. More specifically, public participation may be delayed or waived upon a determination that even a short delay in remedy implementation would adversely affect human health and the environment.

When public notice is delayed or waived, it must take place at the earliest opportunity. In all cases, public involvement must occur upon the decision that additional remedial action is not needed at the facility.

Public involvement must be "meaningful." This means that all impacted and affected parties have ample time to participate in the facility cleanup decisions. See the rule discussion at 63 FR 56720.

Cleanup activities conducted prior to the effective date of this rule may be used to satisfy post-closure permit requirements. However, public involvement must be conducted for the facility to be considered to be fully addressed.

Administrative Appeals

- The rule does not require that States or EPA provide for administrative appeals
- EPA believes that administrative appeals are not appropriate in an enforcement setting

Notes:

Recognizing that enforcement orders will frequently be used as alternative mechanisms, the Post-Closure Rule does not require that States or EPA provide for administrative appeals.

While this is a change from the current Federal (but not necessarily State) administrative procedures (40 CFR Part 124), EPA believes that administrative appeals are not appropriate in an enforcement setting.

Implementation Issues

- Facilities remain subject to interim status requirements
- The rule does not alter EPA's Authority to issue a permit after a facility has been addressed through an alternate Authority
- EPA and authorized States retain the Authority to use the mechanism best suited to the site

Notes:

Facilities conducting post-closure care under an alternate Authority remain subject to interim status requirements until final administrative disposition of a permit application.

EPA and authorized States retain the Authority to use the mechanism best suited to the site, considering all factors.

Implementation Issues (Cont.)

- Facilities do not have the ability to challenge the Agency's decision regarding the appropriate alternative mechanism
- The use of alternate authorities in lieu of a post-closure permit applies only to facilities that have not received a permit

Notes:

Consistent with EPA's long-standing policy on enforcement discretion, facilities do not have the ability to challenge an Agency's decision regarding the appropriate alternative mechanism.

Essential Elements of Facility-Wide Corrective Action

- Facility-wide assessments
- Address releases of hazardous waste or constituents to all media from all SWMUs within the facility boundary
- Address releases off-site to the extent required under §3004(v)
- Protective of human health and the environment

Actions Prior to the Effective Date of the Post-Closure Rule

- EPA intends that responses conducted under alternative mechanisms prior to the rule's effective date may satisfy post-closure permitting requirements
- If so, public involvement must be conducted

Notes:

Depending on public comment, the implementing Agency may; impose additional requirements by:

- Amending the existing instrument;
- Issuing a new instrument;
- Modifying a post-closure plan; or
- Issuing a post-closure permit.

EPA does not intend to re-open cleanups underway or completed prior to this rule, or to revisit through public notice and comment issues that have already been subject to comment.

Commingled Releases

- In some instances, commingled releases from both RUs and SWMUs must be addressed
- Which regulations apply? Closure requirements (inflexible, prevention-oriented), or corrective action (flexible, response-oriented)?

Notes:

Alternative (to closure requirements) groundwater monitoring, closure/post-closure, and financial assurance requirements (Subparts F, G, and H) may be imposed under a remediation Authority where:

- A release of hazardous waste or hazardous constituents has occurred; and
- Both a RU and one or more SWMUs are likely to have contributed to the release.

This option exists for both operating and closed facilities, permitted and interim status.

This option may also be used at closed/closing facilities being addressed under an alternative mechanism.

Examples of Conflicts Between Closure and Corrective Action

- A cap required by closure may be incompatible with a corrective action groundwater remedy
- Regulated unit monitoring wells at the unit boundary may not make sense for characterizing a commingled plume
- Closure financial assurance for a regulated unit may be better used for cleanup work

Integrate Closure/Corrective Action Standards & Technical Standards

- Requirements in Parts 264/265 Subparts F, G, and H may be replaced with corrective action requirements
- These Subparts apply to groundwater monitoring, closure and financial assurance, respectively

Changes to Parts 264/265 Subpart F - Groundwater Monitoring

- The Regional Administrator may replace all or parts of Sections §264.91-100 with alternative requirements for groundwater monitoring and corrective action for releases to groundwater

Notes:

The Regional Administrator must make the following findings to support the alternative requirements:

> The regulated unit is situated among solid waste management units (SWMUs) or areas of concern (AOCs), a release has occurred, and both the regulated unit and one or more SWMUs or AOCs are likely to have contributed to the release; and it is not necessary to apply the conditions of § 264.91-100 because the alternative requirements are protective of human health and the environment

264/265 Subpart G, Closure/Post-Closure Performance Standards

- Parallel the provisions of Subpart F groundwater monitoring, except that alternative closure standards must additionally meet the closure performance standards of §264/265.111(a) and (b)

- Alternative closure requirements do not have to meet the unit-specific closure technical standards referenced by §264/265.111(c)

264/265 Subpart H, Financial Assurance Requirements

- Parts of Subpart F may be replaced with alternative requirements for financial assurance

Notes:

Parts of Subpart F may be replaced with alternative requirements for financial assurance provided the following conditions are met:

> Alternative requirements have been specified for regulated units for groundwater monitoring and financial assurance; and
>
> The Regional Administrator finds it is not necessary to apply traditional requirements for regulated unit financial assurance) because alternative financial assurance requirements will protect human health and the environment.

For permitted facilities, alternative requirements under this option must be either:

> Directly included in the permit; or
>
> Included in a non-permit document that is incorporated by reference into the permit.

Inclusions/references must appear in the closure and/or post-closure sections of the permit (264.112(b)(8), 264.118(b)(4)).

Notes (cont.):

For interim status facilities, EPA or authorized States must incorporate these alternative requirements into an enforceable document, such as:

3008(h) orders

Actions under 104 or 106 of CERCLA

State actions under authorities reviewed and approved by EPA

If an alternative enforceable document is used at an interim status facility, the closure/post-closure plan must be amended to include the alternative requirements, or to reference the enforceable document that sets forth those provisions.

Implementation Issues

- Changes to permits to incorporate a remedy addressing combined releases from SWMUs and RUs are Class 3 modifications
- Agency-initiated permit modifications may be used on the basis of significant new information
- Changes to interim status closure/post closure plans should use the existing Part 265 closure plan modification process

Implementation Issues - Financial Assurance Questions

- For corrective actions addressing combined RU/SWMU releases, site-specific financial assurances for corrective action can be developed
- Funds from the RU financial assurance instrument can be transferred to the corrective action

Information Submission Requirements

- These requirements are intended to outline requirements applicable to applications for post-closure permits, a special form of RCRA permits
- Post-closure information submission requirements are a subset of full Part B information requirements, tailored to the needs of post-closure permits
- Additional information may be requested by the implementing agency

HSWA and non-HSWA Authorities

- The post-closure rule is promulgated under both HSWA and non-HSWA authorities
- The following elements that allow the option of alternate mechanisms to post-closure permits are non-HSWA:

  §264.90(e), §265.110(c), §265.118(c)(4), §265.121 (except §265.121(a)(2)), §270.1, §270.14(a), §270.28

HSWA and Non-HSWA Authorities (Cont.)

- These requirements are effective immediately only in States that have not received final authorization for base RCRA (In Region 10, this is Alaska only)
- These requirements are not effective in other States unless and until the State receives final authorization for the post-closure rule
- These requirements are not more stringent than existing requirements, so States are not required to adopt or seek authorization

Review of Alternate State Authorities

- Review of alternate State authorities proposed for use in lieu of post-closure permits is required
- EPA review will evaluate whether these authorities provide:
  - the substantive requirements of adequate Authority to clean up SWMUs within facility's boundary;
  - and procedural requirements to insure compliance

The Elements that Allow Closing RUs in Close Proximity to SWMUs

- The elements are addressed through a corrective action process
- They are promulgated pursuant to HSWA Authority:
  - §264.90(f)
  - §265.110(c)
  - §264.140(d)
  - §265.90(f)
  - §265.110(d)
  - §265.140(d)
  - §271.16(e)

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Notes:

These requirements:

Are not more stringent than the current base RCRA program applicable to closing regulated units (RUs);

Are effective immediately only in States that have not received final authorization for base RCRA.

Cannot be implemented in authorized States until the State adopts them. Once adopted, these not-more-stringent HSWA requirements can be implemented by EPA prior to State authorization; and

Are not more stringent than existing requirements, so that States are not required to adopted or seek authorization for them.

GLOSSARY/ACRONYMS

RESULTS-BASED PROJECT MANAGEMENT FOR RCRA CORRECTIVE ACTION WORKSHOP

GLOSSARY OF KEY WORKSHOP ACRONYMS AND TERMS

action levels	Health- or environmental-based concentrations derived using chemical-specific toxicity information and standardized exposure assumptions; commonly referred to as screening levels.
Advanced Notice of Proposed Rulemaking (ANPR), 1996	The major product of the Subpart S Initiative. The May 1, 1996 ANPR discussed improvements to the corrective action program that were already underway; updated the 1990 proposal and other documents by providing the Agency' s current guidance on corrective action implementation; and requested comments on many issues that could affect future corrective action rulemaking and policies. Section III of the ANPR is EPA' s most current guidance on corrective action implementation and includes seven " guiding principles" (61 FR 19432). http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/
Area of Contamination (AOC) Policy	Interpretation of RCRA that equates certain discrete areas of dispersed contamination (" AOCs") with a RCRA unit. The AOC policy was first articulated in the National Oil and Hazardous Substances Pollution Contingency Act (NCP). See 53FR51444 for detailed discussion in proposed NCP preamble; 55FR8758-8760, march 8, 1990 for final NCP preamble discussion. See also, most recent EPA guidance, March 13, 1996 EPA memo, " Use of the Area of Contamination Concept During RCRA Cleanups."
ASTSWMO	The Association of State and Territorial Solid Waste Management Officials (ASTSWMO) is an organization supporting the environmental agencies of the States and trust territories. ASTSWMO focuses on the needs of State hazardous waste programs; nonhazardous municipal solid waste and industrial waste programs; recycling, waste minimization, and reduction programs; Superfund and State cleanup programs; waste management and cleanup activities at federal facilities, and underground storage tank and leaking underground storage tank programs.
authorized State	A State that has been authorized to carry out their hazardous waste program in lieu of EPA. A State program must be at least as stringent as the Federal standards. " Base" authorization is the first step.

balancing criteria	Criteria that should be used in the justification/selection of a remedy: (1) long-term reliability and effectiveness; (2) reduction of toxicity, mobility, or volume through treatment of hazardous wastes and hazardous constituents, including how treatment is used to address principal threats posed by the facility; (3) short-term effectiveness; (4) implementability; (5) cost; (6) community acceptance; and (7) State acceptance.
Blind Window	The " window" in a communication in which information is visible to another but not to us.
brownfields	Abandoned, idle, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act. The act that authorizes EPA to identify, access and clean up site where there is a release of a hazardous substance. CERCLA provides EPA with authority to ensure that responsible parties pay the costs associated with cleaning up a site where there is a release of hazardous substances.
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System. A computerized database used to track hazardous substance sites.
CFR	Code of Federal Regulations. A compilation of all regulations issued by Executive departments and agencies of the Federal Government that is published annually. Title 40 of the CFR contains environmental regulations and may be accessed via the Internet at http://www.epa.gov/epacfr40 .
closure	Period following active hazardous waste management during which operations cease, hazardous wastes are no longer accepted and owners/operators of TSDFs complete treatment, storage, and disposal operations; apply final covers to or cap landfills; and dispose of or decontaminate equipment, structures and soil. " Closure" is define in 40 CFR § 270.2 as the act of securing a hazardous waste management facility pursuant to the requirements of 40 CFR Part 264.
Conceptual Site Model (CSM)	A three-dimensional picture and/or other illustration (i.e., flow diagram) of site conditions that conveys what is known or suspected about contamination sources, releases or, release mechanisms; contaminant fate and transport; exposure pathways and potential receptors; and risks.

Contained-In Policy	Contaminated environmental media that contain hazardous waste are subject to all RCRA requirements until they no longer contain hazardous waste. The contained-in policy was first articulated in a November 13, 1986 EPA memorandum, " RCRA Regulatory Status of Contaminated Groundwater." See 53FR31138, 31142, 31148 (Aug. 17, 1988), 57FR 21450, 21453 (May 20, 1992) for updated versions. A detailed discussion is in the HWIR-media proposal preamble, 61FR18795 (April 29, 1996).
Corrective Action	EPA' s program to address the investigation and remediation of contamination at or from hazardous waste treatment, storage, or disposal facilities.
CAMU	Corrective Action Management Unit. A CAMU is defined in 40 CFR § 260.10 as an area within a facility that is used only for managing remediation wastes for implementing corrective action or cleanup at the facility. 63 FR 65937 (Nov. 30, 1998). (Amendments to 1993 rule reflected here will become effective June 1, 1999)
Corrective Action Management Rule	58 FR 8658, February 16, 1993. The CAMU rule allows EPA or an authorized state to create a unit for the on-site treatment, storage, or disposal of remediation wastes; wastes placed into the unit are not subject to RCRA' s LDR pre-treatment requirements and CAMUs are not subject to RCRA' s minimum technological requirements.
Corrective Action Plan (CAP)	Office of Solid Waste and Emergency Response (OSWER) Directive 9902.3-2A, May 1994. Provides an overall program implementation framework; and model scopes of work for site characterizations, interim actions, evaluation of remedial alternatives, and remedy implementation.
Corrective Action Results	A term-of-art in context of the Corrective Action Workshop referring to the requirements, recommended performance standards, and remedial expectations (e.g., protect human health and the environment, control sources, restore contaminated groundwater to beneficial uses) for the corrective action program.
Corrective Measures Implementation (CMI)	Component of corrective action in which the owner and operator performs detailed design, construction, operation, maintenance, and monitoring of a chosen cleanup remedy.
Corrective Measures Study (CMS)	An evaluation, if deemed necessary by the overseeing regulatory program, in which the owner/operator identifies and evaluates remediation alternatives at a given contaminated site.

CSGWPP	Comprehensive State Groundwater Protection Program. Program to be developed by States and supported by EPA which is aimed at preventing contamination of high priority ground water, facilitating coordination among intrastate programs that protect ground water, and building a comprehensive approach to protection of ground water that includes all stakeholders.
debris	solid material exceeding 60mm particle size that is intended for disposal and that is a manufactured object, plant or animal matter, or natural geologic material. 40 CFR § 268.2 (note exceptions).
Disclosure	The sharing of relevant information.
DQO	Data Quality Objective. DQOs are qualitative and quantitative statements developed to ensure that data of known and appropriate quality are obtained to support decisions or actions. DQOs encompass all aspects of data collection, analysis, validation and evaluation.
Environmental Indicators (EIs)	Two environmental indicators are used by the corrective action program. Human exposures controlled is attained when there are no unacceptable risks to humans due to releases of contaminants at or from the facility subject to RCRA corrective action. Groundwater releases controlled is attained when the migration of groundwater contamination at or from the facility across designated boundaries is controlled. See the most recent EPA guidance, February 5, 1999 EPA memo, " Interim-Final Guidance for RCRA Corrective Action Environmental Indicators."
environmental media	Materials such as soil, groundwater, air, and sediment.
ETV	Environmental Technology Verification Program. Verifies the performance of innovative technical solutions to problems that threaten human health or the environment. Managed by EPA' s Office of Research and Development, ETV was created to substantially accelerate the entrance of new environmental technologies into the domestic and international marketplace.
Feedback	The cross-checking of information to ensure a similar interpretation of data or events.
Fugacity	The " escaping tendency" of a chemical to migrate from one compartment of the environment to another. Fugacity is to mass diffusion as temperature is to heat diffusion. Chemicals move from high fugacity to low fugacity.

generator accumulation units	Tanks, containers, containment buildings, and drip pads used by generators for the on-site accumulation of hazardous waste, including remediation waste. Such units are not subject to permitting requirements. 40 CFR § 262.34. Treatment in accumulation tanks or containers that meet the requirements of § 262.34 is permissible. 51 FR 10146, 10148 (Mar. 24, 1986).
GPRA, 1993	Government Performance and Results Act. Places new management expectations and requirements on Federal agencies by creating a framework for more effective planning, budgeting, program evaluation, and fiscal accountability for Federal programs. The intent of GPRA is to improve public confidence in Federal agency performance by holding agencies accountable for achieving program results.
Groundwater EI	A positive " No Further Migration of Contaminated Groundwater" EI determination indicates that no further migration of " contaminated" groundwater is occurring or expected, based on physical evidence.
Guiding Principles	The seven-part corrective action program management philosophy included in Section III of the May 1, 1996 Advanced Notice of Proposed Rulemaking. 61 FR 19432.
hazardous waste	Hazardous waste is defined under RCRA § 1004(5) as " a solid waste, or combination of solid waste, which because of it quantity, concentration, or physical, chemical, or infectious characteristics may - (A) cause, or contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed." Also see the narrower regulatory definition of " hazardous waste" provided in 40 CFR § 261.3.
Hazardous Waste Identification Rule for Contaminated Media (HWIR-Media Rule)	A final rule with provisions for streamlined permits for managing remediation wastes, increased flexibility for staging wastes prior to their ultimate disposition, an exclusion for certain dredged materials, and streamlined State authorization procedures. 63 FR 65874 (Nov. 30, 1998). http://www.epa.gov/fedrgstr/EPA-WASTE/1998/November/Day-30/f30269.htm
Hazardous and Solid Waste Amendments (HSWA), 1984	This 1984 Act amended RCRA by, among other things, enacting provisions that required phasing out land disposal of untreated hazardous waste. Some of the other mandates of this law include increased enforcement authority for EPA and a program requiring corrective action at treatment, storage, and disposal facilities " seeking a permit" .

Hidden Window	The " window" in a communication in which information is visible to us but not to another.
hot spots	Highly contaminated areas of contaminated media.
Human Exposures EI	A positive " No Current Human Exposures" EI determination indicates that there are no unacceptable exposures to contamination (i.e., contaminants present in concentrations in excess of appropriate risk-based levels) that can be reasonably expected under current land and ground water use conditions (for all contamination at or from the identified facility). See Feb. 5, 1999 EPA memorandum, " Interim-Final Guidance for RCRA Corrective Action Environmental Indicators."
institutional controls (IC)	Non-engineering controls used to restrict land use or land access in order to protect people and the environment from exposure to hazardous substances left in the land. E.g., deed restrictions.
interim measures	Under RCRA Subtitle C corrective action, short-term actions to control ongoing risks while site characterization is underway or before a final remedy is selected.
interim status facilities	Treatment, storage, and disposal facilities (TSDFs) that were already in operation when the applicable RCRA standards were established, and that are operating under the standards in 40 CFR Part 265 until they receive a permit. To qualify for interim status an owner or operator of an existing facility had to provide a RCRA § 3010(a) notification of hazardous waste activity and submit a Part A permit application. 40 CFR § 270.70.
Johari Window	A communication model developed by Dr. Joseph Luft and Dr. Harrington Ingham in the 1950's.
LDR	Land Disposal Restrictions. These restrictions were mandated by the 1984 HSWA amendments to RCRA. A major part of the LDR program is to require EPA to establish treatment standards for hazardous wastes that must be met before the waste can be disposed of in land disposal units.
MCL	Maximum Contaminant Level. Contaminant-specific levels established under the SDWA that are the maximum levels of a contaminant in drinking water that will ensure protection of human health. Used by RCRA site decision-makers in determining appropriate monitoring and remediation of groundwater.
media cleanup levels	Site-specific concentrations of individual hazardous constituents in a given medium that must be achieved as part of a corrective action remedy.
Media Cleanup Objective (MCO)	Broad cleanup objectives made up of media cleanup levels, points of compliance, and remediation time frames.

MTR	The Minimum Technological Requirements (MTR) under RCRA § 3004(o)(A) which require, among other things, " for each new landfill or surface impoundment ... (i) the installation of two or more liners and a leachate collections system above (in the case of a landfill) and between such liners; and (ii) ground water monitoring."
NCAPS	National Corrective Action Prioritization System. NCAPS considers the setting of a facility, actual and potential releases of hazardous constituents from the facility, and the toxicity of constituents of concern, to group facilities into high, medium, or low priority groups. EPA uses this system to set priorities to ensure that it is using its resources in the most effective manner.
NPL	National Priorities List is defined in 40 CFR § 300.5 to mean the list, compiled by EPA pursuant to CERCLA section 105, of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response. The NPL is contained in 40 CFR Part 300, Appendix B.
OSHA	Occupational Safety and Health Act of 1970 was enacted to assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the Act; by assisting and encouraging the States in their efforts to assure safe and heathful working conditions; by providing for research, information, education, and training in the field of occupational safety and health; and for other purposes. http://www.osha-slc.gov/OshAct_data/ACT1.html
OSW	The Office of Solid Waste (OSW) operates under authority of the Resource Conservation and Recovery Act to protect human health and the environment by ensuring responsible national management of hazardous and nonhazardous waste. OSW' s goals are (1) to conserve resources by reducing waste; (2) to prevent future waste disposal problems by writing result-oriented regulations; and (3) to clean up areas where waste may have spilled, leaked, or been improperly disposed of.
OSWER	The Office of Solid Waste and Emergency Response provides policy, guidance and direction for the land disposal of hazardous waste, underground storage tanks, solid waste management, encouragement of innovative technologies, source reduction of wastes, and the Superfund Program.

PCBs	Polychlorinated Biphenyls (PCBs) are a class of chemical, clear to yellow oily liquids or solids. They are used as insulating material in electrical transformers and capacitors, in hydraulic and heater transfer fluids, as plasticizers and in many heat and fire sensitive applications. Their major benefit, durability, is also a problem: They do not break down in the environment. They have caused cancer in laboratory animals and are suspected human carcinogens.
permit waivers	Guidance indicating that RCRA-authorized states with state waiver authorities comparable to CERCLA 121 (e) or RCRA Section 7003 could use those state waiver authorities to waive some RCRA requirements as long as the state did so in a manner no less stringent than that allowed under the corresponding Federal authorities. See EPA guidance memo from J. Winston Porter to EPA Regional Administrators, " RCRA Permit Requirements for State Superfund Action," November 16, 1987, OSWER Directive 9522.00-2.
performance standards	A results-based measure that protects human health and the environment, attains " media cleanup objectives," and remediates the sources of release to eliminate or further reduce threats to human health and the environment.
points of compliance (POCs)	Site-specific locations where media cleanup levels must be measured and achieved. Should be established for all affected media subject to the remedial action.
post-closure	Applies only to land disposal facilities and facilities that cannot decontaminate, or " clean close" all equipment, structures, and soils. Post closure is normally a 30 year period after closure during which owners/operators conduct monitoring and maintenance activities to preserve the integrity of the disposal system and continue to prevent or control releases of contaminants from the disposal units. The requirements for post-closure are found in 40 CFR §§ 264.117 and 265.117.
Post-Closure Rule	63 FR 56710 of October 22, 1998. Rule does not change post-closure requirements–it changes the authorities the EPA or authorized States will use to enforce the requirements. It also allows the lead agency to regulate a unit under a closure or post-closure plan without a permit and to perform facility-wide corrective action utilizing an alternate authority. http://www.epa.gov/fedrgstr/EPA-WASTE/1998/October/Day-22/f28221.htm
presumptive remedies	Preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA' s scientific and engineering evaluation of performance data on technology implementation.

principle threat	Contamination that is highly toxic, highly mobile, or cannot be reliably contained, and that would present a significant risk to human health and the environment should exposure occur.
problem	Conditions that require a response that remove, modify, or otherwise reduce the impact of the condition.
problem statement	Clear, concise format communicating the condition that needs a response.
RCI	RCRA Cleanup Initiative. Focuses on meeting the Environmental Indicators set in response to the GPRA. It will implement reforms that increase the number and speed of RCRA cleanups.
RCRA	Resource Conservation and Recovery Act, 1976. Amended the Solid Waste Disposal Act and laid the framework for regulating hazardous and nonhazardous wastes. RCRA gave EPA authority to control hazardous waste from "cradle-to-grave." This includes the minimization, generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes.
RFA	RCRA Facility Assessment. Element of RCRA Corrective Action where regulators and/or owners and operators compile existing information on environmental conditions at a given facility, including information on actual and potential releases.
RFI	RCRA Facility Investigation. Site characterization that should describe the facility and releases of hazardous wastes and constituents as necessary to enable the identification and implementation remedies needed to achieve the desired results.
RCRIS	Resource Conservation and Recovery Information System. A database that tracks RCRA Subtitle C facility-specific data and contains events and activities related to hazardous waste generators, transporters, and TSDFs.
RAP	Remedial Action Plan. Defined in 40 CFR § 270.2 as a special form of RCRA permit that a facility owner or operator may obtain instead of a permit issued under §§ 270.3 through 270.66, to authorize the treatment, storage or disposal of hazardous remediation waste at a remediation waste management site. 63 FR 65941 (Nov. 3, 1998) (Rule will become effective June 1, 1999)
remedial expectations	Developed by EPA to assist owner/operators in assessing one or more remedial alternatives that meet the remedy performance standard and in choosing or recommending a remedy that presents an appropriate balance between the remedy balancing factors. Discussed in detail in the May 1, 1996 ANPR.

remediation timeframe	Site-specific schedule under which a remedy will be implemented, including an estimate when media cleanup levels will be achieved at the points of compliance.
remediation waste	All solid and hazardous wastes, and all media (including groundwater, surface water, soils, and sediments) and debris that contain listed hazardous wastes or that themselves exhibit a hazardous waste characteristic and are managed for implementing cleanup. 63 FR 65937 (Nov. 30, 1998) (Amendments to current definition reflected here will become effective June 1, 1999)
risk	The likelihood or probability that a given contaminant exposure or series of exposures may damage human health or the environment.
risk assessment	Activity to understand risks; the application of tools to evaluate probabilities of risks occurring.
risk management	The process of evaluating and selecting alternative regulatory and non-regulatory responses to risk.
risk-based decision making	A process that utilizes risk and exposure assessment methodology to help implementing agencies make determinations about the extent and urgency of corrective action and about the scope and intensity of their oversight of corrective action.
RU	RCRA Regulated Units are defined in 40 CFR § 264.90 as surface impoundments, waste piles, land treatment units, and landfills that receive hazardous waste after July 26, 1982. RCRA regulated units are a subset of the universe of solid waste management units (SWMU).
Shared Window	The " window" in a communication in which information is readily known and clearly visible to all parties.
Site Conceptual Exposure Model Builder	A computer graphics tool that generates SCEMs and associated documentation. http://tis-mt.eh.doe.gov/oepa/programs .
SWMU	Solid Waste Management Unit. For purposes of RCRA corrective action, a SWMU is " any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area of a facility at which solid wastes have been routinely and systematically released." 61 FR 19442 (May 1, 1996).
Statement of Basis	Document that summarizes a proposed remedial action plan and the findings supporting that selected plan in the RCRA Subtitle C corrective action process. *(Guidance on RCRA Corrective Action Decision Documents: The Statement of Basis, Final Decision and Response to Comments,* Office of Waste Programs Enforcement, EPA, OSWER Directive 9902.6, April 29, 1991.)

Subpart S Proposal (1990)	EPA-proposed, detailed regulations on the technical and procedural elements of corrective action. 55FR30802 (July 27, 1990).
Subpart S Initiative (1994)	EPA and State collaboration to develop a comprehensive strategy to identify and develop improvements to the corrective action program and resolve the Subpart S proposal. The Subpart S Initiative involves the assessment of the current corrective action program, outreach to stakeholders, finalization of some elements of the 1990 proposal, development of new proposals, guidance documents, and the 1996 Advanced Notice of Proposed Rulemaking.
Stabilization Initiative	Encouraged program implementors to implement near term activities to control or abate threats to human health and the environment and prevent/minimize movement of existing contamination at all facilities rather than focusing on final, facility-wide, cleanups for only a few sites.
Staging Pile	Defined in 40 CFR § 260.10 as an accumulation of solid, non-flowing remediation waste that is not a containment building and that is used only during remedial operations for temporary storage at a facility. 63 FR 65937 (Nov. 30, 1998). (Rule will become effective June 1, 1999)
TCLP	Toxicity Characteristic Leaching Procedure. A test designed to determine whether a waste meets the regulatory definition of " hazardous waste" ; also can be used to monitor treatment techniques for effectiveness. The TCLP (Method 1311) is published in " Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" EPA Publication SW-846. 58 FR 46049 (Aug. 31, 1993).
temporary units (TUs)	Containers or tanks that are designated by EPA or an authorized state to manage remediation wastes during cleanup at permitted or facilities authorized to operate in Interim Status. 40 CFR § 264.553. 58 FR 8683 (Feb. 16, 1993), 63 FR 65939 (Nov. 30, 1998)
treatment standards	Land disposal restrictions (LDR) criteria that hazardous waste must meet before it is disposed. 40 CFR Part 268.
TSDF	Treatment, Storage, and Disposal Facility. Generally, facilities engaged in the treatment, storage, or disposal of hazardous waste.
Unknown Window	The " window" in a communication in which no one can see the data, solutions, or opportunities.

UST	Underground Storage Tank is defined to mean any one or combination of tanks (including underground pipes connected thereto) that is used to contain an accumulation or regulated substances, and the volume of which (including the volume of underground pipes connected thereto) is 10 percent or more beneath the surface of the ground. See exemptions in 40 CFR § 280.12.
VOCs	Volatile Organic Compounds. Any organic compound which evaporates readily to the atmosphere. VOCs contribute significantly to photochemical smog production and certain health problems.

REFERENCES

Management of Remediation Waste Under RCRA

RCRA Corrective Action Workshop
On Results-Based Project Management

Developed by the Corrective Action Programs Branch
Office of Solid Waste

United States
Environmental Protection
Agency

Solid Waste and
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 14 1998

MEMORANDUM

SUBJECT: Management of Remediation Waste Under RCRA

FROM: Timothy Fields, Jr., Acting Assistant Administrator for Solid Waste and Emergency Response

Steven A. Herman, Assistant Administrator for Enforcement and Compliance Assurance

TO: RCRA/CERCLA Senior Policy Managers
Regional Counsels

Rapid clean up of RCRA corrective action facilities and Superfund sites is one of the Agency's highest priorities. In this context, we often receive questions about management of remediation waste under the Resource Conservation and Recovery Act (RCRA). To assist you in successfully implementing RCRA requirements for remediation waste, this memorandum consolidates existing guidance on the RCRA regulations and policies that most often affect remediation waste management. We encourage you to work with the regulations, policies and approaches outlined in this memorandum to achieve our cleanup goals as quickly and efficiently as possible.

Note that not all remediation wastes are subject to RCRA Subtitle C hazardous waste requirements. As with any other solid waste, remediation wastes are subject to RCRA Subtitle C only if they are listed or identified hazardous waste. Environmental media are subject to RCRA Subtitle C only if they contain listed hazardous waste, or exhibit a characteristic of hazardous waste. These distinctions are discussed more completely below.

The information in this memo is divided into three categories: information on regulations and policies that apply to all remediation waste; information on regulations and policies that apply only to contaminated media; and, information on regulations and policies that apply only to contaminated debris. Most of the references cited in this memo are available over the Internet. The Federal Register notices published after 1994 are available at www.access.gpo.gov/nara; the

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guidance memos and other EPA documents are available at www.epa.gov/correctiveaction. Federal Register notices and other documents are also available through the RCRA/CERCLA hotline: in Washington D.C., call (703) 412-9810; outside Washington D.C., call (800) 424-9346; and hearing impaired call (800) 553-7672. The hotline's hours are Monday - Friday, excluding Federal holidays, 8:00 - 5:00, eastern standard time. Many EPA guidance memos and other documents may also be obtained through the RCRA/CERCLA hotline fax-back system. To obtain a list of documents available over the fax-back system, and fax-back system code numbers, call the RCRA/CERCLA hotline at the numbers listed above.

I hope this information will assist you as you continue to make protective, inclusive, and efficient cleanup decisions. If you have additional questions or require more information, please contact Robert Hall or Greg Madden, of our staffs, on (703) 308-8484 or (202) 564-4229 respectively.

Regulations and Policies that Apply to All Remediation Wastes

Area of Contamination Policy. In what is typically referred to as the area of contamination (AOC) policy, EPA interprets RCRA to allow certain discrete areas of generally dispersed contamination to be considered RCRA units (usually landfills). Because an AOC is equated to a RCRA land-based unit, consolidation and *in situ* treatment of hazardous waste within the AOC do not create a new point of hazardous waste generation for purposes of RCRA. This interpretation allows wastes to be consolidated or treated *in situ* within an AOC without triggering land disposal restrictions or minimum technology requirements. The AOC interpretation may be applied to any hazardous remediation waste (including non-media wastes) that is in or on the land. Note that the AOC policy only covers consolidation and other in situ waste management techniques carried out within an AOC. For *ex situ* waste management or transfer of wastes from one area of contamination to another, see discussion of corrective action management units, below.

The AOC policy was first articulated in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). See 53 FR 51444 for detailed discussion in proposed NCP preamble; 55 FR 8758-8760, March 8, 1990 for final NCP preamble discussion. See also, most recent EPA guidance, March 13, 1996 EPA memo, "Use of the Area of Contamination Concept During RCRA Cleanups."

Corrective Action Management Units (CAMUs). The corrective action management unit rule created a new type of RCRA unit – a Corrective Action Management Unit or CAMU – specifically intended for treatment, storage and disposal of hazardous remediation waste. Under the CAMU rule, EPA and authorized states may develop and impose site-specific design, operating, closure and post-closure requirements for CAMUs in lieu of MTRs for land-based units. Although there is a strong preference for use of CAMUs to facilitate treatment, remediation waste placed in approved CAMUs does not have to meet LDR treatment standards.

The main differences between CAMUs and the AOC policy (discussed above) are that, when a CAMU is used, waste may be treated *ex situ* and then placed in a CAMU, CAMUs may be located in uncontaminated areas at a facility, and wastes may be consolidated into CAMUs from areas that are not contiguously contaminated. None of these activities are allowed under the AOC policy, which, as discussed above, covers only consolidation and *in situ* management techniques carried out within an AOC.

CAMUs must be approved by EPA or an authorized state and designated in a permit or corrective action order. In certain circumstances, EPA and states (including states that are not authorized for the CAMU regulations) may use other mechanisms to approve CAMUs. See, 58 FR 8677, February 16, 1993; appropriate use of RCRA Section 7003 orders and comparable state orders is discussed below and in an EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2. In addition, as appropriate, CAMUs may be approved by EPA as an applicable or relevant and appropriate requirement during a CERCLA cleanup using a record of decision or by an authorized state during a state cleanup using a CERCLA-like authority and a similar state document. See, e.g., 58 FR 8679, February 16, 1993. An opportunity for the public to review and comment on tentative CAMU approvals is required by the regulations when CAMUs are approved using permitting procedures and as a matter of EPA policy when CAMUs are approved using orders. EPA recommends that, whenever possible, remediation project managers combine this public participation with other public involvement activities that are typically part of remediation. For example, public notice of tentative approval of a CAMU could be combined with public notice of a proposed plan under CERCLA.

The CAMU rule is currently subject to litigation; however, the suit has been stayed pending promulgation of the final HWIR-Media regulations. Although EPA proposed to withdraw CAMUs as part of the HWIR-Media proposal, the Agency now intends to retain the CAMU rule. The Agency encourages approval of CAMUs when they are appropriate given the site-specific conditions.

The CAMU regulations are at 40 CFR 264.552, promulgated February 16, 1993 (58 FR 8658). The differences between CAMUs and AOCs are discussed in more detail in the March 13, 1996 EPA guidance memo, "Use of the Area of Contamination Concept During RCRA Cleanups."

Corrective Action Temporary Units (TUs). Temporary units, like corrective action management units, are RCRA units established specifically for management of hazardous remediation waste. The regulations for temporary units (TUs) were promulgated at the same time as the regulations for corrective action management units. The CAMU regulations established land-based units for treatment, storage and disposal of remediation waste; the TU regulations established non-land based units for treatment and storage of hazardous remediation waste. Under the TU regulations, EPA and authorized states may modify existing MTR design, operating and closure standards for temporary tank and container units used to treat and store

hazardous remediation waste. Temporary units may operate for one year, with an opportunity for a one year extension.

Like CAMUs, temporary units must be approved by EPA or an authorized state and designated in a permit or corrective action order. In certain circumstances, EPA and states (including states that are not authorized for the TU regulations) may use other mechanisms to approve TUs. See, 58 FR 8677, February 16, 1993; appropriate use of RCRA Section 7003 orders and comparable state orders is discussed below and in an EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2. In addition, as appropriate, TUs may be approved by EPA as an applicable or relevant and appropriate requirement during a CERCLA cleanup using a record of decision or by an authorized state during a state cleanup using a CERCLA-like authority and a similar state document. Placement of waste in tanks or containers, including temporary units, is not considered land disposal. Therefore, waste does not have to be treated to meet LDR treatment standards prior to being placed in a TU. Of course, LDRs must be met if hazardous remediation wastes are eventually land disposed, for example, after they are removed from the TU; however, if treatment in a TU results in constituent concentrations that comply with applicable land disposal restriction treatment standards, no further treatment prior to land disposal is required as a condition of the LDRs.

An opportunity for the public to review and comment on tentative TU approvals is required by the regulations when TUs are approved using permitting procedures and as a matter of EPA policy when TUs are approved using orders. As with CAMUs, EPA recommends that whenever possible, remediation project managers combine this public participation with other public involvement activities that are typically part of remediation. For example, public notice of tentative approval of a temporary unit could be combined with public notice of a proposed plan under CERCLA.

The TU regulations are at 40 CFR 264.553, promulgated February 16, 1993 (58 FR 8658).

Determination Of When Contamination is Caused by Listed Hazardous Waste. Where a facility owner/operator makes a good faith effort to determine if a material is a listed hazardous waste but cannot make such a determination because documentation regarding a source of contamination, contaminant, or waste is unavailable or inconclusive, EPA has stated that one may assume the source, contaminant or waste is not listed hazardous waste and, therefore, provided the material in question does not exhibit a characteristic of hazardous waste, RCRA requirements do not apply. This approach was first articulated in the Proposed NCP preamble which notes that it is often necessary to know the source of a waste (or contaminant) to

determine whether a waste is a listed hazardous waste under RCRA[1] and also notes that, "at many CERCLA sites no information exists on the source of the wastes." The proposed NCP preamble goes on to recommend that the lead agency use available site information such as manifests, storage records and vouchers in an effort to ascertain the sources of wastes or contaminants, but that when this documentation is not available or inconclusive the lead agency may assume that the wastes (or contaminants) are not listed RCRA hazardous wastes. This approach was confirmed in the final NCP preamble. See, 53 FR 51444, December 21, 1988 for proposed NCP preamble discussion; 55 FR 8758, March 13, 1990 for final NCP preamble discussion.

This approach was also discussed in the HWIR-Media proposal preamble, 61 FR 18805, April 29, 1996, where it was expanded to also cover dates of waste disposal – i.e., if, after a good faith effort to determine dates of disposal a facility owner/operator is unable to make such a determination because documentation of dates of disposal is unavailable or inconclusive, one may assume disposal occurred prior to the effective date of applicable land disposal restrictions. This is important because, if hazardous waste was originally disposed of before the effective dates of applicable land disposal restrictions and media contaminated by the waste are determined not to contain hazardous waste when first generated (i.e., removed from the land, or area of contamination), the media are not subject to RCRA requirements, including LDRs. See the discussion of the contained-in policy, below.

Site Specific LDR Treatment Variances. The regulations for site-specific LDR treatment variances allow EPA and authorized states to establish a site-specific LDR treatment standard on a case-by-case basis when a nationally applicable treatment standard is unachieveable or inappropriate. Public notice and a reasonable opportunity for public comment must be provided before granting or denying a site-specific LDR treatment variance. EPA recommends that remediation project managers combine this public involvement with other public involvement activities that are typically part of remediation. Regulations governing site-specific LDR treatment variances are at 40 CFR 268.44(h), promulgated August 17, 1988 (53 FR 31199) and clarified December 5, 1997 (62 FR 64504). The most recent EPA guidance on site-specific LDR treatment variances, which includes information on establishing alternative LDR treatment standards, is in the January 8, 1997 guidance memo, "Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups."

In 1996, EPA revised its policy on state authorization for site-specific LDR treatment variances and began encouraging states to become authorized to approve variances. See, HWIR-Media proposal, 61 FR 18828 (April 29, 1996).

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[1] Listing determinations are often particularly difficult in the remedial context because the listings are generally identified by the sources of the hazardous wastes rather than the concentrations of various hazardous constituents; therefore, analytical testing alone, without information on a waste's source, will not generally produce information that will conclusively indicate whether a given waste is a listed hazardous waste.

On May 26, 1998, EPA promulgated additional site-specific land disposal restriction treatment variance opportunities specific to hazardous contaminated soil. These opportunities are discussed below.

Treatability Studies Exemption. The term "treatability study"as defined at 40 CFR 260.10 refers to a study in which a hazardous waste is subjected to a treatment process to determine: (1) whether the waste is amenable to the treatment process; (2) what pretreatment (if any) is required; (3) the optimal process conditions needed to achieve the desired treatment; (4) the efficiency of a treatment process for a specific waste or wastes; or, (5) the characteristics and volumes of residuals from a particular treatment process. Under regulations at 40 CFR 261.4(e) and (f), hazardous wastes managed during a treatability study are exempt from many RCRA Subtitle C requirements. The regulations limit the amount of waste that may be managed under an exempt treatability study to, generally, 1000 kg of hazardous waste or 1 kg of acutely hazardous waste per study. For contaminated environmental media, the volume limit is, generally, 10,000 kilograms of media that contain non-acutely hazardous waste and 2,500 kilograms of media that contain acutely hazardous waste per study. There are also limits on the types and lengths of studies that may be conducted under the exemption and record keeping and reporting requirements. Regulations governing treatability studies are at 40 CFR 261.4(e) and (f), associated preamble discussions at 52 FR 27290 (July 19, 1988) and 59 FR 8362 (February 18, 1994).

Exemption for Ninety Day Accumulation. Management of hazardous waste in tanks, containers, drip pads and containment buildings does not constitute land disposal. In addition, EPA has provided an exemption for generators of hazardous waste which allows them to accumulate (i.e., treat or store) hazardous waste at the site of generation in tanks, containers, drip pads or containment buildings for up to ninety days without RCRA interim status or a RCRA permit. Accumulation units must meet applicable design, operating, closure and post-closure standards. Because putting hazardous waste in a tank, container, drip pad or containment building is not considered land disposal, LDR treatment standards do not have to be met before putting waste in such units. LDRs must be met if hazardous wastes are eventually land disposed, for example, after they are removed from the accumulation unit; however, if treatment in an accumulation unit results in constituent concentrations that comply with applicable land disposal restriction treatment standards, no further treatment prior to land disposal is required as a condition of the LDRs. The exemption for ninety-day accumulation is found in regulations at 40 CFR 262.34; associated preamble discussion is at 51 FR at 10168 (March 24, 1986).

Permit Waivers. Under CERCLA Section 121(e), no Federal, state or local permit is required for on-site CERCLA response actions. EPA has interpreted CERCLA Section 121(e) to waive the requirement to obtain a permit and associated administrative and procedural requirements of permits, but not the substantive requirements that would be applied through

permits.[2]

In addition, on a case-by-case basis, where there may be an imminent and substantial endangerment to human health or the environment, EPA has broad authority to require corrective action and other appropriate activities under RCRA Section 7003. Under RCRA Section 7003, EPA has the ability to waive both the requirement to obtain a permit and the substantive requirements that would be imposed through permits. When EPA uses RCRA Section 7003, however, the Agency seldom uses RCRA Section 7003 to waive substantive requirements. In rare situations where substantive requirements are waived, the Agency would impose alternative requirements (e.g, waste treatment or storage requirements) as necessary to ensure protection of human health and the environment. EPA may issue RCRA Section 7003 orders at, among other sites, facilities that have been issued RCRA permits and facilities that are authorized to operate under RCRA interim status. In discussing the use of 7003 orders, where other permit authorities are available to abate potential endangerments, EPA generally encourages use of those other permit authorities (e.g., 3005(c)(3) omnibus permitting authority) rather than RCRA Section 7003. Similarly, if RCRA Section 3008(h) or RCRA Section 3013 authority is available, EPA generally encourages use of these authorities rather than RCRA Section 7003. If permit authorities or non-RCRA Section 7003 enforcement authorities are inadequate, cannot be used to address the potential endangerment in a timely manner, or are otherwise inappropriate for the potential endangerment at issue, use of RCRA Section 7003 should be considered. See, "Guidance on the Use of Section 7003 of RCRA," U.S. EPA, Office of Enforcement and Compliance Assurance, October 1997.

In 1987, EPA issued guidance indicating that RCRA-authorized states with state waiver authorities comparable to CERCLA 121(e) or RCRA Section 7003 could use those state waiver authorities to waive RCRA requirements as long as the state did so in a manner no less stringent than that allowed under the corresponding Federal authorities. These waivers are most often used, as are the Federal waivers, to obviate the need to obtain a RCRA permit, rather than to eliminate substantive requirements. See, EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements for State Superfund Actions," November 16, 1987, OSWER Directive 9522.00-2.

Exemption from 40 CFR Part 264 Requirements for People Engaged in the Immediate Phase of a Spill Response. Regulations at 40 CFR 264.1(g)(8) provide that people engaged in treatment or containment activities are not subject to the requirements of 40 CFR part 264 if the activities are carried out during immediate response to: (1) a discharge of hazardous waste; (2) an imminent and substantial threat of a discharge of hazardous waste; (3) a discharge of a materials which, when discharged, becomes a hazardous waste; or, (4) an immediate threat to human health, public safety, property or the environment from the known or suspected presence of military munitions, other explosive material, or an explosive device. This means

[2] Note that, under certain circumstances, substantive requirements may be waived using CERCLA. See the ARAR waiver provisions at 40 CFR 300.430(f)(1)(ii)(C).

that, during the immediate phase of a spill response, hazardous waste management activities do not require hazardous waste permits (or interim status) and hazardous waste management units used during immediate response actions are not subject to RCRA design, operating, closure or post-closure requirements.

Of course, if hazardous waste treatment activities or other hazardous waste management activities continue after the immediate phase of a spill response is over, all applicable hazardous waste management and permitting requirements would apply. In addition, if spills occur at a facility that is already regulated under 40 CFR part 264, the facility owner/operator must continue to comply with all applicable requirements of 40 CFR Part 264 Subparts C (preparedness and prevention) and D (contingency plan and emergency procedures). See regulations at 40 CFR 260.1(g) and associated preamble discussion at 45 FR 76626 (November 19, 1980). See also, Sept. 29, 1986 memo from J. Winston Porter (EPA Assistant Administrator) to Fred Hansen interpreting the 40 CFR 264.1(g) regulations.

Changes During Interim Status to Comply with Corrective Action Requirements. Under regulations at 40 CFR 270.72(a)(5), an owner or operator of an interim status facility may make changes to provide for treatment, storage and disposal of remediation wastes in accordance with an interim status corrective action order issued by EPA under RCRA Section 3008(h) or other Federal authority, by an authorized state under comparable state authority, or by a court in a judicial action brought by EPA or an authorized state. These changes are limited to treatment, storage and disposal of remediation waste managed as a result of corrective action for releases at the facility in question; however, they are exempt from the reconstruction ban under 40 CFR 270.72(b). Under this provision, for example, EPA could approve a corrective action management unit for treatment of remediation waste using a 3008(h) order (or an authorized state could approve a CAMU using a similar state authority), even if that unit would otherwise amount to "reconstruction." Of course, units added at interim status facilities in accordance with this provision must meet all applicable unit requirements; for example, in the case of a CAMU, the CAMU requirements apply. See, regulations at 40 CFR 270.72(a)(5) promulgated March 7, 1989 and associated preamble discussion at 54 FR 9599.

Emergency Permits. In the event of an imminent and substantial endangerment to human health or the environment, EPA, or an authorized state, may issue a temporary emergency permit for treatment, storage or disposal of hazardous waste. Emergency permits may allow treatment, storage or disposal of hazardous waste at a non-permitted facility or at a permitted facility for waste not covered by the permit. Emergency permits may be oral or written. (If oral, they must be followed within five days by a written emergency permit.) Emergency permits must specify the hazardous wastes to be received and managed and the manner and location of their treatment, storage and disposal. Emergency permits may apply for up to ninety days, but may be terminated at any point if EPA, or an authorized state, determines that termination is appropriate to protect human health or the environment. Emergency permits must be accompanied by a public notice that meets the requirements of 40 CFR 124.10(b), including the name and address of the office approving the emergency permit, the name and location of the hazardous waste

treatment, storage or disposal facility, a brief description of the wastes involved, the actions authorized and the reason for the authorization, and the duration of the emergency permit.

Emergency permits are exempt from all other requirements of 40 CFR part 270 and part 124; however, to the extent possible and not inconsistent with the emergency situation, they must incorporate all otherwise applicable requirements of 40 CFR part 270 and parts 264 and 266.

See, regulations at 40 CFR 270.61, originally promulgated as 40 CFR 122.27 on May 19, 1987 (45 FR 33326). EPA has also written a number of letters interpreting the emergency permit regulations, see, for example, November 3, 1992 letter to Mark Hansen, Environmental Products and Services Inc., from Sylvia Lowrance, Director Office of Solid Waste (available in the RCRA Permit Policy Compendium).

Temporary Authorizations at Permitted Facilities. Under regulations at 40 CFR 270.42(e), EPA, or an authorized state, may temporarily authorize a permittee for an activity that would be the subject of a class two or three permit modification in order to, among other things, facilitate timely implementation of closure or corrective action activities. Activities approved using a temporary authorization must comply with applicable requirements of 40 CFR part 264. Temporary authorizations are limited to 180 days, with an opportunity for an extension of 180 additional days. To obtain an extension of a temporary authorization, a permittee must have requested a class two or three permit modification for the activity covered in the temporary authorization. Public notification of temporary authorizations is accomplished by the permittee sending a notice about the temporary authorization to all persons on the facility mailing list and to appropriate state and local governments. See regulations at 40 CFR 270.42, promulgated on September 28, 1988, and associated preamble at 53 FR 37919.

Regulations and Policies that Apply to Contaminated Environmental Media Only

Contained-in policy. Contaminated environmental media, of itself, is not hazardous waste and, generally, is not subject to regulation under RCRA. Contaminated environmental media can become subject to regulation under RCRA if they "contain" hazardous waste. As discussed more fully below, EPA generally considers contaminated environmental media to contain hazardous waste: (1) when they exhibit a characteristic of hazardous waste; or, (2) when they are contaminated with concentrations of hazardous constituents from listed hazardous waste that are above health-based levels.

If contaminated environmental media contain hazardous waste, they are subject to all applicable RCRA requirements until they no longer contain hazardous waste. EPA considers contaminated environmental media to no longer contain hazardous waste: (1) when they no longer exhibit a characteristic of hazardous waste; and (2) when concentrations of hazardous constituents from listed hazardous wastes are below health-based levels. Generally, contaminated environmental media that do not (or no longer) contain hazardous waste are not subject to any RCRA requirements; however, as discussed below, in some circumstances,

contaminated environmental media that contained hazardous waste when first generated (i.e., first removed from the land, or area of contamination) remain subject to LDR treatment requirements even after they "no longer contain" hazardous waste.

The determination that any given volume of contaminated media does not contain hazardous waste is called a "contained-in determination." In the case of media that exhibit a characteristic of hazardous waste, the media are considered to "contain" hazardous waste for as long as they exhibit a characteristic. Once the characteristic is eliminated (e.g., through treatment), the media are no longer considered to "contain" hazardous waste. Since this determination can be made through relatively straightforward analytical testing, no formal "contained-in" determination by EPA or an authorized state is required. Just like determinations about whether waste has been adequately decharacterized, generators of contaminated media may make independent determinations as to whether the media exhibit a characteristic of hazardous waste. In the case of media that are contaminated by listed hazardous waste, current EPA guidance recommends that contained-in determinations be made based on direct exposure using a reasonable maximum exposure scenario and that conservative, health-based, standards be used to develop the site-specific health-based levels of hazardous constituents below which contaminated environmental media would be considered to no longer contain hazardous waste. Since this determination involves development of site-specific health-based levels, the approval of EPA or an authorized state is required.

In certain circumstances the, RCRA land disposal restrictions will continue to apply to contaminated media that has been determined not to contain hazardous waste. This is the case when contaminated media contain hazardous waste when they are first generated (i.e., removed from the land, or area of contamination) and are subsequently determined to no longer contain hazardous waste (e.g., after treatment), but still contain hazardous constituents at concentrations above land disposal restriction treatment standards. It is also the case when media are contaminated as a result of disposal of untreated (or insufficiently treated) listed hazardous waste after the effective date of an applicable LDR treatment requirement. Of course, if no land disposal will occur (e.g., the media will be legitimately recycled) the LDR treatment standards do not apply. In addition, contaminated environmental media determined not to contain any waste (i.e., it is just media, it does not contain solid or hazardous waste) would not be subject to any RCRA Subtitle C requirements, including the LDRs, regardless of the time of the "contained-in" determination.

The contained-in policy was first articulated in a November 13, 1986 EPA memorandum, "RCRA Regulatory Status of Contaminated Groundwater." It has been updated many times in Federal Register preambles, EPA memos and correspondence, see, e.g., 53 FR 31138, 31142, 31148 (Aug. 17, 1988), 57 FR 21450, 21453 (May 20, 1992), and detailed discussion in HWIR-Media proposal preamble, 61 FR 18795 (April 29, 1996). A detailed discussion of the continuing requirement that some soils which have been determined to no longer contain hazardous waste (but still contain solid waste) comply with land disposal treatment standards can be found in the HWIR-Media proposal preamble, 61 FR 18804; the September 15, 1996 letter

from Michael Shapiro (EPA OSW Director) to Peter C. Wright (Monsanto Company); and the preamble to the LDR Phase IV rule, 63 FR 28617 (May 26, 1998).

Note that the contained-in policy applies only to environmental media (soil, ground water, surface water and sediments) and debris. The contained-in policy for environmental media has not been codified. As discussed below, the contained-in policy for hazardous debris was codified in 1992.

RCRA Section 3020(b) Exemption for Reinjection of Contaminated Ground Water. Under RCRA Section 3020(a), disposal of hazardous waste into or above a formation that contains an underground source of drinking water is generally prohibited. RCRA Section 3020(b) provides an exception for underground injection carried out in connection with certain remediation activities. Under RCRA Section 3020(b), injection of contaminated ground water back into the aquifer from which it was withdrawn is allowed if: (1) such injection is conducted as part of a response action under Section 104 or 106 of CERCLA or a RCRA corrective action intended to clean up such contamination; (2) the contaminated ground water is treated to substantially reduce hazardous constituents prior to reinjection; and, (3) the response action or corrective action will, on completion, be sufficient to protect human health and the environment. Approval of reinjection under RCRA Section 3020(b) can be included in approval of other cleanup activities, for example, as part of approval of a RCRA Statement of Basis or CERCLA Record of Decision. See, RCRA Section 3020(b), established as part of the 1984 HSWA amendments. See also, OSWER Directive 9234.1-06, "Applicable of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26," November 27, 1989.

LDR Treatment Standards for Contaminated Soils. On May 26, 1998, EPA promulgated land disposal restriction treatment standards specific to contaminated soils.[3] These treatment standards require that contaminated soils which will be land disposed be treated to reduce concentrations of hazardous constituents by 90 percent or meet hazardous constituent concentrations that are ten times the universal treatment standards (UTS), whichever is greater. (This is typically referred to as 90% capped by 10xUTS.) For contaminated soil that exhibits a characteristic of ignitable, reactive or corrosive hazardous waste, treatment must also eliminate the hazardous characteristic.

The soil treatment standards apply to all underlying hazardous constituents[4] reasonably expected to be present in any given volume of contaminated soil when such constituents are found at initial concentrations greater than ten times the UTS. For soil that exhibits a

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[3] This rule, which also addresses a number of non-soil issues, has been challenged by a number of parties. To date, the parties have filed non-binding statements of issues only; however, based on those statements, it appears that, with the exception of the requirement that PCBs be included as an underlying hazardous constituent which has been challenged for both soil and non-soil wastes, the soil treatment standards are not included in the challenges.

[4] Except fluoride, selenium, sulfides, vanadium and zinc.

characteristic of toxic, ignitable, reactive or corrosive hazardous waste, treatment is also required for: (1) in the case of the toxicity characteristic, the characteristic constituent; and, (2) in the case of ignitability, reactivity or corrosivity, the characteristic property. Although treatment is required for each underlying hazardous constituent, it is not necessary to monitor soil for the entire list of underlying hazardous constituents. Generators of contaminated soil can reasonably apply knowledge of the likely contaminants present and use that knowledge to select appropriate underlying hazardous constituents, or classes of constituents, for monitoring. As with the LDR treatment standards for hazardous debris (discussed below), generators of contaminated soil may use either the applicable universal treatment standards for the contaminating hazardous waste or the soil treatment standards.

See, soil treatment standard regulations at 40 CFR 268.49, promulgated May 26, 1998 and associated preamble discussion at 63 FR 28602-28622.

Note that the soil treatment standards supersede the historic presumption that an LDR treatment variance is appropriate for contaminated soil. LDR treatment variances are still available for contaminated soil, provided the generator can show that an otherwise applicable treatment standard (i.e., the soil treatment standard) is unachieveable or inappropriate, as discussed above, or can show that a site-specific, risk-based treatment variance is proper, as discussed below.

Site-Specific, Risk-Based LDR Treatment Variance for Contaminated Soils. On May 26, 1998, EPA promulgated a new land disposal restriction treatment variance specific to contaminated soil. Under 40 CFR 268.44(h)(3), variances from otherwise applicable LDR treatment standards may be approved if it is determined that compliance with the treatment standards would result in treatment beyond the point at which short- and long-term threats to human health and the environment are minimized. This allows a site-specific, risk-based determination to supersede the technology-based LDR treatment standards under certain circumstances.

Alternative land disposal restriction treatment standards established through site specific, risk-based minimize threat variances should be within the range of values the Agency generally finds acceptable for risk-based cleanup levels. That is, for carcinogens, alternative treatment standards should ensure constituent concentrations that result in the total excess risk to an individual exposed over a lifetime generally falling within a range from 10^{-4} to 10^{-6}, using 10^{-6} as a point of departure and with a preference for achieving the more protective end of the risk range. For non-carcinogenic effects, alternative treatment standards should ensure constituent concentrations that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; in general, the hazard index should not exceed one (1). Constituent concentrations that achieve these levels should be calculated based on a reasonable maximum exposure scenario – that is, based on an analysis of both the current and reasonable expected future land uses, with exposure parameters chosen based on a reasonable assessment of the maximum exposure that might occur; however, alternative LDR treatment standards may not

be based on consideration of post-land disposal controls such as caps or other barriers.

See, regulations at 40 CFR 268.44(h)(4), promulgated May 26, 1998 and associated preamble discussion at 63 FR 28606-28608.

Regulations and Policies that Apply Only to Debris

LDR Treatment Standards for Contaminated Debris. In 1992, EPA established land disposal restriction treatment standards specific to hazardous contaminated debris. The debris-specific treatment standards established by these regulations are based on application of common extraction, destruction, and containment debris treatment technologies and are expressed as specific technologies rather than numeric criteria. As with the contaminated soil treatment standards discussed earlier, generators of hazardous contaminated debris may choose between meeting either the debris treatment standards or the numerical treatment standard promulgated for the contaminating hazardous waste. See, regulations at 40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 57 FR 37194 and 27221.

Interpretation that Debris Treated to the LDR Debris Treatment Standards Using Extraction or Destruction Technologies no Longer Contain Hazardous Waste. With the land disposal restriction treatment standards for hazardous contaminated debris, in 1992, EPA determined that hazardous debris treated to comply with the debris treatment standards using one of the identified extraction or destruction technologies would be considered no longer to contain hazardous waste and would, therefore, no longer be subject to regulation under RCRA, provided the debris do not exhibit any of the hazardous waste characteristics. This "contained-in determination" is automatic; no agency action is needed. Note that this automatic contained-in determination does not apply to debris treated to the debris treatment standards using one of the identified immobilization technologies. See, regulations at 40 CFR 261.3(f) and treatment standards at Table 1 of 40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 51 FR 37225.

cc: Barbara Simcoe, Association of State and Territorial Solid Waste Management Officials

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 15 1998

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Summary Chart of October 14, 1998 Memorandum, "Management of Remediation Waste Under RCRA."

FROM: Stephen F. Heare, Acting Director
Permits and State Programs Division

TO: RCRA Senior Policy Advisors, Regions I - X
Regional Counsels

On October 14, 1998 we issued a guidance memorandum, "Management of Remediation Waste under RCRA" which provides information on the RCRA regulations and policies that most often affect remediation waste. The attached chart summarizes the memo and can be used to quickly identify possible remediation waste management strategies and to compare one remediation waste management approach to another.

I emphasize that the information in the chart significantly simplifies many of the RCRA remediation waste regulations and policies for purposes of summary. For complete information you should continue to refer to the guidance memorandum and the materials referenced therein.

I hope this information in this chart will be helpful as you continue to make protective, inclusive and efficient cleanup decisions.

cc: Barbara Simcoe, Association of State and Territorial Solid Waste Management Officials

Attachment.

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Summary of Regulations and Policies That Often Affect Management of Remediation Waste Under RCRA – October 1998

Regulation / Policy	On-site / Off-site	Wastes Covered	More Information
Area of Contamination – Allows wastes to be consolidated and treated *in situ* within an AOC without triggering land disposal restrictions or minimum technology requirements. For AOC, contamination must be contiguous but does not have to be homogeneous.	On-site, *in situ* only	All RW	53 FR 51444 for detailed discussion in proposed NCP preamble; 55 FR 8758-8760, March 8, 1990 for final NCP preamble discussion. See also, most recent EPA guidance, March 13, 1996 EPA memo, "Use of the Area of Contamination Concept During RCRA Cleanups."
CAMU – Corrective Action Management Units are a type of RCRA unit specifically for RW. RW may be placed into CAMUs and treated in CAMUs without triggering LDRs or MTRs. Prior state or EPA approval and specification of unit standards required.	On-site only	All RW	40 CFR 264.552, promulgated February 16, 1993 (58 FR 8658). The differences between CAMUs and AOCs are discussed in more detail in the March 13, 1996 EPA guidance memo, "Use of the Area of Contamination Concept During RCRA Cleanups."
TU – Corrective Action Temporary Units are a type of RCRA unit specifically for RW. TUs may meet modified design, operating and closure standards instead of the RCRA standards that usually apply to tanks and containers. Prior state or EPA approval and specification of unit standards required. Operation limited to one year with opportunity for one one-year extension.	On-site only	All RW	40 CFR 264.553, promulgated February 16, 1993 (58 FR 8658).
Determination of whether contamination caused by listed hazardous waste – If, after a good faith effort to find information, information about the source of a waste or contamination is unavailable or inconclusive, one may assume waste is not, or the contamination was not caused by, listed RCRA hazardous waste.	Both	All RW	53 FR 51444, December 21, 1988 for proposed NCP preamble discussion; 55 FR 8758, March 13, 1990 for final NCP preamble discussion.
Site-specific LDR treatment variances – EPA and authorized states may establish a site-specific LDR treatment standard on a case-by-case basis when a nationally applicable treatment standard is unachieveable or inappropriate. Public notice and a reasonable opportunity for public comment must be provided before granting or denying a site-specific LDR treatment variance.	Both	All RW	40 CFR 268.44(h), promulgated August 17, 1988 (53 FR 31199) and clarified December 5, 1997 (62 FR 64504). Most recent EPA guidance, January 8, 1997 memo "Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups."
Treatability study exemption – Certain quantities of hazardous waste are exempted from many RCRA requirements during treatability studies.	On-site only	All RW	40 CFR 261.4(e) and (f), associated preamble discussions at 52 FR 27290 (July 19, 1988) and 59 FR 8362 (February 18, 1994).

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

Summary of Regulations and Policies That Often Affect Management of Remediation Waste Under RCRA – October 1998

Regulation / Policy	*On-site / Off-site*	Wastes Covered	More Information
Exemption for 90 day accumulation – Generators may accumulate (i.e., treat or store) hazardous waste in tanks, containers, drip pads or containment buildings for up to ninety days without RCRA interim status or a RCRA permit. Placement of waste in accumulation units does not constitute land disposal. Accumulation units must meet applicable design, operating, closure and post-closure standards.	On-site only	All RW	40 CFR 262.34; associated preamble discussion is at 51 FR at 10168 (March 24, 1986).
Permit waivers – No Federal, state or local permit is required for on-site CERCLA *response actions*. Under RCRA Section 7003, EPA has the ability to waive both the requirement to obtain a permit and the substantive requirements that would be imposed through permits. States with state waiver authorities comparable to CERCLA 121(e) or RCRA Section 7003 may waive RCRA requirements in a manner no less stringent than that allowed under the corresponding Federal waivers.	Both	All RW	CERCLA Section 121(e); "Guidance on the Use of Section 7003 of RCRA," U.S. EPA, Office of Enforcement and Compliance Assurance, October 1997 and EPA guidance memo from J. Winston Porter to EPA Regional Administrators, "RCRA Permit Requirements *for State Superfund Actions*," November 16, 1987, OSWER Directive 9522.00-2.
Exemption from part 264 requirements for people engaged in the immediate phase of a spill response – People engaged in treatment or containment activities are not subject to 40 CFR part 264 during immediate response to discharges or *imminent and substantial threats* of discharges of hazardous waste and known or suspected military munitions, other explosive materials, or explosive devices.	Both	All RW	40 CFR 260.1(g) and associated preamble discussion at 45 FR 76626 (November 19, 1980) and Sept. 29, 1986 memo from J. Winston Porter (EPA Assistant Administrator) to Fred Hansen interpreting the 40 CFR 264.1(g) regulations.
Changes during interim status to comply with corrective action requirements – An owner or operator of an interim status facility may make changes to provide for treatment, storage and disposal of RW in accordance with an interim status corrective action order issued by EPA *under RCRA Section 3008(h) or other* Federal authority, by an authorized state under comparable state authority, or by a court in a judicial action brought by EPA or an authorized state.	On-site	All RW	40 CFR 270.72(a)(5) promulgated March 7, 1989 and associated preamble discussion at 54 FR 9599.

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

Regulation / Policy	On-site / Off-site	Wastes Covered	More Information
Emergency permits – If there is an imminent and substantial endangerment to human health or the environment, EPA, or an authorized state, may issue a temporary emergency permit for treatment, storage or disposal of hazardous waste. Emergency permits may allow treatment, storage or disposal of hazardous waste at a non-permitted facility or at a permitted facility for waste not covered by the permit.	Both	All RW	40 CFR 270.61, originally promulgated as 40 CFR 122.27 on May 19, 1987 (45 FR 33326) and November 3, 1992 letter to Mark Hansen, Environmental Products and Services Inc., from Sylvia Lowrance, Director Office of Solid Waste (available in the RCRA Permit Policy Compendium).
Temporary authorizations at permitted facilities – EPA, or an authorized state, may temporarily authorize a permittee for an activity that would be the subject of a class two or three permit modification in order to, among other things, facilitate timely implementation of closure or corrective action.	Both	All RW	40 CFR 270.42, promulgated on September 28, 1988, and associated preamble at 53 FR 37919.
Contained-in policy – Contaminated environmental media that does not exhibit a characteristic of hazardous waste and, if contaminated by listed waste, has concentrations of hazardous constituents that are below health-based levels does not need to be managed as hazardous waste.	Both	Media only	Nov. 13, 1986 memo, "RCRA Regulatory Status of Contaminated Groundwater" and 53 FR 31138, 31142, 31148 (Aug. 17, 1988); 57 FR 21450, 21453 (May 20, 1992); 61 FR 18795 (April 29, 1996); September 15, 1996 letter to Monsanto Company; and 63 FR 28617 (May 26, 1998).
RCRA Section 3020(b) exemption for reinjection of contaminated ground water – Injection of contaminated ground water back into the aquifer from which it was withdrawn is allowed if certain requirements are met.	Both	Ground water only	RCRA Section 3020(b). See also, OSWER Directive 9234.1-06, "Applicable of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26," November 27, 1989.
LDR treatment standards for contaminated soil – Soil specific treatment standards of 90% reduction in concentrations of hazardous constituents or ten times the universal treatment standard, whichever is less stringent. Treatment required for all underlying hazardous constituents reasonably expected to be present when such constituents are found at initial concentrations greater than 10 X UTS.	Both	Soil only	40 CFR 268.49, promulgated May 26, 1998 and associated preamble discussion at 63 FR 28602-28622.

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

Summary of Regulations and Policies That Often Affect Management of Remediation Waste Under RCRA – October 1998

Regulation / Policy	On-site / Off-site	Wastes Covered	More Information
Site-specific risk-based LDR treatment variance for contaminated soil – EPA, or an authorized state, may approve a variance from an otherwise applicable treatment standard if compliance with that standard would result in treatment beyond the point at which threats are minimized.	Both	Soil only	40 CFR 268.44(h)(4), promulgated May 26, 1998 and associated preamble discussion at 63 FR 28606-28608.
LDR treatment standards for contaminated debris – Debris specific treatment standards expressed as specified treatment methods / technologies.	Both	Debris only	40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 57 FR 37194 and 27221.
Interpretation that debris treated using extraction or destruction technologies no longer contain hazardous waste – Debris treated to comply with the debris treatment standards using one of the identified extraction or destruction technologies would be considered no longer to contain hazardous waste and would, therefore, no longer be subject to regulation under RCRA, provided the debris do not exhibit any of the hazardous waste characteristics.	Both	Debris only	40 CFR 261.3(f) and treatment standards at Table 1 of 40 CFR 268.45, promulgated August 18, 1992, and associated preamble discussion at 51 FR 37225.

Most of the references cited in this chart re available over the Internet. The Federal Register notices published after 1994 are available at www.access.gpo.gov/nara; the guidance memos and other EPA documents are available at www.epa.gov/correctiveaction. Federal Register notices and other documents are also available through the RCRA/CERCLA hotline: in Washington D.C., call (703) 412-9810; outside Washington D.C., call (800) 424-9346; and hearing impaired call (800) 553-7672. The hotline's hours are Monday - Friday, excluding Federal holidays, 8:00 - 5:00, eastern standard time. Many EPA guidance memos and other documents may also be obtained through the RCRA/CERCLA hotline fax-back system. To obtain a list of documents available over the fax-back system, and fax-back system code numbers, call the RCRA/CERCLA hotline at the numbers listed above.

The descriptions of regulations and policies in this chart have been significantly simplified for purpose of summary. All of the regulations and policies summarized have additional complexities and may be subject to additional limitations. For complete information, please refer to the referenced materials and to the U.S. EPA guidance memorandum, "Management of Remediation Waste Under RCRA," October 14, 1998.

Attachment to October 15, 1998 memorandum "Summary Chart of October 14, 1998 Memorandum 'Management of Remediation Waste Under RCRA,'" from Stephen F. Heare, Acting Director Permits and State Programs Division, U.S. EPA Office of Solid Waste and Emergency Response.

MANAGEMENT OF REMEDIATION WASTE UNDER RCRA
ROAD MAP

GUIDANCE SUBJECT AREA	CITATION	TOPICS
REGULATIONS AND POLICIES THAT APPLY TO ALL REMEDIATION WASTE		
Area of Contamination Policy (AOC)	EPA Letter from Michael Shapiro to Norman Nosenchuck, March 25, 1996	Information on the Scope and Applicability of the Area of Contamination Policy
	EPA Memorandum from Michael Shapiro, Stephen D. Luftig, and Jerry Clifford to RCRA Branch Chiefs and CERCLA Regional Managers, March 13, 1996	Use of the Area of Contamination Concept During RCRA Cleanups
	EPA Letter from David Bussard to Scott DuBoff, April 6, 1994	EPA Interpretation of "Active Management" in the Closing of Waste Management Facilities
	EPA Memorandum and Document from Sylvia Lowrance and Bruce Diamond to Waste Management Division Directors, RCRA Branch Chiefs, and RCRA Regional Counsel, August 31, 1992	Use of the Corrective Action Management Unit Concept
	EPA Letter from Sylvia Lowrance to Douglas Green, June 11, 1992	Applicability of RCRA Requirements to Common Excavation Activities
	EPA Memorandum from Caroline Wehling to Steven Golian, April 16, 1991	Land Disposal Restrictions (LDR) Applicability for Investigative Derived Wastes
	EPA Letter from Don Clay to Richard Stoll, January 7, 1991	Applicability of LDR Guides
	EPA Memorandum from Sylvia Lowrance to David Ullrich, October 9, 1990	Replacement of Contaminated Soil and Debris Treated Under a Treatability Variance
	EPA Letter from Lisa Friedman to Richard Stoll, September 5, 1990	Applicability of LDR and Permitting
	55 FR 8758-8764 (March 8, 1990)	Final National Contingency Plan (NCP) - Preamble Discussing the Area of Contamination (AOC)

MANAGEMENT OF REMEDIATION WASTE UNDER RCRA
ROAD MAP

GUIDANCE SUBJECT AREA	CITATION	TOPICS
Area of Contamination Policy (AOC) - Continued	Superfund Directive : 9347.3-OSFS; Superfund LDR Guide #5 (July, 1989)	Superfund LDR Guide #5 : Determining When Land Disposal Restrictions (LDRs) Are Applicable to CERCLA Response Actions
	53 FR 51443-51447 (December 21, 1988)	Proposed National Oil and Hazardous Substances Pollution Contingency Plan (NCP) - Preamble Discussing the Area of Contamination (AOC)
Corrective Action Management Units (CAMUs) & Corrective Action Temporary Units (TUs)	EPA Memorandum from Michael Shapiro, Stephen D. Luftig, and Jerry Clifford to RCRA Branch Chiefs and CERCLA Regional Managers, March 13, 1996	Use of the Area of Contamination Concept During RCRA Cleanups Which Covers Some of the Differences Between AOCs and CAMUs [located with "AOC" materials]
	EPA Letter from Michael Shapiro to M.L. Mullins, October 18, 1995	Agency Flexibility in the CAMU Rule
	EPA Memorandum from Devereaux Barnes to Norm Niedergang, February 17, 1995	Appropriate Mechanism for Approval of CAMU at U.S.S. Lead Facility
	EPA Letter from Sylvia Lowrance to Doug MacMillan, May 4, 1993	Impact of CAMU Regulations on the Management of "As-Generated" Hazardous Wastes
	58 FR 8658-8685 (February 16, 1993)	CAMUs & TUs, Final Rule
	58 FR 8679 (February 16, 1993)	EPA Authority of CAMUs During a State Cleanup Using CERCLA-like Authority and Similar State Documents

MANAGEMENT OF REMEDIATION WASTE UNDER RCRA
ROAD MAP

GUIDANCE SUBJECT AREA	CITATION	TOPICS
Determination of When Contamination is Caused by Listed Hazardous Waste	63 FR 28619 (May 26, 1998)	Land Disposal Rule Phase IV; Preamble Discussion on LDR Applicability to Contaminated Soil
	61 FR 18804-18805 (April 29, 1996)	Management of Hazardous Contaminated Media (HWIR-Media); Proposed Preamble Discussion on Application of LDRs
	55 FR 8758-8760 (March 8, 1990)	Final NCP [located with "AOC" materials]
	53 FR 51444 (December 21, 1988)	Proposed NCP - Preamble Discussion on Determination of When a Waste is a Listed Waste under RCRA
Site-Specific LDR Treatment Variances	63 FR 28606-28608 (May 26, 1998)	LDR Phase IV Soil Treatment and Standards - Preamble Discussion on Variance from Soil Treatment Standards
	62 FR 64504-64509 (December 5, 1997)	Clarification of Standards for Hazardous Waste - LDR Treatment Variances, Final Rule
	EPA Memorandum from Michael Shapiro and Steve Luftig to RCRA/CERCLA Regional Senior Policy Managers, January 8, 1997	Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups
	61 FR 18828 (April 29, 1996)	HWIR-Media Proposal - Preamble Discussion on Media Treatment Variances
	53 FR 31199-31200 (August 17, 1988)	Preamble Discussion on Non-Rulemaking Procedures for Site-Specific LDR Treatment Variances
Treatability Studies Exemption	59 FR 8362-8366 (February 18, 1994)	Hazardous Waste Treatability Studies Sample Exclusion Rule
	EPA Letter from Sylvia Lowrance to Joseph Paulick, September 9, 1992	Clarification of RCRA Regulations Concerning Notification for Treatability Studies
	53 FR 27290-27302 (July 19, 1988)	Hazardous Waste Treatability Studies Sample Exemptions - Final Rule

MANAGEMENT OF REMEDIATION WASTE UNDER RCRA
ROAD MAP

GUIDANCE SUBJECT AREA	CITATION	TOPICS
Exemption for Ninety Day Accumulation	51 FR 10168 (March 24, 1986)	Exemption for Ninety Day Accumulation
Permit Waivers	EPA Memorandum from J. Winston Porter to Regional Administrators, November 16, 1987	RCRA Permit Requirements for State Superfund Actions
	EPA OECA Memorandum from Steven A. Herman to Addressees, October 20, 1997	Transmittal of Guidance on the Use of Section 7003 of RCRA (Actual Guidance located in Corrective Action Toolbook)
Exemption from 40 CFR Part 264 Requirements for People Engaged in the Immediate Phase of a Spill Response	EPA Letter from Sylvia Lowrance to Elizabeth Powell, June 15, 1989	Response to Questions on a Variety of RCRA Issues Related to Remediation of Contamination at a Facility
	EPA Letter from J. Winston Porter to Fred Hansen, September 29, 1986	Responses to questions related to accidental spills of listed or characteristic hazardous wastes
	45 FR 76626-76630 (November 19, 1980)	Preamble Discussion on the Hazardous Waste Spill Response Exemption
Changes During Interim Status to Comply with Corrective Action Requirements	54 FR 9599 (March 7, 1989)	Changes to Interim Status Facilities, Final Rule - Changes During Interim Status Related to Corrective Action
Emergency Permits	EPA Letter from Sylvia Lowrance to Mark Hansen, November 3, 1992	Interpreting the Emergency Permit Regulations
	40 CFR 270.61, originally promulgated as 40 CFR 122.27 45 FR 33326-33327 (May 19, 1980)	Hazardous Waste and Consolidated Permit Regulations Preamble Discussion on Emergency Permits
Temporary Authorizations at Permitted Facilities	53 FR 37919-37921 (September 28, 1988)	Permit Modifications for Hazardous Waste Management Facilities, Final Rule - Preamble Discussion on Temporary Authorizations

MANAGEMENT OF REMEDIATION WASTE UNDER RCRA
ROAD MAP

GUIDANCE SUBJECT AREA	CITATION	TOPICS
REGULATIONS AND POLICIES THAT APPLY TO CONTAMINATED ENVIRONMENTAL MEDIA		
Contained-In Policy	63 FR 65877-65879 (November 30, 1998)	HWIR Media - Final Rule - Preamble Discussion on "How has EPA Tried To Solve These Problems in the Past?"
	EPA Letter from Elizabeth Cotsworth to William R. Weissman, August 21, 1998	USWAG's, EEI's, and AGA's Concerns Regarding the Effects the LDR Treatment Standards Published on May 26, 1998 May Have on Cleanup of Manufactured Gas Plant Sites
	63 FR 28621-28622 (May 26, 1998)	LDR Phase IV Final Rule - The Contained-In Policy Preamble Discussion
	61 FR 18795-18803 (April 29, 1996)	HWIR Media - Proposed Preamble Discussion on the Contained-In Policy
	EPA Letter from Michael Shapiro to T.L. Nebrich, Jr., February 27, 1996	Clarification of Several RCRA Issues Including the Contained-In Policy
	EPA Letter from Michael Shapiro to Peter Wright, September 15, 1995	Response to a Letter Seeking Clarification of the Contained-In Policy
	EPA Memorandum from Devereaux Barnes to Norm Niedergang, February 17, 1995	The Contained-In Policy as it Applies to Environmental Media Contaminated with P and U Listed Wastes
	EPA Letter to T.L. Nebrich, Jr., March 22, 1994	The Contained-In Policy as it Applies to Contaminated Soils
	EPA Letter from Michael Shapiro to William Warren, October 15, 1992	Clarification of Issues Relating to the Regulatory Status of Soils Contaminated from the Releases of Commercial Chemical Products
	57 FR 37225-37226 (August 18, 1992)	Identification and Listing of Hazardous Waste CERCLA Hazardous Designation - Preamble Discussion on Codification of Contained-In Policy for Debris
	EPA Letter from Sylvia Lowrance to John Ely, March 26, 1991	Summarization of EPA's Current Position on the Contained-In Policy

MANAGEMENT OF REMEDIATION WASTE UNDER RCRA
ROAD MAP

GUIDANCE SUBJECT AREA	CITATION	TOPICS
Contained-In Policy - Continued	EPA Letter from Jonathan Cannon to Thomas Jorling, June 19, 1989	EPA Interpretation of the Contained-In Policy
	EPA Memorandum from Sylvia Lowrance to Jeff Zelikson, January 24, 1989	Status of Contaminated Groundwater and Limitations on Disposal and Reuse
	EPA Memorandum from Sylvia Lowrance to Timothy Fields, Jr., January 3, 1989	Status of Personnel Protective Equipment as a RCRA Waste
	EPA Memorandum from Marcia Williams to Patrick Tobin, November 13, 1986	RCRA Regulatory Status of Contaminated Groundwater
Soil Treatment Standards	EPA Memorandum From Elizabeth A. Cotsworth to RCRA Regional Senior Policy Advisors, October 19, 1998	Phase IV Land Disposal Restrictions Rule - Clarification of Effective Dates
	63 FR 28602-28622, (May 26, 1998)	LDR Phase IV Final Rule - Preamble Discussion on LDR Treatment Standards for Soil
	63 FR 28751-28752 (May 26, 1998)	Alternative LDR Treatment Standards for Contaminated Soil
	EPA Letter from Michael Shapiro to Janell Bergman, June 14, 1995	Interpretation of Land Disposal Restrictions Phase II Final Rule as it Pertains to Underlying Hazardous Constituents in the Soil that Exhibit Toxicity Characteristics
RCRA Section 3020(b) Exemption for Reinjection of Contaminated Groundwater	EPA Memorandum from Don R. Clay to Waste Management Division Directors and Regional Counsel, December 27, 1989	Applicability of Land Disposal Restrictions to RCRA & CERCLA Groundwater Treatment Reinjection - Superfund Management Review: Recommendation No. 26
LDR Treatment Standards for Contaminated Soils	63 FR 28602-28622 (May 26, 1998)	LDR Phase IV Soil Treatment Standard Regulations [located with "Soil Treatment Standards " materials]

MANAGEMENT OF REMEDIATION WASTE UNDER RCRA
ROAD MAP

GUIDANCE SUBJECT AREA	CITATION	TOPICS
Site-Specific, Risk-Based LDR Treatment Variance for Contaminated Soils	63 FR 28606-28608 (May 26, 1998)	LDR Phase IV Final Rule - Preamble on Site-Specific, Risk-Based LDR Treatment Variance for Contaminated Soils [located with "Regulations and Policies that Apply to Contaminated Environmental Media" materials]
REGULATIONS AND POLICIES THAT APPLY ONLY TO DEBRIS		
LDR Treatment Standards for Contaminated Debris	EPA Letter from Michael Shapiro to Kenneth Kastner, June 3, 1994	Clarification of the RCRA Regulations Applicable to Hazardous Debris
	57 FR 37194, (August 18, 1992)	LDRs for Newly Listed Wastes and Hazardous Debris - Final Rule Summary
	57 FR 37221-37243, (August 18, 1992)	LDRs for Newly Listed Wastes and Hazardous Debris - Preamble Discussion
	57 FR 37277-37280, (August 18, 1992)	LDRs for Newly Listed Wastes and Hazardous Debris - Treatment Standards for Hazardous Debris

Area of Contamination Policy (AOC)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 25 1996

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

Norman H. Nosenchuck, P.E., Director
Division of Solid & Hazardous Materials
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233-7250

Dear Mr. Nosenchuck:

Thank you for your letter requesting additional information on the scope and applicability of the Area of Contamination (AOC) concept. Independent of your request, EPA recently completed guidance on application of the AOC concept during cleanups regulated under the Resource Conservation and Recovery Act (RCRA) and other cleanups. This guidance is attached.

As you requested, we have reviewed the June 11, 1992 letter from Sylvia K. Lowrance to Douglas H. Green regarding application of the AOC concept to routine earthmoving and grading activities. The discussion in the June 11, 1992 letter continues to reflect Agency policy on areas of contamination.

The area of contamination concept was discussed in detail in the preamble to the National Contingency Plan (55 FR 8758-8760, March 8, 1990). Through the AOC concept, EPA recognizes that certain discrete areas of generally dispersed contamination may be equated to RCRA landfills. Just as movement of hazardous wastes within a landfill would not typically constitute a new act of treatment, storage or disposal for purposes of RCRA, movement of media contaminated by hazardous wastes within an area of contamination does not typically trigger RCRA requirements. While the area of contamination concept was first explained in the CERCLA NCP, it is based on an interpretation of RCRA. It applies equally to RCRA corrective action sites and other actions.

In most cases the AOC concept is applied in the context of a government overseen cleanup action, and delineation of AOCs are reviewed, overseen and approved as part of those actions. However, since the AOC concept is an interpretation of current Federal statutory and regulatory requirements, its application outside overseen cleanup actions does not require oversight or

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advance approval at the Federal level. When the AOC concept is applied outside the context of an overseen cleanup action, EPA encourages consultation with the appropriate agency and routinely cautions individuals that mis-application of the AOC concept could, potentially, result in substantial fines and penalties associated with improper disposal of hazardous waste. EPA also routinely cautions individuals that state standards may be more stringent and may require oversight or advance approval of all AOCs.

In your letter, you mention the specific concern that individuals could store soils contaminated with hazardous wastes in temporary piles anywhere within an overall area of contamination while installing pipelines or foundation footings and then replace the soil, "all with no RCRA regulatory requirements or governmental oversight." We note that, while movement of soil contaminated with hazardous waste within an area of contamination would not typically trigger RCRA, the AOC concept in no way shields individuals from otherwise applicable cleanup requirements. For example, in many states discovery of contaminated soils triggers reporting requirements under the state cleanup program. In these cases, if a state determined that cleanup was warranted it could require management or removal of contaminated soils, independent of RCRA. We believe that, addressing potential cleanup needs for contaminated soils discovered during normal earthmoving and grading activities using cleanup laws is more appropriate than imposing the RCRA permitting process on these activities.

Thank you for your concern regarding the AOC concept. EPA continues to believe that proper application of this concept will support appropriate remedies and expedite cleanup processes, not encourage avoidance of legitimate cleanup obligations. For additional information, your staff may wish to contact Elizabeth McManus or Hugh Davis, of my staff, at (703) 308-8657 and (703) 308-8633, respectively.

Sincerely yours,

Elizabeth A Cotsworth

for Michael Shapiro, Director
Office of Solid Waste

Enclosure

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 13 1995

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Use of the Area of Contamination (AOC) Concept During RCRA Cleanups

FROM: Michael Shapiro, Director
Office of Solid Waste

Stephen D. Luftig, Director
Office of Emergency and Remedial Response

Jerry Clifford, Director
Office of Site Remediation Enforcement

TO: RCRA Branch Chiefs
CERCLA Regional Managers

This memorandum confirms that, under current regulations, certain broad areas of contamination (AOCs) may be considered RCRA landfills. Under certain conditions, hazardous wastes may be moved within such areas without triggering RCRA land disposal restrictions or minimum technology requirements. This memorandum also describes the distinctions between the final Corrective Action Management Unit (CAMU) regulations and the Area of Contamination (AOC) approach, and encourages appropriate use of both options to expedite remedial actions.

Area of Contamination Approach

The area of contamination concept was discussed in detail in the preamble to the National Contingency Plan (55 FR 8758-8760, March 8, 1990). In this discussion, EPA clarified that certain discrete areas of generally dispersed contamination (called "areas of contamination" or "AOCs") could be equated to a RCRA landfill and that movement of hazardous wastes within those areas would not be considered land disposal and would not trigger the RCRA land disposal restrictions. The NCP also discusses using the concept of "placement" to determine which requirements might apply within an AOC. The concept of "placement" is important because placement of hazardous waste into a landfill or other land based unit is considered land disposal,

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which triggers the land disposal restrictions, and may trigger other RCRA requirements including permitting (at a non-CERCLA site), closure and post-closure. In the NCP, EPA stated, "placement does not occur when waste is consolidated within an AOC, when it is treated in situ, or when it is left in place." Placement does occur, and additional RCRA requirements may be triggered, when wastes are moved from one AOC to another (e.g., for consolidation) or when waste is actively managed (e.g., treated *ex situ*) within or outside the AOC and returned to the land. Additional information on when placement does and does not occur is provided in the attached guidance document, *Determining When Land Disposal Restrictions (LDRs) Are Applicable to CERCLA Response Actions*, OSWER Directive 9347.3-05FS, July 1989.

Although the AOC concept was initially discussed in the context of the CERCLA program, it applies equally to RCRA corrective action sites, cleanups under state law, and voluntary cleanups[1]. For additional information on the AOC concept, see, for example, the October 9, 1990 memorandum from Sylvia Lowrance to David Ullrich, "Replacement of Contaminated Soil and Debris Treated under a Treatability Variance," the January 7, 1991 letter from Don Clay to Richard Stoll, and the June 11, 1992 letter from Sylvia Lowrance to Douglas Green (attached).

The interpretations of landfill, placement and the area of contamination concept discussed in the NCP preamble were reiterated by EPA in the 1990 subpart S proposal (55 FR 30798, July 27, 1990). In the 1990 proposal, EPA termed AOCs at RCRA facilities "Corrective Action Management Units" or "CAMUs." Although the name was changed, from AOC to CAMU, the CAMU concept discussed in the 1990 proposal was equivalent to the AOC concept (although, as discussed below, the CAMU concept was broadened when the final CAMU rule was issued). In response to great interest in the CAMU/AOC concept as discussed in the 1990 proposal, EPA issued a fact sheet titled *Use of the Corrective Action Management Unit Concept* in August 1992 (attached). In the August, 1992 fact sheet, EPA further reiterated the AOC concept by explaining that broad areas of contamination, including specific subunits[2], could be considered landfills under the RCRA regulations and discussed activities which would or would not trigger additional RCRA requirements when conducted in such areas.

The discussions of the AOC approach in the NCP preamble, 1990 subpart S proposal, and the August, 1992 fact sheet continue to reflect EPA's interpretation of current statutory and regulatory provisions. They remain useful guidance documents when the AOC approach is

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[1]Although advance approval at the Federal level is not required for private parties to take advantage of the AOC concept, we encourage them to consult with the appropriate agency to ensure they implement the AOC concept appropriately. It should be noted that the agency responsible for determining that the AOC concept is being properly applied might not be the same as the agency overseeing cleanup at a site. Additionally, states may have more stringent standards which require consultation and/or prior approval of an AOC.

[2] Note, if the subunit were a RCRA regulated unit, inclusion of the unit within an AOC could necessitate a RCRA permit modification or a change under RCRA interim status.

under consideration at RCRA corrective action sites, Superfund sites and during other cleanup actions involving the movement or consolidation of hazardous waste, or media and debris contaminated with hazardous waste.

Relationship of the AOC Concept to the Final CAMU Rules

On February 16, 1993, EPA published final Corrective Action Management Unit regulations (58 FR 8658, February 16, 1993). The final CAMU rule differs from the AOC approach in important respects. First, the CAMU regulations create a new type of RCRA unit - a "Corrective Action Management Unit" or "CAMU." CAMUs are distinct from the type of units listed in RCRA Section 3004(k)[3]. Second, only EPA and authorized states may choose to designate CAMUs for management of remediation waste during RCRA corrective action and other cleanups. Third, the CAMU regulations expanded the flexibility available for management of remediation wastes beyond that offered by the AOC approach. Under the CAMU regulations, certain activities which would normally be considered placement are allowed when carried out in an agency-approved CAMU, including: remediation waste[4] may be removed from a CAMU and replaced (before or after treatment) in the same or a different CAMU; remediation waste may be consolidated into a CAMU before or after treatment; and, remediation waste may be moved (again, before or after treatment) between two or more CAMUs at the same facility.

While the CAMU concept contained in the final CAMU rule was historically an outgrowth of the AOC concept, it has a separate statutory and regulatory basis; therefore, it supplements rather than supersedes the AOC concept. The AOC concept was not altered when the final CAMU rules were promulgated and it does not depend on the existence of the CAMU rule.

As you may be aware, several parties challenged the CAMU rule. The lawsuit has been stayed pending promulgation of the final Hazardous Waste Identification Rule for contaminated media ("HWIR-Media"). At the time the stay was issued, EPA stated that the HWIR-Media rule was expected to replace a substantial portion of the CAMU rule; however, as long as the CAMU rule remains in effect, CAMUs may be used to facilitate protective remedies under RCRA, CERCLA, and state cleanup authorities. If a CAMU is under consideration, we recommend you take the following steps, in addition to the CAMU approval steps required at 40 CFR § 264.552:

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[3] RCRA Section 3004(k) defines the term land disposal, when used with respect to a specified hazardous waste, to include placement of such hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave.

[4] Remediation waste is defined as; "all solid and hazardous wastes, and all media (including groundwater, surface water, soils, and sediments) and debris, which contain listed hazardous wastes or which themselves exhibit a hazardous waste characteristic, that are managed for the purpose of implementing corrective action requirements under 40 CFR § 264.101 and RCRA section 3008(h). For a given facility, remediation wastes may originate only from within the facility boundary, but may include waste managed in implementing RCRA sections 3004(v) or 3008(h) for releases beyond the facility boundary.

1) explain the potential risks associated with CAMUs to facility owner/operators by informing them that the CAMU rule has been challenged and that EPA may issue a proposal to withdraw it; 2) where possible, mitigate potential risks associated with CAMUs by, for example, implementing a CAMU remedy within the shortest possible time frame; and 3) document all CAMU decisions completely, emphasizing how the CAMU provides support for the best site-specific remedy.

Continued Use of the AOC Concept

Both AOCs and CAMUs can be used to expedite effective and protective remedial actions; however, EPA encourages the use of the AOC concept in cases where the additional flexibility provided in the final CAMU regulations is not needed. For example, the AOC concept is particularly useful for consolidation of contiguous units or areas of contaminated soil. Using the AOC concept, a RCRA facility owner/operator with a large contiguous area of soil contamination could consolidate such soils into a single area or engineered unit within an AOC without triggering the RCRA land disposal restrictions or minimum technology requirements. Use of the AOC concept would not be affected by the pending litigation over CAMU or any changes in the CAMU rule. In addition, please note, the AOC and CAMU concepts only address management of materials which would otherwise be subject to RCRA (i.e., hazardous wastes, or media and debris contaminated with hazardous waste). RCRA regulated materials are a subset of the materials managed during site cleanups.

We know you will continue to use the AOC and CAMU concepts to support appropriate remedies and to expedite cleanup processes. If you have any questions regarding the AOC or CAMU concepts, please contact Elizabeth McManus, Hugh Davis or Robin Anderson at (703) 308-8657, (703) 308-8633, and (703) 603-8747, respectively.

attachments

cc: Susan Bromm, OECA
Elizabeth Cotsworth, OSW
Larry Reed, OERR
Jim Woolford, FFRRO
Barbara Pace, OGC
George Wyeth, OGC
Earl Salo, OGC
RCRA Regional Division Directors
Superfund Regional Division Directors

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

9484.1994(01)

APR - 6 1994

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

Mr. Scott M. DuBoff
WINSTON & STRAWN
1400 L Street, N.W.
Washington, D.C. 20005-3502

Dear Mr. DuBoff:

In your letter of February 9, 1994, you request clarification of the Agency's interpretation of "active management" in the closing of waste management facilities (surface impoundments) that contain waste sludges meeting the description of waste types that became subject to Subtitle C of the Resource Conservation and Recovery Act (RCRA) after the impoundments had been permanently removed from service. Specifically, this request seeks verification of a site-specific case described in the letter.

In the specific case of an impoundment which stopped receiving or generating any hazardous wastes prior to the effective date of the newly identified characteristic or newly identified listing, and the impoundment is the final disposal site for the wastes, the unit is not subject to regulation under 40 CFR parts 264 or 265 (See 55 FR 39410, September 27, 1990 and 55 FR 46383, November 2, 1990). However, it should be noted that inactive units that are located at facilities otherwise subject to Subtitle C interim status or permitting requirements are solid waste management units subject to corrective action requirements under sections 3008(h) and 3004(u) of RCRA. Any treatment, storage, or disposal of wastes (i.e., active management) in the unit after the effective date of the new listing or characteristic could subject the unit and wastes to Subtitle C control.

Section 3005 of RCRA prohibits the operation of hazardous waste treatment, storage, or disposal facilities without a permit. EPA interprets the term "disposal" for purposes of RCRA Subtitle C regulation to have the same meaning as the term "land disposal" as defined under section RCRA 3004(k). Therefore, conducting any of the activities that constitute "land disposal" of hazardous waste will subject the unit to Subtitle C permitting and land disposal restrictions. "Land disposal" occurs when hazardous wastes are placed into a unit, including when hazardous

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wastes from different units are consolidated into one unit, or removed and treated outside a unit and redeposited, or treated within the unit in an incinerator, impoundment, or tank and then redeposited. "Land disposal" does not occur, for example, when hazardous wastes are moved or consolidated within a unit, treated in situ, or capped in place, or when non-hazardous solid waste is added to the unit. As noted in the final rule which identified wastewater treatment sludges from petroleum refining as hazardous wastes (55 FR 46383, November 2, 1990), EPA does not view the one time removal of wastes during closure as changing the status of the unit with respect to permitting, as long as there has not been ongoing management of the waste in the impoundment. One-time removals do "generate" waste, and this waste must comply with treatment standards prior to final land disposal.

It also should be noted that although the movement of waste within a unit would <u>not</u> constitute land disposal under RCRA 3005 or 3004(k) (as described above), this activity <u>would</u> generally be defined as "disposal" under RCRA section 1004(3) and thus be subject to RCRA section 7003 authorities.

During closure-in-place, the sludges are often mixed with a stabilizing material designed to stabilize the sludge either chemically or physically to provide sufficient bearing capacity for the placement of an impervious cap and to prevent migration of any contaminants to groundwater from a unit. Conducting activities that constitute hazardous waste "treatment" (including in situ treatment) would subject the unit to permit requirements as a hazardous waste treatment facility.

Because "treatment" may be occurring during activities designed to stabilize the wastes prior to capping, Subtitle C permitting may be triggered. However, whether or not the addition of material to improve the load-bearing ability of final cover actually involves the physical or chemical stabilization (i.e., treatment) of RCRA hazardous waste is a site-specific determination. Therefore, we will forward your letter to Region V and help the appropriate Regional staff obtain any additional national guidance they may require.

Sincerely,

David Bussard

David Bussard, Director
Characterization and Assessment Division

cc: David Fagan, OSW/PSPD, 5303W
Richard Witt, OGC, 2355
Mike Ribody, Region V

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 31 1992

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Use of the Corrective Action Management Unit (CAMU) Concept

TO: Waste Management Division Directors, Regions I - X
RCRA Branch Chiefs, Regions I - X
RCRA Regional Counsel, Regions I - X

FROM: Sylvia Lowrance, Director
Office of Solid Waste

for Bruce Diamond, Director
Office of Waste Programs Enforcement

At the February 1992 Stabilization Conference in Colorado Springs we discussed the possibility of implementing the corrective action management unit (CAMU) concept before final promulgation of the Subpart S regulations. At that time OSWER made a commitment to provide further guidance to the Regions on how to use existing RCRA regulations to achieve some of the remedial benefits of the CAMU. The attached document, "Use of the Corrective Action Management Unit Concept," provides that guidance.

The CAMU portion of Subpart S is on a current schedule to be finalized by December 1992. The attached guidance, which was developed jointly by OSWER and OGC, clarifies the Agency's legal authority for utilizing a CAMU-like approach before the CAMU rule is finalized, and provides guidance on when and how to use the concept. The concept can be applied during final remedies, and in the implementation of stabilization actions to reduce imminent threats and contain releases. We encourage the use of this concept whenever the success of the remedial option at a particular facility will be enhanced.

If you have any questions regarding the content of this guidance, please call Dave Fagan at (202) 260-4497.

cc: Lisa Friedman, OGC
Henry Longest, OERR
Kathie Stein, OE

United States
Environmental Protection
Agency

Office of Solid Waste and
Emergency Response
Washington, D.C. 20460

August 1992

EPA

Use of the Corrective Action Management Unit Concept

Office of Solid Waste

BACKGROUND

Beginning in 1992, EPA began implementing a new strategy to increase the pace of cleanup and to achieve positive environmental results at RCRA treatment, storage and disposal facilities (TSDFs) requiring corrective action. While comprehensive facility cleanup is still the long-term goal for the RCRA Corrective Action Program, this new initiative emphasizes the importance of stabilizing sites by controlling releases and preventing the further spread of contaminants.

At most RCRA facilities, stabilization or final remedial actions will involve excavation and on-site management of contaminated soils, sludges and other wastes that are subject to the RCRA Subtitle C hazardous waste regulations. In these situations, a number of issues can arise regarding the applicability of certain RCRA requirements, and how these requirements may affect the remedial activities. Specifically, experience in the RCRA and CERCLA remedial programs has shown that the RCRA land disposal restrictions (LDRs) and minimum technology requirements (MTRs) may limit the types of remedial options available at sites, as well as affect the types of specific technologies that may be used, the volumes of materials that are managed, and other features of remedies under consideration.

Recognizing that strict application of these RCRA requirements may limit or constrain desirable remedies, including stabilization programs, EPA is developing an important regulatory concept, known as the Corrective Action Management Unit (CAMU), to facilitate effective and protective remedial actions. This concept, first discussed in the proposed Subpart S corrective action regulations (55 FR 30798, July 27, 1990), is similar to the Superfund concept of the "area of contamination," in which broad areas of contamination, often including specific subunits, are considered to be a single land disposal unit for remedial purposes.

CAMUs may be particularly useful for specific remedial activities such as consolidation of units or contaminated surficial soils. For example, a group of unlined inactive lagoons that are continuing sources of releases to groundwater may be best remediated by removing and treating the concentrated wastes in another unit, and excavating the remaining low-concentration contaminated soils from underneath the lagoons. These soils could then be consolidated and placed into a protective and cost-effective single-capped unit, thereby controlling further releases to groundwater. In other situations site remediations will require excavation of large quantities of relatively low-level contaminated surficial soils. In these cases a protective and cost-effective remedy might be to excavate the soils and consolidate them into a single area or engineered unit within the area of contamination. For both of these examples, application of LDRs and possibly MTR requirements would result in a more costly and complex remedy, that may delay remediation and result in little additional environmental protection for the site.

As proposed in the Subpart S rule, there may be certain types of situations in which application of the CAMU concept (55 FR 30842) would be inappropriate. In addition, several

factors (55 FR 30883) may be considered by decision-makers in determining how CAMUs would actually be designated at sites. Although owner/operators may propose a specific area as a CAMU, it is the responsibility of EPA or the authorized State to determine whether a CAMU is necessary and appropriate, and, if so, to determine the boundaries of the unit.

The Subpart S regulations have not yet been finalized. However, although the CAMU concept has been presented only in proposed regulations, existing regulatory authority may be used to implement this type of approach in site remediations and stabilization actions. The Agency's experience with the RCRA and CERCLA remedial programs indicates that the CAMU concept could be applied immediately to great advantage at a significant number of RCRA cleanup sites. This guidance is presented to clarify the use of the CAMU concept prior to final regulations.

USE OF LANDFILL DESIGNATION FOR REMEDIAL PURPOSES

Specifically, certain contaminated areas at sites that require remediation, including groups of units in such areas, may be designated as a "landfill" under the current RCRA landfill definition (40 CFR § 260.10). Designating such an area of a facility as a landfill within the existing regulatory framework can achieve remedial benefits similar to those that would be obtained by using CAMUs under the Subpart S proposal. Prior to the promulgation of final CAMU rules, EPA encourages the use of this approach at contaminated sites, where it can promote effective and expeditious remedial solutions. EPA recommends that decisions on designating certain contaminated areas or groups of units as a landfill be made in accordance with applicable regulations and generally in accordance with the CAMU provisions in the Subpart S proposal.

Owner/operators proposing to address certain areas at a facility as a single landfill for remedial purposes should request approval from EPA or the authorized State agency. The Regional Administrator or the authorized State Director will be the ultimate decision-maker as to whether such a landfill unit will help achieve the remedial objectives at the facility. EPA recommends decisions to use existing authorities, waivers, or variances to achieve many of the same objectives as the proposed Subpart S rule CAMU provisions should generally follow the proposed regulatory provisions (55 FR 30883) and preamble discussion (55 FR 30842) in defining the boundaries of the remedial unit. The Region or authorized State may also look to Superfund guidance in the designation of AOCs (55 FR 8758-8760).

Designating an area of contamination as a "landfill" will require that the unit comply with certain RCRA requirements that are applicable to landfills. The specific requirements that apply will differ, depending on whether the landfill is considered to be: (1) an existing non-regulated landfill, or (2) a regulated hazardous waste landfill. This distinction is determined by the regulatory status of the units or areas that are included as part of the landfill. The following discussion explains further the requirements associated with these two types of landfills.

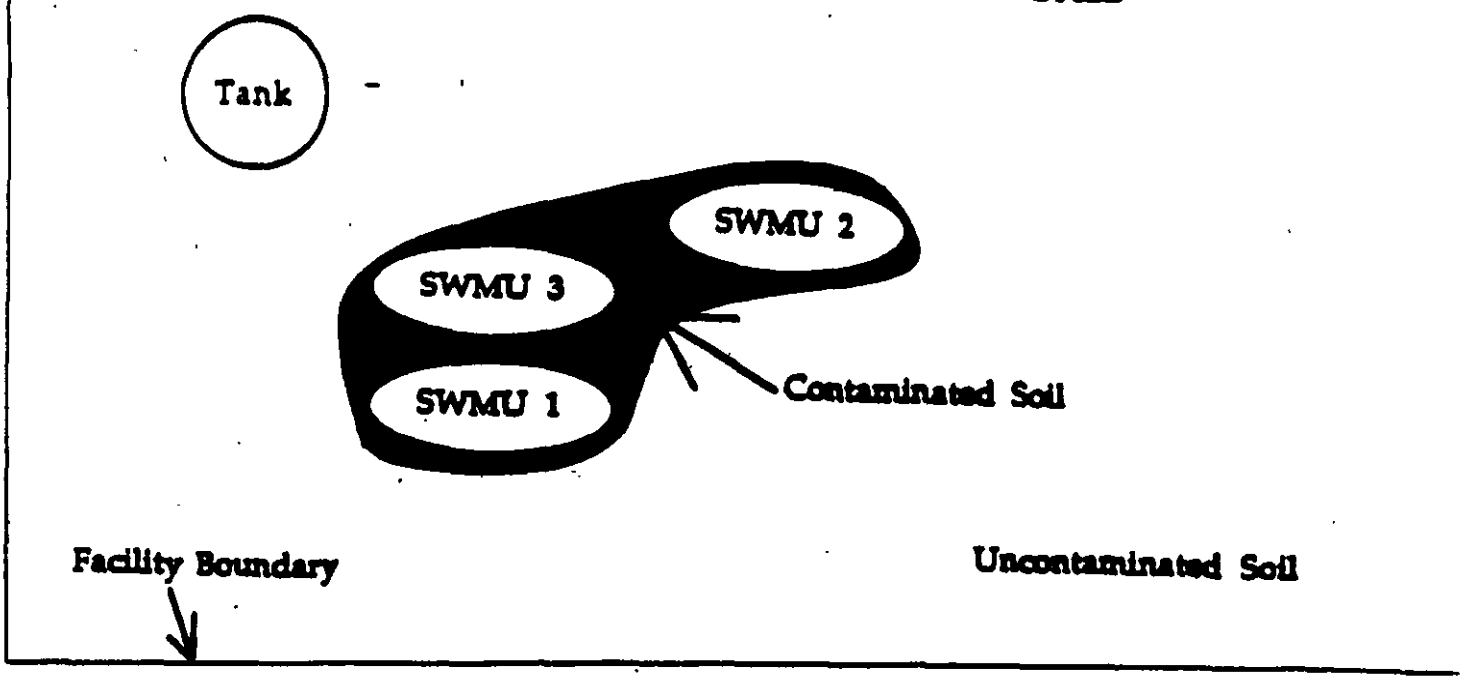
Existing Non-Regulated Landfills

Figure 1 shows an area of contamination at a facility that includes several land-based solid waste management units (SWMUs) that are not regulated as hazardous waste units under RCRA (e.g., because all of the disposal occurred before the RCRA hazardous waste regulations went into effect). By designating this area as a single landfill, EPA can approve movement and consolidation of hazardous wastes and soils contaminated with hazardous waste within the unit boundary, without triggering the LDRs or MTRs. For example, contaminated soils in and around SWMUs 1 and 2 could be consolidated into SWMU 3 and capped without triggering LDR requirements.

This landfill would not be subject to the RCRA Part 264 or Part 265 design and operating requirements for hazardous waste landfills. This is because the landfill would not have received hazardous waste after November 19, 1980. (See 40 CFR § 270.1(c)). In the absence of specific Part 264 or 265 requirements for such units, appropriate ground water monitoring and closure requirements for the landfill can be determined by EPA or the State as part of the corrective action remedial decision-making process. These requirements would be based on an assessment of site specific factors, such as waste characteristics, site hydrogeology, exposure potential, and other factors. This allows the regulator further flexibility in designing remedial solutions which are effective and protective based on actual site conditions.

These non-regulated landfills would remain exempt from regulation under Parts 264 and 265, under the following circumstances:

FIGURE 1
EXISTING NON-REGULATED LANDFILL



- The landfill cannot receive hazardous waste from other units, either on-site or off-site. The landfill could, however, receive non-hazardous wastes as part of the cleanup actions. If it were to receive hazardous waste, the landfill would become a regulated unit (40 CFR § 270.1(c)) subject to the requirements of Subparts F (40 CFR § 264.90) and G (40 CFR § 264.110). The facility permit would have to be modified accordingly (for interim status facilities, a change would have to be approved under 40 CFR § 270.72), and the wastes would have to be treated to comply with applicable LDR standards prior to placement in the landfill.

- If hazardous waste treatment (including in-situ treatment) takes place within the landfill, the owner/operator must comply with all Part 264 or 265 requirements applicable to the treatment unit, and must modify the permit or Part A to include the new treatment unit.

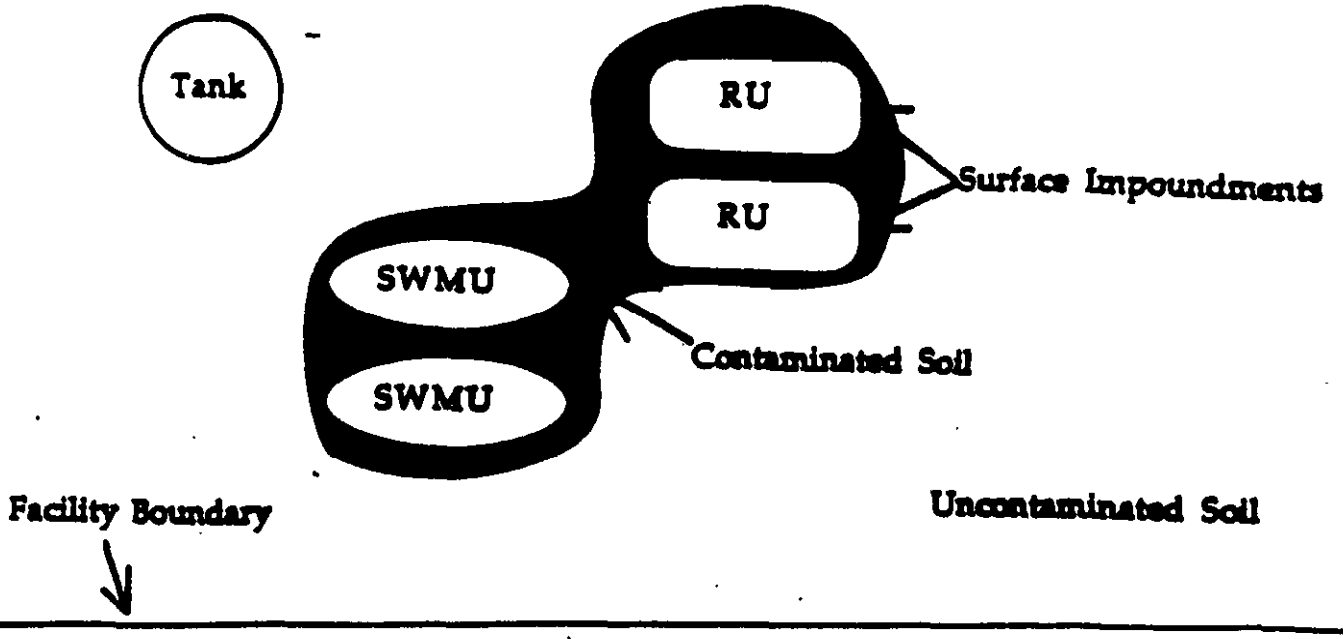
- Similarly, residuals from treatment of hazardous wastes that have been removed from the landfill and treated in a non-land-based unit cannot be redeposited into the landfill unless the residuals meet the LDRs. If the residuals were still hazardous by characteristic or still contained hazardous wastes, disposal of the residuals into the landfill would require the landfill to be designated a "regulated unit," as the unit would have received hazardous waste after July 26, 1982.

- Hazardous wastes transferred from the non-regulated landfill to another land-based unit would also have to meet LDR standards.

Regulated Landfills

Figure 2 shows an area of contamination that could be designated as a landfill, which contains two regulated units (as defined in 40 CFR § 264.90). As with the previous example in Figure 1, designating this area as a landfill would allow wastes to be moved and consolidated within the area without triggering the LDRs. However, because this landfill contains regulated units, the entire area must be considered a regulated unit. Accordingly, the following requirements would apply:

FIGURE 2
REGULATED LANDFILL



- The unit boundaries of the original regulated units that were specified on the Part A or Part B application would have to be redesignated to encompass the entire new landfill unit, according to the applicable procedures in 40 CFR §§ 270.72, 270.41 or 270.42.

- The landfill would have to comply with applicable Part 264 or 265 requirements for landfills, including the Subpart F ground water monitoring requirements and Subpart G closure and post-closure requirements. Subpart F requirements would generally involve installation of additional ground water monitoring wells. Compliance with Subpart G would likely also require modifications to the closure and post-closure plans for the unit.

MTRs would not necessarily apply to these newly designated regulated landfills. If the original regulated unit located within the landfill was not subject to the MTRs (i.e., the landfill was not new or expanding after 1984), the landfill could be considered by the Agency or authorized State to be a redesignation of that existing unit, rather than a lateral expansion. As such, the landfill would not be subject to the MTRs. However, if the regulated unit encompassed by the landfill was originally subject to MTRs, the entire area of the landfill would be subject to MTRs.

SUMMARY

Existing regulatory standards (e.g., replacement of treatment residuals into the CAMU triggers the LDRs) cannot be waived to implement the CAMU concept prior to a final CAMU rulemaking. EPA is considering removing some of these limitations in the final rule. Nonetheless, despite these current limitations, there may be a number of situations where the use of landfills can yield substantial benefits in remediating sites. EPA recommends that the guidance provided in this fact sheet be used in evaluating the use of landfills to implement timely and protective corrective actions at RCRA facilities.

FOR FURTHER INFORMATION

Inquiries concerning the guidance contained in this fact sheet should be directed to Dave Fagan (202) 260-4497, or Anne Price (202) 260-6725.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 11 1992

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

Mr. Douglas H. Green
Piper & Marbury
1200 Nineteenth Street, N.W.
Washington, D.C. 20036-2430

Dear Mr. Green:

Thank you for your letter of April 30, 1992, requesting clarification of the Environmental Protection Agency's (EPA's) interpretation of the applicability of certain Resource Conservation and Recovery Act (RCRA) requirements to common excavation-type activities.

The particular situation which you presented in your letter involves excavation of soils, such as trenching operations for pipeline installation, where the soils may be hazardous by characteristic, or may contain listed hazardous wastes. We understand that your questions specifically relate to excavations being conducted on public roadways or at other similar locations that are not necessarily associated with or are part of a RCRA-regulated treatment, storage, or disposal facility.

In the example which you cited in your letter, the soils from the excavation or construction activities are temporarily moved within the area of contamination, and subsequently redeposited into the same excavated area. In these situations, we agree that such activity does not constitute treatment, storage, or disposal of a hazardous waste under RCRA. The activity of placing waste in the ground would not normally meet the regulatory definitions of "treatment" or "storage" (40 CFR 260.10). In addition, as you noted in your letter, movement of wastes within an area of contamination does not constitute "land disposal" and thus does not trigger RCRA hazardous waste disposal requirements (55 FR 8666, March 8, 1990). Thus, RCRA requirements such as land disposal restrictions would not apply.

With respect to generator requirements, as you indicated, a hazardous waste "generator" is one, by site, who produces a hazardous waste or first causes the waste to be regulated as hazardous (40 CFR 260.10). In the circumstances you described, the excavation does not "produce" the hazardous waste, nor does it subject the waste to hazardous waste regulation since, as

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discussed above, the activity you described is not "treatment," storage," or "land disposal" of hazardous waste. Therefore, we agree that the activity is not subject to any generator requirements.

Please let me know if you have any further questions regarding this issue.

Sincerely yours,

Sylvia K. Lawrence, Director
Office of Solid Waste

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 16 1991

OFFICE OF
GENERAL COUNSEL

MEMORANDUM

SUBJECT: LDR Applicability for Investigative Derived Waste

FROM: Caroline H. Wehling CHW
Attorney
Solid Waste and Emergency
Response Division (LE-132S)

TO: Steven C. Golian
Chief
Remedial Guidance Section (OS-220)

This is in response to your request for guidance on compliance with land disposal restrictions for investigative-derived wastes which are temporarily stored in drums within an AOC pending response selection. Specifically you have asked whether a drum is in itself a RCRA "unit" such that, if waste is removed from the drum, it must meet LDR requirements prior to redeposition in the AOC.

I agree that, in certain circumstances, the placement of hazardous waste from an AOC into a drum within the AOC, followed by replacement in the AOC would not constitute "land disposal" for RCRA purposes. For RCRA regulatory purposes, "land disposal" is the placement of waste into a land disposal unit (such as an AOC). Land disposal of hazardous wastes is subject to the pretreatment requirements of the LDR program. Movement of hazardous waste from a storage unit (such as a tank or container storage area) into a land disposal unit constitutes "land disposal" of hazardous waste.

As we have discussed, a drum is not in itself a RCRA unit. See 40 C.F.R. 260.10 (definition of "hazardous waste management unit"). However, drums and the land on which drums are placed may constitute a RCRA storage unit, specifically a "container storage area". Thus, if the drum storage you described involved the placement of hazardous waste into drums within a separate storage or treatment area, either on land within the AOC or on a pad, the removal of waste and replacement into the AOC could

constitute land disposal. On the other hand, EPA does not generally consider drums placed within a landfill to form "container storage areas". Thus, if waste is placed into drums which remain within the AOC and which are not placed into a separate storage or treatment area, such placement would not be considered a unit distinct from the landfill itself. As a result, removal of waste from the drums and redeposition within the landfill would not constitute land disposal.

Please call me if you have any additional questions about this. I can be reached at FTS 382-7720.

cc: Tina Kaneen, OGC
Larry Starfield, OGC
George Wyeth, OGC
John Hollister, OERR
Dave Fagan, OSW

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 7 1991

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

Richard G. Stoll
Freedman, Levy, Kroll & Simonds
1050 Connecticut Ave. N.W.
Washington, D.C. 20036-5366

Dear Mr. Stoll,

This letter is in response to your inquiry dated August 22, 1990 concerning the applicability of EPA's "Superfund LDR Guides." As you asserted, those interpretations of RCRA were found in the 1990 NCP and other CERCLA documents, but you asked whether those interpretations apply at all sites, regardless of whether the cleanup activity is being conducted under federal CERCLA authorities.

The preamble to the 1990 NCP represents an official Agency-wide position concerning the interpretation of RCRA and other statutes relevant to federally-mandated CERCLA cleanups (see 53 FR 51394, 51443-45 (December 21,1988) and 55 FR 8666, 8758-62 (March 8,1990)). The LDR Guides implement these interpretations in more detail. These interpretations of RCRA would apply at Superfund sites and at non-Superfund sites. Therefore, in general, the answer to your question about the applicability of the LDR Guides and NCP interpretations is that they apply wherever the cleanup involves a RCRA waste. However, it is conceivable that some of the interpretations of RCRA developed to apply to federal CERCLA sites may not exactly match non-CERCLA circumstances because of different statutory constraints or authorities. With that caveat, let me address the specific issues and questions raised in your letter.

First, your comments focus on the interpretations of Area of Contamination (AOC), "placement," and the presumption of entitlement to treatability variances for contaminated soil and debris. Your principal concern focused on whether the interpretations offered of these issues in the NCP and LDR Guides apply at all sites. The answer is yes.

Second, you also questioned whether the NCP interpretations and the LDR Guides noted above apply equally where "a party may want to move or treat contaminated soil and debris as part of a

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RCRA corrective action, as part of a cleanup carried out under State law, and/or as part of a voluntary cleanup." The answer is yes.

Third, you asked whether in situ treatment that is not "placement" at a CERCLA site is also not placement at a non-CERCLA site (site A in your letter). The answer is yes.

Fourth, you question whether excavation and movement of contaminated soil within a certain area would be "placement" at a non-CERCLA site (site B), since you interpret it not to be placement at a CERCLA site. The limited facts given in that question do not allow us to unambiguously state whether there is "placement" at either site, although as a general rule the AOC concept is operable at RCRA corrective action sites. It should be noted, however, that designation of an AOC is a function performed by the regulating agency.

Fifth, you asked whether the presumption in favor of treatability variances and definition of appropriate alternative treatment would be the same for a non-CERCLA site (site C). The answer is that any presumption in favor of a treatability variance would be the same whether the site is a RCRA site or a federal or private party CERCLA site.

I hope that this response meets your needs. If you need additional information or clarification, please contact Steve Golian at (703) 308-8360.

Sincerely,

Don R. Clay
Assistant Administrator

OSW-206

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 9 1990

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONS

MEMORANDUM

SUBJECT: Replacement of Contaminated Soil and Debris Treated under a Treatability Variance

FROM: Sylvia K. Lowrance, Director
Office of Solid Waste

TO: David Ullrich, Acting Director
Waste Management Division, Region V

This memorandum is in response to your correspondence of April 25, 1990, in which you requested guidance in relation to six specific questions dealing generally with how the RCRA land disposal restrictions may affect certain remedial situations. We apologize for the delay in responding to your request; however, it was necessary for us to insure consensus at Headquarters in order to address the questions you have posed. We offer the following response to those six questions:

1. Q: Can soil and debris which has been treated in a tank within the area of contamination (AOC) in accordance with a treatability variance be replaced within the area of contamination without meeting any additional 40 CFR Part 264 requirements?

A: If contaminated soil and debris is treated to meet standards specified in a treatability variance that has been approved by the Agency, the treated soil/debris may then be placed in any treatment, storage or disposal unit that is in compliance with RCRA Subtitle C. This could include an "area of contamination" (i.e., a RCRA landfill) that has been designated by the Regional Administrator for the purpose of remediating the facility or site. Thus, as a regulatory matter, there would be no real distinction between soil/debris that is treated to the standard(s) set in the treatability variance and then placed in another unit, as opposed to "pure" hazardous wastes that are treated to the applicable Part 268 standards, and placed in another unit, except as discussed in the response to Question #5 (concerning contaminated media which no longer contains any waste).

By stating in your question that the treated wastes are to be redeposited into the AOC, we assume there is an

implied question as to what design and operating standards would then be applicable to the AOC itself. This is discussed in our response to question #6, below.

2. Q: Has the policy set forth on Page 5.12 of the document Implementing the Land Disposal Restrictions, October 1989, been revised?

   A: This policy has not been revised. The policy states that once an owner/operator receives a treatability variance, completes treatment, and has a treatment residual to be land disposed, the residue can be directed to any permitted or interim status unit.

3. Q: For the purpose of land disposal, is the residue of soil treated under a treatability variance to be distinguished from the residue of waste treated according to treatment standards?

   A: No. See response to Question 1, above.

4. Q: For the purpose of land disposal, is the residue of soil treated under a treatability variance in a tank within the area of contamination to be distinguished from the residue of soil treated under a treatability variance in a tank outside of the area of contamination?

   A: No. The location of the tank in relation to the "area of contamination" would not create a distinction as to how or where the treatment residuals could be land disposed. This assumes, of course, that the wastes have been treated to the standards specified in the treatability variance. A tank cannot be considered a part of the AOC (landfill), regardless of where it is physically located; thus, its location would have no bearing on the standards that would apply to management of the contaminated soils (or other hazardous wastes, for that matter) after they have been treated in the tank.

5. Q: Is a treatability variance for soil and debris to be considered in effect a delisting? Do the principles of the "contained in" policy for the treatment of contaminated ground water have any applicability to the treatment of contaminated soil and debris?

   A: A treatability variance for soil/debris does not have the effect of a delisting approved for the waste. The treated residuals typically will still contain hazardous wastes, and thus must be managed as such. In contrast, when wastes are delisted they are generally no longer subject to Subtitle C regulation.

The "contained in" policy applies to ground water

and other contaminated media such as soil which are contaminated with listed hazardous wastes. Thus, if ground water or soil are treated such that concentrations of the listed wastes are at or below health based levels, the ground water or soil would no longer "contain" the hazardous wastes, and would therefore be no longer subject to Subtitle C regulation.

6. Q: If an AOC can be considered a RCRA unit for the purpose of closure, would an AOC ever be considered equivalent to a RCRA compliant unit for the purpose of disposal? (See page 6 of OSWER Directive 9234.2-04FS RCRA ARARs: Focus on Closure Requirements.)

A: As outlined in the cited ARARs manual, the AOC is a concept which can be applied in the context of remediation under CERCLA response actions or RCRA corrective actions. It is in many ways analogous to situations where two or more regulated surface impoundments would be treated as one unit in the context of closure of the impoundments.

When applied in the context of RCRA corrective actions or CERCLA remedial actions, the AOC concept would allow the Regional Administrator to designate a broadly contaminated contiguous area to be a RCRA "unit" (i.e., a landfill) for the purpose of implementing the remedy. In an existing landfill, the movement or consolidation of hazardous wastes within the designated area would not by itself trigger Subtitle C requirements (including the land disposal restrictions and the RCRA minimum technology requirements) since that movement or consolidation does not constitute "disposal" for Subtitle C purposes. If, however, wastes are excavated from the designated area, treated in another unit, and subsequently redeposited into the same area or unit, disposal has occurred, and the landfill would have to comply with applicable Part 264 or 265 requirements, including the LDRs, MTRs, closure standards (264.310), and the ground water monitoring requirements of Subpart F, Part 264 or 265.

The proposed Subpart S corrective action rule explains the AOC (described therein as the "corrective action management unit") concept in more detail. However, if you have more specific questions or issues regarding AOCs, we will be glad to work with you or your staff to resolve them.

If there are any questions on the above responses to your questions, please contact Dave Fagan (FTS 382-4497) or Judy

View Record Detail

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

September 5, 1990

Richard G. Stoll
Freedman, Levy, Kroll & Simonds
Washington Square
1050 Connecticut Ave., N.W.
Washington, D.C. 20036-5366

Dear Mr. Stoll:

This is in response to your request for confirmation that certain activities do not require a hazardous waste management permit under the Resource Conservation and Recovery Act ("RCRA"). Specifically, you have asked whether movement of hazardous waste that does not constitute "land disposal" would nonetheless require a hazardous waste disposal permit. It would not.

Section 3005 of RCRA prohibits the operation of a hazardous waste treatment, storage or disposal facility without a permit. EPA has interpreted the term "disposal" for purposes of RCRA Subtitle C regulation to have the same meaning as the term "land disposal" as defined under Section 3004(k). 53 Fed. Reg. 51444 (December 21, 1988) (defining "treatment", "storage" and "disposal" under Subtitle C of RCRA); 55 Fed. Reg. 8759, 8760 (March 8, 1990). Moreover, EPA has interpreted "land disposal" under Section 3004(k) to include movement of hazardous waste <u>into</u> a unit, but not movement within the unit. 55 Fed. Reg. 8759, 8760 (March 8, 1990). As a, result, movement of hazardous waste within a land disposal unit --- for instance, the transfer of waste from one part of a hazardous waste disposal unit to another part of that unit --- would not constitute "disposal" under Section 3005 and thus would not require a permit. <u>See</u> 55 Fed. Reg. 8760 (March 8, 1990) (earthmoving operations within a land disposal unit would not be subject to Subtitle C disposal requirements or permitting).

Note, however, that if such transfer were associated with land treatment activities, the unit may be subject to permit requirements as a hazardous waste <u>treatment</u> facility. In addition, the movement of waste within a unit would generally constitute "disposal" as defined under Section 1004(3) and thus be subject to Section 7003 authorities.

If you have further questions about this issue please feel free to contact me or Carrie Wehling of my staff.

Sincerely,

Lisa K. Friedman
Associate General Counsel
Solid Waste and Emergency
Response Division (LE-132S)

LAW OFFICES
FREEDMAN, LEVY, KROLL & SIMONDS

July 10, 1990

Lisa K. Friedman, Esq.
Associate General Counsel
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LE-132S
Room 503, West Tower
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Washington, D. C. 20460

Dear Lisa:

I am seeking your confirmation that certain types of hazardous waste movement will not trigger the need for a disposal permit under RCRA. If you agree with my analysis and conclusions, I ask that you please send me a letter stating this.

EPA has recently explained in some detail how to determine whether various types of activities constitute "placement" for purposes of triggering land disposal restrictions (LDRs) under RCRA. EPA's interpretations may be found in (1) OSWER Directive 9347.3-05FS, July 1989, also known as "Superfund LDR Guide #5;" (2) the proposed NCP preamble of December 21, 1988, particularly at 53 Fed. Reg. 51444, and (3) the final NCP preamble of March 8, 1990, particularly at 55 Fed. Reg. 8758-60.

In these documents, the concept of "placement" within or outside an "Area of contamination" (AOC) is pivotal. Essentially, EPA has stated that the act of moving hazardous wastes within a single AOC will not be considered "placement" that triggers LDRs (unless such movement also includes placing the waste in a separate unit such as incinerator or tank within the AOC).

While these documents deal with placement in the LDR context, they do not generally address the equally important issue of whether certain activity triggers the need for a permit under RCRA. Based upon my review of the statute, EPA regulations, and various EPA preamble statements, I have the following conclusion: any moving of hazardous waste not placement for purposes of triggering LDRs similarly trigger the need for a RCRA disposal permit. My analysis follows.

First, RCRA §1004(3) defines "disposal" quite broadly, and goes well beyond active "placement" to include passive leaking, leaching, etc. The statutory requirement to obtain a permit, however, is not triggered merely by any such disposal. Rather RCRA §3005(a) requires only that disposal facilities have permits. See first sentence of §3005(a).
The statute does not define the term "disposal facility." EPA's regulations, however, have defined this term consistently since 1980:

> Disposal facility means a facility or part of a facility at which hazardous waste is intentionally placed into or on any land or water, and at which waste will remain after closure.

40 CFR 260.10 (emphasis added).

Even at this early stage of the analysis, one can detect the basis for my conclusion. "Placement" of waste is a key to the definition of a disposal facility, and a disposal facility is necessary to trigger the requirement for a disposal permit.

Recent EPA discussions provide strong support for this conclusion. In the final "first third" LDR preamble, EPA made the following statement in responding to a comment:

> Thus, only facilities where hazardous waste is intentionally placed into land or water after November 19, 1980 require a RCRA disposal permit.

53 Fed. Reg. 31149, cols. 1-2, August 17, 1988 (emphasis added).

This statement may still beg the question whether EPA defines "placed" (or "placement") in the same way for both LDR-triggering and disposal permit-triggering purposes. In the final NCP preamble of March 8, 1990, however, EPA moves clearly in this direction:

> Under RCRA section 1004(3), the term "disposal" is very broadly defined and includes any "discharge, deposit, injection, dumping, spilling, leaking, or placing" of waste into or any land or water. Thus, "disposal" (in a statutory, rather than the regulatory subtitle C meaning of the term) would include virtually any movement of waste, whether within a unit or across a unit boundary. In fact, the RCRA definition of "disposal" has been interpreted by numerous courts to include passive leaking, whore no active management is involved (see, e.g., U.S. v. Waste Industries. Inc.

> 734 F.2d.159 (4th Cir. 1984)). However, Congress did not use the term "disposal" as its trigger for the RCRA land disposal restrictions, but instead specifically defined the new, and more narrow, term "land disposal" in section 3004(k). The broader "disposal" language continues to be applicable to RCRA provisions other than those in subtitle C. such as section 7003.

55 Fed. Reg. 8759, emphasis added.

In this passage, EPA makes quite clear that the broad definition of disposal in RCRA §1004(3) not only is inapplicable to LDRs but also is inapplicable throughout the entirety of Subtitle C. Instead, EPA relies on the term "placement" as it appears in RCRA §3004 (k) to define disposal for all purposes throughout Subtitle C. 55 Fed. Reg. 8759, col. 2.

If there were any further doubt about the linkage of the concept of "placement" in the LDR context and the concept of "placed" in the permit context, EPA appears to have resolved it in an example in the same preamble. After noting that certain movement of wastes within a unit would not be placement that triggers LDRs, EPA says that the requirement to obtain a RCRA permit would similarly not apply. 55 Fed. Reg. 8759-60.

I submit that all this points to only one logical conclusion: when one appropriately determines that a particular act is not placement for LDR purposes, such act will therefore not trigger the need for a disposal permit under RCRA.

I ask that you please confirm in writing the validity of my conclusion. I look forward to hearing from you.

Very truly yours,

Richard G. Stoll

FaxBack # 11950

federal register

Thursday
March 8, 1990

Part II

Environmental Protection Agency

40 CFR Part 300
National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule

requirements. Rather, given the need to ensure finality of remedy selection in order to achieve expeditious cleanup of sites, and given the length of time often required to design, negotiate, and implement remedial actions, EPA believes that this is the most reasonable interpretation of the statute.

As EPA discusses elsewhere in this preamble, one variation to this policy occurs when a component of the remedy was not identified when the ROD is signed. In that situation, EPA will comply with ARARs in effect when that component is identified (e.g., during remedial design), which could include requirements promulgated both before and after the ROD was signed. EPA notes that newly promulgated or modified requirements may directly apply or be more relevant and appropriate to certain locations, actions or contaminants than existing standards and, thus, may be potential ARARs for future responses.

It is important to note that a policy of freezing ARARs at the time of the ROD signing will not sacrifice protection of human health and the environment, because the remedy will be reviewed for protectiveness every five years, considering new or modified requirements at that point, or more frequently, if there is reason to believe that the remedy is no longer protective of health and environment.

In response to the specific comments received, EPA notes that under this policy, EPA does not intend that a remedy must be modified solely to attain a newly promulgated or modified requirement. Rather, a remedy must be modified if necessary to protect human health and the environment; newly promulgated or modified requirements contribute to that evaluation of protectiveness. For example, a new requirement for a chemical at a site may indicate that the cleanup level selected for the chemical corresponds to a cancer risk of 10^{-2} rather than 10^{-4}, as originally thought. The original remedy would then have to be modified because it would result in exposures outside the acceptable risk range that generally defines what is protective.

This policy that newly promulgated or modified requirements should be considered during protectiveness reviews of the remedy, but should not require a reopening of the ROD during implementation every time a new state or federal standard is promulgated or modified, was discussed in the preamble to the proposed rule (53 FR at 51440) but not in the rule section itself. For the reasons outlined above, EPA believes that this concept is critical to the expeditious and cost-effective accomplishment of remedies duly selected under CERCLA and the NCP, and thus is appropriate for inclusion in § 300.430(f)(1)(ii)(B) of the final NCP. This will afford both the public and implementing agencies greater clarity as to when and how requirements must be considered during CERCLA responses, and thus will allow the CERCLA program to carry out selected remedies with greater certainty and efficiency. Of course, off-site CERCLA remedial actions are subject to the substantive and procedural requirements of applicable federal, state, and local laws at the time of off-site treatment, storage or disposal.

Final rule: EPA is adding the following language to the rule at § 300.430(f)(1)(ii)(B):

(B) On-site remedial actions selected in a ROD must attain those ARARs that are identified at the time of ROD signature or provide grounds for invoking a waiver under § 300.430(f)(1)(ii)(C)(3).

(1) Requirements that are promulgated or modified after ROD signature must be attained (or waived) only when determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment.

(2) Components of the remedy not described in the ROD must attain (or waive) requirements that are identified as applicable or relevant and appropriate at the time the amendment to the ROD or the explanation of significant differences describing the component is signed.

Name: Applicability of RCRA requirements.

Proposed rule: The preamble to the proposed rule discussed when RCRA subtitle C requirements will be applicable for site cleanups (53 FR 51443). It described the prerequisites for "applicability" at length, which are that: (1) The waste must be a listed or characteristic RCRA hazardous waste and (2) treatment, storage or disposal occurred after the effective date of the RCRA requirements under consideration (for example, because the activity at the CERCLA site constitutes treatment, storage, or disposal, as defined by RCRA).

The preamble explained how EPA will determine when a waste at a CERCLA site is a listed RCRA hazardous waste. It noted that it is often necessary to know the origin of the waste to determine whether it is a listed waste and that, if such documentation is lacking, the lead agency may assume it is not a listed waste.

The preamble discussed how EPA will determine that a waste is a characteristic hazardous waste under RCRA. It stated that EPA can test to determine whether a waste exhibits a characteristic or can use best professional judgment to determine whether testing is necessary, "applying knowledge of the hazard characteristic in light of the materials or process used."

The preamble also discussed when a CERCLA action constitutes "land disposal," defined as placement into a land disposal unit under section 3004(k) of RCRA, which triggers several significant requirements, including RCRA land disposal restrictions (LDRs) and closure requirements (when a unit is closed). It equated an area of contamination (AOC), consisting of continuous contamination of varying amounts and types at a CERCLA site, to a single RCRA land disposal unit, and stated that movement within the unit does not constitute placement. It also stated that placement occurs when waste is redeposited after treatment in a separate unit (e.g., incinerator or tank), or when waste is moved from one AOC to another. Placement does not occur when waste is consolidated within an AOC, when it is treated in situ, or when it is left in place.

Response to comments: EPA received many comments on its discussion of when RCRA requirements can be applicable to CERCLA response actions. On the issue of compliance with RCRA in general, most of these commenters argued that RCRA requirements are not intended for site cleanup actions, that such compliance will result in delays and that RCRA requirements are often unnecessary to protect human health and the environment at CERCLA sites. Other commenters argued, however, that EPA is trying to avoid compliance with RCRA requirements. Most of the comments, however, focused on when LDRs are applicable to CERCLA actions and on EPA's discussion of what actions associated with remediation trigger LDRs.

Some commenters opposed EPA's interpretation of "land disposal" or "placement" as too lenient, believing that EPA is trying to avoid compliance with RCRA laws, particularly LDRs. These commenters argued that LDRs should be applicable when hazardous wastes are managed, excavated, or moved in any way. One argued that ARARs waivers are available to address situations when the LDR levels cannot be achieved and should be used as necessary, rather than trying to narrowly define the universe of ARARs to avoid waivers. This commenter was also concerned with EPA's use of the term "unit," calling it an inappropriate concept for Superfund sites because it

will allow the excavation and redeposition of waste within very large areas without ever meeting RCRA design and operating standards and LDR. One commenter asserted that EPA concerns on LDRs stem from an unjustifiable belief that LDR cleanup levels cannot be achieved.

Other commenters believed that the definition of "placement" should provide more flexibility. One asserted that replacement of treated residuals in the proximate area should not constitute placement. The commenter argued that Congress intended to address, preventively or prospectively, the original act of disposal, and that an innocent government or public entity should not be required to assume the entire environmental responsibility of the original disposers. The commenter also argued that establishing that replacement of treated waste triggers LDRs will be a serious disincentive to treating wastes. Some commenters argued that LDRs should not be relevant and appropriate where the CERCLA waste to be disposed on land is merely similar in composition to RCRA banned waste.

Other commenters argued that LDRs are inappropriate for CERCLA remedial actions. They noted an inherent conflict between LDRs, which require treatment to BDAT levels, and the CERCLA process, and claimed that LDRs will supplant CERCLA's "carefully articulated and balanced approach to remedy selection." Commenters asserted that compliance with LDRs will create technical problems because of differences between CERCLA wastes and those evaluated for LDRs. The solutions recommended by these commenters primarily focused on narrowing or eliminating RCRA applicability, but included suggestions for creating treatability groups for CERCLA-type waste and seeking legislative waivers from LDRs, e.g., a waiver from LDRs for Superfund actions at NPL sites.

One commenter believed that the concept of "unit" is not readily transferable to CERCLA sites due to the age and former uses of many of the site undergoing remediation. Given the ramifications of LDRs, the commenter argued, it may be more reasonable to create a presumption of treating the entire site as one "unit," even if remediation includes a series of operable units.

Some comments were received on EPA's statements on consolidating waste. One stated that consolidation of small amounts of waste across units should not be considered placement, because that will lead to less environmentally sound and less cost-effective solutions, particularly if LDRs are triggered. Another recommended that EPA should allow consolidation of small volumes of waste anywhere on-site, for purposes of storage or treatment, without triggering otherwise applicable RCRA standards. Another commenter requested clarification that consolidation within a unit included normal earthmoving and grading operations.

1. *Actions constituting land disposal.* EPA disagrees with commenters who considered EPA's interpretation of the definition of "land disposal" under RCRA section 3004(k) to be too narrow. These commenters argued that any movement of waste should be considered "placement" of waste, and thus "land disposal" under RCRA section 3004(k).

The definition of "land disposal" is central to determining whether the RCRA LDRs are applicable to a hazardous waste which is being managed as part of a CERCLA response action, or RCRA closure or corrective action. The term "land disposal" is defined under RCRA section 3004(k) as including, but not limited to, "any placement of such hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave." The terms "landfill", "surface impoundment," and the others, refer to specific types of units defined under RCRA regulations. Thus, Congress generally defined the scope of the LDR program as the placement of hazardous waste in a land disposal unit, as those units are defined under RCRA regulations.

EPA has consistently interpreted the phrase "placement * * * in" one of these land disposal units to mean the placement of hazardous wastes into one of these units, not the movement of waste within a unit. See e.g., 51 FR 40577 (Nov. 7, 1986) and 54 FR 41566–67 (October 10, 1989)(supplemental proposal of possible alternative interpretations of "land disposal"). EPA believes that its interpretation that the "placement * * * in" language refers to a transfer of waste into a unit (rather than simply any movement of waste) is not only consistent with a straightforward reading of section 3004(k), but also with the Congressional purpose behind the LDRs. The central concern of Congress in establishing the LDR program was to reduce or eliminate the practice of disposing of untreated hazardous waste at RCRA hazardous waste facilities. The primary aim of Congress was prospective rather than directed at already-disposed waste within a land disposal unit. See 51 FR 40577 (Nov. 7, 1986). Moreover, interpreting section 3004(k) to require application of the LDRs to any movement of waste could be difficult to implement and could interfere with necessary operations at an operating RCRA facility. For instance, when hazardous waste is disposed of in a land disposal unit at an operating RCRA facility, there may well be some "movement" of the waste already in the unit. Under the commenters' approach, such movement without pretreatment of the moved waste could be in violation of the LDRs. Thus, under the commenters' interpretation, virtually no operational activities could occur at any RCRA land disposal unit containing hazardous waste without pretreatment of any waste disturbed by the operation: clearly an infeasible approach.

EPA also believes that this interpretation of section 3004(k) is supported by the legislative history for this provision (see 129 Cong. Rec. H8139 (Oct. 6, 1983)(statement of Rep. Breaux)), and by the Congressional choice to define "land disposal" more narrowly for purposes of application of the LDRs than the already-existing term "disposal", which has a much broader meaning under RCRA. Under RCRA section 1004(3), the term "disposal" is very broadly defined and includes any "discharge, deposit, injection, dumping, spilling, leaking, or placing" of waste into or on any land or water. Thus, "disposal" (in a statutory, rather than the regulatory subtitle C meaning of the term) would include virtually any movement of waste, whether within a unit or across a unit boundary. In fact, the RCRA definition of "disposal" has been interpreted by numerous courts to include passive leaking, where no active management is involved (see, e.g., *U.S. v. Waste Industries, Inc.*, 734 F.2d 159 (4th Cir. 1984)). However, Congress did not use the term "disposal" as its trigger for the RCRA land disposal restrictions, but instead specifically defined the new, and more narrow, term "land disposal" in section 3004(k). The broader "disposal" language continues to be applicable to RCRA provisions other than those in subtitle C, such as section 7003. Thus, for the reasons outlined above, EPA believes that the existing interpretation, that movement of waste within a unit does not constitute "land disposal" for purposes of application of the RCRA LDRs, is reasonable.

With respect to the commenter who asked whether normal earthmoving and grading operations within a land disposal unit constitute "placement into

the unit", under EPA's interpretation of RCRA section 3004(k), such activity would not be "placement into the unit" and thus the RCRA LDRs and other subtitle C disposal requirements would not be applicable (nor would the requirement to obtain a permit under RCRA or minimum technology requirements in RCRA section 3004(o) apply).

Given this interpretation of section 3004(k), EPA does not believe that it is necessary to invoke ARAR waivers of LDRs for any movement of waste within a unit, which was the alternative suggested by the commenters. Nor does EPA believe that the widespread use of such waivers would be practical or desirable. 54 FR 41568–69 (October 10, 1989).

EPA also does not fully agree with the commenters who argued that the RCRA concept of "unit" does not apply to CERCLA sites. The commenters who criticized the application of the RCRA "unit" to the CERCLA area of contamination for purposes of section 3004(k) believed it to be either too broad, allowing large areas to escape the LDRs, or too narrow, not allowing entire CERCLA sites to be considered a single "unit". In contrast to hazardous waste management units at a RCRA facility, CERCLA sites often do not involve discrete waste management units, but rather involve land areas on or in which there can be widespread areas of generally dispersed contamination. Thus, determining the boundaries of the RCRA land disposal "unit," for which section 3004(k) would require application of the LDRs at these sites, is not always self-evident.

EPA generally equates the CERCLA area of contamination with a single RCRA land-based unit, usually a landfill. 54 FR 41444 (December 21, 1988). The reason for this is that the RCRA regulatory definition of "landfill" is generally defined to mean a land disposal unit which does not meet the definition of any other land disposal unit, and thus is a general "catchall" regulatory definition for land disposal units. As a result, a RCRA "landfill" could include a non-discrete land area on or in which there is generally dispersed contamination. Thus, EPA believes that it is appropriate generally to consider CERCLA areas of contamination as a single RCRA land-based unit, or "landfill". However, since the definition of "landfill" would not include discrete, widely separated areas of contamination, the RCRA "unit" would not always encompass an entire CERCLA site.

Waste consolidation from different units or AOCs at a CERCLA site are subject to any applicable RCRA requirements regardless of the volume of the waste or the purpose of the consolidation. Thus, EPA disagrees with those commenters that asserted that small volumes of hazardous waste at a CERCLA site can be consolidated anywhere on-site for storage or treatment purposes without consideration of any applicable RCRA requirements. Such requirements may, however, be subject to ARAR waivers in appropriate circumstances.

The remaining comments received with respect to EPA's interpretation of section 3004(k) discussed the achievability of LDR cleanup levels, questioned the appropriateness of applying the LDRs to remedial actions, and requested more flexibility regarding the LDRs. These comments were the basis for EPA's supplemental notice and proposed reinterpretation of section 3004(k), which is discussed below.

In light of the numerous comments received on the interpretation of "land disposal" in RCRA section 3004(k), as it relates to removal, treatment, and redeposition of hazardous wastes generated by CERCLA and RCRA remedial and other activities, and in view of the important policy decisions that RCRA LDRs pose for the CERCLA and RCRA programs, EPA decided to separately and more fully discuss the issue, the interpretation outlined in the proposed NCP, and possible alternative interpretations of "land disposal". In a supplemental notice to the proposed NCP (54 FR 41566 (Oct. 10, 1989)), EPA outlined several technical, policy, and legal issues concerning LDR applicability to removal, treatment, and redeposition of hazardous wastes, and requested comment on two alternative interpretations of "land disposal". The first alternative would allow the excavation and replacement of previously disposed hazardous wastes in the same unit or area of contamination; since the same wastes would remain in the same unit, this activity would not constitute "land disposal". Under the second alternative, hazardous wastes could be excavated and redeposited either within the original unit or area of contamination, or elsewhere at the site in a new or existing unit. These interpretations would allow greater flexibility in remedial decision-making, in the context of both CERCLA actions and RCRA corrective actions and closures.

On November 6 and 7, 1989, EPA held a forum on contaminated soil and groundwater ("Contaminated Media Forum") to provide an opportunity for interested groups to further address these issues. The Contaminated Media Forum was attended by representatives from EPA, states, environmental groups, Congress, and the regulated community. A summary of the concerns raised and suggested solutions appears in the public docket for this rulemaking.

2. *Selection of LDR treatment standards.* Upon further examination, EPA believes that many of the problems discussed in the supplemental notice, and raised by commenters, result from treatment standards developed pursuant to the RCRA LDR program that are generally inappropriate or infeasible when applied to contaminated soil and debris. As discussed in the October 1989 notice, EPA's experience under CERCLA has been that treatment of large quantities of soil and debris containing relatively low levels of contamination using LDR "best demonstrated available technology" (BDAT) is often inappropriate. 54 FR 41567, 41568 (October 10, 1989). EPA noted that:

> Experience with the CERCLA program has shown that many sites will have large quantities—in some cases, many thousands of cubic meters—of soils that are contaminated with relatively low concentrations of hazardous wastes. These soils often should be treated, but treatment with the types of technologies that would meet the standard of BDAT may yield little if any environmental benefit over other treatment based remedial options.

54 FR 41568 (October 10, 1989). Examples of these and other situations reflecting EPA's experience concerning the inappropriateness of incinerating contaminated soil and debris are included in the record for this rule. In addition, as discussed below, EPA has experienced problems in achieving the current noncombustion LDRs for contaminated soil and debris. Based on EPA's experience to date and the virtually unanimous comments supporting this conclusion, EPA has determined that, until specific standards for soils and debris are developed, current BDAT standards are generally inappropriate or unachievable for soil and debris from CERCLA response actions and RCRA corrective actions and closures. Instead, EPA presumes that, because contaminated soil and debris is significantly different from the wastes evaluated in establishing the BDAT standards, it cannot be treated in accordance with those standards and thus qualifies for a treatability variance from those standards under 40 CFR 268.44.

Accordingly, persons seeking a treatability variance from LDR treatment standards for contaminated soil and debris do not need to demonstrate on a case-by-case basis

that BDAT standards for prohibited hazardous wastes are inappropriate or not achievable. As an alternative, persons seeking a treatability variance for soil and debris may meet the appropriate levels or percentage reductions in the currently available guidance (Superfund LDR Guidance #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions", EPA OSWER Directive 9347.3-06FS, July 1989). In the context of Superfund Records of Decision (ROD), this means that EPA will generally include such a variance in the proposed plan and ROD when treatment of contaminated soil and debris is an element of the remedial action. Further, EPA intends to issue guidance supplementing the Superfund Guidance #6A to expedite the processing of such treatability variances in conjunction with established remedy selection procedures.

Treatment standards for prohibited hazardous wastes are based on performance achievable by application of BDAT. 51 FR at 40578 (Nov. 7, 1986). BDAT, however, is not a technology-forcing program, nor does it always require the lowest possible levels of waste treatment achievable with any technology. See 130 Cong. Rec. S9178 (July 25, 1984) (Statement of Sen. Chaffee introducing the amendment that became RCRA section 3004(m)). Rather, what Congress contemplated is a scheme whereby hazardous wastes are to be treated using the technology (or technologies) generally considered to be suitable for the waste and that substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration. Id.; see also H. Rep. No. 198, 98th Cong. 1st Sess. 33; S. Rep. No. 284, 98th Cong. 1st Sess. 16-17.

EPA's rules developing treatment standards likewise recognize that the treatment standards be based on appropriate technologies even if more stringent treatment methods are technically feasible. 51 FR at 40588-592 (Nov. 7, 1986). For example, EPA has generally based treatment standards for organic contaminants in wastewaters (normally defined as aqueous materials containing less than 1% total organic compound (TOC) and total suspended solids (TSS)) on technologies other than incineration (or other combustion), even though such organics could be treated to lower levels if the wastewaters were incinerated. This is because incineration (or other combustion) is not normally an appropriate technology for wastewaters, notwithstanding its capability of performing to lower levels than conventional wastewater treatment. More generally, EPA's rules on treatability variances recognize that prohibited wastes be treated by appropriate technologies. The rules thus state that a petitioner may request a treatability variance "where the treatment technology is not appropriate to the waste". 40 CFR 268.44(a).

Similarly, treatability variances are warranted where the applicable numerical treatment standard for the waste cannot be achieved. 40 CFR 268.44(a). For this reason, EPA has found that current BDAT standards based on noncombustion technology also warrant a treatability variance for soil and debris. The complex matrices often present in soil and debris may reduce the effectiveness of stabilization and other noncombustion technologies in treating these wastes. For example, the presence of oil and grease or sulfites in the mixture may substantially interfere with the stabilization process. More generally, stabilization is a complex treatment process and its application to unique soil and debris mixtures is not yet well understood. EPA's development of alternative treatment levels in the Superfund Guidance #6A noted above was based on available data for soil and debris mixtures and thus is more tailored with respect to achievability than the existing BDAT standards for these waste mixtures. The difference between these levels and the existing BDAT standards for these wastes demonstrates the feasibility of achieving the current BDAT standards for soil and debris. These alternative numbers thus support EPA's presumption that the BDAT standards are generally inappropriate or not achievable for soil and debris.

This presumption is supported by the commenters on the December, 1988 and October, 1989 proposals. EPA received numerous comments from a wide range of commenters discussing the inappropriateness or infeasibility of applying BDAT standards to contaminated soil and debris. The principal reason given for the inappropriateness of the current BDAT standards was the complexity of soil and debris mixtures and the interference with treatability caused by unique matrices of contaminants in the soil and debris. Moreover, commenters noted that wastestream-derived BDATs have not been fully demonstrated for many contaminated soils and debris and that the presence of trace quantities of one waste in soil and debris may inappropriately require use of a treatment method that would not otherwise be applicable to the other wastes present. These comments were further supported by comments made at the Contaminated Media Forum.

The Agency's experience also supports this conclusion of general inappropriateness or infeasibility of current BDAT standards for soil and debris. For example, as indicated above EPA has developed alternative treatment levels for soil and debris in the Superfund #6A guidance which are based on the application of the specific treatment technologies to soil and debris, rather than industrial process wastes. Thus, these alternative levels, which are better tailored to the treatability of the complex soil and debris mixtures found at Superfund sites, reflect Agency experience concerning the inappropriateness or infeasibility of current BDAT for soil and debris.

EPA has long indicated its intention to develop separate treatment standards for contaminated soil and debris (without regard, incidentally, to the origin of such waste, so that the treatment standards would apply whether the soil and debris is generated from a CERCLA action or some other activity). 51 FR 40577 (Nov. 7, 1986). Although the Agency has already expended considerable effort on such standards, it has not been able to propose or promulgate regulations because of the more pressing need to implement the rest of the land disposal prohibition statutory provisions before the various statutory deadlines. See RCRA sections 3004 (d), (e), and (g). EPA does not expect that the same level of treatment performance will be required for soil and debris as for industrial process wastes.

In the interim period until EPA promulgates these treatment standards, contaminated soil and debris are subject to the same treatment standards as the prohibited hazardous wastes that they contain, unless a variance is appropriate and is approved according to 40 CFR 268.44. 53 FR at 31146-149 (Aug. 17, 1988) and *Chemical Waste Management* v. EPA, 869 F.2d 1526, 1535-46, 1538-40 (D.C. Cir. 1989). Where standards for the underlying waste are based on the performance of incineration, EPA has granted national capacity variances for the contaminated soils and debris because there is insufficient national capacity to treat these wastes. 40 CFR 268.30(c), 268.31(a)(1), 268.32(d)(1), 268.33(b), and 268.34(d). Where BDAT treatment standards are in effect, it is possible to petition for a treatability variance based on the inappropriateness of the BDAT standards to treat the contaminated soil and debris. 40 CFR 268.44(a). As discussed earlier, EPA

believes that it is unnecessary for petitioners (or the lead Agency in CERCLA response actions) to make site-specific demonstrations that BDAT standards are inappropriate for contaminated soil and debris. The numerous comments and Agency experience supporting a presumption that the BDAT standards are inappropriate or not achievable is clearly warranted at this time because the criteria in 40 CFR 268.44 for treatability variances are generally met for soil and debris. As a result, under EPA's established treatability variance procedures (40 CFR 268.44), variance applications for contaminated soil and debris do not need to demonstrate that the physical and chemical properties differ significantly from wastes analyzed in developing the treatment standard and that, therefore, the waste cannot be treated to specified levels or by specified methods. Petitions need only focus on justifying the proposed alternative levels of performance, using existing interim guidance containing suggested treatment levels for soil and debris (Superfund LDR Guidance #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions", EPA OSWER Directive 9347.3-06FS, July 1989) as a benchmark.

Although the presumption is that BDAT standards are not appropriate for soil and debris, there may be special circumstances where EPA determines that the existing BDAT standards are appropriate for contaminated soils and debris at a particular site, such as where high levels of combustible organics in soil are present. In these circumstances, the Agency would make a determination that treatment to the BDAT standards was appropriate and would require such treatment.

EPA regulations provide that treatability variances may be issued on a site-specific basis. 40 CFR 268.44(h).[22] Thus, they may be approved simultaneously with the issuance of a RCRA permit, the approval of a RCRA closure plan, or the selection of a remedy in a CERCLA response action in the ROD. In the case of an on-site CERCLA response action, the procedural requirements of the variance process do not apply. See CERCLA sections 121(e)(1) and 121(d)(2). The variance decision will be made as part of EPA's remedy selection process, during which data justifying alternative treatment levels will be included in the administrative record files, and public participation opportunities and Agency response to comment will be afforded as appropriate under this rule.

In EPA's view, the Agency's determination that the BDAT standards are generally inappropriate for contaminated soil and debris addresses many of the practical concerns raised by commenters in the supplemental notice on the Agency's interpretation of the term "land disposal". For this reason, and because EPA has had insufficient time to review and evaluate the many lengthy and complex issues raised by commenters on the supplemental notice, EPA is deferring any final decision to modify that interpretation. (EPA will respond to comments on the alternatives in the supplemental notice when the Agency makes a final decision on the proposed reinterpretation of land disposal.) Until a final decision is made, the interpretation announced in the preamble to the proposed NCP and discussed in section 1 above will remain in effect.

Final rule: There is no rule language on this issue.

Name: Determination of whether a waste is a hazardous waste.

Proposed rule: The preamble to the proposed rule discussed how to determine whether hazardous waste regulated under RCRA Subtitle C was present at a site (53 FR 51444).

Response to comments: Some commenters raised questions about EPA's discussion about determining whether a waste exhibits a hazardous characteristic. One argued that EPA cannot assume a waste is not a characteristic waste in the absence of testing and should therefore adopt a liberal and inclusive approach to determining whether RCRA applies to avoid expensive and time-consuming testing. Another commenter asked for clarification on who was responsible for applying "process knowledge" to determine whether a waste was a hazardous waste in the absence of testing. The commenter asserted that, under RCRA, EPA exercises prosecutorial discretion if a generator, acting in good faith, decides incorrectly that his waste is not hazardous. EPA notes that when it determines that there is a violation there will normally be some kind of enforcement action taken; the level and type of prosecutorial response will depend on a number of factors, for example, the size of the company, the significance of the violation, the intent, etc.

Under RCRA rules, a generator is not required to test, but may use knowledge of the waste and its constituents to judge whether the waste exhibits a characteristic. (See 40 CFR 262.11(c).) EPA believes this should also apply if the lead agency or PRP at a CERCLA site is the "generator." EPA wants to make clear, however, that a decision that a waste is not characteristic in the absence of testing may not be arbitrary, but must be based on site-specific information and data collected on the constituents and their concentrations during investigations of the site. Based on site data, it will be very clear in some cases that a waste cannot be characteristic; for example, if a waste does not contain a constituent regulated as EP toxic, a decision that the waste does not exhibit this characteristic can reliably be made without testing for EP toxicity. EPA does not expect to undertake testing when it can otherwise be determined with reasonable certainty whether or not the waste will exhibit a characteristic.

In response to the second concern, the determination whether a waste is a hazardous waste may be made by EPA, the state, or a PRP, depending on the nature of the action. EPA will take any necessary or appropriate action if decisions about the hazardous nature of the waste are in error or are made without proper basis.

Several commenters discussed the question of whether RCRA requirements can be applicable to RCRA hazardous waste disposed of before the RCRA requirements went into effect in 1980. One commenter argued that they could not be, unless the waste exhibited a characteristic at the time of the CERCLA action. However, as one commenter noted, EPA has consistently maintained in enforcement actions that RCRA requirements apply to any waste

[22] In light of today's determination, the application of this rule requires clarification in two respects. First, although EPA is today establishing a general presumption that BDAT standards are inappropriate or not achievable for treating soil and debris, the Agency does not believe that this presumption triggers the rulemaking variance procedures in 40 CFR 268.44(a). Even with the presumption, treatment levels will be determined on a case-by-case basis, and commenters may submit information contending that the presumption is not applicable in a particular case. Thus, it is EPA's view that the site-specific, non-rulemaking procedures in 40 CFR 268.44(h) are entirely appropriate. See 53 FR 31199-31200 (August 17, 1988).

Second, EPA does not interpret its site specific variance procedures as invariably requiring applicants to demonstrate that they cannot meet applicable treatment levels or methods. The first sentence of 40 CFR 268.44(h) makes it clear that an applicant may make one of *two* demonstrations to qualify for a variance: he may show either that he cannot meet a treatment standard, *or* that a treatment method (or the method underlying the standard is inappropriate for his waste. The final sentence of § 268.44(h), identifying the showing an applicant must include in his variance application, on its terms applies only to applications submitted under the first criterion. EPA's presumption, however, applies to soil and debris regardless of which of the two types of variances apply.

materials disposed of prior to 1980 when those materials are managed or disposed of today. EPA agrees with this latter comment and believes that this policy applies to CERCLA actions as well. This was also upheld in a recent DC Court of Appeals decision, *Chemical Waste Management* v. *EPA*, 869 F.2d 1526 (DC Cir. 1989). RCRA requirements can apply when the CERCLA action constitutes treatment, storage or disposal of RCRA hazardous waste. Note that RCRA requirements may also be relevant and appropriate to pre-1980 waste.

One commenter suggested that EPA allow consolidation, for purposes of storage or treatment, of small volumes of wastes without triggering RCRA standards. In response, while EPA appreciates the concerns with meeting substantive storage and treatment requirements for small amounts of waste, EPA believes that waste should be managed according to standards when those standards are ARARs unless a waiver (such as for interim measures) can be justified. It should be noted that RCRA may not be applicable for small quantity generators, as defined under RCRA; however, a determination would still have to be made about whether any RCRA requirements would be relevant and appropriate to small quantities.

Final rule: There is no rule language on this issue.

Name: When RCRA requirements are relevant and appropriate to CERCLA actions.

Proposed rule: The preamble to proposed § 300.400(g)(2)(i), identification of applicable or relevant and appropriate requirements, criteria for relevant and appropriate, stated that RCRA requirements may be relevant and appropriate when a waste is similar in composition to a RCRA listed waste (53 FR 51446).

Response to comments: 1. *RCRA requirements as relevant and appropriate for wastes similar to RCRA hazardous waste.* Several commenters expressed concern that RCRA requirements may be potentially relevant and appropriate for waste that is not a RCRA hazardous waste, but is similar to a RCRA hazardous waste. Commenters argued that virtually any waste or CERCLA substance is similar to a RCRA hazardous waste in some way, either in chemical composition, in toxicity, in mobility, or in persistence, and were concerned that this policy represented an enormous expansion of the RCRA program.

EPA believes that RCRA requirements can potentially be relevant and appropriate to wastes other than those that are known to be hazardous waste. For example, some information or records must be available that identify the source of the waste in order to determine that the waste is a listed hazardous waste. As a result, two separate wastes could be identical in composition, but only one identified as a RCRA hazardous waste because manifests are available that identify it as a listed waste. RCRA requirements would be applicable for the manifested waste, but not for the other, even though the two wastes are physically the same. EPA believes that RCRA requirements can be potentially relevant and appropriate when the waste cannot be definitively identified as a listed hazardous waste.

EPA wants to emphasize, however, that a number of the factors identified in § 300.400(g)(2) should be considered in determining whether a RCRA requirement is relevant and appropriate. The similarity of the waste to RCRA hazardous waste or the presence of a RCRA constituent alone does not create a presumption that a RCRA requirement will be relevant and appropriate. Nor is it always necessary or useful to conduct an in-depth, constituent-by-constituent comparison of a CERCLA waste with RCRA hazardous wastes, because most RCRA requirements are the same regardless of the specific composition of the hazardous waste. Indeed, the statute requires attainment of those requirements that are relevant and appropriate under the circumstances of the release. Thus, the decision about whether a RCRA requirement is relevant and appropriate is based on consideration of a variety of factors, including the nature of the waste and its hazardous properties, other site characteristics, and the nature of the requirement itself.

EPA anticipates that it will often find some RCRA requirements to be relevant and appropriate at a site and others not, even for the same waste. This is because certain waste characteristics shared with RCRA hazardous wastes may be more important than others when evaluating whether a given requirement is relevant and appropriate. For example, the mobility of the waste, among other factors, may be a key concern in evaluating whether the RCRA requirement that the cap used in closing a landfill be less permeable than the bottom liner (40 CFR 264.310(a)(5)) is relevant and appropriate. Other properties of the waste might be more important in evaluating the relevance and appropriateness of other RCRA requirements.

2. *RCRA requirements as relevant and appropriate for mining wastes.* Several commenters asked EPA to state in the NCP or its preamble that RCRA subtitle C requirements will not be relevant and appropriate to mining wastes. They noted that, recognizing the unique characteristics of mining wastes, Congress exempted certain mining wastes from regulation as hazardous wastes under RCRA until EPA completed studies on these wastes to determine specifically whether such regulation was appropriate. On July 3, 1986, EPA published its determination for beneficiation and extraction wastes which found that regulation under subtitle C was not warranted for these wastes, because EPA believes such requirements, " * * * if universally applied, would be either unnecessary to protect human health and the environment, technically infeasible, or economically impracticable to implement." (51 FR 24496.) The commenters argue, therefore, that subtitle C requirements, which are not legally applicable to these mining wastes, also cannot be relevant and appropriate, since EPA has formally made the determination that these requirements are not appropriate for such wastes.

The commenters emphasized that mining waste sites differ in a number of ways from industrial wastes sites. They argue that mining wastes are of enormous volume and generally of lower toxicity, that the sites typically cover extremely large areas and may present less hazard because they tend to be in drier climates, reducing leaching potential, or contain constituents that are less mobile. For these reasons, which formed the basis of EPA's decision under RCRA, RCRA requirements would not be relevant and appropriate for mining sites remediated under CERCLA. Commenters requested that EPA give guidance specifically in the NCP to ensure consistent decisions on ARARs at mining sites.

EPA agrees that RCRA requirements for hazardous waste will not be applicable to those mining wastes excluded from regulation by the statute. (Note, however, that EPA has recently removed certain mineral processing wastes from the mining waste exclusion, making them subject to subtitle C, 54 FR 36592, September 1, 1989; 55 FR 2322, January 23, 1990. EPA has also promulgated regulations listing certain wastes from mineral processing operations as hazardous, 53 FR 35412, September 13, 1988.) In addition, EPA agrees that RCRA subtitle C requirements will generally not be

relevant and appropriate for those mining wastes for which EPA has specifically determined that such regulation is not warranted. The reason is that the factors that caused EPA not to regulate these wastes as hazardous include many of the same factors that EPA considers in judging whether a requirement is relevant and appropriate at a particular site.

However, EPA does not agree that RCRA requirements for hazardous waste can never be relevant and appropriate for CERCLA remediation of mining sites. In its determination for beneficiation and extraction wastes, EPA found that, *"if universally applied,"* subtitle C requirements would not be appropriate for mining wastes. (51 FR 24500.) However, a decision about whether a requirement is relevant and appropriate is made on a case-by-case basis, based on the specific characteristics of the site and the release. There may be some sites where the site circumstances differ significantly from those which caused EPA to decide that subtitle C regulation is not warranted and where certain requirements are appropriate and well-suited to the site or portions of the site. In such a situation, some RCRA requirements may be relevant and appropriate.

EPA is developing regulations under subtitle D of RCRA designed specifically for mining wastes that will not be regulated as hazardous waste. When promulgated, these regulations are likely to be either applicable or relevant and appropriate for remediation of mining sites.

Another commenter stated that EPA needs to develop a long-term initiative to simplify the use of RCRA ARARs. EPA recognizes that the interaction between the two laws can be very complicated and continues to work to resolve and give guidance on issues involving CERCLA compliance with RCRA laws.

Final rule: There is no rule language on this issue.

Name: Examples of potential federal and state ARARs and TBCs.

Potential ARARs and TBCs include, but are not limited to, the following:

1. *Federal requirements which may be potential applicable or relevant and appropriate requirements.* i. EPA's Office of Solid Waste administers, inter alia, the Resource Conservation and Recovery Act of 1976, as amended, (42 U.S.C. 6901). Potentially applicable or relevant and appropriate requirements pursuant to that Act are:

a. Open Dump Criteria—Pursuant to RCRA subtitle D criteria for classification of solid waste disposal facilities (40 CFR part 257).

Note: Only relevant to nonhazardous wastes.

b. RCRA subtitle C requirements governing standards for owners and operators of hazardous waste treatment, storage, and disposal facilities: (40 CFR part 264, for permitted facilities, and 40 CFR part 265, for interim status facilities):

(1) Ground-Water Protection and Monitoring (40 CFR 264.90–264.109).

(2) Closure and Post Closure (40 CFR 264.110–264.120).

(3) Containers (40 CFR 264.170–264.178).

(4) Tanks (40 CFR 264.190–264.199).

(5) Surface Impoundments (40 CFR 264.220–264.249).

(6) Waste Piles (40 CFR 264.250–264.269).

(7) Land Treatment (40 CFR 264.270–264.299).

(8) Landfills (40 CFR 264.300–264.339).

(9) Incinerators (40 CFR 264.340–264.999).

(10) Land Disposal Restrictions (40 CFR 268.1–268.50).

(11) Dioxin-containing wastes (50 FR 1978).

(12) Standards of performance for storage vessels for petroleum liquids (40 CFR part 60, subparts K and K(a)).

(13) Codification rule for 1984 RCRA amendments (50 FR 28702, July 15, 1985; 52 FR 45788, December 1, 1987).

ii. EPA's Office of Water administers several potentially applicable or relevant and appropriate statutes and regulations issued thereunder:

a. Section 14.2 of the Public Health Service Act as amended by the Safe Drinking Water Act, as amended, (42 U.S.C. 300(f)).

(1) Maximum Contaminant Levels (for all sources of drinking water exposure). (40 CFR 141.11–141.16).

(2) Maximum Contaminant Level Goals (40 CFR 141.50–141.52, 50 FR 46936).

(3) Underground Injection Control Regulations (40 CFR parts 144, 145, 146, 147).

b. Clean Water Act, as amended, (33 U.S.C. 1251).

(1) Requirements established pursuant to sections 301, 302, 303 (including state water quality standards), 304, 306, 307, (including federal pretreatment requirements for discharge into a publicly owned treatment works), 308, 402, 403 and 404 of the Clean Water Act. (33 CFR parts 320–330, 40 CFR parts 122, 123, 125, 131, 230, 231, 233, 400–469).

(2) Available federal water quality criteria documents are listed at 45 FR 79318, November 28, 1980; 49 FR 5831, February 15, 1984; 50 FR 30784, July 29, 1985; 51 FR 8012, March 7, 1986; 51 FR 22978, June 28, 1986; 51 FR 43665, December 3, 1986; 52 FR 6213, March 2, 1987; 53 FR 177, January 5, 1988; 53 FR 19028, May 26, 1988; 53 FR 33177, August 30, 1988; 54 FR 19227, May 4, 1989.

(3) Clean Water Act section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR part 230).

(4) Procedures for Denial or Restriction of Disposal Sites for Dredged Material (Clean Water Act section 404(c) Procedures, 33 CFR parts 320–330, 40 CFR part 231).

c. Marine Protection, Research, and Sanctuaries Act (33 U.S.C. 1401). (1) Incineration at sea requirements (40 CFR parts 220–225, 227–229. See also 40 CFR 125.120–125.124).

iii. EPA's Office of Pesticides and Toxic Substances administers the Toxic Substances Control Act (15 U.S.C. 2601). Potentially applicable or relevant and appropriate requirements pursuant to that Act are:

PCB requirements generally: 40 CFR part 761; Manufacturing, Processing, Distribution in Commerce, and Use of PCBs and PCB Items (40 CFR 761.20–761.30); Markings of PCBs and PCB Items (40 CFR 761.40–761.45); Storage and Disposal (40 CFR 761.60–761.79); Records and Reports (40 CFR 761.180–761.185, 761.187 and 761.193). See also 40 CFR 129.105, 750.

iv. EPA's Office of External Affairs administers potentially applicable or relevant and appropriate requirements regarding requirements for floodplains and wetlands (40 CFR part 6, Appendix A).

v. EPA's Office of Air and Radiation administers several potentially applicable or relevant and appropriate statutes and regulations issued thereunder:

a. The Uranium Mill Tailings Radiation Control Act of 1978 (42 U.S.C. 2022) and Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR part 192).

b. Clean Air Act (42 U.S.C. 7401). (1) National Primary and Secondary Ambient Air Quality Standards (40 CFR part 50).

(2) Standards for Protection Against Radiation (10 CFR part 20). See also 10 CFR parts 10, 40, 60, 61, 72, 960, 961.

(3) National Emission Standards for Hazardous Air Pollutants (40 CFR part 61). See also 40 CFR 427.110–427.116, 763.

(4) New source performance standards (40 CFR part 60).

vi. Other Federal Requirements:

a. National Historic Preservation Act (16 U.S.C. 470). Compliance with NHPA

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response
Directive: 9347.3-05FS
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EPA

Superfund LDR Guide #5

Determining When Land Disposal Restrictions (LDRs) Are Applicable to CERCLA Response Actions

CERCLA Section 121(d)(2) specifies that on-site Superfund remedial actions shall attain "other Federal standards, requirements, criteria, limitations, or more stringent State requirements that are determined to be legally applicable or relevant and appropriate (ARAR) to the specified circumstances at the site." In addition, the National Contingency Plan (NCP) requires that on-site removal actions attain ARARs to the extent practicable. Off-site removal and remedial actions must comply with legally applicable requirements. This guide outlines the process used to determine whether the Resource Conservation and Recovery Act (RCRA) land disposal restrictions (LDRs) established under the Hazardous and Solid Waste Amendments (HSWA) are "applicable" to a CERCLA response action. More detailed guidance on Superfund compliance with the LDRs is being prepared by the Office of Solid Waste and Emergency Response (OSWER).

For the LDRs to be applicable to a CERCLA response, the action must constitute placement of a restricted RCRA hazardous waste. Therefore, site managers (OSCs, RPMs) must answer three separate questions to determine if the LDRs are applicable:

(1) Does the response action constitute placement?

(2) Is the CERCLA substance being placed also a RCRA hazardous waste? and if so

(3) Is the RCRA waste restricted under the LDRs?

Site managers also must determine if the CERCLA substances are California list wastes, which are a distinct category of RCRA hazardous wastes restricted under the LDRs (see Superfund LDR Guide #2).

(1) DOES THE RESPONSE CONSTITUTE PLACEMENT?

The LDRs place specific restrictions (e.g., treatment of waste to concentration levels) on RCRA hazardous wastes prior to their placement in land disposal units. Therefore, a key determination is whether the response action will constitute placement of wastes into a land disposal unit. As defined by RCRA, land disposal units include landfills, surface impoundments, waste piles, injection wells, land treatment facilities, salt dome formations, underground mines or caves, and concrete bunkers or vaults. If a CERCLA response includes disposal of wastes in any of these types of off-site land disposal units, placement will occur. However, uncontrolled hazardous waste sites often have widespread and dispersed contamination, making the concept of a RCRA unit less useful for actions involving on-site disposal of wastes. Therefore, to assist in defining when "placement" does and does not occur for CERCLA actions involving on-site disposal of wastes, EPA uses the concept of "areas of contamination" (AOCs), which may be viewed as equivalent to RCRA units, for the purposes of LDR applicability determinations.

An AOC is delineated by the areal extent (or boundary) of contiguous contamination. Such contamination must be continuous, but may contain varying types and concentrations of hazardous substances. Depending on site characteristics, one or more AOCs may be delineated. Highlight 1 provides some examples of AOCs.

Highlight 1: EXAMPLES OF AREAS OF CONTAMINATION (AOCs)

- A waste source (e.g., waste pit, landfill, waste pile) and the surrounding contaminated soil.
- A waste source, and the sediments in a stream contaminated by the source, where the contamination is continuous from the source to the sediments.*
- Several lagoons separated only by dikes, where the dikes are contaminated and the lagoons share a common liner.

* The AOC does not include any contaminated surface or ground water that may be associated with the land-based waste source.

For on-site disposal, placement occurs when wastes are moved from one AOC (or unit) into another AOC (or unit). Placement does not occur when wastes are left in place, or moved within a single AOC. Highlight 2 provides scenarios of when placement does and does not occur, as defined in the proposed NCP. The Agency is current reevaluating the definition of placement prior to the promulgation of the final NCP, and therefore, these scenarios are subject to change.

Highlight 2: PLACEMENT

Placement does occur when wastes are:

- Consolidated from different AOCs into a single AOC;
- Moved outside of an AOC (for treatment or storage, for example) and returned to the same or a different AOC; or
- Excavated from an AOC, placed in a separate unit, such as an incinerator or tank that is within the AOC, and redeposited into the same AOC.

Placement does not occur when wastes are:

- Treated in situ;
- Capped in place;
- Consolidated within the AOC; or
- Processed within the AOC (but not in a separate unit, such as a tank) to improve its structural stability (e.g., for capping or to support heavy machinery).

In summary, if placement on-site or off-site does not occur, the LDRs are not applicable to the Superfund action.

(2) IS THE CERCLA SUBSTANCE A RCRA HAZARDOUS WASTE?

Because a CERCLA response must constitute placement of a restricted RCRA hazardous waste for the LDRs to be applicable, site managers must evaluate whether the contaminants at the CERCLA site are RCRA hazardous wastes. Highlight 3 briefly describes the two types of RCRA hazardous wastes --listed and characteristic wastes.

Highlight 3: RCRA HAZARDOUS WASTES

A RCRA solid waste* is hazardous if it is listed or exhibits a hazardous characteristic.

Listed RCRA Hazardous Wastes

Any waste listed in Subpart D of 40 CFR 261, including:

- F waste codes (Part 261.31)
- K waste codes (Part 261.32)
- P waste codes (Part 261.33(e))
- U waste codes (Part 261.33(f))

Characteristic RCRA Hazardous Wastes

Any waste exhibiting one of the following characteristics, as defined in 40 CFR 261:

- Ignitability
- Corrosivity
- Reactivity
- Extraction Procedure (EP) Toxicity

* A solid waste is any material that is discarded or disposed of (i.e., abandoned, recycled in certain ways, or considered inherently waste-like). The waste may be solid, semi-solid, liquid, or a contained gaseous material. Exclusions from the definition (e.g., domestic sewage sludge) appear in 40 CFR 261.4(a). Exemptions (e.g., household wastes) are found in 40 CFR 261.4(b).

Site managers are not required to presume that a CERCLA hazardous substance is a RCRA hazardous waste unless there is affirmative evidence to support such a finding. Site managers, therefore, should use "reasonable efforts" to determine whether a substance is a RCRA listed or characteristic waste. (Current data collection efforts during CERCLA removal and

remedial site investigations should be sufficient for this purpose.) For listed hazardous wastes, if manifests or labels are not available, this evaluation likely will require fairly specific information about the waste (e.g., source, prior use, process type) that is "reasonably ascertainable" within the scope of a Superfund investigation. Such information may be obtained from facility business records or from an examination of the processes used at the facility. For characteristic wastes, site managers may rely on the results of the tests described in 40 CFR 261.21 - 261.24 for each characteristic or on knowledge of the properties of the substance. Site managers should work with Regional RCRA staff, Regional Counsel, State RCRA staff, and Superfund enforcement personnel, as appropriate, in making these determinations.

In addition to understanding the two categories of RCRA hazardous wastes, site managers will also need to understand the derived-from rule, the mixture rule, and the contained-in interpretation to identify correctly whether a CERCLA substance is a RCRA hazardous waste. These three principles, as well as an introduction to the RCRA delisting process, are described below.

Derived-from Rule (40 CFR 261.3(c)(2))

The derived-from rule states that any solid waste derived from the treatment, storage, or disposal of a listed RCRA hazardous waste is itself a listed hazardous waste (regardless of the concentration of hazardous constituents). For example, ash and scrubber water from the incineration of a listed waste are hazardous wastes on the basis of the derived-from rule. Solid wastes derived from a characteristic hazardous waste are hazardous wastes only if they exhibit a characteristic.

Mixture Rule (40 CFR 261.3(a)(2))

Under the mixture rule, when any solid waste and a listed hazardous waste are mixed, the entire mixture is a listed hazardous waste. For example, if a generator mixes a drum of listed F006 electroplating waste with a non-hazardous wastewater (wastewaters are solid wastes - see Highlight 3), the entire mixture of the F006 and wastewater is a listed hazardous waste. Mixtures of solid wastes and characteristic hazardous wastes are hazardous only if the mixture exhibits a characteristic.

Contained-in Interpretation (OSW Memorandum dated November 13, 1986)

The contained-in interpretation states that any mixture of a non-solid waste and a RCRA listed hazardous waste must be managed as a hazardous waste as long as the material contains (i.e., is above health-based levels) the listed hazardous waste. For example, if soil or ground water (i.e., both non-solid wastes) contain an F001 spent solvent, that soil or ground water must be managed as a RCRA hazardous waste, as long as it "contains" the F001 spent solvent.

Delisting (40 CFR 260.20 and .22)

To be exempted from the RCRA hazardous waste "system," a listed hazardous waste, a mixture of a listed and solid waste, or a derived-from waste must be delisted (according to 40 CFR 260.20 and .22). Characteristic hazardous wastes never need to be delisted, but can be treated to no longer exhibit the characteristic. A contained-in waste also does not have to be delisted; it only has to "no longer contain" the hazardous waste.

If site managers determine that the hazardous substance(s) at the site is a RCRA hazardous waste(s), they should also determine whether that RCRA waste is a California list waste. California list wastes are a distinct category of RCRA wastes restricted under the LDRs (see Superfund LDR Guide #2).

(3) IS THE RCRA WASTE RESTRICTED UNDER THE LDRs?

If a site manager determines that a CERCLA waste is a RCRA hazardous waste, this waste also must be restricted for the LDRs to be an applicable requirement. A RCRA hazardous waste becomes a restricted waste on its HSWA statutory deadline or sooner if the Agency promulgates a standard before the deadline. Because the LDRs are being phased in over a period of time (see Highlight 4), site managers may need to determine what type of restriction is in

Highlight 4: LDR STATUTORY DEADLINES

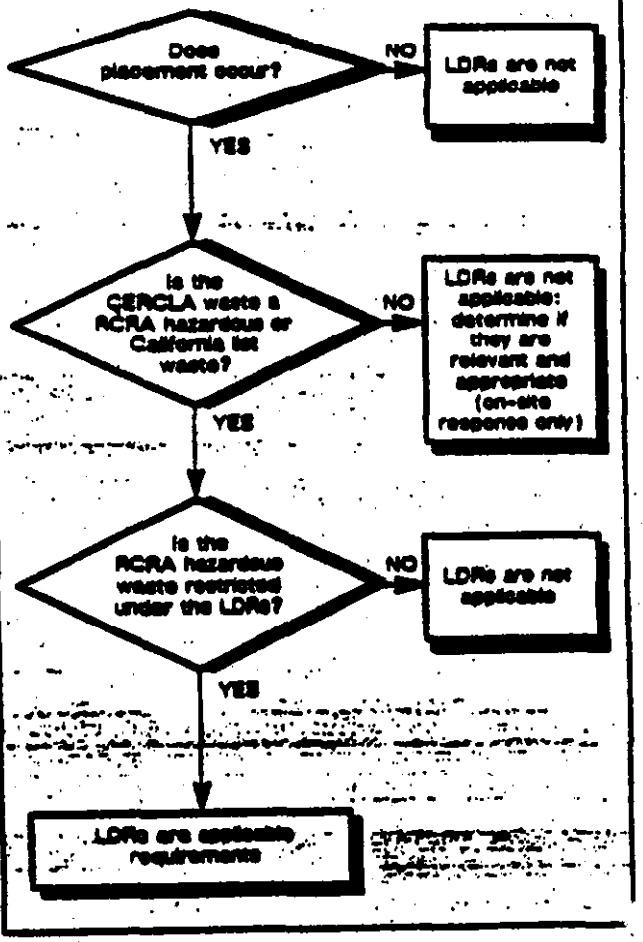
Waste	Statutory Deadline
Spent Solvent and Dioxin-Containing Wastes	November 8, 1986
California List Wastes	July 8, 1987
First Third Wastes	August 8, 1988
Spent Solvent, Dioxin-Containing, and California List Soil and Debris From CERCLA/RCRA Corrective Actions	November 8, 1988
Second Third Wastes	June 8, 1989
Third Third Wastes	May 8, 1990
Newly Identified Wastes	Within 6 months of identification as a hazardous waste

effect at the time placement is to occur. For example, if the RCRA hazardous wastes at a site are currently under a national capacity extension when the CERCLA decision document is signed, site managers should evaluate whether the response action will be completed before the extension expires. If these wastes are disposed of in surface impoundments or landfills prior to the expiration of the extension, the receiving unit would have to meet minimum technology requirements, but the wastes would not have to be treated to meet the LDR treatment standards.

APPLICABILITY DETERMINATIONS

If the site manager determines that the LDRs are applicable to the CERCLA response based on the previous three questions, the site manager must: (1) comply with the LDR restriction in effect, (2) comply with the LDRs by choosing one of the LDR compliance options (e.g., Treatability Variance, No Migration Petition), or (3) invoke an ARAR waiver (available only for on-site actions). If the LDRs are determined not to be applicable, then, for on-site actions only, the site manager should determine if the LDRs are relevant and appropriate. The process for determining whether the LDRs are applicable to a CERCLA action is summarized in Highlight 5.

Highlight 5 - DETERMINING WHEN LDRS ARE APPLICABLE REQUIREMENTS



federal register

Wednesday
December 21, 1988

Part V

Environmental Protection Agency

40 CFR Part 300

National Oil and Hazardous Substances Pollution Contingency Plan; Proposed Rule

would need to comply with the applicable closure requirements for those units in completing the remedial action. Second, if the lead agency determines that RCRA listed or characteristic hazardous waste is present at the site (even if the waste was disposed before the effective date of the requirement) and the proposed CERCLA action involves treatment, storage, or disposal as defined under RCRA, then RCRA requirements related to those actions would be applicable.

These two scenarios are contingent upon determinations that RCRA Subtitle C hazardous waste is present and on the identification of the period of waste management. To determine whether a waste is a listed waste under RCRA, it is often necessary to know the source. However, at many CERCLA sites no information exists on the source of the wastes nor are references available citing the date of disposal. The lead agency should use available site information, manifests, storage records, and vouchers in an effort to ascertain the source of these contaminants. When this documentation is not available, the lead agency may assume that the wastes are not listed RCRA hazardous wastes, unless further analysis or information becomes available which allows the lead agency to determine that the wastes are listed RCRA hazardous wastes. If the lead agency assumes the wastes are not listed RCRA hazardous wastes and it is determined that the wastes are not characteristic wastes under RCRA (see discussion below, 17.i.) RCRA requirements would not be applicable to CERCLA actions, but may be relevant and appropriate if the CERCLA action involves treatment, storage or disposal and/or if the wastes are similar or identical to RCRA hazardous waste.

Under certain circumstances, although no historical information exists about the waste and when it was treated, stored, or disposed, it may be possible to identify the wastes as RCRA characteristic wastes. With respect to hazardous characteristics, (ignitability, corrosivity, reactivity, or EP toxicity), it is the responsibility of the generator (in this case, the lead agency or PRP conducting the action) to determine if the wastes exhibit any of these characteristics (defined in 40 CFR 261.21 through 24). The lead agency must use best professional judgment to determine, on a site-specific basis, if testing for hazardous characteristics is necessary. Testing is required unless it can be determined, by "applying knowledge of the hazard characteristic in light of the materials or process used," that the waste does not have hazardous characteristics (40 CFR 262.11(c)).

In determining whether to test for the toxicity characteristic using the Extraction Procedure (EP) Toxicity Test, it may be possible to assume that certain low concentrations of waste are not toxic. For example, if the total waste concentration is 20 times or less the EP Toxicity concentration, the waste cannot be characteristic hazardous waste. In such a case RCRA requirements would not be applicable and would not likely be relevant or appropriate unless the waste also contained other RCRA hazardous wastes and the CERCLA action involved treatment, storage, or disposal.

If the wastes exhibit hazardous characteristics, RCRA requirements are potentially applicable if the wastes also were either treated, stored, or disposed after the effective date of the applicable RCRA requirement or if the CERCLA actions will involve treatment, storage, or disposal.

ii. *Actions constituting treatment, storage, or disposal.* Many CERCLA actions occur in areas of contamination that contain waste treated, disposed of, or stored prior to November 19, 1980. If left untouched, wastes in such areas are not currently regulated under Subtitle C of RCRA. (Solid waste management units at RCRA facilities are regulated by the 3004(u) corrective action requirements.) However, certain physical movement, alteration, or disturbance of RCRA hazardous waste associated with a remedial action may meet the RCRA definition of treatment, storage, or disposal. For instance, treatment has occurred when the CERCLA remedial action uses "any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, dispose of; or amenable for recovery, amenable for storage, or reduced in volume." 40 CFR 260.10.

Similarly, storage occurs when a CERCLA remedial action involves the "holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere." 40 CFR 260.10.

Land disposal occurs when RCRA hazardous waste is placed into a land disposal unit, including a "landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave." RCRA section 3004(k).

Movement of hazardous waste entirely within a unit does not constitute "land disposal" under Subtitle C of RCRA. However, movement of hazardous waste into a unit (i.e., across the boundary of a unit) does constitute "land disposal."

In many cases CERCLA sites contain areas of contamination (with differing levels of concentration, including hot spots, of hazardous substances, pollutants, or contaminants) that may be characterized as a unit, usually a landfill, under RCRA. In such cases where RCRA hazardous waste is moved into the area of contamination, RCRA disposal requirements are applicable to the disturbed waste and certain land disposal requirements (such as for closure) may be applicable to the area where the waste is received.

Therefore, the following activities constitute land disposal under RCRA Subtitle C where the waste involved is RCRA hazardous waste:

a. Wastes from different units are consolidated into one unit;

b. Waste is removed and treated outside a unit and redeposited into the same or another unit; or

c. Waste is picked up from the unit and treated within the area of contamination in an incinerator, surface impoundment, or tank and then redeposited into the unit (does not include in-situ treatment).

In contrast, an example of an activity that does not constitute "land disposal" is the mere consolidation of RCRA hazardous wastes within a unit. Similarly, the covering and sealing off of hazardous waste, called "capping with waste in place," is also not considered "land disposal" and RCRA Subtitle C requirements would not be applicable. If some of the waste at a site is moved into another unit, but other waste is left behind in the original unit (the unit in which such waste was found), "land disposal" applies only with regard to the waste that is moved into another unit. Under these examples, however, certain RCRA land disposal requirements might nevertheless be relevant and appropriate to such waste. (See ARARs preamble sections below, 16.iii. and 17.)

iii. *Hypothetical examples of compliance with RCRA: land disposal restrictions.* Land disposal restrictions under RCRA sections 3004 (d) through (k) are triggered whenever there is placement of RCRA hazardous wastes subject to land disposal restrictions ("banned waste") into a land-based unit. Such land disposal does not occur when

wastes disposed prior to the effective date of the applicable prohibition only become subject to the LDRs if they are removed from the land and placed into a land disposal unit after the effective date of the applicable prohibition. (See 53 FR 31138, 31148, (August 17, 1988) and *Chemical Waste Management* v. *US EPA*, 86 9 F.2d 1526, 1536 (D.C. Cir. 1989)), "treatment or disposal of [hazardous waste] will be subject to the [LDR] regulation only if that treatment or disposal occurs after the promulgation of applicable treatment standards.") Similarly, environmental media contaminated by hazardous wastes placed before the effective dates of the applicable land disposal restrictions does not become subject to the LDRs unless they are removed from the land and placed into a land disposal unit after the effective dates of the applicable restrictions.

The land disposal restrictions do not attach to environmental media contaminated by hazardous wastes when the wastes were placed before the effective dates of the applicable land disposal prohibitions. If these media are determined not to contain hazardous wastes before they are removed from the land, then they can be managed as non-hazardous contaminated media and they're not subject to land disposal restrictions. For example, soil contaminated by acetone land disposed ("placed") in 1986 (prior to the effective date of the land disposal prohibition for acetone) and, while still in the land, determined not to contain hazardous waste, is not subject to the land disposal restrictions.[17] This is consistent with the Agency's approach in the HWIR-waste rule, where it indicates that LDRs do not attach to wastes that are not hazardous at the time they are first generated (60 FR 66344, December 21, 1995).

Since application of the land disposal restrictions is limited, in order to determine if a given environmental medium must comply with LDRs one must know the origin of the material contaminating the medium (i.e., hazardous waste or not hazardous waste), the date(s) the material was placed (i.e., before or after the effective date of the applicable land disposal prohibition), and whether or not the medium still contains hazardous waste (i.e., contained-in decision or not).

Facility owner/operators should make a good faith effort to determine whether media were contaminated by hazardous wastes and ascertain the dates of placement. The Agency believes that by using available site- and waste-specific information such as manifests, vouchers, bills of lading, sales and inventory records, storage records, sampling and analysis reports, accident reports, site investigation reports, spill reports, inspection reports and logs, and enforcement orders and permits, facility owner/operators would typically be able to make these determinations. However, as discussed earlier in the preamble of today's proposal, if information is not available or inconclusive, facility owner/operators may generally assume that the material contaminating the media were not hazardous wastes. Similarly, if environmental media were determined to be contaminated by hazardous waste, but if information on the dates of placement is unavailable or inconclusive, facility owner/operators may, in most cases assume the wastes were placed before the effective date.

The Agency believes that, in general, it is reasonable to assume that environmental media do not contain hazardous wastes placed after the effective dates of the applicable land disposal prohibitions when information on the dates of placement is unavailable or inconclusive, in part, because current regulations, in effect since the early 1980's, require generators of hazardous waste to keep detailed records of the amounts of hazardous waste they generate. These records document whether the waste meets land disposal treatment standards and list the dates and locations of the waste's ultimate disposition. With these records, the Agency should be able to determine if environmental media were contaminated by hazardous wastes and if they would be subject to the land disposal restrictions.

In addition, EPA believes that the majority of environmental media contaminated by hazardous wastes were contaminated prior to the effective dates of the applicable land disposal restrictions. Generally, the contamination of environmental media by hazardous waste after the effective date of the applicable land disposal restriction would involve a violation of the LDRs, subject to substantial fines and penalties, including criminal sanctions. The common exception would be one-time spills of hazardous waste or hazardous materials. In these cases, the Agency believes that, typically, independent reporting and record keeping requirements (e.g., CERCLA sections 102 and 103 reporting requirements or state spill reporting requirements) coupled with ordinary "good housekeeping" procedures, result in records that will allow the Agency to determine the nature of the spilled material, and the date (or a close approximation of the date) of the spill. The Agency requests comments on this approach and on any other assumptions, records, or standards of evaluation that would ensure that facility owner/operators would identify any contaminated media subject to land disposal restrictions properly and completely.

Information on contained-in decisions should be immediately available since, generally, these determinations are made by a regulatory agency on a site-specific basis and careful records are kept.

2. Treatment Requirements—§ 269.30

a. Approach to treatment requirements and recommendations of the FACA Committee. RCRA section 3004(m) requires that treatment standards for wastes restricted from land disposal, "* * * specify those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." A recurring debate through EPA's development of the land disposal restriction program has been whether treatment standards should be technology-based (i.e., based on performance of a treatment technology) or risk-based (i.e., based on assessment of risks to human health and the environment that are posed by the wastes). The Agency believes that both approaches are allowed. It has long been recognized that Congress did not directly address the questions of how to set treatment standards in the language of section 3004(m).[18] In addition, Congress did not specifically address whether the LDR treatment standards for newly generated wastes and remediation wastes must be identical; the structure of RCRA's LDR provisions suggests that Congress believed that remediation waste may merit special consideration. (See, RCRA sections 3004(d)(3) and 3004(e)(3), which

[17] Similarly, soil contaminated by acetone placed in a solid waste management unit in 1986, but leaked into the soil at some point after 1986, is not subject to the land disposal restrictions provided that, while the soil is still in the land, the Director determines it does not contain hazardous wastes. LDRs would not attach because, in this case, it is the initial placement of hazardous waste that determines whether there is a duty to comply with LDRs.

[18] See, e.g., 51 FR 40572, 40578 (November 7, 1986); *Hazardous Waste Treatment Council v. US EPA*, 886 F.2d 355, 361–3 D.C. Cir. 1989); 55 FR 6640, 6641 (February 26, 1990). The legislative history of section 3004(m) is likewise inconclusive. See discussion of the legislative history at 55 FR 6640, 6641–6642 (February 26, 1990)"[a]t a minimum, the [legislative history shows] that Congress did not provide clear guidance on the meaning of 'minimize threats'."

Corrective Action Management Units (CAMUs) and Corrective Action Temporary Units (TUs)

CAMU

View Record Detail

FAXBACK 13766

9502.1995(03)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

October 18, 1995

M.L. Mullins, Vice President
Regulatory Affairs
Chemical Manufacturing Association (CMA)
2501 M St., NW
Washington, DC 20037

Dear Mr. Mullins:

This letter is in response to your letter of August 22, 1995 in which you expressed CMA's concern regarding the Agency's plans to "disallow continued use of the corrective action management unit (CAMU) provision" that was promulgated on February 16, 1993 (55 FR 8658).

As I believe you know, the CAMU rule was the Agency's initial attempt at resolving many of the problems that have been encountered by EPA State remediation programs in applying the prevention-oriented Subtitle C regulations to the management of remedial wastes. The Agency continues to support the need for flexibility in this area; however, some parties have argued that the CAMU rule allows regulators too much discretion in determining appropriate, site-specific management requirements for remediation wastes. In recognition of this view, the Agency agreed to evaluate whether the CAMU regulations should be modified or replaced with a different regulatory approach. As an outcome of this process, the Agency agreed the CAMU regulation should be replaced with the Hazardous Waste Identification Rule for Contaminated Media (HWIR-Media). The Agency is currently planning to propose the HWIR-media rule in December of this year and issue final regulations in March 1997.

The Agency believes that much of the site-specific flexibility provided in the CAMU will be preserved based on the current version of the draft HWIR-media regulation, especially for less contaminated media. Furthermore, the Agency intends to include a provision in the proposed HWIR-media rule that would in effect "grandfather" CAMUs that were approved before the

HWIR-media rule is issued final. However, no new CAMUs could be approved after the that date. The Agency believes that this "grandfathering" provision, if finalized, would will result in minimal disruptions to cleanups involving CAMUs that are planned or underway. It should be noted, however, that the Agency plans to ask for comment in the proposal as to whether grandfathering" of CAMUs is appropriate, and, in particular, whether the Agency should set a date upon which approval of "grandfathered" CAMUs would expire.

In the interim, our recommendation to both the regulators and the regulated community is to use a CAMU if it truly provides the best alternative for a site (and the AOC concept, which is a concept independent of the CAMU rule, cannot be used). Of course, the most conservative course of action would be to use a CAMU only if it can be completed prior to publication of the final HWIR-media rule.

I hope that this letter helps to clarify the basis for our current plans. If you have any questions regarding the HWIR-media rule and its impact on the CAMU rule, please call Carolyn Hoskinson at 703/308-8626. Questions regarding the AOC concept should be directed either to Hugh Davis at 703/308-8633 or Elizabeth McManus at 703/308-8657.

Sincerely,

Michael Shapiro, Director
Office of Solid Waste

Attachment

CHEMICAL MANUFACTURERS ASSOCIATION

August 22, 1995

Mr. Michael H. Shapiro, Director
Office of Solid Waste (5301)
U.S. Environmental Protection Agency
401 M Street S.W.
Washington, D.C. 20460

Re: Corrective Action Management Unit

Dear Mr. Shapiro:

The Chemical Manufacturers Association (CMA) is concerned by

reports that EPA, in the context of the upcoming HWIR contaminated media proposal, plans to disallow continued use of the corrective action management unit (CAMU) provision that was promulgated on February 16, 1993 (58 FR 8658).

EPA has recognized that "remediation of existing contamination problems is inherently different from the management of as-generated industrial waste " (58 FR 8660) and that "the existing regulatory structure of RCRA Subtitle C, when applied to the management of hazardous waste for remedial purposes, can often seriously hamper the ability of decision makers to select and implement effective, protective, and cost effective remedies" (58 FR 8659). The Agency promulgated the CAMU provision to provide remedial decision makers with an added measure of flexibility in order to expedite and improve remedial decisions. Many CMA member companies have found the CAMU provision to be highly successful in that regard. It has afforded valuable and much needed flexibility and has significantly expedited remediation efforts by removing many of the impediments that existed under Subtitle C.

In her statement before the U.S. House of Representatives Committee on Science on January 6, 1995, Administrator Browner said:

"All of us are committed to protect public health and our air, land, and water. At EPA, we want to implement these commitments in the most cost effective way possible. But to do this, we must move beyond a "one size fits all" regulatory approach towards a more common sense approach - an approach that uses flexibility, creativity, and innovation in reaching these goals."

CMA believes that the CAMU provision is an excellent example of focused regulation that provides considerable flexibility, fosters creativity - and enables expedited clean-up of contaminated hazardous waste sites in a more cost effective manner. To disallow this sensible and valuable provision would be totally inconsistent with the many on-going EPA regulatory reform initiatives. If EPA is to be successful in achieving meaningful regulatory reform, it must stand behind the good progress it has made with the CAMU provision and continue to work to identify additional opportunities to better focus regulations to achieve environmental goals in a more flexible cost effective manner. To disallow the CAMU provision would be a giant step backward.

CMA recognizes that some parties have challenged the legal and policy basis of the CAMU and temporary unit (T.U.) rules. CMA urges the Agency to vigorously defend these rules. They received broad support when they were promulgated and have been widely accepted and implemented by affected stakeholders, states, and

regional offices. Regulatory agencies have devoted significant energies toward the constructive use of CAMUs to facilitate cleanups. A large number of CMA member companies have invested significant money and effort incorporating CAMUs into their remedial plans, and many have been approved and are presently in use, while others are nearing final approval. EPA has provided no justification for disrupting the protective practices that have been initiated under the CAMU provision. At a minimum, EPA must grandfather existing CAMUs to protect the investment that facilities have made in planning, obtaining approval, and implementing remedial actions based upon the CAMU provision.

If you should have any questions concerning this issue, or desire additional information, please contact Chip Vitarelli, of my staff, at (202) 887-6936.

Sincerely,

M.L. Mullins
Vice President - Regulatory Affairs

cc: Matthew Hale, Jr., Director
Permits and State Programs Division
Office of Solid Waste

Robert Hall, Chief
Corrective Action Programs Branch
Permits and States Programs Division
Office of Solid Waste

CAMU

View Record Detail

FAXBACK 13733

9502.1995(01)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

February 17, 1995

MEMORANDUM

SUBJECT: CAMU at U.S.S. Lead Facility

FROM: Devereaux Barnes, Director
Permits and State Program Division, OSW

TO: Norm Niedergang, Director
Office of RCRA, Region V

Recently we have had several discussion with your staff regarding the approval of a corrective action management unit (CAMU) at the U.S.S. Lead Refinery facility in East Chicago, Indiana. In those discussions we were asked to provide the Agency position on the specific question of whether a 3008(h) enforcement order is an appropriate mechanism for approving a CAMU at this facility. As you know, interim status for this facility was terminated under the provisions of RCRA 3005(e).

It is the Agency's position that 3008(h) orders are an appropriate mechanism for approval of CAMUs at facilities that have lost interim status pursuant to 3005(e). Other types of hazardous waste management units (e.g., tanks, piles) that may be needed to implement remedial actions at facilities like U.S.S. Lead may also be approved under 3008(h) orders. This interpretation of the scope of 3008(h) authority is supported by the broad language of 3008(h) (providing for "corrective action or such other response measure as...necessary to protect human health or the environment"). The legislative history supports this interpretation in that the conference report indicates that the intent was to allow EPA to address ongoing problems without a permit. In addition, EPA's longstanding interpretation is that 3008(h) applies to LOIS facilities as well as facilities that are currently operating under interim status, and the CAMU rule itself imposes no limits on this interpretation. See memo from J. Winston Porter, "Interpretation of Section 3008(h) of the Solid Waste Disposal Act" (Dec. 16, 1985).

We believe that this is a reasonable reading of the statute. Based on this interpretation, RCRA permits are not necessary for such units as long as they are part of the selected remedy (or interim measure), and they are specifically authorized under the 3008(h) order. Furthermore, we believe that from a policy perspective, permits would generally be inappropriate in these circumstances, since they would likely have the effect of delaying cleanup and adding to procedural costs without increasing environmental protection. As explained in the preamble to the CAMU rule (58 FR 8676, February 16, 1993), public participation procedures similar to those for Class III permit modifications should be followed in approving CAMUs under 3008(h) corrective action orders.

If you or your staff have more specific questions about the use of orders to approve CAMUs and other types of units, you may wish to contact Barbara Pace of the Office of General Counsel, at (202) 260-7713, or Dave Fagan of my staff at (703) 308-8620. Please let us know if we can be of any further assistance.

cc: Joe Boyle
Kevin Pierard
Barbara Pace
Larry Starfield

File: CAMU

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL

To Elizabeth McNamara	From Dave Fagan
Dept./Agency	Phone #
Fax #	Fax #
NSN 7540-01-317-7368 5099-101	GENERAL SERVICES ADMINISTRATION

# of pages ►

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

MAY 4 1993

OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE

Doug MacMillan
Institute of Chemical Waste Management
1730 Rhode Island Ave., NW
Suite 1000
Washington, DC 20036

Dear Mr. MacMillan:

I am writing in response to your letter of January 28, 1993, in which you expressed several concerns regarding the potential effect that the newly promulgated regulations for corrective action management units (CAMUs) may have on the management of "as-generated" hazardous wastes.

As I understand from your letter, and from subsequent discussions with my staff, your primary concern is that as-generated containerized hazardous wastes being stored at a facility could be considered remediation wastes, and therefore could be managed at an area of a facility that has been designated as a CAMU, with the effect that those wastes would no longer be subject to the RCRA land disposal requirements, or to minimum technology requirements.

Let me assure you unequivocally that it was not the Agency's intent in promulgating this regulation to allow or to encourage such waste management practices; furthermore, the regulations as finalized prohibit such practices. As stated in the regulations, and as explained in the preamble, CAMUs may only be used for the management of remediation wastes (40 CFR §260.10; 58 FR 8663-4), and only for the purpose of implementing remedial actions (e.g., corrective actions under RCRA 3004(u) or 3008(h) authorities). The concept of remediation wastes is somewhat new to RCRA, and I agree that it is important to have a clear understanding of what these wastes are, and the limitations on the use of the CAMU concept in regard to management of "as-generated" hazardous wastes.

As-generated hazardous wastes, whether containerized or non-containerized, are subject to the full set of Subtitle C requirements applicable to treatment, storage and disposal of hazardous wastes. These regulations are designed with the primary goal of preventing such wastes from creating environmental contamination problems that require remediation. Thus, so long as as-generated hazardous wastes are managed in accordance with applicable RCRA standards and regulations, there should be

no need to "remediate" those wastes.

In contrast, remediation wastes as defined in the CAMU rule include only wastes that are generated and managed for the purpose of implementing corrective actions at facilities. It is this purpose--cleanup of environmental problems resulting from historic waste mismanagement practices--that is fundamental to the concept of remediation wastes. In the preamble to the CAMU rule we articulated the inherent differences between cleanup (i.e., corrective action) and management of as-generated, or "new" wastes. The Agency's rationale for promulgating the CAMU rule is tied directly to our conclusion that cleanup is a fundamentally different activity than management of as-generated wastes, and that RCRA requirements for management of cleanup wastes can and should differ from those for as-generated wastes.

As stated in the preamble of the final CAMU rule (58 FR 8664), "Today's definition of remediation waste excludes 'new' or as-generated wastes (either hazardous or non-hazardous) that are generated from ongoing industrial operations at a facility." Further, the regulatory definition of remediation waste in the final rule is limited to wastes "...that are managed for the purpose of implementing corrective action requirements under §264.101 and RCRA section 3008(h)." (40 CFR §260.10) In crafting the definition of remediation waste in this way (particularly when the definition is read together with the preamble discussion), we believe that it is clear that CAMUs are not to be used for management of as-generated wastes. However, we understand your concern that if read alone, the definition might mislead some readers or allow some room for abuse. We are currently developing guidance for EPA and State decision makers on implementation of the CAMU rule. Among other things, the guidance will emphasize that containerized as-generated wastes that are stored at RCRA facilities cannot be managed in CAMUs. In addition, we are willing to consider adding a clarification to the regulation that would specifically exclude management of as-generated wastes in CAMUs, as well as in temporary units. I would welcome further discussions with you and your organization on this matter.

In your letter you suggested that owner/operators might have incentives to stockpile containerized as-generated wastes, fc subsequent treatment and disposal in CAMUs. As explained above, such wastes would be as-generated wastes, not eligible for placement in a CAMU (unless all applicable Subtitle C requirements, including the land disposal restrictions, were satisfied). Furthermore, in storage the wastes would be subject to the applicable "prevention" requirements of Subtitle C, which should serve to ensure that they are not mismanaged such that "cleanup" of the wastes would be required. If an owner/operator were to mismanage such wastes, for example, by dumping the wastes with the intent that the wastes would then become remediation wastes, such activities would clearly be illegal, and subject tc the substantial civil and/or criminal penalties under RCRA, as

well as possible liabilities under CERCLA. In addition, such purposeful dumping of wastes would likely result in contamination of large volumes of soils or other media, and the costs of the required cleanup could be many times the costs of complying with the Subtitle C prevention standards. Thus, we do not believe that the CAMU concept realistically creates an incentive for mismanagement of as-generated wastes.

As an additional safeguard, it should be emphasized that CAMUs may only be designated by EPA or an authorized State; an owner/operator could not himself simply designate an area of a facility as a CAMU, as a means of changing the requirements that would apply to those wastes.

In your letter you suggested amending the CAMU regulation to restrict the definition of remediation waste to contaminated media resulting from corrective action at a facility. I would like to clarify that in the CAMU rule the Agency did not intend to distinguish between contaminated media and other cleanup wastes. By restricting the definition to contaminated media, certain other cleanup wastes could not be managed in CAMUs, such as sludges disposed of before 1980. As explained in the preamble to the rule, the CAMU concept is a response to the inherent differences in the objectives and incentives of remediation of "old" wastes, as distinguished from management of "new" wastes. Since remediation of facilities will often involve management of sludges and other pre-RCRA wastes that would not be considered contaminated media, we do not believe that it would be appropriate to amend the CAMU regulations to apply only to contaminated media.

As you know, many of the issues addressed in the CAMU rule are now being discussed in the context of the HWIR Forum, in which you have been actively involved. As we have discussed in the Forum, a major component of the HWIR discussions focuses on contaminated media; this important dialogue is thus an opportunity to reevaluate many of the issues associated with remediation, as well as requirements for as-generated hazardous wastes. It is possible that the HWIR dialogue will result in substantial revisions to the existing RCRA regulations that address management of remediation wastes, including the CAMU regulations. If so, the Agency is committed to reviewing the need for changes to those regulations. I look forward to the continued participation of ICWMA in these discussions.

I hope this has been responsive to the concerns raised in your letter. If you have any further questions, please do not hesitate to contact me or Dave Fagan ((703) 308-8620).

Sincerely,

Sylvia K. Lowrance
Director, Office of Solid Waste

ICWM

Institute
of Chemical
Waste Management

received
2/2/93
RMS

January 28, 1993

Sylvia Lowrance
Director
Office of Solid Waste
Room M2101
U.S. EPA
401 M Street SW
Washington, DC 20460

Dear Sylvia:

I have reviewed the Corrective Action Management Unit rule recently signed by Administrator Reilly and have very mixed reactions. While the rule would permit the implementation of many of the site cleanup reforms that ICWM supports, it also suffers from certain serious omissions.

The key problem identified in our review involves the definition of "remediation waste". Under the new definition, containerized as-generated waste stored within a facility boundary would be eligible for special and potentially less-protective treatment in the facility's Correction Action Management Unit. (See pages 1 and 2 of attached memo.) These special standards would be available even if the waste in question was not subject to the special "matrix interference" problems sometimes associated with contaminated soil and debris.

In our view, there are no defensible technical or environmental arguments that support the application of less protective handling and treatment requirements to this category of waste. The argument that it might be "cheaper" and "simpler" to ignore existing Land Disposal Restrictions and Minimum Technology requirements when handling containerized as-generated waste stored at cleanup sites is not persuasive. Obviously, it would be "simpler" for everyone producing as-generated waste to ignore the current regulatory requirements.

In our view, application of special CAMU standards to containerized as-generated wastes not only undercuts the validity of the existing treatment and disposal standards but would also provide site owners and operators with incentives to stockpile as-generated wastes at possible CAMU facilities in order to take advantage of less burdensome treatment and disposal standards. We urge EPA to reconsider the regulatory language of the January 11 rule and to restrict the definition of remediation waste to contaminated media resulting from corrective action activities at a facility.

NSWMA

An Institute
of the National
Solid Waste
Management Association

1730 Rhode Island Ave., N.W.
Washington, DC 20036
(202) 659-4613

The Institute would like to be able to support the CAMU rule. I fear, however, that without clarification of this regulatory "definition" we may be forced to actively oppose the regulation.

Sincerely,

Doug MacMillan
Director Hazardous Waste Program

c.c. Caroline Wehling, EPA Office of General Counsel
Attachment: January 26 Memo

federal register

Tuesday
February 16, 1993

Part II

Environmental Protection Agency

40 CFR Part 260, et al.

Corrective Action Management Units and Temporary Units; Corrective Action Provisions; Final Rule

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 260, 264, 265, 268, 270 and 271

[FRL-4555-7]

RIN 2050-AB80

Corrective Action Management Units and Temporary Units; Corrective Action Provisions Under Subtitle C

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency is promulgating today certain corrective action-related regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA). The specific provisions finalized in this rulemaking address two new units that will be used for remedial purposes under RCRA corrective action authorities: corrective action management units (CAMUs), and temporary units (TUs). These specific provisions were proposed as part of a more comprehensive corrective action rulemaking on July 27, 1990.

EFFECTIVE DATE: These final regulations are effective on April 19, 1993.

ADDRESSES: The official record for this rulemaking is located in the RCRA Docket, located in room 2427 at the U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460. The telephone for the RCRA Docket is (202) 260-9327. The record is available for inspection, by appointment only, between the hours of 9 a.m. and 4 p.m., Monday through Friday, excluding legal holidays. As provided in 40 CFR part 2, a reasonable fee may be charged for copying services.

FOR FURTHER INFORMATION CONTACT: Questions relating to the technical content of this rule should be directed to Anne Price or David Fagan, Corrective Action Programs Branch, Office of Solid Waste (5303W), U.S. Environmental Protection Agency, at (703) 308-8657 or (703) 308-8620. Other inquiries should be directed to the RCRA/Superfund Hotline, at (800) 424-9346 or at (202) 260-3000.

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I. Authority

These regulations are issued under the authority of sections 1006, 2002(a), 3004(u), 3004(v), 3005(c), 3007 and 3008(h) of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, as amended by the Hazardous and Solid Waste Amendments of 1984.

II. Background

The RCRA Hazardous and Solid Waste Amendments of 1984 established a broad new mandate for EPA and the States to implement corrective action at hazardous waste treatment, storage, and disposal facilities (TSDFs) regulated under subtitle C of RCRA. Under section 3004(u), permits issued to such facilities must address corrective action for all releases from solid waste management units at the facility. Under section 3008(h), EPA may issue administrative orders to compel corrective action at facilities authorized to operate under section 3005(e) of this subtitle (i.e., interim status facilities). Section 3004(v) established the authority to compel remediation of releases that have migrated beyond a facility's boundary.

On July 27, 1990, EPA issued a proposed rulemaking to establish, under subpart S of 40 CFR part 264, a comprehensive regulatory framework for implementing corrective actions at RCRA facilities under these new statutory authorities. 55 FR 30796-884 (July 27, 1990). The proposal established a detailed set of technical requirements and procedures for investigating and responding to environmental releases at RCRA facilities.

EPA received numerous public comments on the Subpart S proposal, many of which raised substantial issues which must be resolved prior to a final rulemaking. In addition, EPA is currently conducting a comprehensive new Regulatory Impact Analysis (RIA) to more thoroughly assess the costs and benefits of the Subpart S proposal, and to analyze specific regulatory alternatives for the final rule. EPA will make the results of the RIA available for public review and comment prior to promulgating the remainder of the proposed subpart S rules.

The proposed subpart S regulations contained several key remediation waste management provisions. These provisions were designed to reduce or eliminate certain waste management requirements of the current RCRA subtitle C regulations which, when applied to remediation wastes, impede the ability of the Agency to select and implement reliable, protective and cost-effective remedies at RCRA facilities. These impediments also occur at sites being remediated under CERCLA authorities, since RCRA requirements are often applicable or relevant and appropriate requirements (ARARs), as defined in CERCLA and in the CERCLA National Contingency Plan.

Therefore, EPA believes that pending the promulgation of the comprehensive subpart S rules, it is useful and necessary to expedite the promulgation of these key provisions of subpart S, and thereby realize the benefits that they will provide in an accelerated time frame.

The Agency remains committed to promulgating final comprehensive rules governing RCRA corrective actions. Today's rule is intended to advance that

different from the management of as-generated industrial hazardous waste, and that applying "as-generated" regulatory requirements to remediation wastes does not always result in implementation of the best remedies. In fact, EPA's preliminary analysis indicates that better remedies, in terms of increased environmental benefits, are likely under a regulatory framework tailored to remediation wastes.

The original RCRA subtitle C program, which was established beginning in 1980, was designed to be a "cradle-to-grave" system of controls governing the generation and subsequent transportation, storage, treatment and disposal of hazardous wastes from ongoing industrial processes. Thus, RCRA was first and foremost a "prevention" oriented program, with the primary objective to prevent new releases (e.g., new Superfund sites) resulting from management of hazardous wastes. Following this objective, a stringent set of standards were developed to ensure protection of human health and the environment from such ongoing waste management. For the most part, the subtitle C regulations are specified as uniform, national standards that must be complied with at all RCRA-regulated facilities. These standards are generally considered very stringent; in order to ensure an adequate level of protection nationally, the standards must be adequate in preventing or minimizing environmental releases over a wide range of hazardous wastes types, environmental conditions, operational contingencies and other factors. Although there are certain limited provisions for waivers from the subtitle C regulations based on site-specific factors, the regulated community's experience has been that it is difficult and time-consuming to modify RCRA standards through site-specific waivers.

The 1984 HSWA amendments to RCRA strengthened the RCRA prevention program by adding several important statutory provisions governing the treatment and disposal of hazardous wastes. In particular, the RCRA land disposal restrictions (LDRs) and the minimum technology requirements (MTRs) have become central features of the RCRA prevention program. One of the important objectives of Congress in mandating the 1984 amendments (including LDRs and MTRs) was to provide increased incentives for generators of hazardous wastes to minimize the amounts of wastes being generated. See RCRA section 1003(b). EPA's experience in implementing the LDR program has shown that the costs associated with meeting the stringent, technology-based LDR standards actually have resulted in substantial reductions in the volumes of hazardous wastes generated from many industrial sectors.

In addition to these prevention-oriented provisions, the HSWA corrective action provisions created a very different, new mandate for the RCRA program: Cleaning up releases from solid waste management units (SWMUs) at over 4,000 RCRA TSDFs. RCRA is now both a prevention program and a cleanup program. These two basic elements of the RCRA program have markedly different objectives and incentives, and are impacted in very different ways by regulatory controls on waste management. As discussed below, therein lies the basic problem that today's final rule is intended to address.

EPA has found that subtitle C requirements, when applied to remediation wastes, can act as a disincentive to more protective remedies, and can limit the flexibility of a regulatory decisionmaker in choosing the most practicable remedy at a specific site. In contrast, RCRA subtitle C regulations, when applied to as-generated wastes, ensure that the wastes are handled according to stringent national standards; due to the cost of subtitle C management, they also create a significant incentive for process changes to minimize hazardous waste generation. Yet these same requirements, when applied to existing contamination problems, provide a strong incentive for leaving wastes in place, or for selecting remedies that minimize regulation under subtitle C.

EPA recognizes, of course, that both Superfund and RCRA provide it the authority to compel specific remedies, as long as the remedies are consistent with the goals of the statutes. Under the current programs, the Agency can require facility owner/operators or responsible parties to excavate wastes and manage them fully in compliance with Subtitle C. Similarly, in a fund-financed remedy under Superfund, EPA can use CERCLA funds to effect a similar remedy. Thus, through its regulatory authority, EPA can, at least in theory, override any regulatory disincentive against a given remedy. In its conduct of the Superfund and RCRA programs, however, EPA has come to recognize the fact that RCRA subtitle C requirements may make more sense when applied to some remedies than to others, and can influence the remedy selection process in undesirable ways. For example, compliance with LDR requirements may completely eliminate from consideration remedies that would otherwise meet Superfund or RCRA remedial standards, and that might be the most sensible remedy from a technical point of view. In such cases, the regulatory decisionmaker might be faced with the dilemma of choosing between two or more extreme options, such as a remedy involving containment in place versus removal of the wastes and management according to full RCRA subtitle C standards, without having the opportunity to consider a middle option that might be fully protective, in compliance with Superfund or RCRA cleanup goals, and acceptable to the local community. In such cases, practical considerations and the need for prompt action may often force the decisionmaker to select the less protective of the available extremes.

More broadly, under Superfund and RCRA corrective action, the regulatory decisionmaker must address a situation that is already unacceptable—that is, a situation which needs remediation. The decisionmaker's goal in each case is to select a remedy that is fully protective, yet that reflects the technical and practical realities of the site. In addressing this situation, the decisionmaker needs the flexibility to consider a full range of strategies so that one may be selected that promptly and effectively addresses the problem. EPA believes that constraining this range of strategies by requiring compliance with subtitle C standards for wastes "generated" during remediation can often lead to remedies that are not cost-effective and that in some cases may actually be less protective solutions than the remedies that otherwise would be chosen.

This is reflected in the results of the preliminary CAMU analysis ("Supplemental Information of Corrective Action Management Units (CAMUs)", October 16, 1992) and in the Regulatory Impact Analysis (summarized in section VI. of today's preamble). According to these analyses, the "expanded" CAMU concept, which has been adopted in today's rule, is estimated to result in more treatment of wastes using more effective treatment technologies than would occur under the other regulatory options considered by the Agency. In addition, today's rule is predicted to result in more on-site waste management (vs. off-site management); lesser reliance on incineration; greater reliance on innovative technologies; and a lower incidence of capping waste in place without treatment.

Another reason for instituting a regulatory approach for management of remediation wastes that differs from the base Subtitle C program is the type and amount of Agency oversight that is

given to cleanup activities under RCRA and CERCLA, as opposed to ongoing generated waste streams. Remedial actions under these statutes are typically conducted with substantial Agency oversight; remedial decisions are made by the Agency based on a thorough study of the nature and extent of the contamination problems at the site. In contrast, most RCRA subtitle C regulations for as-generated waste streams are uniform, national standards, and as such must require a level of protection sufficient for a highly diverse universe of facilities and environmental settings, so as to be implemented with little Agency oversight.

One final difference between as-generated wastes and remediation wastes is that remediation often involves management of large volumes of contaminated media, such as soils or ground water. The physical characteristics of contaminated media can be quite different from those of as-generated wastes. Contaminated soils, for example, are highly variable in their composition and handling characteristics. Treatment of such soils can thus be particularly difficult. This is not to say that remediation wastes are always different; some remediation wastes, such as sludges, may be essentially identical to as-generated wastes. As a general matter, however, remediation wastes pose unique waste management issues.

The above considerations—the level of Agency oversight over remedial actions, the counterproductive constraints and disincentives that subtitle C requirements can impose on the remedy selection process, and the physical and chemical differences that are often found between remediation wastes and as-generated wastes—suggest that it is sensible and necessary to develop regulations under RCRA for management of remediation wastes that are better tailored to the realities of remediation actions. As a result, under today's rule, regulatory requirements for remediation wastes will differ from the standards applied to as-generated wastes.

Today's final rule for CAMU and temporary units is consistent with that policy objective. As explained earlier, these rules will create a markedly different regulatory framework for applying subtitle C requirements, particularly the LDRs and MTRs, to remediation waste management.

B. Summary of Today's Rule

Today's rule promulgates regulations for CAMUs and temporary units. These regulations will provide the Regional Administrator with the authority to designate and approve such units for the purpose of managing remediation waste. The final CAMU provisions are an expansion of the proposed CAMU concept, and are intended to provide even greater flexibility for decisionmakers in implementing protective, reliable and cost-effective remedies. CAMU is a tool that can be used by an owner/operator when implementing corrective action at a facility. It is available to those owner/operators compelled to take corrective action under RCRA or those who initiate corrective action and seek Agency approval under RCRA. The temporary unit provisions in today's rule are changed little from the proposal, except that the time limit for temporary units has been increased from 180 days to one year.

Today's regulations will apply to corrective action implemented under RCRA permits (as provided under RCRA section 3004(u) and in § 264.101) and under section 3008(h) actions. In the subpart S proposal, EPA fully intended that the CAMU and TU regulations would apply to interim status facilities under section 3008(h). See 55 FR 30,802 (July 27, 1990). However, the proposed regulatory language did not contain explicit requirements for the use of CAMUs and TUs under section 3008(h). Several commenters requested clarification as to how and to what extent the substantive subpart S requirements would actually be applied under section 3008(h). Today's rule clarifies, in § 264.552 and in other conforming changes, that these rules for CAMUs and TUs will be applicable to corrective actions under section 3008(h). The Agency has also provided the opportunity for public comment through both the permit modification and order processes.

Under the final CAMU provisions, remediation waste management will be subject to LDRs and MTRs in a much more limited way than has been the case under existing regulations. For example, remediation wastes, including hazardous remediation wastes, may be placed into a CAMU without triggering applicability of LDRs or any other unit-specific requirements applying to hazardous waste land disposal units. Thus, remediation wastes generated at a facility, but outside a CAMU can be consolidated into the CAMU, and remediation wastes may be moved between two or more CAMUs at that facility, without triggering LDRs. Likewise, the "replacement" scenario, where remediation wastes are excavated from a CAMU, treated in a separate unit (which could be located inside or outside the CAMU at the facility), and redeposited into the CAMU, is not a new "disposal" event which triggers LDRs or other hazardous waste land disposal unit requirements. As explained in the proposal, MTRs would not apply to CAMUs, since by definition a CAMU is not subject to MTRs under 3004(o) and 3015. These regulatory features of CAMUs are described in more detail later in today's preamble.

Today's final rules for CAMUs grow out of the proposed approaches for defining the CAMU and the comments received by the Agency on those approaches. In the July, 1990 notice, the Agency discussed in detail several important proposed limitations on the scope of the CAMU. 55 FR 30843–44. First, a CAMU could only be designated by the Agency or the authorized State, and such designations would be subject to the public review and comment process as part of remedy selection. Second, the CAMU could only contain contaminated areas. Third, the CAMU was a land area and non-land-based units, such as incinerators or tanks, could not be considered part of the CAMU. Fourth, remediation waste from outside the CAMU that would be placed within the CAMU would be subject to the land disposal restriction requirements.

In the preamble, EPA also discussed several alternatives to the proposed CAMU, including options under which the CAMU would not have the second, third, or fourth restrictions noted above. 55 FR 30844. The Agency cited several problems with these options, noting that (1) including uncontaminated areas in the CAMU could be viewed as contradicting its remedial purpose, (2) including non-land-based units could be viewed as inconsistent with the land-based concept of the CAMU, and (3) including non-land-based units would complicate the application of relevant 264 standards to the non-land-based units.

Many of the comments on the proposed CAMU were critical of these proposed limitations and requested that EPA adopt an expanded type of CAMU as discussed in the preamble to the proposal. In response, EPA evaluated regulatory options for defining a CAMU and provided supplemental information for public comment summarizing the relative environmental benefits of the proposed CAMU and expanded CAMU options. 57 FR 48195 (October 22, 1992).

In light of EPA's 1992 supplemental information and the public comments received on the July, 1990 proposal and the October, 1992 supplemental information notice, EPA has decided to adopt a CAMU definition which is

broader than the proposed CAMU, but is consistent with the options for expanding the CAMU discussed in the July, 1990 preamble and in the October, 1992 supplemental notice. As explained below, EPA believes that the CAMU definition adopted today better achieves the policy goal of facilitating timely, protective, and effective cleanups at RCRA facilities than does the proposed CAMU. Moreover, EPA has structured the final CAMU definition to avoid the problems relating to expanding the CAMU concept, as noted in the July, 1990 preamble and in comments received by the Agency.

The principal difference between the proposed CAMU and the CAMU definition in today's final rule is that, under today's rule, the CAMU has been structured so that any waste managed within the CAMU which was generated as part of the corrective action at that facility (i.e., remediation waste) would not be subject to RCRA regulatory disposal requirements. Thus, waste generated from the corrective action at the facility may be placed within the CAMU without pre-treatment to the technology-based levels established under the RCRA land disposal restrictions (LDR) program.

EPA believes that Congress left ample authority for the Agency to modify, where appropriate, the regulatory requirements for as-generated hazardous waste under RCRA when applying those requirements to wastes generated during cleanup activities, so long as the requirements for these remediation wastes remain protective of human health and the environment. With respect to LDRs in particular, Congress defined the term "land disposal" to include the placement of hazardous waste in certain types of units historically used by the Agency to establish land disposal requirements for non-remediation wastes. See section 3004(k). Congress did not address in that provision how the LDRs would apply to wastes managed in newly-created types of land-based units or to units created solely for the management of remediation wastes, rather than as-generated hazardous wastes. Congress did, however, recognize the special problems that might be created by applying the LDRs to remediation wastes in the same manner as to as-generated wastes and provided some relief for remediation wastes placed in the units enumerated in section 3004(k). See e.g., RCRA sections 3004(d)(3) and 3020.

For the reasons outlined above, the application of regulatory requirements designed for as-generated wastes to remediation wastes has proven problematic. In essence, standards designed to prevent releases from occurring and to force hazardous waste generators to internalize the costs posed by hazardous waste management can be highly counterproductive when applied to wastes generated during remediations, where the release has already occurred and the desired incentive is to increase, rather than decrease, waste production. Cf. H.Rep. 98–198, Part 1, 98th Cong., 1st Sess. at 37 (1983) (noting that one of the primary Congressional purposes in establishing the comprehensive LDR program was to "compel generators to internalize the costs of disposal and treatment of hazardous wastes.") In addition, a primary goal of Congress in establishing the land disposal restrictions program was to ensure that hazardous wastes are managed properly in the first instance, thereby reducing the need for costly corrective action. See RCRA section 1003(5); H.Rep. 98–198, Part 1, 98th Cong., 1st Sess. at 30, 32 (1983). Remediation wastes are, however, waste which, by definition, were not managed properly "in the first instance," and for which corrective action is now necessary.

That Congress recognized, but did not fully resolve, the dilemma of applying preventive standards to remediation wastes when enacting remediation-related amendments to RCRA in 1984 is not surprising, since EPA's principal remedial programs, under CERCLA and RCRA subtitle C, were at that time in their early stages of development or sharply limited in scope.

Since 1984, the Agency also has struggled to determine exactly how the regulatory units described in section 3004(k) should apply to remediation situations, where the areas in question do not easily fit within the unit definitions referenced in that provision, and where the unit concepts themselves were designed with as-generated and managed wastes in mind. For example, a RCRA permitted disposal facility managing hazardous wastes will typically have one or more well-defined land areas constructed and operated for the purpose of a single type of hazardous waste land disposal practice (e.g., landfilling of containers, or treatment of liquid hazardous wastes in a surface impoundment). A typical RCRA corrective action, in contrast, involves scattered and diverse land and/or water areas with both "hot spots" of wastes and highly contaminated soils and generally dispersed contamination. In addition, such areas typically include a variety of historical land disposal practices, many of which are far different from the management practices authorized for ongoing hazardous waste management in land disposal units (e.g., pipeline leaks, product spills, dewatered surface impoundments). Since 1988, the Agency has used the definition of "landfill" to describe these remediation land areas simply because EPA had no unit definition that applied to these areas, and the "landfill" definition served as a catchall. See 55 FR 8760 (March 8, 1990). With today's rule, EPA intends to provide a more appropriate set of standards and definitions tailored to remediation areas.

Today's rule addresses the ambiguity in the application of RCRA preventive standards to remediation wastes generated at RCRA facilities, especially the LDRs. Because Congress did not provide direction under section 3004(k) on how the LDRs should apply to areas that are used solely for the management of remediation wastes, and consequently, do not fit within the unit definitions constructed by EPA for as-generated wastes, EPA interprets the definition of "land disposal" in section 3004(k) to exclude the placement of remediation waste in CAMUs under today's rule. EPA believes that this interpretation is reasonable since remedial areas are not a listed regulatory unit under section 3004(k), because Congress recognized that the application of LDRs to remediation wastes might require a different framework than that developed for the application to as-generated wastes, and, as discussed above, because the direct application of preventive standards to remediation wastes is often inappropriate and counterproductive.

Today's rule is thus designed to address RCRA's ambiguity with respect to remediation wastes in a manner which best meets the twin Congressional objectives of minimizing reliance on land disposal by encouraging proper treatment of hazardous remediation wastes and by facilitating prompt and effective corrective action at RCRA facilities. As a result of today's rule, remediation wastes placed in CAMUs will not be subject to LDRs or other hazardous waste disposal requirements.

III. Section-by-Section Analysis

A. Definitions

Today's final rule defines three key terms related to the implementation of CAMUs: Corrective Action Management Unit, Facility, and Remediation Wastes. In addition, certain conforming changes have been made to several § 260.10 and § 270.2 definitions, to § 264.3, to § 264.101, to § 265.1, and to § 268.2.

1. Corrective Action Management Unit (CAMU) (§ 260.10 and § 270.2)

The proposed rule defined CAMU as "a contiguous area within a facility as designated by the Regional Administrator[1] for the purpose of implementing corrective action requirements of this subpart, which is contaminated by hazardous wastes (including hazardous constituents), and which may contain discrete, engineered land-based sub-units." The definition of CAMU in today's final rule modifies the proposed definition in several ways:

(1) The final definition is promulgated under § 260.10, rather than under § 264.501, as proposed;

(2) The definition specifies that CAMUs may be used for corrective actions under section 3008(h) orders, as well as at permitted facilities under section 3004(u);

(3) The new definition does not specify CAMUs as being contiguous areas of contamination; and

(4) The definition specifies that CAMUs are to be used for the purposes of managing remediation wastes only.

These changes to the proposed definition are intended to clarify and provide a more complete description of what a CAMU is and how it may affect management of wastes in the context of implementing corrective actions. As such, the definition includes certain provisions that were not included in the actual definition as proposed, but were presented in the proposed regulations for CAMUs under § 264.551(c). The definition also reflects the substantive changes that have been made in "expanding" the CAMU concept under today's final rule. Each of these modifications from the original proposed CAMU definition is discussed below.

The definition of CAMU has been finalized in § 260.10 and in § 270.2, rather than under § 264.501. As proposed, § 264.501 specified definitions that would apply only to subpart S of 40 CFR part 264. However, EPA is promulgating in today's rule only the CAMU and temporary unit provisions of subpart S. Rather than create a section under subpart S that would only contain the definition of CAMU, EPA believes that it will be clearer and more straightforward to codify this definition under the general definitions sections of parts 260 and 270. These definitions apply to the part 264 CAMU provisions, as well as other parts of 40 CFR. However, the new locations of the CAMU definition will not affect either the applicability or the substance of the definition.

In the proposal, the regulations for CAMUs did not explicitly state that CAMUs could be implemented under section 3008(h) orders, as well as at permitted facilities under section 3004(u) authority. However, as stated in the July 27, 1990 preamble, EPA intended that the subpart S regulations would be implemented at interim status facilities through section 3008(h) orders, as well as at permitted facilities. 55 FR 30802. In addition, the general applicability of subpart S to section 3008(h) orders was raised as a question by several commenters to the proposal. Thus, in order to make clear that the final CAMU provisions will apply under section 3008(h) and section 3004(u), the CAMU definition contains an explicit reference to 3008(h) orders.

As mentioned earlier, the definition in today's final rule does not specify that a CAMU is a "contiguous area of contamination". This change reflects the basic change in the nature of the CAMU as related to the applicability of LDRs. Under the proposal, the CAMU was in essence linked to where existing contamination was located at the facility. As provided in the final rule, a CAMU instead is linked primarily to where remediation wastes are to be managed. In other words, decisions for designation of CAMUs will now be more related to the function and purpose they will serve in facilitating management of remediation wastes during cleanup, rather than to the areal extent and "contiguousness" of surficial contamination at the facility prior to cleanup. Although these changes to the CAMU definition have provided the discretion for the Regional Administrator to include uncontaminated land areas in a CAMU, the decision factors specified in § 264.552(c) (see § 264.552(c)(3), in particular) make clear that inclusion of uncontaminated areas in a CAMU is only allowed when necessary to achieve the overall remedial goals for the facility, and when such inclusion will enhance the protectiveness of the remedial actions.

In addition to other advantages, this new definition will eliminate many of the drawbacks of the proposed definition that were identified by numerous commenters. For example, many commenters requested clarification as to what was to be considered "contaminated" or "uncontaminated" in the context of defining the areal extent of a CAMU. Such issues could potentially have been contentious and technically difficult to resolve. Likewise, some commenters suggested that the remedial advantages provided by CAMUs would actually create an incentive to contaminate additional areas of facilities. These issues have been effectively eliminated by the final CAMU definition.

The proposed definition also stated that CAMUs could contain "discrete, engineered land-based sub-units". This was intended to make clear that contaminated areas could include solid waste management units (e.g., pre-RCRA impoundments or landfills); it also provided that remediation within a CAMU could involve construction of land-based "sub-units", where wastes could be managed during remediation, or left in place with long-term monitoring and maintenance. Although such sub-units might still be located within a CAMU, today's definition does not explicitly refer to them because, as explained above, CAMUs are now designated with regard to where remedial wastes will be managed, rather than what areas of the facility are "contaminated".

As mentioned in section II of this preamble, EPA outlined in the subpart S proposal an alternative regulatory option for CAMUs that would have broadened the concept in ways similar to today's final CAMU provisions. In addition, EPA received many comments that identified the shortcomings of the proposed CAMU, as well as the advantages that an expanded CAMU would provide in implementing protective, timely and cost-effective remedies. The results of the RIA developed for this rulemaking, in the Agency's estimation, corroborate many of these comments. As a policy matter, therefore, EPA believes that its decision to promulgate today's CAMU definition is amply justified. As explained in detail in section II of this preamble, the Agency also believes that there is ample legal support for today's expanded CAMU definition.

The final CAMU definition also specifies that CAMUs must be used only for the management of remediation wastes. One commenter on the proposal requested that the Agency clarify that only wastes that are generated as part of a facility's corrective action cleanup would be eligible for management within a CAMU. The commenter noted that this restriction was explicitly provided in the temporary unit provisions of the proposal. The Agency's intention, under both the proposed CAMU provisions and under today's final rule is that only wastes that are generated pursuant to implementing corrective actions for a facility can be

[1] The term Regional Administrator, as used in today's rule, refers to the EPA Regional Administrator or the State Hazardous Waste Program Director (or equivalent) in a State authorized for this rule.

managed within a CAMU. Today's CAMU definition thus clarifies this important limitation, by specifying that a CAMU "shall only be used for the management of remediation wastes." (See the following discussion of the definition of remediation waste).

2. Facility for the Purpose of Corrective Action (§ 260.10)

As clarification, today's rule codifies, in § 260.10, the definition of facility for the purposes of corrective action. Under this definition, a facility is "all contiguous property under the control of the owner or operator seeking a Subtitle C permit." This definition is the same as was proposed in the July, 1990 proposal, presented in the First Codification Rule (50 FR 28702, Codification Rule, July 15, 1985), and upheld in a decision of the U.S. District Court of Appeals (*United Technologies v. U.S. EPA*, 821 F.2d 714 (DC Cir. 1987).

As explained in the proposed rule and in the Codification Rule, this definition applies only in the context of implementing HSWA-mandated corrective actions. As such, this definition is distinct from the other facility definition in § 260.10 that is narrower in scope, and applies to the non-corrective-action-related provisions of RCRA subtitle C. EPA believes that codifying this definition is important to the clear understanding of today's CAMU and temporary unit rules. Both types of units are restricted to managing wastes that are generated in implementing corrective action at a "facility". Finalizing this facility definition, therefore, will ensure that this key concept is clear within the definitions of CAMU and remediation wastes (see following discussion).

Although the July, 1990 definition of facility did not explicitly state that this definition applied to facilities undergoing corrective action pursuant to section 3008(h) authority, as with the definition of CAMU, this definition was always intended to apply both to facilities with a RCRA permit and to those operating under interim status. This has been clarified by adding a phrase stating that this definition also applies to facilities implementing corrective action under section 3008(h).

In the July, 1990 proposal, EPA addressed several issues associated with this facility definition, including the concept of "contiguous" property, and EPA's interpretation of "owner or operator". These subsidiary issues will be addressed in the final subpart S rulemaking, and/or in subsequent guidance.

3. Remediation Wastes (§ 260.10)

Today's rule defines remediation wastes as "* * * all solid and hazardous wastes, and all media (including ground water, surface water, soils and sediments) and debris that contain listed hazardous wastes, or which themselves exhibit a hazardous waste characteristic, that are managed at a facility for the purpose of implementing corrective action requirements under § 264.101 and RCRA section 3008(h). For a given facility, remediation wastes may originate only from within the facility boundary, but may include waste managed in implementing RCRA section 3004(v) or section 3008(h) for releases beyond the facility boundary."

This new definition provides clarification as to the types of wastes that may be managed in CAMUs or temporary units. The proposed temporary unit provisions specified that such units would be used only for treatment or storage of wastes "* * * that originated within the boundary of the facility." However, a similar provision was not specified in the proposed CAMU regulations, although the Agency clearly intended that CAMUs would function only for the purpose of implementing corrective action at facilities. 55 FR 30843. One commenter, citing the language in the proposed temporary unit provisions, requested that EPA make clear that CAMUs may be used only to manage wastes that are part of implementing corrective actions under section 3004(u), 3004(v) or 3008(h) authorities. Thus, for the sake of clarity, EPA is promulgating in § 260.10 a definition for remediation wastes; both the CAMU and temporary unit sections of today's rule specify that only remediation wastes can be managed in these units.

Today's definition of remediation waste excludes "new" or as-generated wastes (either hazardous or non-hazardous) that are generated from ongoing industrial operations at a facility. In addition, remediation wastes must have originated from the facility (including waste managed as a result of section 3004(v) or section 3008(h) corrective action). Wastes generated as part of the site investigations (e.g., drilling muds, etc.) are considered to be remediation wastes.

In limiting remediation wastes to those that have "originated" from the facility, it should be clear that this term refers to wastes that originate from remedial activities at the facility, rather than where such wastes might first have been produced. For example, some facilities, such as commercial waste management facilities, may have accepted wastes from off-site, but which have subsequently contributed to contamination problems at the facility, and thus need remediation. Such waste would be considered remediation wastes for that facility when they are managed in the course of conducting corrective action requirements under § 264.101 or 3008(h).

Although the definition of remediation wastes includes non-hazardous solid wastes, it should be noted that management of such wastes would not require the designation of a CAMU or a temporary unit, since subtitle C requirements would not apply to management of those wastes.

Contaminated media in the context of this rule includes groundwater, surface water, soils and sediments that contain listed hazardous wastes or that themselves exhibit a hazardous waste characteristic. Like other remediation wastes, these media can be managed within the CAMU even if they were originally located at the facility, but outside of the CAMU, or if they were associated with a release that had migrated beyond the facility boundary, and that was being remediated under section 3004(v) or section 3008(h) authorities. Debris, for the purpose of this rule, is as defined in § 268.2. (See 57 FR 37270).

The definition of remediation wastes does not include wastes from outside the facility undergoing remediation, other than those associated with off-site releases being managed under section 3004(v) or section 3008(h). If wastes are transported to the facility from an outside source, they would not be considered remediation waste for that facility, regardless of whether those wastes were the result of some type of remedial action conducted at another facility. Therefore, those wastes could not be managed in a temporary unit or in a CAMU at that facility. Similarly, wastes that are excavated, transported to an off-site treatment facility, and returned to the facility are not remediation wastes under this rule.

EPA believes that restricting the definition of remediation wastes in today's rule is important to preserving the concept of CAMUs and temporary units as units to be used only for the purpose of remediating the facility at which these units are located. Wastes which leave a facility for off-site treatment are no longer subject to direct oversight, and it may be difficult to ensure that the wastes that are returned after treatment are actually the same wastes that left the facility originally. Fundamentally, the Agency is concerned that allowing wastes from

off-site to be managed in CAMUs or temporary units could create an undesirable incentive for such units to "attract" wastes that are not legitimately linked to the objective of remediating that facility.

4. Conforming Changes

a. *Conforming change to § 264.101.* The proposed subpart S regulations were to have replaced the current corrective action regulatory provisions codified in § 264.101. However, since the Agency is not finalizing all of subpart S in today's final rule, § 264.101 is being retained and the amendment to § 264.101 promulgated today creates a link between the general corrective action requirements of § 264.101 and the CAMU and temporary unit provisions of subpart S. This is necessary to make clear that these sections together now constitute the regulatory provisions for corrective action under sections 3004(u) and (v), and section 3008(h).

b. *Conforming changes to § 264.3 and § 265.1.* As discussed earlier in this section of today's preamble, the definitions of CAMU and remediation waste specify, as a clarification of the subpart S proposal, that the final CAMU and temporary unit provisions apply to interim status facilities undergoing corrective action according to section 3008(h) authority, as well as to permitted facilities. In effect, these corrective action provisions promulgated under subpart S of part 264 will be the only part 264 requirements that actually apply to interim status facilities; heretofore, technical requirements for interim status facilities were specified only under part 265. Therefore, conforming changes are necessary for the regulatory provisions of § 264.3, so as to address the relationship of the part 264 standards to interim status facilities, and to § 265.1, so as to specify the applicability of part 265 regulations. In effect, these two conforming changes create a bridge between the interim status regulations and the regulations for permitted facilities, for the purpose of implementing today's CAMU and temporary unit regulations.

c. *Conforming changes to Definitions in § 260.10, § 268.2 and § 270.2.* Today's rules also make several conforming changes to existing regulatory definitions that are specified in various sections of the subtitle C regulations. The specific definitions being modified are:

- The definition of "disposal facility" in § 260.10 and § 270.2;
- The definition of "land disposal" in § 268.2;
- The definition of "landfill" in § 260.10; and
- The definition of "miscellaneous units" in § 260.10.

The changes to the definitions of "disposal facility" and "land disposal" are for the purpose of clarifying how LDRs apply to CAMUs. As discussed earlier in this preamble, LDRs will not apply to hazardous remediation wastes that are placed into a CAMU, since such placement is not considered "land disposal" for the purposes of section 3004(k). These existing definitions must therefore be modified to reflect this important concept. The conforming changes to the definitions of "landfill" and "miscellaneous units" are both intended to clarify that such units do not include CAMUs.

B. Corrective Action Management Units (CAMUs) (§ 264.552)

1. General Authority (§ 264.552(a))

The general authority for allowing the Regional Administrator to designate a CAMU for remedial purposes is presented in § 264.552(a). This provision is analogous to the CAMU provision specified at § 264.551(c) in the proposed subpart S regulations. This final provision specifies, for clarification, that CAMUs may be designated for purposes of implementing corrective action under section 3008(h) authority, as well as at permitted facilities under section 3004(u) and § 264.101. This explicit reference to section 3008(h) order authority conforms with similar references in other provisions of today's rule (see, e.g., the definitions of CAMU and remediation waste). The provisions of today's rule that delineate the relationship of the subpart S regulations to section 3008(h) orders are in response to commenters who requested a general clarification of the relationship of the subpart S proposed rules to section 3008(h) orders.

In the July, 1990 proposed rule, CAMUs were identified as areas of contiguous contamination. Today's rule in § 264.552(a) has eliminated the provision that a CAMU must be a contiguously contaminated area of a facility. As explained earlier in today's preamble (see discussion of the CAMU definition in § 260.10), the expanded CAMU concept is linked primarily to where remediation wastes will be managed at the facility, rather than where there may be contiguous, surficially contaminated land areas prior to cleanup. Specific criteria regarding how CAMUs must be designated, and how the existence of contaminated land areas may affect CAMU decisions, are specified under § 264.552(c) of today's rule.

The language of § 264.552(a) specifies that the Regional Administrator may designate a CAMU "in accordance with the requirements of this section" (i.e., 264.552). This language, which did not appear in the proposal, simply clarifies that the requirements for CAMUs have been consolidated into a separate section. In the proposed rule, CAMUs were addressed as part of a section that dealt generally with management of hazardous wastes.

Section 264.552(a) also specifies that one or more CAMUs may be designated at a facility. This statement is included for clarification; the Agency received a number of comments on the proposal which queried how CAMUs might address situations where several non-contiguous areas of a facility were contaminated. In addition, given the expanded CAMU concept promulgated in today's rule, EPA believes that this explicit statement in the CAMU regulations will be useful in clarifying that two or more CAMUs may be necessary and appropriate to implementing remedial solutions for a given facility.

As discussed earlier in this preamble, the CAMU provisions in today's final rule codify an expanded version of the CAMU concept that was presented in the proposed subpart S rule. In particular, § 264.552(a) (1) and (2) specify the essential regulatory basis for the expanded CAMU:

(1) Placement of remediation wastes into or within a CAMU does not constitute land disposal of hazardous wastes; and

(2) Consolidation or placement of remediation wastes into or within a CAMU does not constitute creation of a unit subject to MTRs.

These provisions are derived from those in the proposed CAMU regulations. The primary difference reflected in today's rule is that placement "into" a CAMU does not trigger LDRs or MTRs, whereas the proposal stated only that those requirements would not apply when hazardous wastes were moved or consolidated within the CAMU. This important distinction primarily derives from the fact that under these final CAMU rules, placement of hazardous remediation wastes into a CAMU is not "land disposal," under RCRA section 3004(k). A detailed explanation of the Agency's rationale for adopting this expanded CAMU concept is presented in section II of this preamble.

The final CAMU regulations will greatly enhance the waste management flexibility provided by CAMUs, and

thereby will enhance EPA's ability to select and implement effective, protective, reliable and cost-effective remedies for RCRA facilities. These general conclusions regarding the positive remedial results that the CAMU will provide are supported by the preliminary analyses developed by the Agency that were made available for public review and comment as part of this rulemaking process (57 FR 48195 (Oct. 22, 1992)), and that are summarized in section VIII of today's preamble.

The following is a discussion of some specific waste management scenarios (and limitations) that will be operative under today's CAMU provisions.

a. As with the proposed CAMU, movement and consolidation of remediation wastes within a designated CAMU will not be subject to LDRs or other hazardous wasteland disposal unit requirements. Likewise, the CAMU would not be subject to MTRs, since it is not a landfill, surface impoundment or waste pile and thus is not subject to MTRs under sections 3004(o) and 3015. (See e.g., § 264.301(c)).

b. Placement of remediation wastes into a CAMU from an area or unit at the facility, but outside the CAMU, will not trigger LDRs or MTRs, for the reasons cited above.

c. Movement and subsequent placement of remediation wastes from one CAMU at a facility into another CAMU at the facility will also not trigger LDRs or MTRs.

d. Excavation of remediation wastes from a CAMU, and placement of those wastes into a land-based unit that is not a CAMU (either at the facility or off-site) will be subject to applicable LDRs and MTRs.

e. Excavation of remediation wastes from a CAMU, treatment on-site in another unit (such as a tank, temporary unit or an incinerator), and redeposition of those wastes or residuals into the CAMU will not trigger LDRs or MTRs.

f. Non-land-based units, such as tanks, may be physically located within the boundaries of a CAMU. However, the tank will not actually be a part of the CAMU; it would maintain its separate regulatory identity, and all applicable subtitle C requirements will continue to apply to the tank.

g. Temporary units (as provided under § 264.553 of today's rule) can also be located either inside or outside the physical boundaries of a CAMU. However, such location will not affect the requirements that apply to the temporary unit, for the same reasons as for non-temporary tanks or container storage areas. (See further discussion of the relationship between TUs and CAMUs in section III.C.)

In addition to the waste management activities outlined above, under today's CAMU rule, land-based waste management activities within a CAMU that may otherwise be subject to unit-specific standards under part 264 or 265, may be considered as part of the CAMU, rather than as a distinct and separate "unit". For example, wastes are often excavated and staged in piles before being transported to a treatment unit. Under a CAMU, the area where the wastes are piled would not be considered a separate "waste pile" unit for RCRA purposes; rather, the Regional Administrator will specify technical standards for that area of the CAMU (e.g., liners, wind dispersion controls, closure requirements) according to the decision criteria in § 264.552(c). Similarly, areas of a CAMU could also be used for land-based treatment processes, such as bioremediation systems that involve structures or equipment to maintain optimal treatment conditions.

2. Inclusion of Regulated Units Into CAMUs (§ 264.552(b))

Given the remedial flexibility afforded by the CAMU provision in today's final rule, EPA anticipates that there may be situations where a CAMU would be useful in promoting effective remedial actions involving "regulated units", as well as SWMUs and other contaminated areas of a facility. Regulated units, as defined in § 264.90(a)(2), are landfills, surface impoundments, waste piles and land treatment units that received hazardous wastes after July 26, 1982. These units are subject to full subtitle C design, operating, closure and post-closure, and financial responsibility requirements under subparts F, G and H, and the unit specific requirements of part 264 or 265. Regulated units thus have a well defined regulatory identity, and can be either operating, closing, or closed units.

Although the 1990 CAMU regulations, as proposed, provided for the incorporation of regulated units into the corrective action remedy at the facility (see proposed § 264.526(c)), the proposal did not explicitly address how and under what circumstance regulated units could be incorporated into CAMUs. One commenter on the proposal suggested that regulated units should be able to be included within CAMUs, if it were to make practical sense. Another commenter suggested that, while it might be advantageous to include one regulated unit within a CAMU, allowing more than one regulated unit to be included within a CAMU could create improper incentives for owner/operators to mismanage wastes so as to create contamination between regulated units, and thereby obtain a larger CAMU. The same commenter also argued that all permitted regulated units should remain separate units throughout the corrective action.

EPA believes that in certain circumstances, inclusion of one or more regulated units as part of a CAMU may be appropriate, and may enhance implementation of sensible remedial actions for a facility. One example could involve a situation where a closing regulated unit (e.g., a surface impoundment) contained a volume of hazardous waste sludges. Under the existing subtitle C closure regulations, the owner/operator could be required to remediate the surface impoundment (e.g., by removing and treating some or all of the sludges). However, by designating the surface impoundment as a CAMU or as part of a CAMU, EPA could allow treatment of the sludges and redeposition of the treatment residuals back into the impoundment without triggering LDRs. Thus, use of a CAMU could provide for more flexibility in selecting among effective and protective waste management options for closing regulated units.

Another example might be a facility undergoing remediation, that also includes a closing regulated landfill unit that was constructed in accordance with the RCRA minimum technology standards. By designating the regulated unit as a CAMU or as part of a CAMU, remediation wastes from elsewhere at the facility could be placed into the unit, which would then be closed. Thus, use of this existing MTR unit would be a highly protective, cost-effective, and expeditious remedial solution for the facility.

EPA believes that the Regional Administrator should have the discretion, in certain well defined circumstances, to designate a regulated unit as a CAMU, or to include a regulated unit as part of a larger CAMU. Today's final rule provides this authority, under § 264.552(b). In addition, this provision specifies two important limitations to this authority. First, only closed or closing units (i.e., those units required to begin the closure process under § 264.113 or § 265.113), would be able to be so designated. Operating regulated units, including regulated units continuing to operate under delay of closure provisions (in § 264.113 or § 265.113), would not be eligible for designation as CAMUs. Such units will continue to receive and manage non-remediation wastes, and

EPA does not believe that designating, as a CAMU, a regulated unit that would subsequently continue operating, is consistent with the general concept of a CAMU being a unit that functions solely for the purpose of facilitating management of remediation wastes.

Second, the Regional Administrator will have the authority to designate a regulated unit as a CAMU, or as a part of a larger CAMU, only if doing so will enhance implementation of an effective, protective and reliable remedy for the facility (see § 264.552(b)(1)(ii)). As illustrated in the examples described above, EPA believes that there may be a number of situations where this would be the case. This requirement is consistent with the overall objective of CAMUs in implementing corrective actions, as outlined in the decision criteria for CAMUs specified in today's rule (see § 264.552(c)).

Today's rule also provides that for any regulated unit that is designated by the Regional Administrator as a CAMU or as part of a CAMU, the applicable part 264 or 265 ground-water monitoring, closure and post-closure, and financial responsibility requirements would continue to apply to the unit as before. (See § 264.552(b)(2).) Inclusion of a regulated unit within a larger CAMU, however, would not cause the entire CAMU to become subject to the standards applicable to the regulated unit. In this case, the part 264 and 265 requirements would apply only to that portion of the CAMU that was originally the regulated unit.

EPA believes that maintaining the applicability of part 264 or 265 standards to regulated units that are included in CAMUs is a logical and conservative approach, which will provide substantial remedial benefits while ensuring that the stringent prevention-oriented requirements of parts 264 and 265 will continue to apply to such units.

EPA expects, on the other hand, that there could be situations in which it would be appropriate in remediating a facility to include a regulated unit in a CAMU, but where it would not make sense to continue treating that specific portion of the CAMU separately according to the applicable part 264 or 265 regulated unit standards. In some situations, therefore, it might be sensible to allow the Regional Administrator the discretion to prescribe requirements for ground-water monitoring and closure/post closure for that portion of the CAMU in the context of the overall remediation of the CAMU, rather than continuing to strictly apply the part 264 or 265 requirements. However, there are a number of issues associated with this particular scenario that EPA believes merit further consideration, and thus EPA has not, in this final rule, provided for such discretion. However, the Agency intends to address this issue and request comment in an upcoming proposed rule addressing changes to certain RCRA closure regulations for regulated units, entitled "Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Units; Post-Closure Permit Requirement; Definition of Unit for Closure; Closure Process."

In situations where regulated units are located within an area that has been designated as a CAMU, but the regulated unit will not be used for remedial purposes and was therefore not designated part of the CAMU, the regulated unit will remain a distinct and separate unit subject to all applicable subtitle C requirements.

For situations where a regulated unit is designated as or is incorporated into a CAMU, issues may arise as to the respective roles of EPA and the State with regard to oversight and enforcement of part 264 or 265 standards that remain applicable to that portion of the CAMU. As a general rule, the State would retain implementation responsibility for the State analogues to parts 264 and 265, that continue to apply with respect to that area of the CAMU that, prior to the CAMU designation, was identified by the State as the regulated unit. Further discussion of Federal and State roles in implementing CAMUs, and this role in particular, is presented in section IV.C. of this preamble.

3. Decision Criteria for CAMU Designation (§ 264.552(c))

Section 264.552(c) specifies decision criteria which will apply to CAMUs and which will be the basis for the Regional Administrator (RA) to make CAMU determinations. These criteria in today's rule are either clarifications of the decision factors for CAMUs in the proposed rule (in § 264.551(c)(3)) or are outgrowths of the proposed subpart S remedy selection decision framework (in § 264.525(a)–(c)).

In the proposed subpart S, EPA identified four main factors that an RA would consider in designating a CAMU. (Sections 264.551(c)(3)(i)–(iv), as proposed.) In addition, under the proposal, CAMUs would have been subject to the overall remedy selection decision framework. As proposed, the remedy selection decision framework presented four standards that remedies must meet, five additional decision factors, and six factors for review in setting the remedy schedule. (Sections 264.525(a)–(c), as proposed.) A key element of a selected remedy is the decision as to how wastes are to be managed during remediation. The CAMU, as promulgated in today's rule, is an important concept in implementing remediation waste management. Therefore, because the remedy selection standards and factors proposed in subpart S are not being finalized today, the Agency believes it is necessary to explicitly incorporate or to capture the intent of several of the proposed rule remedy selection factors in today's rule so as to guide CAMU designations. A number of commenters voiced support for the remedy selection standards and factors. One commenter stated that EPA should retain the factors in the final rule because they are a reasonable and comprehensive mix of considerations. The specific factors addressed in today's rule are discussed under each criterion as applicable.

Of the four CAMU decision factors presented in the July, 1990 proposal, three are not explicitly delineated in this final rule (only the second factor remains). (See proposed § 264.551(c)(3)(i), (iii), and (iv).) The first factor specified in the proposal was that the RA consider the nature, extent, and location of surficial contamination at the facility. As mentioned in today's preamble discussion of the CAMU definition, designation of a CAMU is not determined by the presence of contiguously contaminated areas at the facility. Rather, CAMUs will be designated according to where remediation waste management will occur at the facility. Therefore, although the existing contamination may in some cases be relevant to CAMU decisions (see discussion of the third CAMU decision criterion, § 264.552(c)(3)), there is no longer a need for a specific provision to dictate CAMU boundaries according to the presence of surficial contamination.

The third CAMU consideration in the proposal was that the RA would consider the practicability of alternative remedial approaches. This factor was originally included, because, in general, remedial alternatives which did not employ CAMUs would involve two basic choices—in situ remediation or excavation and treatment to best demonstrate available technology (BDAT) levels. In some cases, these alternatives might have been considered impracticable by the RA. However, given today's expanded CAMU definition, and the increased variety of remedial options that will be enabled under this final rule, EPA believes that CAMU decisions will be more focused on selecting the most appropriate

remedial alternative(s) for the facility from a wide range of potentially viable approaches, rather than choosing between CAMU vs. non-CAMU options. The decision criteria in today's rule provide a more comprehensive decision framework for CAMUs than the proposal; thus the third general factor proposed in § 264.551(c)(3)(iii) is unnecessary and has been deleted in today's rule.

The fourth factor presented in the July, 1990 proposal was to allow the RA to consider "other relevant factors" in designating a CAMU. Several commenters requested that the Agency clarify what will be considered by the Regional Administrator in the designation of a CAMU. They requested that the Agency provide more information on the specific criteria that will be used to determine a CAMU designation and that these criteria be promulgated in the final regulation. The Agency agrees that replacing this general catch-all consideration with the more focused criteria presented today will better guide the designation of CAMUs. The Agency is therefore promulgating, in § 264.552(c) of today's rule, the more specific criteria for designating CAMUs.

The RA will consider each of the decision criteria under § 264.552(c) in designating a CAMU. These decision criteria are intended to clarify the objectives that CAMUs should serve, and the limitations that apply to their scope and use. The RA will document the rationale for designating a CAMU and will explain the basis for such designation. Such rationale will be incorporated as part of the permit or order modification documentation, or in the remedy selection documentation under a new order for that facility and will be available to the public (§ 264.552(f)). Documentation of CAMU decisions is analogous to the documentation the Agency must currently make to support the selection of a remedy. Therefore, if a CAMU is selected as part of a final remedy, such an explanation would be incorporated into the Statement of Basis for that remedy (See OSWER Directive Number: 9902.6). The rationale for a CAMU decision will generally address only those criteria that are considered determinative for a given CAMU designation. For example, when a CAMU includes uncontaminated land on which remediation waste management will occur, the rationale supporting this inclusion will be specified. However, if remediation wastes will only be managed on contaminated land as defined by the CAMU, this criterion need not be addressed.

Section 264.552(c)(1): Facilitation of Reliable, Effective, Protective, and Cost-Effective Remedies.

The first decision criterion requires that the Regional Administrator determine that the CAMU will facilitate the implementation of a reliable, effective, protective, and cost-effective remedy. This factor was specified in the July, 1990 proposal as a CAMU determination factor. (§ 264.551(c)(3)(ii)(B), as proposed.) No comments were received specifically on this factor as proposed. Therefore, the Agency is finalizing this factor as a criterion. By including this criterion, the Agency is emphasizing that a CAMU is not intended as a mechanism that will undercut the protectiveness of remedies; rather, CAMUs will facilitate the implementation of more reliable, effective, protective, and cost-effective remedies. If an owner/operator cannot provide information to support that a CAMU will result in remediation activities with these qualities, it will not be designated by the Regional Administrator. The Agency does not intend that evaluation of this CAMU decision criterion will require a detailed cost/benefit or other quantitative analyses. Protectiveness, effectiveness, reliability and cost information provided by the owner/operator will be considered along with other relevant information in making CAMU decisions.

Section 264.552(c)(2): Risks During Remediation

The second decision criterion specifies that remediation waste management associated with CAMUs cannot create unacceptable risks to human health or the environment from exposure to hazardous wastes or hazardous constituents. The basis for this factor is the remedy selection decision factor addressing "short-term effectiveness" (§ 264.525(b)(3)) as presented in the July, 1990 proposal. Remedies will often involve management, including treatment, storage or disposal, of large volumes of wastes that could potentially lead to exposure from windblown particulates, air emissions during excavation and transportation, or other short-term risks due to the implementation of CAMUs in densely populated areas, or where waste characteristics are such that risks to workers are high and special protective measures are needed. Since CAMUs are likely to actually increase the amounts of wastes that are remediated, this provision is intended to ensure that remediation waste management activities are conducted so as to control short-term risks that could potentially occur from remedial activities. This factor will ensure that potential short-term risks from remediation activities will be carefully examined as part of any CAMU designation, and will be carefully controlled during remedy implementation.

In response to a commenter who requested clarification, consideration of this criterion does not require a quantitative risk assessment. As with the other criteria presented today, qualitative assessments will generally be sufficient unless the RA deems that more quantitative data are necessary.

Several commenters noted that the short-term effectiveness remedy decision factor in the proposal, and the proposed remedy selection standard of protectiveness of human health and the environment, are redundant. The first decision criterion in today's rule is meant to embody the general RCRA mandate of protection of human health and the environment by including the goal of facilitating protectiveness in CAMU designations. However, even though there may be some overlap between some of the other criteria finalized today and the general qualities of effectiveness, protectiveness, reliability and cost-effectiveness stated in the first criterion, both the general criterion and the clarification of particular aspects of CAMUs under the specific criteria are important and necessary. The general criterion specifies the critical objective of the decision, while the more specific criteria clarify the Agency's intent regarding particular important aspects of the decisionmaking process for CAMUs.

Section 264.552(c)(3): Uncontaminated Areas

The third decision criterion requires the Regional Administrator to ensure that any land area of a facility that is not already contaminated (i.e., where there is no soil contamination or where wastes are not already located) will be included within a CAMU only if remediation waste management at such an area will, in the RA's opinion, be more protective than management of such wastes at contaminated areas of the facility. As explained in the preamble to the proposed subpart S, EPA believes that it is generally inadvisable to extend a CAMU to include areas of facilities that have not been environmentally degraded by historic waste management practices. The proposed rule, in fact, prohibited the inclusion of uncontaminated land areas in CAMUs. Any waste management that occurred

on such land would have needed to meet all applicable subtitle C standards, including the LDRs. However, EPA received comments on this proposed CAMU provision that offered explanations as to why, in some circumstances, the effectiveness of a remedial action could be enhanced by including such areas in CAMUs. These comments fell into two main categories. First, commenters noted that the Agency was not being realistic in the proposal by requiring contiguous contamination, because this would mean that two SWMUs with similar wastes, if separated by a small strip of uncontaminated land, could not be considered one CAMU, thereby arbitrarily limiting effective remediation options. Second, commenters noted that the Agency should allow the inclusion of uncontaminated land areas within a CAMU if such areas are necessary to implement the remedial response.

The first category of comments has been largely addressed by the expanded definition of the CAMU being finalized today. That is, movement of wastes between CAMUs will not trigger the land disposal restrictions; therefore, either or both of the SWMUs, that are separated by a small amount of uncontaminated land area, could be designated as individual CAMUs. Thus, the transfer of waste from one CAMU (or a SWMU) into a CAMU would not be limited by application of RCRA disposal requirements. However, the Agency recognizes that the CAMU is a land-based unit that must be designated by actual physical boundaries identified in the permit or order (see § 264.552(e)(1)). EPA expects that it will not always be realistic to designate a CAMU as an area that is "completely" contaminated. Small areas of uncontaminated land may often exist within a broader area of contamination. In such cases, as one commenter suggested, the RA will generally include permit or order conditions preventing contamination of this uncontaminated land during remediation.

The second category of comments addressed situations where it may be desirable to include uncontaminated land within a CAMU for the purpose of using that land for remediation waste management. For example, a SWMU at a facility may be located within a flood plain. The remedial option which makes most sense could be to move this SWMU to higher ground at the facility. However, if the higher ground was not historically "contaminated" (e.g., because it had been used only for general commercial activities), it could not have been designated under the proposal as part of a CAMU. Today's rule would allow the facility owner/operator and the Regional Administrator to consider options that involve movement of wastes out of the flood plain, and management of such wastes in an uncontaminated area of the facility.

It might also be appropriate to include small portions of uncontaminated land within a CAMU when remediation activity cannot be conducted on or within the contaminated area itself. For example, remediation of a lagoon containing sludges may not be possible within the lagoon. If the Regional Administrator included the lagoon and a small portion of uncontaminated land immediately adjacent to the lagoon within the CAMU, remediation activities, such as staging of wastes or bioremediation, could take place. This scenario may be especially relevant to facilities composed of relatively small land areas, where there may be few options as to where remedial activities can be conducted.

The Agency agrees with commenters that the situations discussed above are realistic and today's rule allows the RA to consider such options on a case-by-case basis. To include previously uncontaminated land areas within a CAMU, for the purpose of remediation waste management, the Regional Administrator will be required to determine that such management in these areas is more protective than managing the remediation wastes in the flood plain (as in the above example) or in other areas of the facility that are "contaminated". In addition, the Agency may consider, as a part of this determination, that movement of wastes for remediation at contaminated areas of the facility could involve greater risks of exposure to human health and the environment than protective remediation options utilizing uncontaminated land directly adjacent to the contaminated area.

By specifying under this decision factor that uncontaminated areas of the facility may be included in a CAMU only when doing so is "more protective" than managing such wastes at contaminated areas of the facility, EPA does not intend that formal risk assessments or other quantitative analyses must be performed to support such decisions. As a general rule, EPA believes that more qualitative assessments of the relative protectiveness of remedial options will be sufficient to support such decisions. The Regional Administrator would have the authority, however, to require that more quantitative analyses be provided by the owner/operator, if necessary.

By clearly defining, under this decision factor, the circumstances in which uncontaminated areas of a facility may be included in a CAMU for remediation waste management purposes, EPA believes that the Agency has alleviated the concern raised in the July, 1990 proposal preamble, that uncontaminated land should not be included in a CAMU because it would frustrate the remedial purpose of the CAMU. Under today's rule, inclusion of such areas within CAMUs will be allowed only if doing so is consistent with the overall remedial objective of the CAMU and will, in fact, be more protective than management of such wastes at contaminated areas of the facility.

Section 264.552(c)(4): Minimizing Future Releases

The fourth decision criterion specifies that areas within a CAMU where wastes will remain in place after closure of the CAMU are to be managed and contained so as to minimize future releases, to the extent practicable. This is a logical outgrowth from the closure provisions that were proposed in subpart S for CAMUs. (See proposed § 264.551(c)(5)).

In the preamble to the proposed rule, the Agency stated that the closure and post-closure provisions were intended to ensure that adequate long-term controls are imposed for any wastes remaining within the CAMU. 55 FR 30844. This decision criterion is intended to make clear that the Regional Administrator must consider at the time of CAMU designation whether long-term reliability and effectiveness will be ensured through the implementation of a CAMU, particularly when it is necessary to leave wastes in place after implementation of remedial activities.

One commenter suggested that the Agency clarify the fact that final closure of the CAMU must be examined very carefully. Therefore, although this decision criterion closely parallels the closure provision for CAMUs, EPA believes that eventual closure of the CAMU is an important enough factor that it should be highlighted at the time the Regional Administrator is making the decision to designate a CAMU. Any CAMU decision must consider, as a primary objective, the long-term (i.e., post-closure) reliability and effectiveness of CAMU-related remedial actions.

Section 264.552(c)(5): Timing

The fifth decision criterion specifies that the CAMU will expedite the timing of remedy implementation, when appropriate and practicable. This criterion is an outgrowth of the

requirement in the proposed rule that, in designating a CAMU, the Regional Administrator consider whether the CAMU would benefit remediation at the facility by expediting the timing of the remedy implementation. (See proposed § 264.551(c)(3)(ii)(A)). No comments were received on this proposed CAMU decision factor. Therefore, the Agency is finalizing this factor as a CAMU designation criterion in today's rule.

The Regional Administrator is encouraged to utilize CAMUs if they will assist in eliminating unnecessary delays and will encourage a faster pace to remediation. However, it should be understood that CAMUs may not always result in remedies that take less time. By allowing for on-site waste management and use of innovative technologies, the resulting remedial actions may take longer to complete than, for example, excavating all wastes and transporting them to commercial treatment or disposal facilities. Thus, this decision criterion only requires that a CAMU expedite remedial timeframes when it is appropriate and practicable, in consideration of the other remedial objectives for the facility.

Section 264.552(c)(6): Enhancing Long-term Effectiveness

The sixth decision criterion requires the Regional Administrator to use, as appropriate, treatment technologies (including innovative technologies) to enhance the long-term effectiveness of the remedial actions at the facility by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the CAMU. This is an outgrowth from the remedy selection decision factors relating to reduction of toxicity, mobility and volume of wastes, and long-term reliability and effectiveness. (See proposed § 264.525(b)(1) and (b)(2)). It is also analogous to the preference under CERCLA for treatment-based remedies (55 FR 8666, Mar. 6, 1990). The proposed rule preamble discusses two Agency preferences supporting this criterion: (1) "As a general goal, remedies will be preferred that employ techniques, such as treatment technologies, that are capable of permanently reducing the overall degree of risk posed by the wastes and constituents at the facility;" and (2) "Source control technologies that involve treatment of wastes, or that otherwise do not rely on containment structures or systems to ensure against future releases, will be strongly preferred to those that offer more temporary or less reliable controls." (55 FR 30824). EPA believes as a general rule that long-term reliability and protectiveness of remedial activities is directly tied to effective treatment of wastes that pose future release threats.

EPA received comments requesting clarification as to whether under this decision factor, EPA was disallowing caps or other forms of containment, stabilization/fixation or other technically sound remedies. The Agency responds by stating that this criterion does not preclude remedial actions that do not employ treatment, as long as they are capable of ensuring long-term effectiveness. As a general rule, the Agency believes that treatment provides greater long-term effectiveness than containment alone, but that in certain circumstances, the Agency may consider containment to be sufficiently effective. A commenter also suggested that the Agency add a new remedy decision factor—the ability of the remedy to leave hazardous wastes in their least environmentally threatening state. EPA believes the objective of such a factor is consistent with this sixth criterion, and therefore an additional factor is not necessary.

Another commenter requested that EPA clarify that there is no relative preference between toxicity reduction, mobility reduction or volume reduction. The Agency agrees with this commenter because the decision as to which characteristic of the waste (i.e., toxicity, mobility, or volume) can be reduced will be a case-by-case determination. In some cases, for example, a reduction in volume will not be possible (e.g., with metals), however, mobility reduction may be possible. Therefore, any preference between such types of treatment will be determined by site and waste specific characteristics that will guide or limit remedial options.

One commenter stated that section 3004(u) provides no statutory basis to establish a preference for remedies that involve treatment or that otherwise do not rely on containment systems or structures. The Agency strongly disagrees with this comment. As noted in the preamble to the July 1990 proposal, EPA believes that long-term reliability of remedies is an essential element in ensuring that actions under sections 3004(u) and 3008(h) satisfy the fundamental mandate of RCRA to protect human health and the environment, and that the reduction of toxicity, mobility or volume is a primary means of achieving such long-term reliability. 55 FR 30824. Moreover, EPA's experience under the RCRA program, and the primary focus of Congress in enacting the 1984 amendments to RCRA, is that reliance on containment structures rather than treatment generally should be discouraged, since land disposal of untreated hazardous wastes cannot provide reliable protection of human health and the environment over the long term. See, e.g., RCRA section 1002(b)(7).

Another commenter noted that the factor addressing reduction in toxicity, mobility, and volume should not be applied to or should not be emphasized in situations which involve high volume, low toxicity wastes, e.g., broad area-wide contamination. As discussed earlier, the decision factor in the proposal that addressed reduction of toxicity, mobility, and volume was not intended to preclude remedial alternatives that did not employ treatment, so long as such options could ensure long-term effectiveness of the remedy. Given the example, therefore, of a situation involving large volumes of low concentration contaminated soils or other wastes, the RA would have the discretion to evaluate containment-based remedial approaches. However, the final decision as to whether treatment of such wastes is necessary and appropriate, and if so what kind of treatment should be done, will necessarily be made on a case-by-case basis.

EPA also encouraged, in the subpart S proposal, that facilities consider "utilizing emerging technologies not yet widely available which may offer significant advantages over currently available technologies." (55 FR 30825; proposed § 264.525(c)(4).) CAMUs may be particularly helpful to the implementation of effective innovative treatment technologies, which in the past have had limited application due to the waste management constraints imposed by the land disposal restrictions.

Several commenters were very supportive of EPA's encouragement of innovative technologies. One commenter, however, stated that the use of an emerging technology should not be compelled, because a particular technology may not have been field tested and may involve greater monetary and time commitment than is necessary to remediate a given facility. EPA did not intend that this criterion mandate the use of innovative technologies. However, an RA, in conjunction with the owner/operator, may decide to utilize the flexibility of the CAMU to implement an innovative technology that could not have been used given the waste management restrictions of subtitle C, most notably the LDRs. This criterion is intended to support and encourage the implementation of innovative technologies when they can

be utilized to reach the overall remediation goals at the facility.

Section 264.552(c)(7): Minimizing Land Areas Where Wastes Will Remain in Place

The seventh decision criterion requires the Regional Administrator to determine that the CAMU will minimize the land area of the facility upon which wastes will remain in place after closure, to the extent practicable. The CAMU, as presented in today's rule, will promote consolidation of remediation wastes into smaller, discrete areas of the facility, that are suitable as long-term repositories for the wastes, and which can be effectively managed and monitored over the long term.

EPA believes that the objective of minimizing the land area at which remediation wastes will remain in place at a facility after closure of the CAMU is consistent with the overall goal of achieving effective, protective remedies with long-term reliability. In some cases, broad areas of a facility (such as a series of large impoundments) could be capped without consolidation of the wastes. However, this approach could complicate monitoring for ground-water releases and could require an extensive maintenance program (e.g., for the cap and for other containment systems). In addition, as a practical matter development of the facility property (for future beneficial uses or by the owner/operator) may be less constrained if a relatively small area of the facility were dedicated to continued long-term containment of remediation wastes.

EPA believes that the objective of minimizing the land-area in which wastes will remain in place is consistent with, and complements, the other objectives for CAMUs that are expressed in the other six CAMU decision factors. In particular, it is consistent with one of the important objectives stated in the proposed subpart S regulations, which stated that "[t]he Agency intends to place special emphasis in selecting remedies on the ability of any remedial approach to provide adequate protection of human health and the environment over the long-term."(55 FR 30824) The comments received regarding long-term reliability and effectiveness did not oppose this overall objective, but raised issues as to how the Agency meant to implement it. These comments were discussed under the above criteria. With regard to this criterion, reducing the land area of wastes remaining in place, in conjunction with a reduction in toxicity, mobility, and volume, is intended to clarify this means of improving long-term effectiveness and reliability.

4. Information Required To Support CAMU Designation (§ 264.552(d))

An owner/operator must provide, as a result of facility investigations, remedial studies, or other site-specific analyses, information sufficient for the Regional Administrator to assess the decision criteria specified in § 264.552(c) as they relate to the implementation of a CAMU at a given facility. This information can be requested under the authority the RA already possesses under § 264.101.

This requirement of today's rule was not explicitly provided for in the proposed rule; under the proposal such information was to have been furnished to the RA as part of the documentation of the remedial studies (e.g., RCRA Facility Investigations, Corrective Measures Studies) required under the subpart S proposal. Since today's rule finalizes only a portion of the proposal, a specific requirement relating to submission of information to support CAMU decisions is necessary. As such, this requirement is simply an expression of the general authority under 3004(u) and 3008(h) to require information from owner/operators to support corrective action implementation decisions.

5. CAMU Requirements To Be Specified in Permits or Orders (§ 264.552(e))

The proposed subpart S CAMU provisions outlined explicit requirements for closure and post-closure of CAMUs that the Regional Administrator would be required to include in the permit or order. Some commenters on the proposal suggested that the regulation should provide a more comprehensive listing of the requirements that would have to be specified in the permit (or order). EPA agrees that a more comprehensive listing of these requirements will clarify the specific requirements that must be addressed for CAMUs in permits and orders. Thus, § 264.522(d) outlines additional features of CAMUs that will be contained in permits or orders.

Section 264.552(e)(1) clarifies that in designating a CAMU at a facility, the Regional Administrator will specify in the permit or order the actual areal extent or configuration of the CAMU. This is a logical outgrowth of one of the fundamental issues involved with designating CAMUs; that is, determining where at the facility the CAMU is to be physically located, and the specific configuration of the CAMU. EPA expects that permits and orders will generally identify the physical boundaries of CAMUs on a facility map, together with a specific description of the physical boundaries or dimensions of the CAMU.

Section 264.552(e)(2) clarifies that the permit or order will specify how remediation wastes will actually be managed in or as part of a designated CAMU, including specification of design, operating and closure requirements. This is also a logical outgrowth from the proposal. The subpart S proposal anticipated that these types of requirements would be specified for CAMUs in a permit modification as part of the overall remedy selected for the facility. Since that portion of subpart S is not being finalized in today's rule, EPA believes that it is appropriate to clearly specify in this rule that these types of requirements must be delineated in permits or orders which establish CAMUs.

As specified in § 264.552(e)(2), requirements will generally be specified for those areas of a CAMU that are to be used for treatment or storage of remediation wastes. Thus, if wastes were to be excavated and bioremediated in an enclosure located within the CAMU, the permit or order would specify the requirements for the bioremediation technology, the design and operation of any structures used for the bioremediation process, the disposition of the treatment residuals, and other associated requirements for those wastes and the areas of the CAMU to be used in managing them. However, as the regulations specify, where a treatment or storage unit separate from a CAMU is already adequately regulated under a facility permit, it would not be necessary to repeat those requirements in the CAMU provisions of the permit.

Under § 264.552(e)(3), the permit or order must also establish the ground-water monitoring requirements for each CAMU. This requirement also derives generally from the subpart S proposal; under the proposal, ground-water monitoring requirements were to be specified as part of the overall facility remedy (see proposed § 264.525(e) and § 264.526). Given that today's rule finalizes only specific portions of the proposal, the Agency believes that it is useful to specify in this rule that ground-water monitoring requirements for CAMU must be specified in the permit or order.

EPA expects that CAMUs will typically be implemented following studies of surface and subsurface contamination at the facility, conducted as part of required remedial investigations. Thus, in most cases, ground-water monitoring systems will already have been installed to

characterize releases to ground water at the facility. Section 264.552(e)(3) is intended to clarify that there will be a continuing responsibility for owner/operators to monitor ground-water quality in the vicinity of the CAMU to ensure that any releases of contaminants from within the CAMU are detected.

This provision does not address the responsibilities of the owner/operator to continue monitoring of releases that are not associated with CAMUs; nor does it address the question of whether ground-water remediation is necessary. Due to the limited scope of today's final rule, those broader remedial requirements (i.e., that are not specifically associated with CAMUs) have not been addressed. EPA expects that those requirements will be included in the final, comprehensive subpart S rulemaking.

The ground-water monitoring requirements as specified in today's rule are not detailed, specific requirements addressing the numerous technical elements of installing and operating an effective ground-water monitoring system. Rather, they provide a general standard of performance for such systems; detailed specifications or performance standards for ground-water monitoring will be specified in the permit or order, based on site-specific information and conditions.

Today's rule promulgates the provisions of the proposed rule that specified closure and post-closure requirements for CAMUs that must be incorporated in permits or orders, with few changes from the proposal. (See § 264.552(e)(4).) This rule also finalizes the decision factors to be considered in making CAMU closure decisions, as proposed. The specific closure and post-closure provisions have been reorganized for the sake of clarity and to fit within the organization of this section of today's regulation.

The only significant difference between the final and proposed closure and post-closure provisions is that today's rule identifies certain specific requirements for CAMU closure to be included in permits or orders that were not explicitly identified in the proposal. (See 264.552(d)(4)(ii)). These requirements address such closure activities as excavation, removal, treatment, capping or containment of wastes, capping of areas where wastes will remain in place, and removal and decontamination of equipment, devices, and structures used for remediation waste management. These provisions specify activities that are normally part of closure for other types of land-based units, and that would, in any case, be incidental to implementing CAMU closure activities under today's rule. This new provision is, thus, intended to clarify the specific types of activities that should be included in the permit or order encompassing CAMU closure.

6. Documentation for CAMUs (§ 264.552(f))

This provision requires the RA to document the rationale for designating a CAMU, and to make the documentation available to the public. (See also section III.B.3.) This will typically be done in a Statement of Basis in a permit, permit modification, order, or order modification. Further explanation of public participation requirements for CAMUs (and TUs) designated under orders, is presented in section IV.A. of this preamble.

7. Permit or Order Modification for CAMUs (§ 264.552(g) and § 270.42)

As outlined in the subpart S proposal, remedies tentatively selected or approved by the Regional Administrator would be incorporated into the permit according to the Agency-initiated modification procedures of § 270.41, which provide for thorough public review and comment. Thus, under the proposal, designation of a CAMU was presumed to be implemented as part of the overall remedy selection process, and incorporation of specific CAMU provisions into the permit would be done under the overall modification for the remedy (see proposed § 264.526).

Several commenters on the proposal argued that there should be a provision for allowing CAMUs to be designated earlier in the corrective action process than at the time of the permit modification for final remedy selection. These commenters elaborated that in some cases remedial activities that may precede implementation of the final remedy could be facilitated by the use of a CAMU. EPA provided for and encouraged implementation of certain remedial activities prior to final remedy selection decisions under the proposed "interim measures" provisions of the subpart S proposal (§ 264.540). A number of comments were received regarding the appropriate permit modification provisions for interim measures, with several commenters suggesting that the Agency clarify the type of permit modification (i.e., Class I, II or III) that would be used to incorporate interim measures into permits.

EPA agrees with the commenters that the regulations should explicitly provide for situations where CAMUs may be appropriate for remediation waste management prior to final remedy implementation. This is consistent with EPA's current implementation strategy for the corrective action program, which emphasizes early implementation of interim or "stabilization" measures at RCRA facilities, with relatively lesser emphasis over the next several years on pursuing "final" cleanups at all facilities.[2] Certain stabilization actions may involve extensive waste management activities, for which CAMUs may be useful and appropriate.

To facilitate early use of CAMUs designated pursuant to permits, today's final rule specifies (in § 264.552(g)) that a CAMU may be approved under an Agency-initiated modification (§ 270.41), or according to the permit modification procedures of § 270.42, for owner/operator initiated modifications. As discussed elsewhere in today's preamble, EPA is amending appendix I of § 270.42 to specify that; when incorporation of a CAMU into a permit is initiated by an owner/operator, a CAMU will generally be approved (or disapproved) according to the Class III permit modification procedures. Class III permit modifications are similar to Agency-initiated modifications in terms of the amount and type of public review and comment that is provided. EPA believes that specifying Class III modifications for CAMUs under § 270.42 is therefore consistent with the proposal, and addresses commenters' concerns that there be an explicit provision for approval of CAMUs, when appropriate, early in the corrective action process.

CAMUs may also be implemented through the use of section 3008(h) orders. Such orders will generally require the same information as required in permits under § 264.552(e). The need to approve a CAMU early in the process (e.g., to support an interim measure or "stabilization" action) will pertain to facilities subject to section 3008(h) orders, as well as permitted facilities. Thus, to implement a CAMU under an existing section 3008(h) order, the order may need to be amended to reflect the addition of the CAMU. It is the Agency's current policy that order modifications regarding remedy selection VR/AP provide a level of public participation and comment comparable to that provided for permit modifications. Section IV.A. of this preamble provides further discussion of the public participation procedures that will be used for CAMU designation under orders.

EPA notes that, in today's rule, the only mechanism for designating a

[2] Guidance on EPA's Stabilization Initiative for the RCRA Corrective Action program may be obtained by contacting the RCRA/Superfund Hotline at 1-800-424-9346.

CAMU at interim status facilities is a section 3008(h) order (or possibly a § 7003 order). The Agency recognizes that owner/operators of interim status facilities may prefer another mechanism (e.g., the closure plan approval process), which would allow accelerated cleanups to proceed outside the context of an enforcement order. While EPA acknowledges that there may be advantages to such an approach, it raises issues that are outside the scope of today's rulemaking. EPA will consider possible options as it develops the final subpart S rulemaking.

8. Effect of CAMU Designations on Other Remedy Selection Decisions (§ 264.552(h))

As is discussed earlier in this preamble, the designation of a CAMU does not change EPA's authority to address clean-up levels, media-specific points of compliance to be applied to remediation at a facility, or other remedy selection decisions. This point is clarified in § 264.552(h).

C. Temporary Units (TUs) (§ 264.553)

The temporary unit provisions (§ 264.551(b)) as proposed in July, 1990, would have provided the Regional Administrator with the authority to modify 40 CFR part 264 or 265 regulatory design, operating, or closure standards for units (except incinerators and non-tank thermal treatment units) used for the storage or treatment of hazardous waste during corrective action, as long as those alternative standards were protective of human health and the environment and complied with statutory requirements. Under this proposal, the operation of such units would have been restricted to 180 days; however, the Regional Administrator could grant extensions to the operating life of such unit(s) in situations where unforeseen, temporary, and uncontrollable circumstances occurred, and where the owner/operator was actively seeking alternatives to continued use of the unit. See 55 FR 30842 (July 27, 1990). If the owner/operator failed to seek alternatives to the continued use of the temporary unit, the Agency would deny further extensions and require the owner/operator to retrofit the unit to meet applicable part 264 and part 265 standards, or remove the waste and close the unit.

In modifying 40 CFR part 264 and part 265 design, operating, and closure regulatory standards for temporary units, proposed § 264.551(b) required the Regional Administrator to consider certain factors relating to the length of time that the unit would be in place, the amount of wastes to be managed, the physical and chemical characteristics of the wastes, and the site characteristics that might influence the migration of any potential releases. The alternative standards developed based on these factors would be specified in the facility's permit or order.

Today's rule finalizes the temporary unit provisions in § 264.553, with minor changes. EPA believes that the temporary unit concept is both sensible and practical within the context of remediation, and will facilitate implementation of RCRA sections 3004(u), 3004(v), and 3008(h). EPA believes that the site-specific review and oversight that is provided in the context of investigating and making remedial decisions for corrective action allows the Agency to ensure protection of human health and the environment for short-term operation of units that may not meet the full set of standards specified for long-term use of such units under current RCRA regulations.

As a general matter, EPA believes that the flexibility provided for in today's rules for CAMUs and temporary units will also encourage the development of new and innovative treatment technologies. In particular, this rule will help further the Administrator's commitment to remove barriers to the use of bioremediation. Consistent with this goal, in the Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris proposed rule (57 FR 958, Jan. 9, 1992), the Agency solicited comment on a temporary version (57 FR 981) of the containment building (later promulgated in the final Debris Rule on 8/18/92). As proposed, these temporary containment buildings would have allowed for the treatment of hazardous waste in temporary structures that would not have been subject to the same stringent design and construction requirements of the containment building promulgated on August 18, 1992. (See 57 FR 37268). Comments on the proposal were almost universally favorable. However, EPA decided to defer a final rule on such buildings pending further analysis.

The CAMU provisions promulgated today achieve most of the objectives of the temporary containment building proposal (e.g., within a CAMU, structures may be used to implement bioremediation systems as an integral part of a remediation). The design and operating plans for such systems will be approved on a case-by-case basis within the context of other waste management activities that will take place within a CAMU. The use of bioremediation technologies as part of CAMUs should greatly expand the base of experience with the use of these treatment technologies. EPA will consider whether separate regulations for temporary containment buildings, as a distinct type of RCRA unit, should be developed in the future.

1. Scope and Applicability of Today's Rule (§ 264.553(a))

Today's rule narrows the applicability of the temporary unit provision. The proposed rule for temporary units would have allowed any unit (except incinerators and non-tank thermal treatment units) used for the treatment or storage of hazardous wastes during corrective action to be designated as a temporary unit. This would have included land-based units such as waste piles. Today's final rule specifies that only tanks and container storage units used for the treatment or storage of remediation wastes will be eligible for designation as temporary units.

EPA expects that land-based waste management activities are more effectively addressed under today's CAMU provisions. For example, under today's CAMU provisions, a waste pile could be designated as part of a CAMU. This would enable the Regional Administrator to specify protective liner requirements and other design/operating requirements for the pile that are appropriate to waste and site conditions, and the length of time the unit may operate. Further, remediation wastes could be placed into the pile without triggering LDRs, thereby enabling one of the most frequent uses of piles, the temporary staging of wastes prior to on-site treatment, or transportation to off-site disposal (in which case, the land disposal restrictions would apply). Thus, designating the pile as part of the CAMU will enable sensible and protective waste management actions to be implemented. Because the provisions already allow flexibility for waste management in land-based units, the temporary unit provisions for those units are unnecessary and thus have been omitted in the final rule.

In addition, the temporary unit provisions will not apply to subpart X units (e.g., "modu-tanks"). EPA believes that the subpart X standards already provide sufficient flexibility for the Regional Administrator to set conditions appropriate to short-term use of a miscellaneous unit at a remediation site. Also, some miscellaneous units involve land-based waste management activities; such activities could be addressed and included as part of a CAMU, in a manner similar to waste piles.

The temporary unit proposed rules specified that the Regional

Administrator could modify standards applicable to such units "solely by regulation." Since today's rules for temporary units are limited to tanks and container storage units, and since these units are not subject to the statutory MTR and LDR requirements, the phrase "solely by regulation" has been omitted from § 264.553(a) of today's final rule, as it is no longer applicable or necessary.

Several commenters requested clarification of the applicability of temporary units to corrective actions under 3008(h) orders. Section 264.553(a) of today's final rule clarifies that the temporary unit concept is applicable to these actions. This change parallels the clarifying change to the definition of CAMU, as discussed previously in this preamble.

2. Restrictions on Temporary Units (§ 264.553(b))

The proposed temporary units provisions specified that such units could only be used for treatment or storage of waste "* * * that [had] originated within the facility boundary." Commenters on the proposal requested that EPA clarify more explicitly the types of wastes that could be managed in temporary units and CAMUs. Accordingly, EPA is promulgating in today's rule a definition of remediation waste, and, in § 264.553(b)(2), a clarification that temporary units shall be used only for treatment or storage of remediation wastes. Although the definition of remediation wastes includes non-hazardous solid wastes, management of such wastes would not require the designation of a temporary unit, since subtitle C requirements would not apply to management of those wastes. The definition of remediation wastes is discussed in section II.A. of this preamble.

In addition, today's rule specifies that temporary units must be located at the facility. One individual who commented on the proposal, supported the restriction that temporary units not be allowed outside the facility, since the owner/operator would not have direct operational control over such units. EPA agrees with this commenter and believes that this requirement will ensure that the Agency maintains direct oversight control over the unit and that the alternate standards specified for the unit by the Regional Administrator are appropriate given the context of the site-specific assessment. EPA believes that allowing temporary units only within the facility is consistent with the overall intent of this provision and, thus, has finalized this requirement as proposed.

3. Temporary Unit Decision Factors (§ 264.553(c))

The proposed TU provisions specified seven factors that the Regional Administrator would consider in establishing standards for temporary units. These factors were:

(1) Length of time the unit will be in operation;

(2) Type of unit;

(3) Volumes of waste to be managed;

(4) Physical and chemical characteristics of the wastes to be managed;

(5) Potential for releases from the unit;

(6) Hydrogeological and other relevant environmental conditions at the facility which may influence the migration of any potential releases; and

(7) Potential for exposure of humans and environmental receptors if releases were to occur from the unit.

EPA did not receive any comment on these specific decision factors. The Agency believes that these factors are reasonable and will result in sound decisions for temporary units; these decision factors have, therefore, been finalized as proposed.

4. Permit or Order Specifications for Temporary Units (§ 264.553(d))

As required under § 264.553(d), the Regional Administrator will specify requirements for temporary units in the permit or order. These requirements will include the design, operating, and closure requirements for such units, as determined by the Regional Administrator in accordance with the decision factors described above.

This section also specifies operating time limits for temporary units. The proposed provisions for temporary units specified a 180-day time limit for the operation of temporary units, with allowance for EPA to extend that time period in certain circumstances. EPA expects that in many cases 180 days would be sufficient for a temporary unit. However, EPA also recognizes that in many other cases involving the storage or treatment of large volumes of wastes, units may need to be operated for periods longer than 180 days. As argued by a number of commenters on the proposal, remediation of facilities will often be a lengthy process, and a 180-day limit for temporary units could impose an unnecessary and artificial constraint on units whose operation beyond 180 days could nevertheless be protective of human health and the environment. An example of such a unit might be a tank that is brought to a remedial site for the treatment of inorganic sludges and that meets or exceeds all part 264 requirements, except for secondary containment. The operation of that tank could be protective for considerably longer than 180 days, given frequent inspections, sound operating procedures, and extensive Agency oversight.

Many commenters argued that there should be no time limit for the operation of temporary units, and that the Regional Administrator should have the discretion to establish operational time frames for temporary units on a case-by-case basis. Other commenters believed that one to two years would be a more reasonable time limit.

EPA agrees with the commenters who argued that the proposed 180-day limit for temporary units may be unnecessarily restrictive in many cases, and would complicate the use of temporary units for potentially beneficial waste management activities, such as certain treatment systems that often require timeframes longer than 180 days. Today's rule, therefore, specifies a one-year time limit for operation of temporary units. Based on an evaluation of the comments to the proposal, EPA believes that a one-year limit for temporary units is reasonable and appropriate. Such a time limit will allow the use of temporary tanks and containers for somewhat lengthier treatment technologies (e.g., bioremediation) while assuring the protectiveness of such units. In addition, the one-year time limit confirms EPA's intent that the alternate standards only be applied to units which are truly "temporary" in this context.

At the end of the specified time limit for a temporary unit, or at the end of an extension if granted by the Regional Administrator, the owner/operator will be required to cease management of remediation wastes in the temporary unit and to initiate the closure requirements prescribed for the unit under § 264.553(d). In cases where it is necessary or desirable to continue the waste management activity that was conducted in the temporary unit, the owner/operator will be required to retrofit the unit to meet applicable part 264 or part 265 standards for that type of unit, arrange for an alternative unit in which to continue conducting the activity, or otherwise modify the remedial practices so that the unit is not used in the remediation at the facility. If the owner/operator chooses to retrofit the unit, but such changes to the unit cannot be made before the end of the extension period, the owner/operator will be required to cease management of the waste until the retrofitting has been completed. Changes to temporary units (e.g., retrofitting) or to other remedial

operations at the end of the operating time limit for a temporary unit will be subject to approval through modifications to the permit or order.

5. Time Limit Extensions for Temporary Units (§ 264.553(e))

Section 264.553(e) specifies the criteria the RA must consider prior to approving an extension to the time limit originally specified for a temporary unit.

EPA recognizes that in some cases a temporary unit may have to remain in service beyond the limit originally specified in the permit or order by the Regional Administrator due to unexpected circumstances. Today's rule finalizes the provisions for extensions as proposed in § 264.551(b)(3), with minor changes. Proposed § 264.551(b)(3) specified that an extension to the operating period originally specified for the unit could only be granted if hazardous wastes had to remain in the unit due to "unforeseen, temporary, and uncontrollable" circumstances. One commenter who suggested that the 180-day time limit was too restrictive also suggested that the regulation be revised to eliminate these criteria as a condition for approving an extension for a temporary unit. Today's final rule does not specify these criteria for the approval of an extension. EPA believes that decisions as to whether or not certain circumstances were unforeseen and uncontrollable could be difficult and contentious, could put the Agency in the position of having to speculate as to whether or not the owner/operator might have seen or might have controlled a circumstance relating to a temporary unit, and are ultimately irrelevant to the issue of the protectiveness of the unit.

Accordingly, § 264.553(e) of today's rule specifies new criteria for approval of time extensions for temporary units. These new criteria are based on an evaluation of the comments received on the proposal. One commenter expressed concern that the standards applied to temporary units may be based on the time limit originally specified for the unit and therefore may not be adequately protective of human health and the environment if the operating life of the unit were extended. EPA agrees with this comment and has specified in § 264.553(e)(1) of today's final rule that in order to grant an extension, the Regional Administrator must determine that continued operation of the unit will not pose a threat to human health and the environment. In addition, § 264.553(e)(2) specifies that the Regional Administrator must also determine that continued use of the unit is necessary to ensure the timely and efficient implementation of remedial actions at the facility. This criterion is essentially a restatement of the overall objective of temporary units and a clarification that the overall objective should be a condition for the approval of an extension. Upon approval of an extension the Regional Administrator will identify the specific time limit for the extension in the permit or order or modification to the permit or order.

Proposed § 264.551(b)(3) did not specify limits as to the time allowed under an extension or the number of extensions that could be approved. Under today's rule § 264.553(e), the Regional Administrator has the authority to grant up to a one-year time extension beyond the time limit originally specified for the unit, in cases where it is necessary to ensure timely and efficient implementation of remedial actions at the facility, and where the continued operation of the unit will not pose a threat to human health and the environment. The Regional Administrator may grant only one extension of up to one year. Based on the comments received on the proposal, EPA believes that these limits are both reasonable and appropriate, and are consistent with the Agency's intent to allow alternative standards under this provision only for truly "temporary" units. In addition, given the increased operational time limit for temporary units provided under today's rule, the need for an extension of more than one year should be eliminated. The Agency also believes that this limit to extensions will reduce the potential administrative burden that could be created by owner/operators seeking multiple extensions for temporary unit operations.

6. Permit and Order Modification Procedures (§ 264.553(f))

In the subpart S proposal EPA expected that in cases where a temporary unit is part of a selected remedy, the approval for that unit would normally be a part of the Agency-initiated major permit modification for the remedy. Similarly, in cases where a temporary unit is a part of a stabilization action or interim measure which requires a Class III modification or an Agency-initiated permit modification, the approval for that unit would also be included in the modification for that action. Thus, the language in the proposal concerning permit modifications only addressed the situation where approval for a temporary unit was included under a Class III or Agency-initiated permit modification for an overall remedy, or interim measure or stabilization action for a facility. EPA recognizes that there may be cases in which a temporary unit is not part of a larger permit modification procedure for a selected remedy, or interim measure or stabilization action (i.e., the unit will be used prior to remedy selection to handle investigation-derived waste or remediation waste generated from remedial activities that do not require a Class III or Agency-initiated permit modification). In such cases, the Agency believes that given the longer timeframes for temporary units provided for in today's rule, opportunity should be provided for the public to be informed of and participate in decisions that affect them and their communities. Thus the owner/operator of a permitted facility will be expected to request approval for a temporary unit as a Class II permit modification according to the procedures under § 270.42. EPA also recognizes, however, that there may be cases where operation of the temporary unit is necessary to contain releases or otherwise protect human health and the environment, before action is likely to be taken on a modification request. In such cases, the Regional Administrator may approve a 180-day temporary authorization for the unit upon request by the owner/operator according to the procedures under § 270.42. Today's rule modifies § 270.42 to classify permit modifications for temporary units as Class II modifications (unless otherwise addressed under a Class III or Agency-initiated permit modification).

The proposed temporary unit provision(s) specified that any extension to the operating period originally specified for a temporary unit would be processed as a Class I permit modification. One commenter suggested that such extensions should be given more thorough public review and comment than is provided by Class I permit modifications. EPA agrees, since temporary units may in some cases be used to manage large volumes of wastes, and could be a key feature of a selected remedy. In addition, the longer timeframes for temporary units allowed in today's rule support the idea of providing somewhat greater public review and comment of temporary unit decisions. Therefore, today's rule specifies that approval for extensions for temporary units that are not addressed under a Class III permit modification or are not part of an Agency-initiated permit modification, will be processed as Class II permit modifications. Section IV of this preamble provides further information regarding public participation procedures that will be used for approval of temporary units

and time extensions for temporary units pursuant to corrective action orders.

7. Documentation of Temporary Unit Designations and Time Extensions (§ 264.553(g))

Section 264.553(g) requires the Regional Administrator to document the rationale for designating a temporary unit or time extension for a temporary unit and to explain the basis for such designation. This new requirement in § 264.553(g) is intended simply to clarify and emphasize that temporary unit decisions must be documented and explained as part of the notice and comment procedures for orders and permits. The rationale for such decisions will be incorporated as part of the Statement of Basis in a permit or order modification. Documentation of temporary unit decisions is analogous to the documentation the Agency must currently make to support the selection of a remedy. Therefore, if a temporary unit is incorporated as part of a final remedy, such an explanation would be incorporated into the Statement of Basis for the remedy under a permit modification or under a new order.

IV. CAMU and TU Implementation

A. Public Participation in CAMU/TU Designations and TU Time Extensions Under Orders

The Agency is committed to providing a meaningful opportunity for the public to be informed of and participate in cleanup decisions that affect them and their communities. Public input on proposed facility-specific corrective action decisions at permitted facilities is obtained through the permit issuance and modification procedures prescribed in 40 CFR parts 124 and 270. Current Agency policy for final remedy selections at interim status facilities under corrective action orders outlines public participation procedures similar to those detailed in 40 CFR part 124. In conjunction with this rulemaking, the Agency is expanding its public participation requirements for corrective action decisions made under corrective action orders to address the proposed designation of CAMUs and temporary units.

Pursuant to this rulemaking, CAMU designations made through the permit process will generally be approved (or disapproved) according to Agency-initiated permit modifications (§ 270.41) or the Class III permit modification procedures under § 270.42 (see section III.B.7.). The designation of CAMUs or temporary units, or the granting of a time extension for a temporary unit made pursuant to a corrective action order, will follow similar public participation procedures, although modified to suit the corrective action order process. Prior to designating a CAMU or temporary unit, or approving a time extension for a temporary unit in a corrective action order, the Agency will prepare draft CAMU and/or temporary unit specifications. The Agency will then notify and provide the public with an opportunity to comment on the CAMU, temporary unit, or time extension for a temporary unit. If a public hearing is requested, the Agency will hold a hearing and provide the public with a notice of the hearing. The Agency will also consider and respond to all significant comments received by the public on the CAMU or temporary unit.

As required in the permit process, the Regional Administrator will document the rationale used to designate CAMUs (§ 264.552(f)), temporary units (§ 264.553(g)), or time extensions for temporary units (§ 264.553(g)), when such designations are made through corrective action orders. A brief discussion of the applicable decision factors used to support the creation of a CAMU or temporary unit will be included in the documentation. If the CAMU or temporary unit is proposed as part of a final remedy, such documentation can be incorporated into the Statement of Basis presenting the Agency's justification for a proposed comprehensive remedy proposal.

Under orders, a 30–45-day public comment period generally will be provided to the public to comment on the designation of a CAMU, temporary unit, or time extension for a temporary unit. However, because corrective action orders may be issued to address immediate threats, the public comment period may be reduced or eliminated if the Regional Administrator determines that even a short delay in the designation of a CAMU or temporary unit would adversely impact human health or the environment. The Agency anticipates needing to use this discretion in rare circumstances.

The Agency will provide additional guidance on public participation procedures for the designation of CAMUs and temporary units under orders. While guidance is pending, EPA will continue to use the guidance provided in RCRA Corrective Action Decisions Documents: The Statement of Basis and Response to Comments (Directive #9902.6).

B. Continuation of Permits for Corrective Action Purposes

Although EPA today is not finalizing most portions of the comprehensive proposed Subpart S rule, several issues have arisen in connection with that rule that deserve further discussion pending its completion. First, the proposed rule reflects Agency policy concerning facility-wide corrective action at RCRA facilities. As a result, EPA's Regional offices are following the proposal, where appropriate, as guidance pending development of the final rule. Several aspects of that proposal, however, require rule changes for implementation; those aspects of the proposal cannot be implemented even as guidance pending development of the final rule. Many of these rule changes are made through today's rulemaking and thus can now be implemented.

One important aspect of the proposal that EPA now believes is a clarification rather than a necessary rule change concerns the scope of the permit requirement. EPA had proposed to revise 40 CFR § 270.1 specifically to require RCRA permittees to have permits during the course of any corrective action required under the permit. Upon further review, EPA believes that this rule change, while a desirable clarification, is not absolutely necessary and that section 3004(u) of RCRA and 40 CFR 264.101(b) and 270.33 already require that RCRA facilities complete any corrective action schedule of compliance prior to termination of permit responsibilities.

The clear intent of Congress in enacting Section 3004(u) was that the price for obtaining a RCRA permit for hazardous waste management is cleanup of the entire property at which the permitted activity occurs. (See HSWA Conference Report, H. Rep. 1133, 98th Cong., 2d Sess. at 92 (1984). See also definition of facility as defined in today's rule.) Congress allowed such cleanup to occur under a schedule of compliance only where such cleanup could not be completed prior to permit issuance. As a result, section 3004(u) of RCRA (and 40 CFR 264.101) clearly require that a facility that obtains a schedule of compliance for corrective action must complete the corrective action prior to termination of permit responsibilities. Similarly, EPA's general regulations concerning schedules of compliance specify that a facility may not simply terminate its operations and thereby avoid compliance with applicable requirements (40 CFR 270.33; see also 45 FR 33310 (May 19, 1980)), including corrective action.

This means that a RCRA permitted facility that is undergoing corrective action under a schedule of compliance and that wishes to cease operations has two choices with respect to its

corrective action responsibilities. First, the facility may choose to accelerate corrective action so that it is completed at the same time as hazardous waste operations at the facility cease, § 270.33(b)(1)(i). Alternatively, where the regulated activities cease prior to termination of a permit which includes corrective action, the facility may complete corrective action under a permit schedule of compliance that extends beyond the date of cessation of hazardous waste operations, § 270.33(b)(2). In the latter case, the facility must continue to comply with applicable permit conditions and requirements, including permit renewal requirements, even though hazardous waste activities at the facility have ceased. See 45 FR 33310–11 (May 19, 1980).

As part of the comprehensive final subpart S rule, EPA will determine whether further regulatory clarification of this issue is necessary. At that time, EPA will respond to comments received on the proposed regulatory changes addressing this issue, and the related issues discussed in the preamble. See 55 FR 30846–49.

In the meantime, EPA, on a case-by-case basis, can improve the clarity of the applicability of this requirement to maintain a permit through the completion of corrective action activities at a specific facility in several ways. First, at the time of permit issuance or when the CAMU or temporary unit is incorporated into the HSWA permit, EPA can establish a schedule of compliance that reflects the responsibility of the permittee to complete corrective action under the permit, even if the permit does not specifically identify the nature or timing of the corrective actions to be required. In addition, the permit as issued or modified could include an express condition requiring the facility owner/operator to submit a permit reapplication prior to permit expiration unless and until all corrective action obligations for the facility have been completed.

C. State and Federal Implementation

1. State Authorization

Under section 3006 of RCRA, EPA may authorize qualified States to administer and enforce the RCRA program within the State. (See 40 CFR part 271 for standards and requirements for authorization.) Following authorization, EPA retains enforcement authority under sections 3008, 7003, and 3013 of RCRA, although authorized States have primary enforcement authority.

Prior to the Hazardous and Solid Waste Amendments of 1984 (HSWA), EPA administered the RCRA hazardous waste program in individual States until the States were formally authorized by the Agency to implement their own programs. Once a State had final authorization, it administered its hazardous waste programs entirely in lieu of EPA. The Federal RCRA requirements no longer applied in the authorized State, and EPA could not issue permits in the State for any facilities that the State was authorized to permit. When new, more stringent Federal requirements were promulgated or enacted, the State was obliged to enact equivalent and consistent authority within specified timeframes. However, the new Federal requirements did not take effect in authorized States until the States adopted them as State law.

The HSWA amendments, however, altered this system. Under section 3006(g)(1) of RCRA as amended by HSWA, 42 U.S.C. 6926(g), new requirements and prohibitions imposed under HSWA authority take effect in authorized States at the same time that they take effect in unauthorized States. EPA is directed to carry out these requirements and prohibitions in authorized States, including the issuance of permits, until the State is granted authorization to do so. To retain final authorization, States must still adopt HSWA-related provisions that increase the stringency of the RCRA program. However, such HSWA provisions apply in authorized States and are implemented Federally in the interim.

Today's rule is promulgated pursuant to section 3004(u), section 3004(v), and section 3005(c) of RCRA, all of which are provisions added through HSWA. (EPA will also use the standards of today's rule in implementing section 3008(h).) Therefore, the Agency is adding today's rule to Table 1 in 40 CFR 271.1(j), which identifies the Federal program requirements that are promulgated pursuant to HSWA. Because, in EPA's view, today's rule is integral to the HSWA corrective action program, EPA intends to implement it immediately in all States and territories in which the Agency now administers the HSWA section 3004(u) and (v) corrective action authorities. Thus, the rule takes effect immediately in (1) States that are unauthorized for the RCRA base program, and (2) States that are authorized for the RCRA base program, but are not yet authorized for the HSWA corrective action program. (The issue of more stringent State standards in these States is discussed in the following section.)

Today's rule does not apply in States that are authorized for the HSWA corrective action requirements. (Fifteen States now fall into this category.) Under section 3009 of RCRA, States may impose more stringent or broader regulations than the Federal program. Because the regulations promulgated today reduce regulatory requirements for certain types of waste management conducted during corrective action, EPA considers them to be less stringent than or reduce the scope of the existing Federal corrective action requirements.[3] Therefore, they will not apply in States authorized for corrective action until those States have adopted comparable provisions under their own State law. Furthermore, because today's rule is less stringent than existing corrective action requirements, authorized States are not required to adopt the rule, and States not yet authorized for corrective action are not required to include its provisions in their programs when they seek authorization.

Even though States are not required to adopt today's rulemaking, EPA strongly encourages them to do so. As already explained elsewhere in this preamble, today's rule is needed to expedite hazardous waste remediation at RCRA corrective action facilities. States are therefore urged to adopt today's rule and to submit to EPA the modification for approval on the schedule for mandatory program revisions, according to 40 CFR 271.21(e).

States are also encouraged to use existing authorities, where available, to allow comparable remedial activities prior to adopting and receiving authorization for today's rule. Some States may have authority comparable to section 7003, which allows EPA to order response action in the case of imminent and substantial endangerment to health or the environment "notwithstanding any other provision in this Act." An authorized State may use a comparable section 7003 authority to authorize activities consistent with today's rulemaking. Other States may have comparable authority under State Superfund programs or may have comparable flexibility for cleanups under their own hazardous waste regulations. EPA encourages States to make use of such flexibility to expedite cleanups. In addition, States with comparable authorities may be eligible to receive interim authorization and to

[3] EPA is considering whether the concept of stringency should be reevaluated with respect to remediation wastes and will address this approach in a separate rulemaking.

implement their provisions under 40 CFR 271.24.

2. Implementation of Rules in Unauthorized and Authorized States

The implementation of today's rule will vary, depending on the authorization status of the State in which a particular facility subject to cleanup requirements is located. Regardless of the situation in individual States, however, EPA's major goals in implementing today's rule are: (1) To enable the use of the CAMU and TU concepts as rapidly as possible for specific RCRA corrective actions, consistent with State requirements, (2) to encourage States to adopt these concepts promptly in their own cleanup programs and regulations, and (3) to work cooperatively with individual States, regardless of their authorization status, to promote the flexible approaches in today's rule. This section briefly discusses implementation of the rule in States at different stages of the authorization process.

A few States and territories have not yet been authorized for either the "base" (i.e., non-HSWA) RCRA program, or the RCRA section 3004(u) and (v) corrective action program under § 264.101. In these States, permits and orders are issued by EPA under the Federal statute and implementing regulations. Any modifications to permits or orders to allow the use of CAMUs or TUs would also be the responsibility of EPA. Of course, it is possible that an unauthorized State has adopted standards addressing CAMUs or TUs that have independent effect. The possibility for a dual program always exists in States that have not applied for or obtained authorization. Although EPA's permit would establish the Federal RCRA standards applying to such a unit, State law might impose additional requirements.

Most States have been authorized for the RCRA base program, but are not yet authorized for HSWA corrective action. In these States, permits are generally issued jointly; that is, the State issues the portion of the permit that addresses compliance with base-program requirements, while the EPA Region issues the HSWA portion of the permit, including corrective action requirements. Together, the base-program and HSWA portions make up the RCRA permit for the facility.

Under this arrangement, EPA is responsible for implementing the HSWA corrective action requirements for permitted facilities. This includes the responsibility of requiring or approving modifications of the HSWA portion of the permit to incorporate new units (including CAMUs and TUs) that are necessary to implement corrective action at the facility. In this case, the new unit would be permitted under the modification to the HSWA portion of the permit, and a separate State action would not be necessary. The process would work similarly for section 3008(h) orders, although procedures for changes in interim status, rather than for permit modifications, would apply. Thus, facility modifications to allow corrective action would not require State approval or use of State permit modification or interim status modification procedures. Rather, under section 3006(g), Congress authorized EPA to implement the corrective action program in each State prior to State authorization. If permit modification or interim status changes are necessary to implement corrective action in States not authorized for corrective action, the Federal rather than the State procedural requirements apply to the changes.

In some cases, a land-based regulated unit already subject to State interim status or permit conditions may be incorporated into a CAMU. In such cases, today's rule provides that the subpart F, G, and H requirements and the unit-specific requirements of 40 CFR part 264 or 265 previously applying to the regulated unit would continue to apply after designation of the CAMU. Authority for implementing and enforcing these requirements could fall either to EPA or to the State. Generally, EPA anticipates that the State would retain direct implementation authority, since it had previously been regulating the unit. However, in some cases it might be more efficient for EPA to assume overall authority over the entire cleanup.[4] In either case, EPA would seek to work out oversight authority with the State through formal or informal agreement. Because the State would retain authority over the regulated unit through its own permit or interim status requirements, unless it modified the permit or allowed a change in interim status, State agreement with EPA's approach to corrective action would be necessary.

As in the case of unauthorized States, States authorized for the base program may have more stringent requirements (e.g., State land ban provisions) that would affect a particular remedy that EPA wished to implement under today's rule. In this case, EPA might modify the remedy so that it was consistent with State law, or structure it so that it mirrored an existing State waiver provision (e.g., waiver of land ban provisions for contaminated media); alternatively, the State might use a waiver authority under its own laws or enforcement discretion to allow the remedy to proceed.

In any case, EPA emphasizes that its goal in implementing the CAMU and TU concepts in States not authorized for corrective action is to facilitate prompt and protective cleanups at RCRA facilities. This rule does not preempt existing State authorities, nor does EPA intend to impose cleanup requirements at specific sites under this rule that the State considers to be unprotective, inadequate, or inconsistent with the State's regulatory requirements. Rather, today's rule provides EPA (and States) greater flexibility in making use of a new type of remediation unit created during the course of corrective action. If a State not yet authorized for corrective action believed a different approach was preferable, either as a general rule or at a specific site, EPA would work with the State—for example, through a Memorandum of Understanding, joint order, or an informal agreement—to ensure that any remedies required were acceptable to the State.

As of October 1992, fifteen States were authorized for corrective action under § 264.101. Until these States develop their own CAMU and TU regulations, these provisions would generally not be available to them in implementing their corrective action program. It is possible, however, that a State authorized for corrective action may wish to have a CAMU or a temporary unit approved for a facility cleanup. In some cases, the State may have a general waiver authority under its own State law, or State enforcement or State Superfund authorities that provide it some flexibility. If the State were to exercise this authority in a way that is consistent with today's rule, EPA would not consider the State's program to be less stringent than the Federal program. Alternatively, the State could request EPA to issue an order under RCRA section 7003, which could be used to override specific Federal or authorized State authorities where necessary to implement a cleanup. In any case, however, these approaches should be used only to cover the transition period during which the State amends its regulations and obtains formal authorization for today's rule.

Even though a State is authorized for § 264.101 or (in the future) subpart S corrective action, EPA retains the authority to issue section 3008(h) orders at interim status facilities. If EPA were

[4] In this case, the State might choose to modify the State permit or the facility Part A to remove the unit as a State-regulated unit. Alternatively, the unit could remain on the State permit or Part A, but EPA could be given lead oversight over the unit through a State-Regional agreement.

to issue such an order in a State authorized for corrective action, it would have the authority to require and approve modifications of the facility part A to accommodate a new CAMU or TU. EPA's authority in this case is analogous to its authority in States not yet authorized for corrective action. Just as in that case, however, EPA emphasizes once again that its goal is to expedite cleanup, and it does not claim the authority to preempt existing State requirements.

D. Effective Date

RCRA section 3010(b)(1) allows EPA to promulgate an immediately effective rule where the Administrator finds that the regulated community does not need additional time to come into compliance with the rule. Similarly, the Administrative Procedures Act (APA) provides for an immediate effective date for rules which relieve a restriction. 5 U.S.C. 553(d)(1). Today's rule provides additional flexibility for facilities undergoing corrective action. As a result, the regulated community does not need significant additional time to come into compliance. In order to allow near term use of the less restrictive rules promulgated today, and yet to provide effective communication regarding the purpose and implementation of this rule, EPA has set an effective date of 60 days from today.

V. Relationship to Other Programs

A. CERCLA

The substantive requirements of today's regulations for CAMUs and temporary units are expected to be applicable or relevant and appropriate requirements (ARARs) for the remediation of many CERCLA sites, especially those sites where CERCLA remediation involves the management of RCRA hazardous wastes. In the CERCLA context, CAMU and temporary unit requirements that are designated to be ARARs would be incorporated into CERCLA decision documents, rather than RCRA permits or orders. Based on EPA's experience in managing the Superfund program, it is anticipated that the increased flexibility provided in today's rule will have an important and positive impact on the Agency's ability to expeditiously implement protective and cost-effective remedies at CERCLA sites. This would include remediation under CERCLA of RCRA hazardous wastes at Federal facilities that are listed on the National Priorities List.

B. State Remedial Programs

Many States have enacted remedial laws and programs to address environmental problems that may not be addressed under RCRA or CERCLA authorities. State remedial programs typically follow a process similar to RCRA and CERCLA for investigating releases, and selecting and implementing remedial measures. As a general rule, since CAMUs are defined as units to be used in connection with § 264.101 or 3008(h) actions, they can be employed only at a facility regulated under subtitle C of RCRA, or at CERCLA sites where determined to be ARARs. However, some states may have enforcement authorities analogous to RCRA section 7003 which provide an implied or explicit waiver from otherwise applicable State RCRA requirements. Thus, in such a State, where cleanup is being compelled at a non-RCRA or CERCLA facility, such enforcement authority could be used to approve and designate a CAMU or a TU in a manner consistent with today's final rules. Note, that a State cannot waive applicable federal requirements; thus, if a State is not authorized to implement the LDR program in the State, for example, then a CAMU will not operate to affect the scope of the LDRs at that site, when implemented under a State remedial program. However, if a State is authorized for LDRs, it may be able to waive such requirements under State law (as indicated above).

C. RCRA Section 7003

CAMUs and temporary units may be available, at the Regional Administrator's discretion, for the purpose of remediation under RCRA section 7003 authority, even if the remediation is not at a RCRA subtitle C regulated facility. Under section 7003, EPA has the discretion to waive any RCRA requirements at a site where appropriate to implementing remedial actions. Thus, the order could provide for and designate a CAMU with or without the use of today's rules, and regardless of the permit status of the facility. As mentioned previously, some States may have enforcement authorities analogous to RCRA section 7003 that would provide similar relief from administrative requirements in implementing cleanups.

D. Corrective Actions at Facilities not Currently Remediating Under Federal RCRA/CERCLA or State Authorities

Since a CAMU or a TU is a RCRA subtitle C unit, it can be utilized only at a facility that is regulated under subtitle C. Therefore, in order to manage hazardous remediation wastes in CAMUs or TUs, a responsible party would have to voluntarily seek regulation by subtitle C by obtaining either a corrective action order issued by the Agency (or by a State—see above), or a RCRA permit, which contains the necessary approvals from the Regional Administrator.

E. RCRA Section 3004(n) Air Emission Standards

EPA is currently developing a comprehensive set of air emission regulations for RCRA hazardous waste management units, as mandated under section 3004(n) of RCRA. Phase I air emission standards for process vents and equipment leaks were promulgated on June 21, 1990. Phase II unit-specific standards are expected to be promulgated in 1993.

If remediation waste management activities associated with CAMUs will involve the use of non-land-based equipment or units for which air emission standards have been promulgated (e.g., air strippers or other treatment devices), such equipment or unit(s) would have to comply with those applicable standards. These requirements will be specified in the permit or order. However, EPA does not intend to promulgate air emission standards specific to CAMUs. EPA believes that the decision criteria for CAMUs in today's rule, and the site-specific oversight provided under the corrective action process, will ensure that adequate air emission controls are imposed on remediation waste management activities.

VI. Regulatory Impact Analysis

A. Executive Order Requirements

Under Executive Order 12291 (issued February 17, 1981), a Regulatory Impact Analysis (RIA) is required for every major Federal regulation. Executive Order 12291 defines a major rule as one that is likely to result in: (1) An annual effect on the economy of $100 million or more; (2) a major increase in costs or prices for consumers, individual industries, Federal, state, or local government agencies, or geographic regions; or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets. The Agency has determined that this rule is not a major rule because the rule does not negatively impact the economy, increase costs or prices, or adversely impact businesses. Nevertheless, EPA recognizes that this rule may have significant positive economic impacts and therefore, at the request of the Office of Management and

Budget, has prepared a Regulatory Impact Analysis (RIA).

B. Background

In preparation for the final subpart S rulemaking, EPA is currently conducting a revised RIA that includes a comprehensive evaluation of the costs and benefits of regulatory alternatives for RCRA Corrective Action. As part of this comprehensive analysis, EPA has conducted a preliminary evaluation of the costs and benefits of the proposed rule provisions concerning CAMUs, and has evaluated several alternatives to the proposed rule CAMU provisions. On October 22, 1992, EPA published a notice of data availability in the Federal Register announcing the availability of a report, "Supplemental Information on Corrective Action Management Units," which summarized the preliminary results of EPA's analyses of the costs (expressed as cost savings) and expected environmental benefits of regulatory alternatives for the CAMU. The RIA prepared for this rulemaking provides additional detail on EPA's evaluation of the cost savings of key regulatory alternatives for the CAMU and the expected impacts of the alternatives on the human health and environmental benefits derived from cleanup under the Subpart S framework. (See sections II and III of this preamble for further discussion of the subpart S rule, the CAMU and temporary unit rule, and the notice of data availability.) Both the report summarizing preliminary results and the RIA for today's rule are available in the RCRA docket.

The Agency conducted the CAMU RIA in order to assess the costs and benefits of certain alternative approaches to regulating remedial waste management at facilities subject to RCRA corrective action. Discussion of the RIA is organized as follows: The CAMU regulatory alternatives that were analyzed are presented first, followed by the general methodology for the analysis, cost results, and finally a qualitative analysis of benefits.

Temporary units (TUs) were not addressed in the CAMU RIA. Based on the preliminary analyses conducted for the RIA, EPA believes that TUs will not be used with great frequency, and the resulting cost and benefit impacts of TUs are expected to be relatively minor compared to CAMUs.

C. Regulatory Alternatives

This RIA evaluates three CAMU regulatory alternatives: The Proposed subpart S CAMU, the Expanded CAMU (the CAMU alternative which EPA has decided to finalize), and, the No CAMU alternative. (The Proposed subpart S CAMU and the Expanded CAMU are defined and discussed further in section II of this preamble.) Based on the results of the analysis presented here and the anticipated remedial benefits of the expanded CAMU option, the Agency has decided to finalize the expanded CAMU option.

The analysis of the No CAMU alternative was conducted using two different sets of assumptions. This means that the cost savings and effects on benefits associated with the Proposed and Expanded CAMU options are presented relative to a range of "baseline" No CAMU outcomes. EPA evaluated the No CAMU alternative in this manner because EPA recognized that under the No CAMU alternative remedial decisionmakers could either choose to maximize removal and treatment of hazardous wastes to LDR standards, or, alternatively, choose to minimize the extent to which wastes would be required to be removed from SWMUs and therefore treated to LDR standards prior to land disposal.

D. Approach to Analysis

To estimate the costs and benefits associated with the various aspects of the subpart S final rule, including the CAMU provisions, EPA selected a random sample of 79 facilities potentially subject to corrective action. The sampling frame was stratified and sampled in order to accurately reflect the composition of the potentially affected universe and to over-sample facilities likely to require corrective action.

As proposed, the subpart S rule provides a regulatory framework to guide site-specific remedial decisionmaking at RCRA facilities. The proposed rule provisions are not, however, overly prescriptive; EPA recognized the site-specific nature of remedial decisionmaking and sought to strike an appropriate balance in the proposed regulations between explicit regulatory standards and requirements and site-specific flexibility and discretion. To develop estimates of the costs and benefits of cleanup under the proposed rule and under different regulatory alternatives, EPA simulated remedy selection at the sampled facilities.

In order to simulate remedy selection at the sample facilities, EPA first collected facility-specific data from a wide variety of sources, including RCRA Facility Assessments (RFAs) and RCRA Facility Investigations (RFIs). RFAs and RFIs provided EPA with the following information: General facility descriptions; SWMU- and waste-specific characteristics; details about the environmental setting; and human exposure information. When facility sampling data were not available for a particular facility, an EPA contaminant fate and transport model, MMSOILS, was used to simulate releases to ground water, surface water, air, and off-site soils. EPA also used the MMSOILS model to simulate releases into the future in order to determine the nature and extent of contamination over time, in the absence of corrective action.

Next, the available data on the nature and extent of contamination (present and future) and facility characteristics were presented to expert panels convened by EPA and comprised of regional EPA staff, state representatives, and experts in the fields of hydrogeology, geology, geophysics, soil science, engineering, and chemistry. Based on their evaluation of the data and their experience in making remedial policy decisions at the state and regional levels, the policy expert panel (made up of regional and state program policy representatives) developed remedial objectives under the proposed subpart S rule framework for each facility in the sample. Accordingly, the policy panel used the proposed subpart S CAMU definition and provisions and, where appropriate, designated areas of facilities as CAMUs.

The remedial objectives, including the policy decision on the use of a CAMU, were then transmitted to the technical expert panel, which was responsible for defining and determining specific remedial activities to meet these objectives. Where more than one alternative was available to meet the policy panel objectives, options were presented and the policy panel made their choice of preferred approach.

The remedial activities identified/selected by the expert panels, for the facilities in the sample that required corrective action, were the foundation for analyses of the proposed CAMU regulatory alternative. To assess the two other CAMU RIA regulatory alternatives (the Expanded CAMU and the No CAMU options), a CAMU expert panel (consisting of civil, chemical, and environmental engineers, risk assessors, RCRA policy analysts, and ecologists) was convened to determine objectives and select remedies.

E. Cost Analysis

In addition to defining and determining remedial activities to meet remedial objectives, the technical experts convened by EPA were also responsible for providing remedial cost estimates which served as the basis for calculating facility-level costs. As discussed above, the expert panels

reviewed each facility in the RIA sample and selected remedies to address releases at the sample facilities. The panels then estimated a cost for each remedial activity at each SWMU addressed. The Agency compiled remedial costs at the SWMU and facility level under each of the three CAMU regulatory alternatives. After the total costs were adjusted to include design, oversight, and contingencies, the costs were discounted to account for the timing of remediation.

On a national basis, a total of approximately 5,800 facilities are potentially subject to RCRA subpart S corrective action requirements. Under the Proposed CAMU alternative, CAMUs would be expected to be used at a total of 200 facilities in the course of remediating 1,360 SWMUs. Under the Expanded CAMU alternative, CAMUs would be expected to be used at 1,500 facilities in the course of remediating 6,000 SWMUs.

The use of CAMUs under the proposed CAMU option results in total present value cost savings of $15.2 billion to $25.2 billion (the range reflects the use of two different assumptions regarding the degree of waste removal and treatment to LDR standards under the No-CAMU option). The present value cost savings of the expanded CAMU option ranges from $16.6 to $26.6 billion. The cost savings under both of the CAMU options are primarily attributable to avoided costs of off-site incineration and disposal. The proposed CAMU option allows for protective management of waste on-site, possibly combined with in-situ treatment. The expanded CAMU option promotes even more protective on-site management by allowing ex-situ treatment of hazardous waste combined with protective on-site management.

F. Qualitative Analysis of Effects on Benefits

Several criteria can be used to qualitatively analyze the relative benefits of the CAMU regulatory alternatives: Expectations regarding the long-term effectiveness of remedies; short-term impacts of implementing the remedies; and, effects on corrective action program implementation.

1. Expectations Regarding Long-Term Effectiveness

Under either the proposed CAMU or the Expanded CAMU alternatives CAMUs may be permitted by the Regional Administrator only if the RA decides that designation of a CAMU would be protective of human health and the environment. However, the types of remedies selected under the different CAMU regulatory alternatives may differ with regard to expectations of long-term effectiveness.

For example, ex-situ treatments (which were selected much more frequently under the Expanded CAMU alternative than under the proposed CAMU alternative) generally provide greater certainty of long-term effectiveness than do in-situ treatments or management without treatment. Treatments, such as stabilization for wastes or media containing inorganic constituents, are employed much more effectively ex-situ than in-situ due to improved mixing and the ability to ensure through sampling that all waste and contaminated media are thoroughly treated. Incineration (which was used much more frequently under the No CAMU alternative than under the CAMU alternatives) provides a high degree of long-term effectiveness for remediation of wastes or media containing organic constituents.

In contrast, containment of wastes without treatment (e.g., by capping the unit) is generally viewed as providing less certainty of long-term effectiveness than alternatives which involve actual removal from the unit and/or treatment. Although EPA believes that engineered containment structures can be highly effective, assuming adequate monitoring and maintenance, few would dispute the general conclusion that there is less certainty regarding long-term effectiveness with remedies which rely solely on containment in contrast to those which involve some degree of removal and/or treatment.

As shown in Exhibit 1, the Expanded CAMU alternative is expected to employ ex-situ treatment at more SWMUs and to employ in-situ treatment or no treatment at fewer SWMUs than is the case for the two other CAMU regulatory alternatives. As a result, the Expanded CAMU alternative appears likely, in actual implementation, to provide greater long-term certainty of remedy effectiveness.

EXHIBIT 1.—NATIONAL ESTIMATES OF THE NUMBER OF SWMUS BY TYPE OF TREATMENT UNDER CAMU REGULATORY ALTERNATIVES

Type of treatment	No. of SWMUs affected			
	Expanded CAMU	Proposed CAMU	No CAMU-(assumes more LDR treatment)	No CAMU-(assumes more management in place)
Ex-Situ	4,400	2,800	2,800	2,200
In-Situ	700	1,700	1,400	1,900
Ex-Situ and In-Situ	130	570	920	920
No Treatment	730	1,000	910	1,000
Total	6,000	6,000	6,000	6,000

Notes:
- Numbers may not total due to rounding.
- CAMU regulatory alternatives discussed in text.
- There are 6,000 SWMUs affected by expanded CAMUs under the Expanded CAMU alternative. The same group of SWMUs was examined under the other CAMU alternatives for comparability.

The Agency developed more detailed comparisons of remedies selected under the three CAMU regulatory options. These comparisons are presented in the document "Supplemental Information on Corrective Action Management Units" and in the Regulatory Impact Analysis for today's final rule; both documents are available in the RCRA docket. A few key findings are discussed in the sections below.

Incineration is estimated to be employed most often (at 3,100 SWMUs) under the No CAMU alternative, when EPA assumes that LDR treatment is required and occurs; least often (at 1,400 SWMUs) under the Expanded CAMU alternative; and in between (at 1,900 SWMUs) under the Proposed CAMU alternative. Incineration is employed at 2,300 SWMUs under the No CAMU alternative when EPA assumes that less LDR treatment occurs and more wastes are left in place and contained.

Reliance on LDR treatments such as incineration, would theoretically provide the greatest degree of certainty regarding long-term effectiveness. However, in practice the high costs of incineration, the public opposition to incineration, and the transportation-related implications of shipping large quantities of wastes off-site to commercial incinerators may discourage its use and instead may often encourage greater reliance on in-situ treatment or containment without treatment, in the absence of a CAMU rule. This scenario is best represented by the results of the analysis for the No CAMU alternative where EPA has assumed much more management of wastes in place than removal and treatment to the LDR standards.

Thus, while the Expanded CAMU alternative would not result in incineration as frequently as under the No CAMU–LDR Treatment scenario, it would likely provide a greater degree of certainty of long-term effectiveness than the No CAMU-Management in Place scenario by encouraging greater use of ex-situ treatments other than incineration and reduced use of management in place.

2. Short-Term Impacts of Remedies

As discussed above, CAMUs could be employed only if they are protective of human health and the environment. However, the remedies selected under the three CAMU regulatory alternatives could differ to some degree with regard to the short-term risks created by truck traffic and by management of wastes and contaminated media during remediation. Remedies which maximize excavation, transport, and off-site management of wastes and contaminated media would pose greater risks of release from transportation-related accidents. In-situ treatment, ex-situ treatment on-site, and containment remedies do not involve transport of wastes off-site.

Management of wastes and contaminated media during remediation could also potentially pose short-term risks to workers on-site and to nearby households off-site. Remedies involving extensive excavation or certain in-situ treatments (such as bioremediation), where wastes are actively managed, could potentially pose more short-term risk than remedies involving only capping in place. However, Occupational Safety and Health Administration standards would act to prevent on-site exposures for workers conducting remediations, and corrective action remedies are required to be designed and implemented to prevent short-term exposures at off-site exposure points. As a result, the Agency believes that the CAMU regulatory alternatives would potentially differ very little with regard to short-term risk from waste management activities.

3. Effects on Corrective Action Program Implementation

The Expanded CAMU and Proposed CAMU regulatory alternatives would provide additional flexibility, relative to the No CAMU alternative, in implementing remedies at RCRA facilities. In increasing this flexibility, EPA would expect to expedite cleanups, achieve better quality remedies at facilities which are operating under financial constraints, avoid situations where remedies would drive owner/operators into bankruptcies and their facilities into the CERCLA queue, and, reduce the number of long-term management units that must be monitored and maintained at remediated facilities.

Further, EPA expects that remedies selected under the Expanded and Proposed CAMU alternatives would likely be more publicly acceptable, relative to those selected under the No CAMU alternative, due to reduced reliance on incineration (as discussed above) and off-site transportation and disposal. Under the Expanded CAMU alternative, wastes from approximately 1,600 SWMUs would go to off-site disposal, compared with wastes from 2,700 SWMUs under the Proposed CAMU. The No CAMU alternative is estimated to result in off-site disposal for wastes from 3,000 to 3,700 SWMUs.

The Expanded CAMU alternative is also likely to have other implementation-related benefits. It may reduce the cost and/or enhance the environmental effectiveness of closing regulated units that are included in CAMUs. For example, a regulated unit that would otherwise be capped with waste in place could be incorporated in a CAMU where the waste would be excavated, treated ex-situ, and replaced in the unit, thus providing a greater degree of long-term effectiveness.

G. Regulatory Flexibility Analysis

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires that whenever an agency publishes a notice of rulemaking, it must prepare a Regulatory Flexibility Analysis (RFA) that describes the effect of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions). However, pursuant to section 605(b) of the Regulatory Flexibility Act, 5 U.S.C. 605(b), the Administrator certifies that this rule will not have a significant economic impact on a substantial number of small entities, because the rule provides relief to the regulated community. As a result of this finding, EPA has not prepared a formal RFA in support of the rule.

H. Paperwork Reduction Act

This rule does not contain any new information collection requirements subject to OMB review under the Paperwork Reduction Act, 44 U.S.C. 3501, et. seq.

List of Subjects

40 CFR Part 260

Administrative practice and procedure, Hazardous waste.

40 CFR Part 264

Hazardous waste, Reporting and recordkeeping requirements.

40 CFR Part 265

Hazardous waste, Reporting and recordkeeping requirements.

40 CFR Part 268

Hazardous waste, Reporting and recordkeeping requirements.

40 CFR Part 270

Administrative practice and procedure, Hazardous materials transportation, Reporting and recordkeeping requirements, Water pollution control.

40 CFR Part 271

Administrative practice and procedure, Hazardous materials transportation, Indian lands, Intergovernmental relations, Penalties, Reporting and recordkeeping requirements, Water pollution control.

Dated: January 14, 1993.

William Reilly,

Administrator.

For the reasons set out in the preamble, title 40, chapter I, of the Code of Federal Regulations, is amended as follows:

PART 260—HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL

1. The authority citation for part 260 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921–6927, 6930, 6934, 6935, 6937, 6938, 6939, and 6974.

2. Section 260.10 is amended adding, in alphabetical order, definitions for "Corrective action management unit" and "Remediation waste," and by revising the definitions for "Disposal Facility," "Facility," "Landfill," and "Miscellaneous Unit" to read as follows:

§ 260.10 Definitions.

* * * * *

Corrective action management unit or *CAMU* means an area within a facility that is designated by the Regional Administrator under part 264 subpart S, for the purpose of implementing corrective action requirements under § 264.101 and RCRA section 3008(h). A CAMU shall only be used for the management of remediation wastes pursuant to implementing such corrective action requirements at the facility.

* * * * *

Disposal facility means a facility or part of a facility at which hazardous waste is intentionally placed into or on any land or water, and at which waste will remain after closure. The term disposal facility does not include a corrective action management unit into which remediation wastes are placed.

* * * * *

Facility means:

(1) All contiguous land, and structures, other appurtenances, and improvements on the land, used for treating, storing, or disposing of hazardous waste. A facility may consist of several treatment, storage, or disposal operational units (e.g., one or more landfills, surface impoundments, or combinations of them).

(2) For the purpose of implementing corrective action under § 264.101, all contiguous property under the control of the owner or operator seeking a permit under subtitle C of RCRA. This definition also applies to facilities implementing corrective action under RCRA Section 3008(h).

* * * * *

Landfill means a disposal facility or part of a facility where hazardous waste is placed in or on land and which is not a pile, a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit.

* * * * *

Miscellaneous unit means a hazardous waste management unit where hazardous waste is treated, stored, or disposed of and that is not a container, tank, surface impoundment, pile, land treatment unit, landfill, incinerator, boiler, industrial furnace, underground injection well with appropriate technical standards under 40 CFR part 146, containment building, corrective action management unit, or unit eligible for research, development, and demonstration permit under § 270.65.

* * * * *

Remediation waste means all solid and hazardous wastes, and all media (including groundwater, surface water, soils, and sediments) and debris, which contain listed hazardous wastes or which themselves exhibit a hazardous waste characteristic, that are managed for the purpose of implementing corrective action requirements under § 264.101 and RCRA section 3008(h). For a given facility, remediation wastes may originate only from within the facility boundary, but may include waste managed in implementing RCRA sections 3004(v) or 3008(h) for releases beyond the facility boundary.

* * * * *

PART 264—STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

3. The authority for part 264 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6924, and 6925.

4. Section 264.3 is amended by revising the first paragraph (and the comment remains unchanged) to read as follows:

§ 264.3 Relationship to interim status standards.

A facility owner or operator who has fully complied with the requirements for interim status—as defined in section 3005(e) of RCRA and regulations under § 270.70 of this chapter—must comply with the regulations specified in part 265 of this chapter in lieu of the regulations in this part, until final administrative disposition of his permit application is made, except as provided under 40 CFR part 264 subpart S.

* * * * *

5. Paragraph (b) of § 264.101 is revised to read as follows:

§ 264.101 Corrective action for solid waste management units.

* * * * *

(b) Corrective action will be specified in the permit in accordance with this section and subpart S of this part. The permit will contain schedules of compliance for such corrective action (where such corrective action cannot be completed prior to issuance of the permit) and assurances of financial responsibility for completing such corrective action.

* * * * *

6. 40 CFR part 264 is amended by adding subpart S to read as follows:

Subpart S—Corrective Action for Solid Waste Management Units

Sec.
264.552 Corrective Action Management Units (CAMU).
264.553 Temporary Units (TU).

Subpart S—Corrective Action for Solid Waste Management Units

§ 264.552 Corrective Action Management Units (CAMU).

(a) For the purpose of implementing remedies under § 264.101 or RCRA Section 3008(h), the Regional Administrator may designate an area at the facility as a corrective action management unit, as defined in § 260.10, in accordance with the requirements of this section. One or more CAMUs may be designated at a facility.

(1) Placement of remediation wastes into or within a CAMU does not constitute land disposal of hazardous wastes.

(2) Consolidation or placement of remediation wastes into or within a CAMU does not constitute creation of a unit subject to minimum technology requirements.

(b)(1) The Regional Administrator may designate a regulated unit (as defined in § 264.90(a)(2)) as a CAMU, or may incorporate a regulated unit into a CAMU, if:

(i) The regulated unit is closed or closing, meaning it has begun the closure process under § 264.113 or § 265.113; and

(ii) Inclusion of the regulated unit will enhance implementation of effective, protective and reliable remedial actions for the facility.

(2) The subpart F, G, and H requirements and the unit-specific requirements of part 264 or 265 that applied to that regulated unit will continue to apply to that portion of the CAMU after incorporation into the CAMU.

(c) The Regional Administrator shall designate a CAMU in accordance with the following:

(1) The CAMU shall facilitate the implementation of reliable, effective, protective, and cost-effective remedies;

(2) Waste management activities associated with the CAMU shall not create unacceptable risks to humans or to the environment resulting from exposure to hazardous wastes or hazardous constituents;

(3) The CAMU shall include uncontaminated areas of the facility, only if including such areas for the purpose of managing remediation waste is more protective than management of such wastes at contaminated areas of the facility;

(4) Areas within the CAMU, where wastes remain in place after closure of the CAMU, shall be managed and contained so as to minimize future releases, to the extent practicable;

(5) The CAMU shall expedite the timing of remedial activity implementation, when appropriate and practicable;

(6) The CAMU shall enable the use, when appropriate, of treatment technologies (including innovative technologies) to enhance the long-term effectiveness of remedial actions by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the CAMU; and

(7) The CAMU shall, to the extent practicable, minimize the land area of the facility upon which wastes will remain in place after closure of the CAMU.

(d) The owner/operator shall provide sufficient information to enable the Regional Administrator to designate a CAMU in accordance with the criteria in § 264.552.

(e) The Regional Administrator shall specify, in the permit or order, requirements for CAMUs to include the following:

(1) The areal configuration of the CAMU.

(2) Requirements for remediation waste management to include the specification of applicable design, operation and closure requirements.

(3) Requirements for ground water monitoring that are sufficient to:

(i) Continue to detect and to characterize the nature, extent, concentration, direction, and movement of existing releases of hazardous constituents in ground water from sources located within the CAMU; and

(ii) Detect and subsequently characterize releases of hazardous constituents to ground water that may occur from areas of the CAMU in which wastes will remain in place after closure of the CAMU.

(4) Closure and post-closure requirements.

(i) Closure of corrective action management units shall:

(A) Minimize the need for further maintenance; and

(B) Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, for areas where wastes remain in place, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground, to surface waters, or to the atmosphere.

(ii) Requirements for closure of CAMUs shall include the following, as appropriate and as deemed necessary by the Regional Administrator for a given CAMU:

(A) Requirements for excavation, removal, treatment or containment of wastes;

(B) For areas in which wastes will remain after closure of the CAMU, requirements for capping of such areas; and

(C) Requirements for removal and decontamination of equipment, devices, and structures used in remediation waste management activities within the CAMU.

(iii) In establishing specific closure requirements for CAMUs under § 264.552(e), the Regional Administrator shall consider the following factors:

(A) CAMU characteristics;

(B) Volume of wastes which remain in place after closure;

(C) Potential for releases from the CAMU;

(D) Physical and chemical characteristics of the waste;

(E) Hydrological and other relevant environmental conditions at the facility which may influence the migration of any potential or actual releases; and

(F) Potential for exposure of humans and environmental receptors if releases were to occur from the CAMU.

(iv) Post-closure requirements as necessary to protect human health and the environment, to include, for areas where wastes will remain in place, monitoring and maintenance activities, and the frequency with which such activities shall be performed to ensure the integrity of any cap, final cover, or other containment system.

(f) The Regional Administrator shall document the rationale for designating CAMUs and shall make such documentation available to the public.

(g) Incorporation of a CAMU into an existing permit must be approved by the Regional Administrator according to the procedures for Agency-initiated permit modifications under § 270.41 of this chapter, or according to the permit modification procedures of § 270.42 of this chapter.

(h) The designation of a CAMU does not change EPA's existing authority to address clean-up levels, media-specific points of compliance to be applied to remediation at a facility, or other remedy selection decisions.

§ 264.553 Temporary Units (TU).

(a) For temporary tanks and container storage areas used for treatment or storage of hazardous remediation wastes, during remedial activities required under § 264.101 or RCRA section 3008(h), the Regional Administrator may determine that a design, operating, or closure standard applicable to such units may be replaced by alternative requirements which are protective of human health and the environment.

(b) Any temporary unit to which alternative requirements are applied in accordance with paragraph (a) of this section shall be:

(1) Located within the facility boundary; and

(2) Used only for treatment or storage of remediation wastes.

(c) In establishing standards to be applied to a temporary unit, the Regional Administrator shall consider the following factors:

(1) Length of time such unit will be in operation;

(2) Type of unit;

(3) Volumes of wastes to be managed;

(4) Physical and chemical characteristics of the wastes to be managed in the unit;

(5) Potential for releases from the unit;

(6) Hydrogeological and other relevant environmental conditions at the facility which may influence the migration of any potential releases; and

(7) Potential for exposure of humans and environmental receptors if releases were to occur from the unit.

(d) The Regional Administrator shall specify in the permit or order the length of time a temporary unit will be allowed to operate, to be no longer than a period of one year. The Regional Administrator shall also specify the design, operating, and closure requirements for the unit.

(e) The Regional Administrator may extend the operational period of a temporary unit once for no longer than a period of one year beyond that originally specified in the permit or order, if the Administrator determines that:

(1) Continued operation of the unit will not pose a threat to human health and the environment; and

(2) Continued operation of the unit is necessary to ensure timely and efficient implementation of remedial actions at the facility.

(f) Incorporation of a temporary unit or a time extension for a temporary unit into an existing permit shall be:

(1) Approved in accordance with the procedures for Agency-initiated permit modifications under § 270.41; or

(2) Requested by the owner/operator as a Class II modification according to the procedures under § 270.42 of this chapter.

(g) The Regional Administrator shall document the rationale for designating a temporary unit and for granting time extensions for temporary units and shall make such documentation available to the public.

PART 265—INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

7. The authority citation for part 265 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6924, 6925, and 6935.

8. Section 265.1(b) is amended by adding the phrase ", and of 40 CFR 264.552 and 40 CFR 264.553," immediately after the phrase "standards of this part" in the first sentence.

PART 268—LAND DISPOSAL RESTRICTIONS

9. The authority citation for part 268 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921, and 6924.

10. Section 268.2 is amended by revising paragraph (c) to read as follows:

§ 268.2 Definitions applicable in this part.

* * * * *

(c) *Land disposal* means placement in or on the land, except in a corrective action management unit, and includes, but is not limited to, placement in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, underground mine or cave, or placement in a concrete vault, or bunker intended for disposal purposes.

* * * * *

PART 270—EPA ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT PROGRAM

11. The authority citation for part 270 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912, 6924, 6925, 6927, 6939, and 6974.

12. Section 270.2 is amended by adding, in alphabetical order, a definition for "Corrective action management unit," and by revising the definition for "Disposal facility" to read as follows:

§ 270.2 Definitions.

* * * * *

Corrective Action Management Unit or *CAMU* means an area within a facility that is designated by the Regional Administrator under part 264 subpart S, for the purpose of implementing corrective action requirements under § 264.101 and RCRA section 3008(h). A CAMU shall only be used for the management of remediation wastes pursuant to implementing such corrective action requirements at the facility.

* * * * *

Disposal facility means a facility or part of a facility at which hazardous waste is intentionally placed into or on the land or water, and at which hazardous waste will remain after closure. The term disposal facility does not include a corrective action management unit into which remediation wastes are placed.

* * * * *

13. Appendix I to § 270.42 is amended by adding a new section N, to read as follows:

§ 270.42 Permit modification at the request of the permittee.

* * * * *

APPENDIX I TO § 270.42—CLASSIFICATION OF PERMIT MODIFICATION

Modification	Class
* * * * *	
N. Corrective Action:	
1. Approval of a corrective action management unit pursuant to § 264.552	3
2. Approval of a temporary unit or time extension for a temporary unit pursuant to § 264.553	2
* * * * *	

PART 271—REQUIREMENTS FOR AUTHORIZATION OF STATE HAZARDOUS WASTE PROGRAMS

14. The authority citation for part 271 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), and 6926.

15. Section 271.1(j) is amended by adding the following entry in Table 1 in chronological order by date of publication:

§ 271.1 Purpose and scope.

* * * * *

(j) * * *

TABLE 1.—REGULATIONS IMPLEMENTING THE HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984

Promulgation date	Title of regulation	Federal Register reference	Effective Date
* * * * * *			
Feb. 16, 1993	Corrective Action Management Units and Temporary Units; Corrective Action Provisions under Subtitle C ..	58 FR	Apr. 19, 1993.

* * * * *

[FR Doc. 93-3154 Filed 2-12-93; 8:45 am]

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Determination of When Contamination is Caused by a Listed Hazardous Waste

federal register

Tuesday
May 26, 1998

Part II

Environmental Protection Agency

40 CFR Parts 148, 261, 266, 268, and 271

Land Disposal Restrictions Phase IV: Final Rule Promulgating Treatment Standards for Metal Wastes and Mineral Processing Wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issues; Treatment Standards for Hazardous Soils, and Exclusion of Recycled Wood Preserving Wastewaters; Final Rule

no hazardous waste to which a land disposal prohibition could attach (principle (2)).

2. Generator B is excavating soil contaminated by leaks from a closing hazardous waste surface impoundment. The surface impoundment received listed hazardous wastes K062 (spent pickle liquor) and characteristic hazardous waste D018 (wastes that fail the TCLP test for benzene). The surface impoundment stopped receiving K062 waste in 1987 and D018 waste in 1993. The soil does not exhibit a characteristic of hazardous waste and has been determined by an authorized state not to contain listed hazardous waste. The soil is not prohibited from land disposal. This is because, for LDR purposes, the point of generation is when the soil is first excavated from the land (principle (1)). Since no prohibited hazardous waste existed before that time (i.e., the contaminating wastes were not prohibited) and the soil does not contain listed hazardous waste or exhibit a characteristic of hazardous waste at its point of generation, there is no hazardous waste to which a land disposal prohibition could attach (principle (2)).

3. Generator C is excavating soil contaminated with listed hazardous waste F024. The F024 waste was land disposed after 1991, after it was prohibited from land disposal, and was not first treated to meet applicable land disposal treatment standards (i.e., it was illegally land disposed or accidentally spilled). Since the contaminating waste was prohibited from land disposal and treatment standards were not achieved prior to land disposal, the LDR prohibition continues to apply to any soil contaminated by the waste (principle (3)) regardless of whether the soil "contains" hazardous waste when generated. The soil is prohibited from land disposal and, before land disposal, must be treated to meet applicable technology-based treatment standards or until a site-specific, risk-based minimize threat determination is made through the variance process.

4. Generator D is excavating soil contaminated by an accidental spill of benzyl chloride, which, when discarded, is listed hazardous waste P028 and is prohibited from land disposal. The accidental spill occurred yesterday. The contaminating waste was prohibited from land disposal and, since the treatment standards were not achieved prior to the accidental spill, the prohibition continues to apply to any soil contaminated by the waste (principle (3)). Thus, the soil is prohibited from land disposal and, before land disposal, must be treated to meet applicable technology-based treatment standards or until a site-specific, risk-based minimize threat determination is made through the variance process.

5. Generator E is excavating soil contaminated by listed hazardous waste F004 (generally, spent non-halogenated solvents). The F004 waste was land disposed in 1984, prior to the effective date of an applicable land disposal prohibition; however, on generation the soil contains high concentrations of cresols constituents, so that an authorized state determines it "contains" hazardous waste. The soil is prohibited from land disposal. Although the contaminating waste was not prohibited from land disposal, since the soil contained hazardous waste at the point of generation (and the waste had since become prohibited from land disposal), the land disposal prohibition attaches to the contaminated soil and, before land disposal, the soil must be treated to meet applicable technology-based treatment standards or until a site-specific, risk-based minimize threat determination is made through the variance process (principles (1), (2), and (3)).

EPA acknowledges that the reading of LDR applicability to contaminated soil discussed above creates potential administrative difficulties, since, in many cases, a factual determination will be required as to when hazardous wastes were land disposed in order to determine whether they were prohibited at that time and whether, therefore, the prohibition continues to apply to contaminated soil. The Agency expects that these difficulties will be minimal because, in most cases, contamination will be caused by hazardous wastes placed before the effective date of applicable land disposal prohibitions since land disposal after prohibition would be illegal. The exception is accidental spills of hazardous waste, which the Agency believes are (1) rare, and (2) known, so determining dates of land disposal should not be problematic. This issue was discussed in detail in the HWIR-Media proposal. 61 FR 18805 (April 26, 1996).

As discussed in the April 29, 1996 proposal, the Agency continues to believe that, if information is not available or inconclusive, it is generally reasonable to assume that contaminated soils do not contain untreated hazardous wastes placed after the effective dates of applicable land disposal prohibitions. This is because placement of untreated hazardous waste after applicable LDR effective dates would be a violation of RCRA, subject to significant fines and penalties including criminal sanctions. 61 FR at 18805 (April 29, 1996). Of course, program implementors and facility owners/operators cannot make the determination that information on the types of waste contamination or dates of waste placement is unavailable or inconclusive without first making a good faith effort to uncover such information. By using available site- and waste-specific information such as manifests, LDR records required under 40 CFR 268.7, vouchers, bills of lading, sales and inventory records, storage records, sampling and analysis reports, accident reports, site investigation reports, spill reports, inspection reports and logs, EPA believes that program implementors and facility owners/operators will typically be able to make informed decisions about the types of waste contamination and dates of waste placement. Most commenters supported this approach.

EPA notes that it is not critical for a decision about whether contaminated soil contains listed hazardous waste or exhibits a characteristic of hazardous waste to be made without removing any of the soil (other than the sample volume) from the land. In an area of generally dispersed soil contamination, soil may be consolidated or managed within the area of contamination to facilitate sampling, for example, to ensure that soil samples are representative or to separate soil from non-soil materials. However, care should be taken not to remove hazardous contaminated soils from separate areas of contamination at a facility and place such hazardous contaminated soil into a land disposal unit unless, of course, the soil meets applicable LDR treatment standards. The area of contamination policy is discussed later in this section of today's preamble.

A few commenters expressed concern or confusion over the application of LDRs to soil contaminated by accidental spills of hazardous wastes. The Agency clarifies that accidental spills of hazardous wastes (or products or raw materials) are not considered placement of hazardous waste into a land disposal unit since, in the case of a spill, prohibited waste is not being placed in one of the identified units named in RCRA Section 3004(m).[45] See, 45 FR 76626 (Nov. 19, 1980), issuing clarifying regulations at 40 CFR 264.10(g) to provide that hazardous waste treatment

[45] Although, if such a spill were not cleaned up in a timely way, EPA or an authorized state could determine that the contaminated area should be considered a land disposal unit for purposes of requiring cleanup under RCRA Subtitle C. 55 FR at 20809 (July 27, 1990).

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Monday
April 29, 1996

Part II

Environmental Protection Agency

40 CFR Part 260, et al.
Requirements for Management of Hazardous Contaminated Media; Proposed Rule

that it may be appropriate to allow States not authorized for this Part to simply approve another authorized States' decision that the media are not hazardous. The Agency requests comments on these issues.

C. Treatment Requirements

1. Overview of the Land Disposal Restrictions

The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA), enacted on November 8, 1984, largely prohibit land disposal of hazardous wastes.[15] Once a hazardous waste is prohibited from land disposal, the statute provides only two options: comply with a specified treatment standard prior to land disposal, or dispose of the waste in a unit that has been found to satisfy the statutory no migration test (referred to as a "no migration" unit) (RCRA section 3004(m)). Storage of waste prohibited from land disposal is also prohibited, unless the storage is solely for the purpose of accumulating the quantities of hazardous waste that are necessary to facilitate proper recovery, treatment, or disposal (RCRA section 3004(j)). For purposes of the land disposal restrictions, land disposal includes any placement of hazardous waste into a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave (hereafter referred to as "placement") (RCRA section 3004(k)).

Not all management of hazardous waste constitutes placement for purposes of the LDRs. EPA has interpreted "placement" to include putting hazardous waste into a land-based, moving hazardous waste from one land-based unit to another, and removing hazardous waste from the land, managing it in a separate unit, and re-placing it in the same (or a different) land-based. Placement does not occur when waste is consolidated within a land-based unit, when it is treated *in situ*, or when it is left in place (e.g., capped). (See 55 FR 8666, 8758–8760, (March 8, 1990) and "Determining When Land Disposal Restrictions (LDRs) Are Applicable to CERCLA Response Actions," EPA, OSWER Directive 9347.3–O5FS, (July 1989)).

Congress directed EPA to establish treatment standards for all hazardous wastes restricted from land disposal at the same time as the land disposal prohibitions take effect. According to the statute, treatment standards established by EPA must substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short- and long-term threats to human health and the environment are minimized (RCRA section 3004(m)(1)). In *Hazardous Waste Treatment Council* v. *EPA*, 886 F.2d 355 (D.C. Dir. 1989), Cert. Denied 111 S.Ct 139 (1990), the court held that section 3004(m) allows both technology- and risk-based treatment standards, provided that technology-based standards are not established "beyond the point at which there is not a 'threat' to human health or the environment." *id.* at 362 (i.e., beyond the point at which threats to human health and the environment are minimized) (59 FR 47980, 47986, September 19, 1994). Hazardous wastes that have been treated to meet the applicable treatment standard may be land disposed in land disposal facilities that meet the requirements of RCRA Subtitle C (RCRA section 3004(m)(2)).

Congress established a schedule for promulgation of land disposal restrictions and treatment standards for all hazardous wastes listed and identified as of November 8, 1984 (the effective date of the HSWA amendments) so that treatment standards would be in effect, and land disposal of all hazardous waste that did not comply with the standards would be prohibited, by May 8, 1990 (RCRA section 3004(g)). For some classes of hazardous wastes, Congress established separate schedules: for certain hazardous wastes identified by the State of California ("California List"), Congress directed EPA to establish treatment standards and prohibit land disposal by July 8, 1987; for hazardous wastes containing solvents and dioxins, Congress directed the Agency to establish treatment standards and prohibit land disposal by November 8, 1986. (RCRA sections 3004(d) and (e)). For wastes listed or identified as hazardous after the HSWA amendments (referred to as "newly identified wastes"), EPA must establish treatment standards and land disposal prohibitions within six months of the effective date of the listing or identification (RCRA section 3004(g)(4)). Under current regulations, environmental media containing hazardous waste are prohibited from land disposal unless they are treated to meet the treatment standards promulgated for the original hazardous waste in question (i.e., the same treatment standard the contaminating hazardous waste would have to meet if it were newly generated). (See 58 FR 48092, 48123, (September 14, 1993)).

The land disposal restrictions generally attach to hazardous wastes, or environmental media containing hazardous wastes, when they are first generated. Once these restrictions attach, the standards promulgated pursuant to section 3004(m) must be met before the wastes (or environmental media containing the wastes) can be placed into any land disposal unit other than a no migration unit. In cases involving characteristic wastes, the D.C. Circuit held that even elimination of the property that caused EPA to identify wastes as hazardous in the first instance (e.g., treating characteristic wastes so they no longer exhibit a hazardous characteristic) does not automatically eliminate the duty to achieve compliance with the land disposal treatment standards. (*Chemical Waste Management* v. *U.S. EPA*, 976 F.2d 2,22 (D.C. Dir. 1992), *cert. denied*, 113 S.Ct 1961 (1993).) The Agency has examined the logic of the *Chemical Waste* decision and concluded that the same logic could arguably be applied in the remediation context; i.e., a determination that environmental media once subject to LDR standards no longer contain hazardous wastes may not automatically eliminate LDR requirements. While the *Chemical Waste* court did not specifically address the remediation context, the Agency believes it may be prudent to follow the logic the court applied to characteristic wastes, and has developed today's proposal accordingly.

It is important to note that the land disposal restrictions apply only to hazardous (or, in some cases, formerly hazardous) wastes and only to placement of hazardous wastes after the effective date of the applicable land disposal prohibition—generally May 8, 1990 for wastes listed or identified at the time of the 1984 amendments, or six months after the effective date of the listing or identification for newly identified wastes.[16] In other words, the duty to comply with LDRs has already attached to hazardous wastes land disposed ("placed") after the applicable effective dates, but not to hazardous wastes disposed prior to the applicable effective dates. Accordingly, hazardous

[15] The LDR requirements are not cleanup requirements; LDR treatment standards do not trigger removal, exhumation, or other management of contaminated environmental media; however, other applicable requirements, such as State or Federal cleanup requirements, could trigger such actions which, in turn, could trigger LDR requirements.

[16] A detailed listing of when the land disposal prohibitions took effect for individual hazardous wastes can be found in 40 CFR Part 268, Appendix VII.

wastes disposed prior to the effective date of the applicable prohibition only become subject to the LDRs if they are removed from the land and placed into a land disposal unit after the effective date of the applicable prohibition. (See 53 FR 31138, 31148, (August 17, 1988) and *Chemical Waste Management* v. *US EPA*, 86 9 F.2d 1526, 1536 (D.C. Cir. 1989)), "treatment or disposal of [hazardous waste] will be subject to the [LDR] regulation only if that treatment or disposal occurs after the promulgation of applicable treatment standards.") Similarly, environmental media contaminated by hazardous wastes placed before the effective dates of the applicable land disposal restrictions does not become subject to the LDRs unless they are removed from the land and placed into a land disposal unit after the effective dates of the applicable restrictions.

The land disposal restrictions do not attach to environmental media contaminated by hazardous wastes when the wastes were placed before the effective dates of the applicable land disposal prohibitions. If these media are determined not to contain hazardous wastes before they are removed from the land, then they can be managed as non-hazardous contaminated media and they're not subject to land disposal restrictions. For example, soil contaminated by acetone land disposed ("placed") in 1986 (prior to the effective date of the land disposal prohibition for acetone) and, while still in the land, determined not to contain hazardous waste, is not subject to the land disposal restrictions.[17] This is consistent with the Agency's approach in the HWIR-waste rule, where it indicates that LDRs do not attach to wastes that are not hazardous at the time they are first generated (60 FR 66344, December 21, 1995).

Since application of the land disposal restrictions is limited, in order to determine if a given environmental medium must comply with LDRs one must know the origin of the material contaminating the medium (i.e., hazardous waste or not hazardous waste), the date(s) the material was placed (i.e., before or after the effective date of the applicable land disposal prohibition), and whether or not the medium still contains hazardous waste (i.e., contained-in decision or not).

Facility owner/operators should make a good faith effort to determine whether media were contaminated by hazardous wastes and ascertain the dates of placement. The Agency believes that by using available site- and waste-specific information such as manifests, vouchers, bills of lading, sales and inventory records, storage records, sampling and analysis reports, accident reports, site investigation reports, spill reports, inspection reports and logs, and enforcement orders and permits, facility owner/operators would typically be able to make these determinations. However, as discussed earlier in the preamble of today's proposal, if information is not available or inconclusive, facility owner/operators may generally assume that the material contaminating the media were not hazardous wastes. Similarly, if environmental media were determined to be contaminated by hazardous waste, but if information on the dates of placement is unavailable or inconclusive, facility owner/operators may, in most cases assume the wastes were placed before the effective date.

The Agency believes that, in general, it is reasonable to assume that environmental media do not contain hazardous wastes placed after the effective dates of the applicable land disposal prohibitions when information on the dates of placement is unavailable or inconclusive, in part, because current regulations, in effect since the early 1980's, require generators of hazardous waste to keep detailed records of the amounts of hazardous waste they generate. These records document whether the waste meets land disposal treatment standards and list the dates and locations of the waste's ultimate disposition. With these records, the Agency should be able to determine if environmental media were contaminated by hazardous wastes and if they would be subject to the land disposal restrictions.

In addition, EPA believes that the majority of environmental media contaminated by hazardous wastes were contaminated prior to the effective dates of the applicable land disposal restrictions. Generally, the contamination of environmental media by hazardous waste after the effective date of the applicable land disposal restriction would involve a violation of the LDRs, subject to substantial fines and penalties, including criminal sanctions. The common exception would be one-time spills of hazardous waste or hazardous materials. In these cases, the Agency believes that, typically, independent reporting and record keeping requirements (e.g., CERCLA sections 102 and 103 reporting requirements or state spill reporting requirements) coupled with ordinary "good housekeeping" procedures, result in records that will allow the Agency to determine the nature of the spilled material, and the date (or a close approximation of the date) of the spill. The Agency requests comments on this approach and on any other assumptions, records, or standards of evaluation that would ensure that facility owner/operators would identify any contaminated media subject to land disposal restrictions properly and completely.

Information on contained-in decisions should be immediately available since, generally, these determinations are made by a regulatory agency on a site-specific basis and careful records are kept.

2. Treatment Requirements—§ 269.30

a. *Approach to treatment requirements and recommendations of the FACA Committee.* RCRA section 3004(m) requires that treatment standards for wastes restricted from land disposal, "* * * specify those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." A recurring debate through EPA's development of the land disposal restriction program has been whether treatment standards should be technology-based (i.e., based on performance of a treatment technology) or risk-based (i.e., based on assessment of risks to human health and the environment that are posed by the wastes). The Agency believes that both approaches are allowed. It has long been recognized that Congress did not directly address the questions of how to set treatment standards in the language of section 3004(m).[18] In addition, Congress did not specifically address whether the LDR treatment standards for newly generated wastes and remediation wastes must be identical; the structure of RCRA's LDR provisions suggests that Congress believed that remediation waste may merit special consideration. (See, RCRA sections 3004(d)(3) and 3004(e)(3), which

[17] Similarly, soil contaminated by acetone placed in a solid waste management unit in 1986, but leaked into the soil at some point after 1986, is not subject to the land disposal restrictions provided that, while the soil is still in the land, the Director determines it does not contain hazardous wastes. LDRs would not attach because, in this case, it is the initial placement of hazardous waste that determines whether there is a duty to comply with LDRs.

[18] See, e.g., 51 FR 40572, 40578 (November 7, 1986); *Hazardous Waste Treatment Council v. US EPA*, 886 F.2d 355, 361–3 D.C. Cir. 1989); 55 FR 6640, 6641 (February 26, 1990). The legislative history of section 3004(m) is likewise inconclusive. See discussion of the legislative history at 55 FR 6640, 6641–6642 (February 26, 1990)"[a]t a minimum, the [legislative history shows] that Congress did not provide clear guidance on the meaning of 'minimize threats'."

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Wednesday
December 21, 1988

Part V

Environmental Protection Agency

40 CFR Part 300

National Oil and Hazardous Substances Pollution Contingency Plan; Proposed Rule

would need to comply with the applicable closure requirements for those units in completing the remedial action. Second, if the lead agency determines that RCRA listed or characteristic hazardous waste is present at the site (even if the waste was disposed before the effective date of the requirement) and the proposed CERCLA action involves treatment, storage, or disposal as defined under RCRA, then RCRA requirements related to those actions would be applicable.

These two scenarios are contingent upon determinations that RCRA Subtitle C hazardous waste is present and on the identification of the period of waste management. To determine whether a waste is a listed waste under RCRA, it is often necessary to know the source. However, at many CERCLA sites no information exists on the source of the wastes nor are references available citing the date of disposal. The lead agency should use available site information, manifests, storage records, and vouchers in an effort to ascertain the source of these contaminants. When this documentation is not available, the lead agency may assume that the wastes are not listed RCRA hazardous wastes, unless further analysis or information becomes available which allows the lead agency to determine that the wastes are listed RCRA hazardous wastes. If the lead agency assumes the wastes are not listed RCRA hazardous wastes and it is determined that the wastes are not characteristic wastes under RCRA (see discussion below, 17.i.) RCRA requirements would not be applicable to CERCLA actions, but may be relevant and appropriate if the CERCLA action involves treatment, storage or disposal and/or if the wastes are similar or identical to RCRA hazardous waste.

Under certain circumstances, although no historical information exists about the waste and when it was treated, stored, or disposed, it may be possible to identify the wastes as RCRA characteristic wastes. With respect to hazardous characteristics, (ignitability, corrosivity, reactivity, or EP toxicity), it is the responsibility of the generator (in this case, the lead agency or PRP conducting the action) to determine if the wastes exhibit any of these characteristics (defined in 40 CFR 261.21 through 24). The lead agency must use best professional judgment to determine, on a site-specific basis, if testing for hazardous characteristics is necessary. Testing is required unless it can be determined, by "applying knowledge of the hazard characteristic in light of the materials or process used," that the waste does not have hazardous characteristics (40 CFR 262.11(c)).

In determining whether to test for the toxicity characteristic using the Extraction Procedure (EP) Toxicity Test, it may be possible to assume that certain low concentrations of waste are not toxic. For example, if the total waste concentration is 20 times or less the EP Toxicity concentration, the waste cannot be characteristic hazardous waste. In such a case RCRA requirements would not be applicable and would not likely be relevant or appropriate unless the waste also contained other RCRA hazardous wastes and the CERCLA action involved treatment, storage, or disposal.

If the wastes exhibit hazardous characteristics, RCRA requirements are potentially applicable if the wastes also were either treated, stored, or disposed after the effective date of the applicable RCRA requirement or if the CERCLA actions will involve treatment, storage, or disposal.

ii. *Actions constituting treatment, storage, or disposal.* Many CERCLA actions occur in areas of contamination that contain waste treated, disposed of, or stored prior to November 19, 1980. If left untouched, wastes in such areas are not currently regulated under Subtitle C of RCRA. (Solid waste management units at RCRA facilities are regulated by the 3004(u) corrective action requirements.) However, certain physical movement, alteration, or disturbance of RCRA hazardous waste associated with a remedial action may meet the RCRA definition of treatment, storage, or disposal. For instance, treatment has occurred when the CERCLA remedial action uses "any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, dispose of; or amenable for recovery, amenable for storage, or reduced in volume." 40 CFR 260.10.

Similarly, storage occurs when a CERCLA remedial action involves the "holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere." 40 CFR 260.10.

Land disposal occurs when RCRA hazardous waste is placed into a land disposal unit, including a "landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave." RCRA section 3004(k).

Movement of hazardous waste entirely within a unit does not constitute "land disposal" under Subtitle C of RCRA. However, movement of hazardous waste into a unit (i.e., across the boundary of a unit) does constitute "land disposal."

In many cases CERCLA sites contain areas of contamination (with differing levels of concentration, including hot spots, of hazardous substances, pollutants, or contaminants) that may be characterized as a unit, usually a landfill, under RCRA. In such cases where RCRA hazardous waste is moved into the area of contamination, RCRA disposal requirements are applicable to the disturbed waste and certain land disposal requirements (such as for closure) may be applicable to the area where the waste is received.

Therefore, the following activities constitute land disposal under RCRA Subtitle C where the waste involved is RCRA hazardous waste:

a. Wastes from different units are consolidated into one unit;

b. Waste is removed and treated outside a unit and redeposited into the same or another unit; or

c. Waste is picked up from the unit and treated within the area of contamination in an incinerator, surface impoundment, or tank and then redeposited into the unit (does not include in-situ treatment).

In contrast, an example of an activity that does not constitute "land disposal" is the mere consolidation of RCRA hazardous wastes within a unit. Similarly, the covering and sealing off of hazardous waste, called "capping with waste in place," is also not considered "land disposal" and RCRA Subtitle C requirements would not be applicable. If some of the waste at a site is moved into another unit, but other waste is left behind in the original unit (the unit in which such waste was found), "land disposal" applies only with regard to the waste that is moved into another unit. Under these examples, however, certain RCRA land disposal requirements might nevertheless be relevant and appropriate to such waste. (See ARARs preamble sections below, 16.iii. and 17.)

iii. *Hypothetical examples of compliance with RCRA: land disposal restrictions.* Land disposal restrictions under RCRA sections 3004 (d) through (k) are triggered whenever there is placement of RCRA hazardous wastes subject to land disposal restrictions ("banned waste") into a land-based unit. Such land disposal does not occur when

wastes disposed prior to the effective date of the applicable prohibition only become subject to the LDRs if they are removed from the land and placed into a land disposal unit after the effective date of the applicable prohibition. (See 53 FR 31138, 31148, (August 17, 1988) and *Chemical Waste Management* v. *US EPA*, 86 9 F.2d 1526, 1536 (D.C. Cir. 1989)), "treatment or disposal of [hazardous waste] will be subject to the [LDR] regulation only if that treatment or disposal occurs after the promulgation of applicable treatment standards.") Similarly, environmental media contaminated by hazardous wastes placed before the effective dates of the applicable land disposal restrictions does not become subject to the LDRs unless they are removed from the land and placed into a land disposal unit after the effective dates of the applicable restrictions.

The land disposal restrictions do not attach to environmental media contaminated by hazardous wastes when the wastes were placed before the effective dates of the applicable land disposal prohibitions. If these media are determined not to contain hazardous wastes before they are removed from the land, then they can be managed as non-hazardous contaminated media and they're not subject to land disposal restrictions. For example, soil contaminated by acetone land disposed ("placed") in 1986 (prior to the effective date of the land disposal prohibition for acetone) and, while still in the land, determined not to contain hazardous waste, is not subject to the land disposal restrictions.[17] This is consistent with the Agency's approach in the HWIR-waste rule, where it indicates that LDRs do not attach to wastes that are not hazardous at the time they are first generated (60 FR 66344, December 21, 1995).

Since application of the land disposal restrictions is limited, in order to determine if a given environmental medium must comply with LDRs one must know the origin of the material contaminating the medium (i.e., hazardous waste or not hazardous waste), the date(s) the material was placed (i.e., before or after the effective date of the applicable land disposal prohibition), and whether or not the medium still contains hazardous waste (i.e., contained-in decision or not).

Facility owner/operators should make a good faith effort to determine whether media were contaminated by hazardous wastes and ascertain the dates of placement. The Agency believes that by using available site- and waste-specific information such as manifests, vouchers, bills of lading, sales and inventory records, storage records, sampling and analysis reports, accident reports, site investigation reports, spill reports, inspection reports and logs, and enforcement orders and permits, facility owner/operators would typically be able to make these determinations. However, as discussed earlier in the preamble of today's proposal, if information is not available or inconclusive, facility owner/operators may generally assume that the material contaminating the media were not hazardous wastes. Similarly, if environmental media were determined to be contaminated by hazardous waste, but if information on the dates of placement is unavailable or inconclusive, facility owner/operators may, in most cases assume the wastes were placed before the effective date.

The Agency believes that, in general, it is reasonable to assume that environmental media do not contain hazardous wastes placed after the effective dates of the applicable land disposal prohibitions when information on the dates of placement is unavailable or inconclusive, in part, because current regulations, in effect since the early 1980's, require generators of hazardous waste to keep detailed records of the amounts of hazardous waste they generate. These records document whether the waste meets land disposal treatment standards and list the dates and locations of the waste's ultimate disposition. With these records, the Agency should be able to determine if environmental media were contaminated by hazardous wastes and if they would be subject to the land disposal restrictions.

In addition, EPA believes that the majority of environmental media contaminated by hazardous wastes were contaminated prior to the effective dates of the applicable land disposal restrictions. Generally, the contamination of environmental media by hazardous waste after the effective date of the applicable land disposal restriction would involve a violation of the LDRs, subject to substantial fines and penalties, including criminal sanctions. The common exception would be one-time spills of hazardous waste or hazardous materials. In these cases, the Agency believes that, typically, independent reporting and record keeping requirements (e.g., CERCLA sections 102 and 103 reporting requirements or state spill reporting requirements) coupled with ordinary "good housekeeping" procedures, result in records that will allow the Agency to determine the nature of the spilled material, and the date (or a close approximation of the date) of the spill. The Agency requests comments on this approach and on any other assumptions, records, or standards of evaluation that would ensure that facility owner/operators would identify any contaminated media subject to land disposal restrictions properly and completely.

Information on contained-in decisions should be immediately available since, generally, these determinations are made by a regulatory agency on a site-specific basis and careful records are kept.

2. Treatment Requirements—§ 269.30

a. Approach to treatment requirements and recommendations of the FACA Committee. RCRA section 3004(m) requires that treatment standards for wastes restricted from land disposal, "* * * specify those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." A recurring debate through EPA's development of the land disposal restriction program has been whether treatment standards should be technology-based (i.e., based on performance of a treatment technology) or risk-based (i.e., based on assessment of risks to human health and the environment that are posed by the wastes). The Agency believes that both approaches are allowed. It has long been recognized that Congress did not directly address the questions of how to set treatment standards in the language of section 3004(m).[18] In addition, Congress did not specifically address whether the LDR treatment standards for newly generated wastes and remediation wastes must be identical; the structure of RCRA's LDR provisions suggests that Congress believed that remediation waste may merit special consideration. (See, RCRA sections 3004(d)(3) and 3004(e)(3), which

[17] Similarly, soil contaminated by acetone placed in a solid waste management unit in 1986, but leaked into the soil at some point after 1986, is not subject to the land disposal restrictions provided that, while the soil is still in the land, the Director determines it does not contain hazardous wastes. LDRs would not attach because, in this case, it is the initial placement of hazardous waste that determines whether there is a duty to comply with LDRs.

[18] See, e.g., 51 FR 40572, 40578 (November 7, 1986); *Hazardous Waste Treatment Council v. US EPA*, 886 F.2d 355, 361–3 D.C. Cir. 1989); 55 FR 6640, 6641 (February 26, 1990). The legislative history of section 3004(m) is likewise inconclusive. See discussion of the legislative history at 55 FR 6640, 6641–6642 (February 26, 1990)"[a]t a minimum, the [legislative history shows] that Congress did not provide clear guidance on the meaning of 'minimize threats'."

Site-Specific LDR Treatment Variances

530-Z-98-001

federal register

Tuesday
May 26, 1998

Part II

Environmental Protection Agency

40 CFR Parts 148, 261, 266, 268, and 271
Land Disposal Restrictions Phase IV: Final Rule Promulgating Treatment Standards for Metal Wastes and Mineral Processing Wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issues; Treatment Standards for Hazardous Soils, and Exclusion of Recycled Wood Preserving Wastewaters; Final Rule

land disposal are minimized. Technology-based standards provide an objective measure of assurance that hazardous wastes are substantially treated before they are land disposed, thus eliminating the "long-term uncertainties associated with land disposal." Eliminating these uncertainties was a chief Congressional objective in prohibiting land disposal of untreated hazardous wastes. Hazardous Waste Treatment Council v. EPA, 886 F.2d at 361–64. In addition, the extent of treatment required, 90 % reduction capped at treatment to concentrations within an order of magnitude of the UTS, "substantially" reduces mobility or total concentrations of hazardous constituents within the meaning of RCRA Section 3004(m)(1).

EPA has made two changes from proposal which strengthen the soil treatment standards to assure that they minimize threats to human health and the environment. First, the Agency has modified its approach to which hazardous constituents will be subject to treatment. In today's rule, when the soil treatment standards are used, EPA requires treatment for all hazardous constituents reasonably expected to be present in contaminated soil when such constituents are initially found at concentrations greater than ten times the universal treatment standard. This treatment is required both for soil contaminated by listed hazardous waste and soil that exhibits (or exhibited) a characteristic of hazardous waste. Constituents subject to treatment are discussed further in Section VII.B.4 of today's preamble.

To further ensure that contaminated soil treated to comply with the soil treatment standards is safely managed, EPA has included additional restrictions on the use of treated contaminated soil in hazardous waste-derived products that are used in a manner constituting disposal (i.e., when such products will be placed on the land). The restrictions on use of treated contaminated soil in hazardous waste-derived products that are used in a manner constituting disposal are discussed in Section VII.B.5 of today's preamble.

Finally, the Agency reiterates that, in the remediation context, in assessing whether threats posed by land disposal have been minimized, one should appropriately consider the risks posed by leaving previously land disposed waste in place as well as the risks posed by land disposal of waste after it is removed and treated. 62 FR at 64506 (December 5, 1997). For example, if a treatment standard for organic constituents based on performance of incineration typically results in already land disposed materials such as contaminated soils being capped in place rather than more aggressively remediated, threats posed by land disposal of the waste ordinarily would not be minimized. Conversely, a treatment standard that results in substantial treatment followed by secure land disposal can be said to minimize threats, taking into account the totality of threats posed (i.e. including those posed if the soil were left in place untreated). *Id.* The soil treatment standards will ordinarily ensure that contaminated soil is appropriately treated within the meaning of RCRA Section 3004(m), considering both the threats posed by new land disposal of treated soil and the threats posed by on-going land disposal of existing contaminated soil (e.g., if the soil were left in place untreated).

EPA recognizes that some people may be concerned that a situation may arise where the soil treatment standards are at levels that are higher than those that EPA or an authorized state believes should be required for soil cleanup under a cleanup program. The Agency acknowledges that this may occur. The soil treatment standards, like other land disposal restriction treatment standards, are based on the performance of specific treatment technologies. As discussed earlier in today's preamble, technology-based standards have been upheld as a permissible means of implementing RCRA Section 3004(m). Most soil cleanup levels are based not on the performance of specific treatment technologies but on an analysis of risk. For this reason, technology-based treatment standards will sometimes over-and sometimes under-estimate the amount of treatment necessary to achieve site-specific, risk-based goals.

The purpose of the land disposal restriction treatment standards is to ensure that prohibited hazardous wastes are properly pre-treated before disposal (i.e., treated so that short- and long-term threats to human health and the environment posed by land disposal are minimized). As discussed above, the Agency believes the soil treatment standards promulgated today fulfill that mandate for soil that contains prohibited listed hazardous waste or exhibits a characteristic of prohibited hazardous waste. However, technology-based treatment standards are not necessarily appropriate surrogates for site-specific risk-based cleanup levels. In a circumstance where the soil treatment standards result in constituent concentrations that are higher than those determined, on a site-specific basis, to be required for soil cleanup, existing remedial programs such as RCRA Corrective Action, CERCLA and state cleanup programs could be applie. to ensure that remedies are adequately protective. These programs already ensure protection of human health and the environment when managing most contaminated soils—i.e., soils that are not subject to the LDRs—and other remediation wastes. Furthermore, as discussed later in today's rule, treated contaminated soil would remain subject to regulation under RCRA Subtitle C unless and until EPA or an authorized state made an affirmative decision that the soil did not contain hazardous waste or, in the case of characteristic soil, no longer exhibited a hazardous characteristic.

3. Variance From the Soil Treatment Standards at Risk-Based Levels

EPA has long indicated that its preference would be to establish a complete set of risk-based land disposal treatment standards at levels that minimize short- and long-term threats to human health and the environment. See, for example, 55 FR at 6641 (Feb. 26, 1990). However, the difficulties involved in establishing risk-based standards on a nationwide basis are formidable due in large part to the wide variety of site-specific physical and chemical compositions encountered in the field and the uncertainties involved in evaluating long-term threats posed by land disposal. *Id.*; 60 FR 66380—66081 (Dec. 21, 1995). For these reasons the Agency has chosen to establish land disposal restriction treatment standards based on the performance of specific treatment technologies. Although technology-based treatment standards are permissible, they may not be established at levels more stringent than those necessary to minimize short and long-term threats to human health and the environment. Hazardous Waste Treatment Council, 886 F. 2d at 362 (land disposal restriction treatment standards may not be established, "beyond the point at which there is not a "threat" to human health or the environment").

While using risk-based approaches to determine when threats are minimized on a national basis has proven extremely difficult, these difficulties will diminish when evaluating risks posed by a specific contaminated soil in a particular remediation setting since, during remediation, one typically has detailed site-specific information on constituents of concern, potential human and environmental receptors, and potential routes of exposure. For this reason, EPA is establishing a site-specific variance from the technology-based soil treatment standards, which

can be used when treatment to concentrations of hazardous constituents greater (i.e., higher) than those specified in the soil treatment standards minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the technology-based soil treatment standards. This approach was first discussed in the September 14, 1993 proposal, where EPA proposed that determinations that contaminated soil did not or no longer contained hazardous waste could supersede LDR treatment standards, if the "contained-in" level also constituted a "minimized threat" level. It was repeated in the April 29, 1996 proposal where the Agency proposed that, in certain circumstances, variances from land disposal restriction treatment standards could be approved in situations where concentrations higher than the treatment standards minimized threats.[18] 58 FR at 48128 (September 14, 1993) and 61 FR at 18811 and 18812 (April 29, 1996).

At this time, EPA is allowing the risk-based variances only for contaminated soils. The Agency believes this limitation is appropriate for a number of reasons. First, contaminated soils are most often generated during agency overseen cleanups, such as CERCLA cleanups, RCRA corrective actions or state overseen cleanups. This type of involvement in cleanups positions EPA and authorized states to appropriately consider site-specific, risk-based issues. Second, during remediation, experts and field personnel typically gather detailed site-specific information on risks posed by specific hazardous constituents or combinations of hazardous constituents, potential direct and indirect exposure routes, risk pathways and human and environmental receptors. Through application of this information, overseeing agencies can eliminate many of the long-term uncertainties associated with land disposal and, therefore, make appropriate risk-based decisions regarding the extent of treatment needed to minimize short- and long-term threats to human health and the environment from any given hazardous constituent or combination of hazardous constituents. EPA and state officials already routinely make these types of decisions when developing site-specific, risk-based cleanup levels and when making decisions about whether any given contaminated medium contains hazardous waste.[19] After experience implementing the site-specific minimize threat variance for contaminated soil, the Agency may consider extending it to other environmental media and remediation wastes.

Some commenters expressed concern that allowing site-specific, risk-based minimize threat determinations would abrogate the Agency's responsibilities under RCRA Section 3004(m). The Agency strongly disagrees. RCRA Section 3004(m) requires EPA to establish "levels or methods of treatment, if any, * * *." In the case of contaminated soil, EPA is establishing those levels today based on the performance of available, appropriate soil treatment technologies. Providing a variance process to modify a level or method of treatment on a case-by-case basis reduces the likelihood that in any particular situation technology-based treatment standards will result in treatment beyond the point at which threats are minimized. The Agency is requiring that minimize threat variance determinations for contaminated soils be evaluated using the existing site-specific variance process set out in 40 CFR 268.44(h). EPA recently added language to this provision to clarify that variances cannot be approved without opportunity for public participation, including notice by appropriate means, opportunity for public comment and adequate explanation of an ultimate determination. 62 FR at 64507 (Dec. 5, 1997).

While not required, EPA anticipates that decisions about site-specific minimize threat decisions variances will often be combined with decisions that soil no longer contains hazardous waste. As discussed later in today's preamble, Agency guidance on "contained-in" determinations is essentially the same as the requirements for site-specific, risk-based minimize threat determinations promulgated today. For that reason, EPA believes it will always be appropriate to combine a contained-in determination with a site-specific, risk-based minimize threat variance. In these cases, EPA encourages program implementors and facility owners/operators to include information about the "contained-in" decision in the public notice of the site-specific minimize threat variance. In cases where a site-specific minimize threat variance is combined with a decision that a soil no longer contains hazardous waste, once treated to comply with the treatment standard imposed by the variance, the soil would no longer have any obligations under RCRA Subtitle C and could be managed—including land disposed—without further control under RCRA Subtitle C. The contained-in policy is discussed in more detail in Section VII.B.8 and Section VII.E of today's preamble.

EPA reminds program implementors that, consistent with the rest of the land disposal restriction program, site-specific determinations that threats are minimized cannot be based on the potential safety of land disposal units, or engineered structures such as liners, caps, slurry walls or any other practice occurring after land disposal. American Petroleum Inst. v. EPA, 906 F.2d 729, 735–36 (D.C. Cir. 1990) (land treatment cannot be considered in determining whether threats posed by land disposal have been minimized because land treatment is a type of land disposal and section 3004(m) requires that threats be minimized before land disposal occurs); see also S. Rep. No. 284, 98th Cong. 1st sess. at 15, stating that engineered barriers cannot be considered in assessing no-migration variances because "[a]rtificial barriers do not provide the assurances necessary to meet the standard." This means that site-specific minimize threat determinations must be based on the inherent threats any given contaminated soil would pose. The Agency recognizes that this will have the effect of precluding site-specific minimize threat variances for remedies that rely, even in part, on capping, containment or other physical or institutional controls. In

[18] In the April 29, 1996 proposal, the Agency proposed to limit variances based on a site-specific minimize threat determination to contaminated soils where all concentrations of hazardous constituents were below a "bright line," that is, below a certain risk level. The Agency also requested comment on extending site-specific minimize threat variances to other contaminated soils. Based on further consideration and consideration of comments, the Agency is persuaded that a site-specific minimize threat variance should be available to all contaminated soils. The Agency believes this is proper because the outcome of a site-specific, risk-based minimize threat variance—alternative, site-specific LDR treatment standards based on risk—will be the same regardless of the initial concentrations of hazardous constituents. In any case, the Agency is not, at this time, taking action on the portion of the April 29, 1996 proposal that would have established a "bright line" to distinguish between higher- and lower-risk media. If, in the future, the Agency takes action to establish a bright line, it will address the relationship of a bright line to site-specific minimize threat variances.

[19] While not forbidden, the Agency believes that site-specific, risk-based minimize threat determinations will rarely be made in the context of an independent or voluntary cleanup action, since, in these types of actions, an overseeing Agency will not, typically, have been involved in the identification exposure pathways and receptors of concern or the calculation of site-specific, risk-based cleanup levels. Of course, generators could apply for a site-specific, risk-based minimize threat variance during an independent or voluntary cleanup and, provided EPA or an authorized state agreed that the proposed alternative treatment standards minimized threats considering appropriate exposure pathways and receptors, a variance could be approved.

addition to being compelled by the statute, the Agency believes this approach is proper, in that it may encourage remedy choices that rely more predominantly on treatment to permanently and significantly reduce the concentrations (or mobility) of hazardous constituents in contaminated soil. The Agency has a strong and longstanding preference for these types of more permanent remedial approaches.

In addition, at a minimum, alternative land disposal restriction treatment standards established through site specific, risk-based minimize threat variances should be within the range of values the Agency generally finds acceptable for risk-based cleanup levels. That is, for carcinogens, alternative treatment standards should ensure constituent concentrations that result in the total excess risk from any medium to an individual exposed over a lifetime generally falling within a range from 10^{-4} to 10^{-6}, using 10^{-6} as a point of departure and with a preference, all things being equal, for achieving the more protective end of the risk range. For non-carcinogenic effects, alternative treatment standards should ensure constituent concentrations that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; in general, the hazard index should not exceed one (1). Constituent concentrations that achieve these levels should be calculated based on a reasonable maximum exposure scenario—that is, based on an analysis of both the current and reasonably expected future land uses, with exposure parameters chosen based on a reasonable assessment of the maximum exposure that might occur. The Agency believes these represent an appropriate range of minimum values for site-specific, risk-based minimize threat determinations because sites cleaned up to these levels are typically released from regulatory control under the Federal CERCLA program and the RCRA corrective action program. See, for example, the National Contingency Plan (55 FR 8666, March 8, 1990) the 1990 RCRA Corrective Action Subpart S Proposal (55 FR 30798, July 27, 1990), and the 1996 RCRA Corrective Action Subpart S ANPR (61 FR 19432, May 1, 1996). In addition to achieving protection of human health, alternative treatment standards must ensure that environmental receptors are protected and must also ensure that no unacceptable transfer of contamination from one medium to another, for example, from soil to ground water, will occur.[20] Protection of environmental receptors and against cross-media contamination may, in some cases, require more stringent (i.e., lower) alternative treatment standards than would be necessary to protect human health alone. The Agency recognizes that this approach is different from the approach used in developing national risk-based minimize threat levels proposed in the Hazardous Waste Identification Rule (HWIR-Waste). 60 FR 66344 (December 21, 1995). This difference is proper, in that the HWIR-Waste proposal contemplated nationally-applicable risk-based LDR treatment standards and, therefore, had to consider the myriad of potential exposure pathways and receptors which might occur at any given site, nation wide. A site-specific minimize threat determination is informed by actual and reasonable potential exposure pathways and receptors at a specific land disposal location.

Although not expressly limited to land disposal of contaminated soil on-site, EPA anticipates that site-specific minimize threat variances will, most often, be applied to these activities. The basis for developing an alternative land disposal restriction treatment standard during the site-specific minimize threat variance is application of risk information about specific exposure pathways and receptors of concern. To apply such a variance to off-site land disposal, the treatment standard would have to be informed by the exposure pathways and receptors present at the off-site land disposal areas (assuming no physical or engineered structures or other post-land-disposal controls). While such an analysis is allowed, this information is not, to the Agency's knowledge, routinely gathered during site remediation.

Most commenters supported the concept of using a treatment variance to reduce the likelihood that, in any particular case, technology-based soil treatment standards might prompt treatment beyond the point at which threats to human health and the environment are minimized.

One commenter was concerned that establishing a risk-based minimize threat variance without adequate minimum standards would be contrary to law and impossible to oversee. EPA was, in part, persuaded by these comments and has added a requirement that, at a minimum, alternative LDR treatment standards approved through a site-specific minimize threat variance be within the range of acceptable values the Agency typically uses for cleanup decisions, as discussed above. In addition, as discussed above, the Agency has clarified that, unlike some CERCLA or RCRA corrective action remedies, site-specific minimize threat variances may not rely on post-land disposal controls.

4. Constituents Subject to Treatment

For soil contaminated by listed hazardous waste, EPA proposed that treatment would be required for each hazardous constituent originating from the contaminating waste. For soil which exhibits (or exhibited) a characteristic of hazardous waste, EPA proposed that treatment would be required: (1) in the case of TC soil, for the characteristic contaminant; (2) in the case of ignitable, reactive or corrosive soil, for the characteristic property; and, (3) in both cases, for all underlying hazardous constituents. 61 FR at 18809 (April 29, 1996). Under the 1996 proposal, treatment would have been required only when those constituents were initially present at concentrations greater than ten times the universal treatment standard. EPA also requested comment on, among other things, whether, for soil contaminated by listed hazardous waste, treatment should be required for all underlying hazardous constituents present at concentrations above ten times the UTS. Underlying hazardous constituent is defined in 40 CFR 268.2(i) as, "any constituent listed in 40 CFR 268.48 table UTS, except fluoride, sulfides, vanadium, selenium, and zinc, which can reasonably be expected to be present at the point of generation of the hazardous waste, at a concentration above the constituent-specific UTS treatment standards."

Many commenters supported the proposed approach. Some commenters, however, expressed concern that, because contaminated soil often contains numerous hazardous constituents from a variety of sources, limiting treatment of soil contaminated by listed hazardous waste to constituents originating from the contaminating waste might result in soil contaminated with listed waste undergoing less treatment than soil which exhibits (or exhibited) a characteristic of hazardous waste. One commenter also asserted that the proposed approach to constituents subject to treatment was, in the case of soil contaminated by listed hazardous waste, inconsistent with the Chemical Waste opinion. On further consideration, EPA was persuaded that it is prudent to apply the logic of the

[20] Unacceptable cross-media transfer would include, for example, transfer of contaminants from soil to air in excess of applicable air emission standards.

federal register

Friday
December 5, 1997

Part V

Environmental Protection Agency

40 CFR Part 268

Clarification of Standards for Hazardous Waste Land Disposal Restriction Treatment Variances; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 268

[No. F-97-TV2F-FFFFF; FRL-5932-5]

Clarification of Standards for Hazardous Waste Land Disposal Restriction Treatment Variances

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: EPA is today finalizing clarifying amendments to the rule authorizing treatment variances from the national Land Disposal Restrictions (LDR) treatment standards. The clarifying changes adopt EPA's longstanding interpretation that a treatment variance may be granted when treatment of any given waste to the level or by the method specified in the regulations is not appropriate, whether or not it is technically possible to treat the waste to that level or by that method. In response to comment, the Agency is indicating in the rule the circumstances when application of the national treatment standard could be found to be "inappropriate", specifically where the national treatment standard is unsuitable from a technical standpoint or where the national treatment standard could lead to environmentally counterproductive results by discouraging needed remediation.

In addition, EPA proposed to reissue the treatment variance granted to Citgo Petroleum under the clarified standard. The Agency is not taking further action on this part of the proposal because, due to changes in Citgo's remediation plans for its Lake Charles Louisiana facility, this particular variance has become moot. The Agency is consequently withdrawing the Citgo variance.

EFFECTIVE DATE: These final regulations are effective December 5, 1997.

ADDRESSES: The official record for this rulemaking is located at the RCRA Information Center at Crystal Gateway I, First Floor, 1235 Jefferson Davis Highway, Arlington, Virginia. The RCRA Information Center is open from 9:00 a.m. to 4:00 EST p.m., Monday through Friday, except Federal holidays. The Docket Identification Number for today's action is F-97-TV2F-FFFFF. Appointments to review docket materials are recommended. Appointments may be made by calling (703) 603-9230. Individuals reviewing docket materials may copy a maximum of 100 pages from any one docket at no cost. Additional copies may be made at a cost of $0.15 per page. In addition, the docket index and some supporting materials are available electronically. See the **SUPPLEMENTARY INFORMATION** section for information on accessing electronic information.

FOR FURTHER INFORMATION CONTACT: For general information on RCRA, land disposal treatment variances, and this rule contact the RCRA Hotline, between 9:00 a.m. and 6:00 p.m. EST, Monday through Friday, except Federal holidays. The RCRA Hotline can be reached toll free on (800) 424-9346 or, from the Washington D.C. area, on (703) 412-9810. Hearing impaired can reach the RCRA Hotline on TDD (800) 553-7672 or, in the Washington D.C. area, on TDD (703) 412-3323. For detailed information on specific aspects of this rulemaking, contact Elizabeth McManus on (703) 308-8657.

SUPPLEMENTARY INFORMATION:

Accessing Today's Rule and Supporting Information Electronically

Today's final rule, its docket index and the following supporting materials are available electronically and may be accessed through the Internet: To access these documents electronically: "Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups" U.S. EPA guidance memorandum from Michael Shapiro, Director EPA Office of Solid Waste and Steve Luftig, Director EPA Office of Emergency and Remedial Response, Jan. 8, 1997.

WWW: Http://www.epa.gov/epaoswer/hazwaste/ldr/ldr-rule.htm
FTP: ftp.epa.gov
Login: anonymous
Password: your Internet address

Files are located in /pub/epaoswer/hazwaste/ldr/ldr-rule.htm.

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I. Background

The essential requirement of the Land Disposal Restrictions (LDR) statutory provisions is that hazardous wastes must not be land disposed until hazardous constituent concentrations in the wastes are at levels at which threats to human health and the environment are minimized, and land disposal is otherwise protective of human health and the environment. RCRA sections 3004 (d), (e), (g) and (m); 56 FR at 41168, August 19, 1991; 62 FR at 26062, May 12, 1997. These requirements normally are satisfied by prohibiting disposal of hazardous wastes until the wastes' hazardous constituent concentrations reflect the performance achievable by the Best Demonstrated Available Treatment technology (BDAT). 62 FR at 26062, May 12, 1997.

EPA recognized from the inception of the LDR program, however, that there would be circumstances when these technology-based treatment standards might not be either achievable or appropriate. Accordingly, EPA adopted a treatment variance provision (codified in 40 CFR 268.44; 51 FR at 40605-40606, Nov. 7, 1986) providing that:

> Where the treatment standard is expressed as a concentration in a waste or waste extract and a waste cannot be treated to the specified level, or where the treatment technology is not appropriate to the waste, the generator or treatment facility may petition the Administrator for a variance from the treatment standard. The petitioner must demonstrate that because the physical or chemical properties of the waste differs significantly from the wastes analyzed in developing the treatment standard, the waste cannot be treated to [the] specified levels or by the specified methods.

A treatment variance takes the form of an alternative LDR treatment standard. Nationally applicable variances and site-specific variances that are approved using rulemaking procedures are codified in the Table to § 268.44, 40 CFR 268. 44(o). Site-specific variances that are approved using non-rulemaking procedures are not codified.

As set out in more detail in the May 12 notice, EPA has interpreted the first sentence of the treatment variance provision as creating two independent tests under which treatment variance applications can be considered: first, where the waste in question cannot be treated to levels or by the methods established in the rules; and second, where such treatment may be possible but is nevertheless "not appropriate". 62 FR at 26059, May 12, 1997. EPA has further viewed the second sentence of the treatment variance provision—which refers to a demonstration that the waste differs chemically or physically from those the Agency analyzed in developing the standard—as applying only to the technical infeasibility part of the standard. 62 FR at 26059, May 12,

1997. However, EPA now recognizes that the existing rule, as drafted, might be read to require a demonstration that a waste is physically or chemically different along with a showing that it cannot be treated to a specified level or by a particular method whenever a treatment variance is sought, including situations where the otherwise applicable treatment standard is technically possible but, nonetheless, inappropriate. This was not EPA's intent, and EPA initiated this rulemaking to remove any drafting ambiguity in the rule.

II. Clarified Standard for Granting Treatment Variances

EPA is finalizing the proposed amendment to the rule, with two changes. First, EPA is clarifying the situations under which treatment variances may be approved because the otherwise applicable LDR treatment standard is "inappropriate." Second, the Agency is adding language that explicitly requires alternative LDR treatment standards approved through the treatment variance process to satisfy the requirement that treatment standards result in substantial treatment of hazardous constituents in the waste so that threats posed by the waste's land disposal are minimized, and also indicates that special considerations may arise in satisfying this standard if the waste is to be used in a manner constituting disposal.[1]

A. Clarification of "Inappropriate" Standard

The Agency proposed amended language simply stating that a treatment variance could be granted if it is "inappropriate" to require treatment to the level or by the method set out in the rules. 62 FR at 26081, May 12, 1997. In the preamble to the proposal, the Agency provided examples as to the situations when application of the otherwise applicable standard could be inappropriate. 62 FR at 26059–26060, May 12, 1997. In response to comment maintaining that the rule language was impermissibly open-ended, EPA has decided to include language codifying more particularly when a standard could be "inappropriate". These circumstances are drawn from EPA's practice in applying the existing rule and are consistent with the examples discussed in the preambles to the proposal and the HWIR-Media proposal. 61 FR at 18810, April 29, 1996.

The first circumstance is when imposition of BDAT treatment, while technically possible, remains unsuitable or impractical from a technical standpoint. The chief example is when a treatment standard would result in combustion of large amounts of mildly contaminated soil or wastewater. 55 FR at 8760 and 8761, March 8, 1990; 61 FR at 18806–18808, April 29, 1996 and other sources cited therein. The same reasoning could apply when media is contaminated with metal contaminants and also contains low levels of organic contaminants. In such a case, it may be inappropriate to require combustion treatment of the organic contaminants both because it may be inappropriate to combust media generally and because it may be inappropriate to combust wastes where metals are the chief hazardous constituent.[2] Another potential example of where treatment for organic contaminants may be technically inappropriate is when a waste contains low concentrations of non-volatile organic contaminants (for example, concentrations slightly exceeding a Universal Treatment Standard) and the waste, for legitimate reasons, has been stabilized. If the mobility of the non-volatile organic contaminants has been reduced, it might be inappropriate to require further treatment of the non-volatile organic contaminants. Cf. 61 FR at 55724, Oct. 28, 1996 where EPA made a similar finding. Still another example of a situation where the otherwise applicable LDR treatment standard is technically inappropriate could be a case where BDAT treatment could expose site workers to acute risks of fire or explosion and an alternative technology would not. 62 FR at 26060, May 12, 1997. In all these types of circumstances, notwithstanding that it is technically possible to achieve the standard by using the best demonstrated available technology, it could be inappropriate to do so.

The second set of circumstances where treatment to the limit of best demonstrated available technology might be inappropriate involves cases where imposition of the otherwise applicable treatment standard could result in a net environmental detriment by discouraging aggressive remediation. The example EPA and authorized states have encountered most often to date is where federal rules allow the option of leaving wastes in place,[3] and a facility then has the choice of pursuing the legal option of leaving the wastes in place or opting to excavate thereby triggering treatment to standards based on the performance of best demonstrated available technology, which can be very expensive. 62 FR at 26059, May 12, 1997, and other sources there cited.[4] In these circumstances, a treatment variance can provide an intermediate option of more aggressive remediation, which may include substantial treatment of the removed waste before disposal of that treatment residue—a net environmental benefit over leaving untreated waste in place. 61 FR at 55720–22, May 12, 1997. In EPA's experience, this situation often occurs when BDAT treatment would require that wastes be treated to achieve constituent concentrations that fall below protective site-specific cleanup levels, thus increasing remediation costs for treatment of excavated wastes. In these instances, EPA has indicated that consideration of a treatment variance is typically warranted (because imposition of the otherwise applicable treatment standard would discourage aggressive remediation and is, therefore, inappropriate) and that, if a variance is approved, protective, site-specific cleanup levels may be used as

[1] EPA is also restoring language to 40 CFR 268.44(a) and (h) that was inadvertently deleted when EPA proposed this clarification and redrafting the introductions to both provisions. These changes are made to restore the inadvertently deleted text and to make the difference between national and site-specific variances more clear, as follows. The 40 CFR 268.44(a) national variance is waste-specific—it could apply to the same type of waste at numerous sites. National variances are obtained by petitioning the Administrator and, as set out in 40 CFR 268.44(b), petitions are processed using the procedures set out in 40 CFR 260.20. The 40 CFR 268.44(h) variance is site-specific—it applies only to a certain waste generated at a particular site. Site-specific variances are obtained by petitioning the Administrator, or the Administrator's delegated representative, or an authorized state. Petitions for site-specific variances are processed on a site-by-site basis and are not required to be processed using the procedures set out in 40 CFR 260.20. Further explanation on this issue is included in the Response to Comments Document for today's action in the response to comments submitted by the Department of Energy. EPA regards the restoration of inadvertently deleted language and the associated clarifications as a technical correction and may, thus, make the changes immediately in this final rule.

[2] Although it should also be noted that it is often routine and obviously appropriate to combust organic-contaminated hazardous wastes and to stabilize the combustion residues to reduce metal mobility; see, e.g. treatment standards for F024 wastes in 40 CFR 268.40.

[3] Examples are where wastes can remain within an "area of contamination", where remedy selection requirements allow a balancing of treatment and containment strategies and where RCRA regulations allow the option of closing a regulated unit with wastes left in place.

[4] Another recent example of such a treatment variance was granted to Dow Chemical Co. by EPA Region V. In this case, the company could legally leave wastes within an area of contamination but requested instead that the wastes be exhumed for more secure disposal in a subtitle C landfill. Viewing this as a net environmental benefit, and further finding that no other treatment but combustion was available to reduce the relatively low levels of hazardous constituents (chlorinated dibenzo-dioxins and furans), the Region found the existing treatment requirement inappropriate and granted the variance. Treatment Variance for Dow Chemical Co., June 10, 1997, Response to Comment Document pp. 15–17.

alternative LDR treatment standards. See recent EPA guidance on LDR treatment variances: Jan 8, 1997 memorandum, "Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups" from Michael Shapiro, Director EPA Office of Solid Waste and Steve Luftig, Director EPA Office of Emergency and Remedial Response and information on compliance with statutory provisions for LDR treatment, below. In addition, see "Hazardous Waste: Remediation Waste Requirements Can Increase the Time and Cost of Cleanups" U.S. General Accounting Office, GAO/RCED-98-4, October 1997.

EPA is accordingly codifying qualifying language stating that treatment variances can be granted where the underlying standard is not appropriate either because it is technically inappropriate or because requiring LDR treatment is environmentally inappropriate in that it could discourage aggressive remediation.

Finally, it must be remembered that this amended rule does not command issuance of treatment variances any more than the existing rule does. Like the existing rules, the amended rules set out circumstances when treatment variances may be considered. The actual determination of whether an otherwise applicable LDR treatment standard is "unachieveable" or technically or environmentally "inappropriate" is a fact-specific determination depending largely on site-and waste-specific circumstances.

B. Compliance With Statutory Provisions for LDR Treatment

As stated in the proposal all treatment variances must be consistent with the root requirement of RCRA section 3004 (m): that treatment be sufficient to minimize threats to human health and the environment posed by land disposal of the waste. See 62 FR at 26060/1, May 12, 1997 ("alternative treatment standards [established by a treatment variance] must comply with the statutory standard of RCRA section 3004(m) by minimizing threats to human health and the environment"). In order to ensure that there is no ambiguity over application of this requirement in the context of alternative LDR treatment standards developed through the treatment variance process, EPA is adding regulatory language that explicitly requires the decision-maker to determine that a revised treatment standard is sufficient to minimize threats posed by land disposal. Cf. 61 FR at 55721, October 23, 1996 (finding that alternate standard in treatment variance does minimize threats posed by land disposal). In making this determination, however, EPA (or authorized State) may consider risks posed by land disposal not only of the treated residue, but also the risks posed by the continuation of any existing land disposal of the untreated waste, that is, the risks posed by leaving previously land disposed waste in place. Thus, for example, in a remediation setting, it is appropriate (and likely necessary) to consider risks posed by leaving previously land disposed waste in place as well as risks posed by land disposal of the waste after it is removed and treated. Cf. 61 FR at 55721, October 28, 1996 (fact-specific determination that threats posed by land disposal are adequately minimized when treatment variance will lead to clean closure of large surface impoundment, substantial treatment of removed waste, and disposal of treatment residue in a subtitle C landfill) and 61 FR at 18808, April 29, 1996, and other sources cited therein (determination that the policy considerations which argue for BDAT as the basis for technology-based standards for as-generated wastes do not always support a BDAT approach in the remediation context).

In addition, when making a determination as to whether the statutory provisions for LDR treatment have been satisfied, EPA may, of course, condition any particular variance to apply only in certain circumstances if the facts warrant. There is, at least, one potentially recurring circumstance when such conditioning may be warranted for treatment variances. Under current regulation, hazardous waste-derived products can be used in a manner constituting disposal provided the waste meets the LDR treatment standards. 40 CFR 266.23. The exemption was premised on findings that hazardous wastes would meet requirements reflecting rigorous treatment which typically destroys, removes, or immobilizes hazardous constituents to the limit of available technology. 53 FR at 31198, August 17, 1988. In order to ascertain whether this exemption is still justifiable for wastes which receive treatment variances on the ground that the treatment standard is inappropriate, EPA is noting that as part of a determination of whether threats are minimized under the circumstances, consideration should be given to whether this exemption should continue to apply.[5] This would entail a fact-specific determination, and notice as to how the determination might be made would have to accompany each such treatment variance. For example, in situations where the decision-maker determines that use of a product derived from hazardous waste in a manner constituting disposal would likely not be adequately protective even if that hazardous waste derived product complied with an alternative land disposal treatment standard established through a treatment variance, the treatment variance approval could include a condition that restricted use of the treated hazardous waste in a manner constituting disposal.

EPA also notes that the Subpart CC rules, relating to control of air emissions from tanks, containers, and surface impoundments managing hazardous waste, state that if a waste has met the LDR treatment standard set out in 40 CFR 268.40 (the generally-applicable treatment standards, normally the Universal Treatment Standards), the waste is not subject to further Subpart CC controls.[6] See 40 CFR 264.1082 (c) (4) and 265.1082 (c) (4)) and 61 FR at 59941, November 25, 1996. The limitation to wastes that have achieved the generally-applicable treatment standard in fact means that the exemption is unavailable to wastes receiving treatment variances that alter the generally-applicable standards for organic hazardous constituents. EPA is confirming here that this literal reading is intentional.

III. Responses to Comment

Most comments supported the Agency's proposal, or suggested that there was no need to clarify the standard in the existing rule. The main negative comment came from the Environmental Defense Fund, raising a number of points.

First, the commenter argued that the Agency's own closure rules for impoundments create the environmentally adverse incentive to leave wastes in place and thus create the dilemma to adopt alternative treatment standards. The comment urges

[5] As EPA explained in the May 12, 1997, **Federal Register** notice, however, remediation activities involving replacement of treated soils or other wastes onto the land is not a type of use constituting disposal. The activity is a type of supervised remediation, and is not the type of unsupervised recycling activity covered by the use constituting disposal provisions. 62 FR at 26063, May 12, 1997.

[6] It should be noted that the Subpart CC standards do not apply to waste management units used solely for on-site treatment or storage of hazardous waste that is generated as the result of remedial activities required by RCRA corrective action authorities, CERCLA authorities, or similar Federal or State authorities. See 40 CFR 264.1080 (b) (5) and 265.1080 (b) (5).

amendment of the closure standards for impoundments.

While it is correct that the closure rules for surface impoundments (and landfills) create more opportunities to close with wastes left in place than do closure standards for tanks, piles, containment buildings, and drip pads, EPA did not, and is not, reopening any of the closure standards in this proceeding.[7] In developing the standards for closure of surface impoundments, EPA allowed the option of leaving wastes in place because of the practical difficulties of removing large volumes of waste from impoundments, many of which had been operating over long periods of time, and the recognition that, when properly capped, some former surface impoundments can safely contain wastes during and after post-closure care. 47 FR at 32320 and 32321, July 26, 1982. EPA also required, in the closure performance standards, that releases must be minimized or controlled at units where waste is left in place. 47 FR at 32320 and 32321, July 26, 1982. In situations where such minimization or control is not achievable, the closure performance standard would not be met and closure with waste in place would not be available under the regulations. In these respects, EPA's closure regulations for surface impoundments are identical to those for landfills, where waste is purposefully disposed of in the land-based units. EPA is re-evaluating the relationship between requirements for closure of regulated units, including surface impoundments, and requirements for RCRA corrective action and will take this comment under consideration during the re-evaluation. In the meantime, the Agency nevertheless intends to act now in order to assure that the treatment variance option continues to provide a potential intermediate alternative between full removal of waste followed by treatment to the extent of best demonstrated technology on the one hand and no waste removal at all on the other.

Second, the commenter argued that the circumstances under which treatment variances could be approved based on the "inappropriate" standard were not adequately defined. The commenter then went on to note that most of the situations in which the Agency contemplated using the "inappropriate" standard occurred in the remediation setting and suggested that the Agency either wait until completion of the ongoing rulemaking relating to management of contaminated environmental media, or limit the scope of the variance to remediation situations.[8]

EPA has addressed the comments regarding the specificity of the "inappropriate" standard by adding clarifying language, based on discussion in May 12, 1997 proposal, to the final regulations as discussed above. Regarding the second part of this comment, EPA does not believe it should await the outcome of the HWIR-Media proceeding to finalize the clarifying amendment to the treatment variance rules. EPA also notes that nothing in this rule forecloses any of the actions proposed in the HWIR Media proposal, including further definition of situations where treatment variances are appropriate—for example, codification of the type of "minimize threat" variance determination discussed in the HWIR-Media proposal. 61 FR at 18810–18812, April 29, 1996. The Agency is continuing to evaluate and review comments on this part of the HWIR-Media proposal.

The Agency is persuaded by the commenter's observation regarding use of treatment variances in the context of remediation. Accordingly, in response to this comment, EPA has chosen to expressly limit approval of treatment variances using the "environmentally inappropriate" test to remediation wastes. In this context, remediation waste includes all solid and hazardous wastes and all media (including groundwater, surface water, soils and sediments) and debris, which contain listed hazardous waste or which themselves exhibit a hazardous waste characteristic when such wastes are generated during remediation, such as RCRA corrective action, CERCLA cleanup, and cleanup under a state program. This definition is consistent with the existing definition of remediation waste in 40 CFR 260.10 except that it is not limited to wastes generated for purposes of corrective action under 40 CFR 264.101 or RCRA Section 3008(h). Since site-specific land disposal restriction treatment variances will undergo review and approval by either EPA or an authorized state, EPA does not believe it is necessary to limit the eligible wastes to corrective action cleanups.

Finally, the commenter went on to argue that the open-ended proposal effectively reopened the question of whether site-specific treatment variances (40 CFR 268.44 (h)) could be issued without going through notice-and-comment rulemaking, the argument being that each such variance would establish a new criterion for what "not appropriate" means.

Site-specific treatment variances can be granted without using rulemaking procedures. 53 FR at 31199–31200, August 17, 1988. EPA did not reopen this issue in this proceeding, which just is adopting clarifying amendments which reflect EPA's longstanding practice and interpretation of the treatment variance rules. 62 FR at 26059, May 12, 1997. However, to ensure there is no ambiguity over the application of treatment variances, EPA is restoring language to 268.44(h) indicating that the alternative LDR treatment standards established through the treatment variance process are site-specific. This language has always been part of 268.44(h) and was inadvertently omitted in the proposal of this clarifying rule. In any case, the amendment adopted today contains explicit qualifying language so that whatever basis, if any, existed for the commenter's argument is no longer present.

The same commenter, in oral conversations with Agency officials as well as in public comments, maintained the importance of allowing opportunity for public participation whenever a site-specific treatment variance is being considered. These opportunities are already provided. The Agency stated in 1988, when adopting 40 CFR 268. 44(h), "[t]he Agency agrees as a matter of policy to allow opportunity for public notice and comment prior to granting a nonrulemaking variance from the treatment standard. Because circumstances under which one might apply for a site-specific variance vary, vehicles for public comment will be specified on a case-by-case basis." 53 FR at 31200, August 17, 1988. In response to this commenter's concerns, however, EPA has decided to indicate in the rule that opportunity for public participation must be provided when granting or denying any site-specific treatment variance. In doing so, the Agency is simply repeating in the rule what it wrote in the August 1988 preamble. The Agency does not view this step as creating a new regulatory requirement or altering existing practice and, by adding the August 1988 preamble language to the rule, is not intending to

[7] The rules for most regulated units in essence require clean closure, with wastes being allowed to be left in place only after a showing that wastes remaining after initial removal and decontamination cannot be practically removed or decontaminated. See e.g., closure standards for piles in 40 CFR 265.258. The closure rules for impoundments and landfills do not contain these provisions, but rather provide alternative standards for closing with wastes in place or for clean closure. See, e.g., 40 CFR 265.228.

[8] EPA proposed regulations addressing contaminated media at 61 FR 18780, April 29, 1996 and has not yet taken final action on this proposal.

reopen the issue (settled in 1988) of whether site-specific treatment variances can be approved or denied without going through rulemaking procedures.

IV. Withdrawal of Citgo Treatment Variance

EPA granted a treatment variance to Citgo Petroleum on October 28, 1996 for wastes presently disposed in a large surface impoundment awaiting closure. 61 FR 55718, October 28, 1996. Because the company had the legal option of closing the impoundment with waste in place (assuming the technical standards for such closure could be justified), and was virtually certain to pursue that option if treatment of the waste to the limit of best demonstrated technology was required, EPA found that it was an environmentally superior result to assure clean closure and partial treatment. *Id.* at 55721. The variance was in essence used as an incentive to assure aggressive clean closure and the associated waste treatment. EPA, as part of the May 12 notice, proposed to reissue the variance under the clarified regulatory standard. 62 FR at 26062–26061, May 12, 1997.

Since the variance was granted, Citgo has chosen to pursue the legal option of seeking to close the impoundment with waste left in place. Because of Citgo's decision, EPA believes there is no longer any basis for the Citgo treatment variance. If the company's application for closure in place is granted, the variance is moot. If the application is not granted, then the company will have to clean close the impoundment and it will not be necessary to use the variance to create a voluntary incentive for them to do so. Thus, in either case, the basis for granting the variance no longer exists. Accordingly, EPA is withdrawing the Citgo treatment variance in today's Notice. Citgo is aware of the Agency's thinking, has discussed the issue with EPA, and agrees not to oppose withdrawal of the variance.

V. State Authorization

Under section 3006 of RCRA, EPA may authorize qualified States to administer and enforce the RCRA program within the State. Following authorization, EPA retains enforcement authority under sections 3008, 3013, and 7003 of RCRA, although authorized States have primary enforcement responsibility. The standards and requirements for authorization are found in 40 CFR part 271.

Today's rule is being promulgated pursuant to section 3004(m) of RCRA (42 U.S.C. 6924(m)), a provision added by HSWA.[9] Therefore, the Agency is adding today's rule to Table 1 in 40 CFR 271.1(j), which identifies the Federal program requirements that are promulgated pursuant to HSWA. States may apply for final authorization for the HSWA provisions in Table 1, as discussed in the following section of this preamble.

EPA originally indicated that states could not be authorized to review and approve national treatment variances pursuant to 40 CFR 268.44(a) because such variances could result in nationally-applicable standards for a new waste treatability group. 52 FR at 25783, July 8, 1987. In the HWIR-Media proposal, EPA clarified that states could seek authorization to review and approve site-specific treatment variances pursuant to 40 CFR 268.44(h). 61 FR at 18828, April 29, 1996.

The site-specific variance provision is less stringent than the generally applicable LDR program (i.e., the underlying treatment standard from which a variance is sought). Since today's final rule clarifies the existing regulations, for authorization purposes it is considered as stringent as, but no more stringent than the existing site-specific variance regulations. Thus, states are not required to adopt regulations equivalent to 268.44(h) either in its current form or in the clarified form promulgated today. Although States are not required to adopt regulations for site-specific LDR treatment variances, EPA strongly encourages States to adopt and become authorized for the clarified standards established today and is committed to expediting the state authorization process for this rule. In the meantime, EPA will continue to review and approve (as appropriate) treatment variance applications in all States.

VI. Regulatory Requirements

A. Regulatory Impact Analysis Pursuant to Executive Order 12866

Executive Order No. 12866 requires agencies to determine whether a regulatory action is "significant." The Order defines a "significant" regulatory action as one that "is likely to result in a rule that may: (1) have an annual effect on the economy of $100 million or more or adversely affect, in a material way, the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities; (2) create serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients; or (4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order."

The Agency considers today's final rule to be nonsignificant as defined by the Executive Order and therefore not subject to the requirement that a regulatory impact analysis has to be prepared. Today's rule clarifies and codifies, in regulatory language, existing EPA standards for the application of a treatability variance where the treatment standard is not appropriate for the restricted waste subject to the standard. Thus, because today's rule clarifies and codifies existing EPA interpretation of the treatability variance provision, no incremental costs are associated with this rulemaking.

B. Regulatory Flexibility Analysis

Pursuant to the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*, as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 [SBREFA]) whenever an agency is required to publish a notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effect of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions). However, no regulatory flexibility analysis is required if the head of an agency certifies the rule will not have a significant adverse economic impact on a substantial number of small entities.

SBREFA amended the Regulatory Flexibility Act to require Federal agencies to provide a statement of the factual basis for certifying that a rule will not have a significant economic impact on a substantial number of small entities. The following discussion explains EPA's determination.

EPA has codified regulatory language in today's rule that petitioners of restricted wastes that wish to obtain a treatment variance do not have to show technical infeasibility when the treatment technology is not appropriate to the waste. This regulatory language clarifies long standing and current Agency interpretation of the 268.44 that the two tests of technical infeasibility and inappropriateness are independent.

[9] Under RCRA section 3006(g) (42 U.S.C. 6926(g)), new requirements and prohibitions imposed by HSWA take effect in authorized states at the same time that they take effect in unauthorized states. EPA is directed to carry out these requirements and prohibitions in all states, including the issuance of permits, until the state is granted authorization to do so.

(See above discussion and 61 FR 55718 at 55720–21, October 28, 1996; 53 FR at 31200, August 17, 1988; 55 FR 8666 and 8760, March 8, 1990; 61 FR 18780 and 18811, April 29, 1996.) Because this regulatory language codifies existing EPA interpretation of current regulations, it imposes no costs or economic impacts on small entities applying for treatability variances.

Because this clarification does not impose an adverse economic impact to any small entity that is either generator of restricted waste or an owner/operator of a treatment, storage or disposal facility managing such waste that is petitioning the Agency for a variance from the treatment standard, I hereby certify that this rule will not have a significant adverse economic impact on a substantial number of small entities. This rule, therefore, does not require a regulatory flexibility analysis.

C. Unfunded Mandates Reform Act

Under Section 202 of the Unfunded Mandates Reform Act of 1995, signed into law on March 22, 1995, EPA must prepare a statement to accompany any rule where the estimated costs to State, local, or tribal governments in the aggregate, or to the private sector, will be $100 million or more in any one year. Under Section 205, EPA must select the most cost-effective and least burdensome alternative that achieves the objective of the rule and is consistent with the statutory requirements. Section 203 requires EPA to establish a plan for informing and advising any small governments that may be significantly impacted by the rule.

Because this regulatory language codifies current EPA interpretation of existing treatability variance language and thus imposes no costs, EPA has determined that this rule does not include a Federal mandate that may result in estimated costs of $100 million or more to either State, local, or tribal governments in the aggregate. As stated above, the private sector is not expected to incur costs exceeding $100 million. EPA has fulfilled the requirement for analysis under the Unfunded Mandates Reform Act.

D. Submission to Congress and the General Accounting Office

Under 5 U.S.C. 801(a)(1)(A) as added by the Small Business Regulatory Enforcement Fairness Act of 1996, EPA submitted a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives and the Comptroller General of the General Accounting Office prior to publication of the rule in today's **Federal Register**. This rule is not a "major rule" as defined by 5 U.S.C. 804(2).

List of Subjects in 40 CFR Part 268

Environmental protection, Hazardous waste, Reporting and recordkeeping requirements.

Dated: December 1, 1997.

Carol M. Browner,

Administrator.

For the reasons set out in the preamble, title 40, chapter 1 of the Code of Federal Regulations is amended as follows:

PART 268—LAND DISPOSAL RESTRICTIONS

1. The authority citation for part 268 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921, and 6924.

2. Section 268.44 is amended to revise paragraphs (a) and (h), add paragraph (m), and remove paragraph (p) as follows:

§ 268.44 Variance from a treatment standard.

(a) Based on a petition filed by a generator or treater of hazardous waste, the Administrator may approve a variance from an applicable treatment standard if:

(1) It is not physically possible to treat the waste to the level specified in the treatment standard, or by the method specified as the treatment standard. To show that this is the case, the petitioner must demonstrate that because the physical or chemical properties of the waste differ significantly from waste analyzed in developing the treatment standard, the waste cannot be treated to the specified level or by the specified method; or

(2) It is inappropriate to require the waste to be treated to the level specified in the treatment standard or by the method specified as the treatment standard, even though such treatment is technically possible. To show that this is the case, the petitioner must either demonstrate that:

(i) Treatment to the specified level or by the specified method is technically inappropriate (for example, resulting in combustion of large amounts of mildly contaminated environmental media); or

(ii) For remediation waste only, treatment to the specified level or by the specified method is environmentally inappropriate because it would likely discourage aggressive remediation.

* * * * *

(h) Based on a petition filed by a generator or treater of hazardous waste, the Administrator or his or her delegated representative may approve a site-specific variance from an applicable treatment standard if:

(1) It is not physically possible to treat the waste to the level specified in the treatment standard, or by the method specified as the treatment standard. To show that this is the case, the petitioner must demonstrate that because the physical or chemical properties of the waste differ significantly from waste analyzed in developing the treatment standard, the waste cannot be treated to the specified level or by the specified method; or

(2) It is inappropriate to require the waste to be treated to the level specified in the treatment standard or by the method specified as the treatment standard, even though such treatment is technically possible. To show that this is the case, the petitioner must either demonstrate that:

(i) Treatment to the specified level or by the specified method is technically inappropriate (for example, resulting in combustion of large amounts of mildly contaminated environmental media where the treatment standard is not based on combustion of such media); or

(ii) For remediation waste only, treatment to the specified level or by the specified method is environmentally inappropriate because it would likely discourage aggressive remediation.

(3) Public notice and a reasonable opportunity for public comment must be provided before granting or denying a petition.

* * * * *

(m) For all variances, the petitioner must also demonstrate that compliance with any given treatment variance is sufficient to minimize threats to human health and the environment posed by land disposal of the waste. In evaluating this demonstration, EPA may take into account whether a treatment variance should be approved if the subject waste is to be used in a manner constituting disposal pursuant to 40 CFR 266.20 through 266.23.

* * * * *

[FR Doc. 97–31914 Filed 12–4–97; 8:45 am]

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 8 1997

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups

FROM: Michael Shapiro, Director
Office of Solid Waste

Steve Luftig, Director
Office of Emergency and Remedial Response

TO: RCRA/CERCLA Senior Policy Managers
Regions I - X

This memorandum encourages appropriate use of site-specific land disposal restriction (LDR) treatability variances under 40 CFR § 268.44(h) for contaminated soils and other materials managed during cleanups. In particular, this memorandum clarifies the minimum requirements for alternative treatment standards and outlines treatability variance procedures. It builds on Superfund LDR Guides 6A and 6B, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions and Obtaining a Soil and Debris Treatability Variance for Removal Action," publication numbers 9347.3-O67S and 9347.3-OB67S, September 1990 and the quick reference fact sheet "Regional Guide: Issuing Site-Specific Treatability Variances for Contaminated Soils and Debris from Land Disposal Restrictions," publication number 9380.3-08FS, January 1992.

LDR Applicability

The Hazardous and Solid Waste Amendments (HSWA), enacted November 8, 1984, largely prohibit land disposal of hazardous wastes. After a waste is prohibited from land disposal the statute provides two options: comply with a specified treatment standard designed to minimize threats to human health and the environment prior to land disposal or dispose of the

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waste in a "no migration" unit.[1] Land disposal includes any placement of hazardous waste into a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave. See, RCRA Section 3004(k).

Since 1984, EPA has developed LDR treatment standards for all hazardous wastes listed or identified at the time HSWA was enacted and many hazardous wastes that have been subsequently listed or identified (e.g., the new toxicity characteristic (TC) wastes). The Agency recognizes, however, that in some cases these generally applicable LDR treatment standards will be unachieveable or inappropriate. When a generally applicable LDR treatment standard is unachieveable or inappropriate, a site-specific LDR treatability variance offers an opportunity to comply with LDRs through development of an alternative standard based on site- and waste-specific characteristics. The Agency's longstanding policy is that site-specific treatability variances are generally appropriate for contaminated soils; they also may be appropriate for other wastes encountered during site cleanups. See, e.g., 55 FR 8666, 8760-8761 (March 8, 1990); 58 FR 48092, 48125 (September 14, 1993); 61 FR 18805-18808, 18810-18812 (April 29, 1996); 61 FR 55717 (October 28, 1996).

It is important to note that the land disposal restrictions apply only to hazardous wastes placed after the effective date of the applicable land disposal prohibition. Not all materials managed during a cleanup action are hazardous wastes and not all activities conducted during a cleanup action constitute placement. For example, EPA has interpreted placement to include putting hazardous waste into a land-disposal unit, moving hazardous wastes from one land-disposal unit to another, and removing hazardous waste from the land, managing it in a separate unit, and re-placing it in the same or a different land-disposal unit. Placement does not occur when hazardous waste is consolidated within a land-disposal unit, when it is treated *in situ*, or when left in place (e.g., capped). See, e.g., 55 FR 8758-8760, (March 8, 1990).

When To Use Site-Specific Variances

Site-specific LDR treatability variances generally do not require rulemaking for approval; they are approved on a case-by-case basis in consideration of site- and waste-specific circumstances and conditions. A site-specific variance may be approved when the properties of the waste at issue are physically or chemically different from the properties of the wastes evaluated in establishing the generally applicable treatment standard and, as a result, the generally applicable standard cannot be achieved. A site-specific variance may also be approved when the generally applicable treatment standard is based on a Best Demonstrated Available Technology (BDAT) that is inappropriate for the waste in question. See, 268.44(h) and 61 FR 55717 (October 28, 1996).

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[1] *A no migration unit is a unit from which there will be no migration of hazardous constituents for as long as the* waste placed in the unit remains hazardous. See, RCRA Sections 3004(d), (e), (g)(5).

Common cleanup situations which may prompt consideration of a site-specific treatability variance include:

- *Cleanup of contaminated soils where the generally applicable land disposal treatment standards are based on combustion.* For large quantities of contaminated soils with relatively low concentrations of hazardous constituents, EPA generally considers treatment standards based on combustion inappropriate.

- *Cleanups where bench or pilot scale studies indicate that the generally applicable land disposal treatment standard cannot be achieved.*

- *Cleanup of old sludges initially placed prior to the effective date of land disposal prohibitions.* In some cases the physical or chemical composition of sludges become significantly altered upon prolonged exposure to: natural sunlight, acidic rainfall, weather cycles (such as freeze-thaw) and intrusion, commingling, or chemical reaction with rainfall, soil, windblown dirt and/or other co-disposed wastes. These types of exposure can result in changes in composition through: evaporation or migration of volatiles, sunlight induced polymerization of organics, lime stabilization (i.e., self-cementation), photodegradation, natural biodegradation, hydrolysis, and even electrolytic oxidation/reduction reactions. As a result, weathered sludges often no longer have the physical or chemical composition of newly generated sludges and a treatability variance may be warranted.

- *Cleanups where, due to site-specific circumstances, compliance with the generally applicable land disposal treatment standard would result in a net environmental detriment, for example, by discouraging cleanup.* In some situations, legal and protective cleanup alternatives involve the choice between remedies that require compliance with LDR treatment standards developed for as-generated wastes and remedies that do not (i.e., remedies that rely on containment). When application of the generally applicable treatment standard provides an incentive for remedies that, while permitted under applicable law, are less aggressive (and, potentially, less protective over the long term) than alternatives, the generally applicable standard may be considered inappropriate. Note, many of these remedies will include some form of treatment; however, it might not be the treatment prescribed for as-generated wastes. See, e.g., 61 FR 55717 (October 28, 1996) where EPA approved alternative treatment standards, in part, because imposing the otherwise applicable standards would have resulted in a net environmental detriment.

Alternative Treatment Standards

All alternative LDR treatment standards must satisfy the statutory requirement of RCRA 3004(m) by minimizing threats to human health and the environment. In many situations, protective, risk-based, site-specific cleanup standards established in the context of an Agency-overseen cleanup will meet this "minimize threat" standard and may be used as alternative treatment standards. In other situations, alternative treatment standards may be established on a technology basis.[2]

Risk-based alternative treatment standards established in the context of an Agency-overseen cleanup should consider EPA guidance on risk-based cleanup standards. EPA has interpreted protective cleanup standards to include risk-based media cleanup standards that are within the 10^{-4} to 10^{-6} risk range for carcinogens and result in a hazard index of one or less for constituents with non-carcinogenic effects. Protective, risk-based, site-specific cleanup standards can be based on generally available constituent concentration standards (e.g., MCLs and many state cleanup standards) or they may be developed for an individual site (e.g., through a site-specific risk assessment). Alternative treatment standards established on a technology basis are most often based on site-specific treatability data or on a "substantial treatment" standard. For example, 90 per cent reduction in constituent concentrations is generally considered substantial treatment.

For contaminated soils, the Superfund LDR Guides 6A and 6B, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions and Obtaining a Soil and Debris Treatability Variance for Removal Action," publication numbers 9347.3-O67S and 9347.3-OB67S, September 1990 provide suggested constituent concentration ranges and per cent reduction targets that may be used as guidance when establishing alternative LDR treatment standards for contaminated soils.[3] When using the constituent concentration ranges or per cent reduction targets from the 6A/6B guidance, the Agency should be prepared to support application of these standards on a site-specific basis. As with application of any Agency guidance, application of the constituent concentration ranges or per cent reduction targets from the 6A/6B guidance could be questioned by facility owners/operators or by the public; the Agency must be prepared to respond to these comments and justify application of any guidance to site- and waste-specific

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[2] The ability to, as appropriate, use site-specific, risk-based cleanup levels as alternative LDR treatment standards does not affect the Agency's other remedial expectations, for example, that treatment will be used to address the principal threats posed by a site whenever practicable.

[3] Note that protective, risk-based cleanup standards that are developed based on site-specific conditions may be either higher or lower than the constituent concentration ranges or per-cent reduction targets from the 6A/6B guidance. In addition, while debris are still eligible for site-specific treatability variance, such variances are no longer presumed to be appropriate. LDR treatment standards specific to debris were promulgated August 18, 1992 (57 FR 37194).

circumstances.

Constituents Subject to Treatment

Unless the generally applicable LDR treatment standard will be met, alternative treatment standards must be set for each constituent subject to treatment. Constituents subject to treatment are, for listed wastes, the constituents for which treatment standards are specified in 40 CFR 268.40 and, for characteristic wastes, the characteristic constituent and any underlying hazardous constituents present at concentrations greater than the Universal Treatment Standards (UTS) specified in 40 CFR 268.48. For example, a waste that fails the toxicity characteristic leaching test for benzene but also contains other organic hazardous constituents such as toluene, ethyl benzene, and xylene must meet treatment standards for both the benzene and the other hazardous constituents.[4] Note that, when testing characteristic waste to determine constituents subject to treatment, individuals do not necessarily have to test for every constituent with a universal treatment standard; they may limit testing to constituents that are reasonably expected to be present.

Multiple Contaminants

It is not automatically necessary to treat all constituents subject to treatment in order to satisfy RCRA Section 3004(m). Just as some industrial wastes are generated with concentrations of constituents subject to treatment that are below the applicable land disposal treatment standards, some wastes generated during cleanup may contain concentrations of hazardous constituents that are below land disposal treatment standards established in a site-specific treatability variance. It is common for cleanup wastes to contain mixtures of many different kinds of hazardous constituents at widely varying concentrations. Often, these combinations of constituents or constituent concentrations are different from the constituents combinations and concentrations typically found in as-generated wastes that carry the same waste code or exhibit the same hazardous characteristic and treatment of all constituents subject to treatment may not be required to satisfy RCRA Section 3004(m).

In some of these cases, a treatability variance might establish alternative treatment standards for some constituents subject to treatment, but not others (i.e., compliance with the otherwise applicable treatment standard might be required for some constituents). In other cases, a treatability variance might require treatment to meet alternative LDR treatment standards for some constituents subject to treatment while for others it might be determined that no treatment is necessary to comply with LDRs. For example, a waste might be characteristic for benzene and

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[4] Note, extending the obligation to treat for underlying hazardous constituents to TC metal waste was discussed in 60 FR 43654, August 22, 1995. The proposal has not been finalized.

contain low levels of toluene, ethyl benzene, or xylene. Depending on the concentrations of the individual constituents, treatment might be required for the benzene, and protective, risk-based alternative treatment standards for the minor contaminants might be established such that treatment to comply with LDR standards was not required (i.e., where the initial constituent concentrations are at or below the risk-based standard). Similarly, a cleanup waste might fail the toxicity characteristic leaching test for a metal contaminant and also contain low levels of organic contaminants. Treatment to the generally applicable LDR treatment standards might be required for the TC metal, but protective, risk-based alternative LDR treatment standards for the organics might be established at or above the initial constituent concentrations, making treatment of the organics unnecessary.[5]

Variance Procedures

In states authorized to issue site-specific LDR treatability variances, applications should be submitted to the state hazardous waste program director, or other official designated by the state. In states that are not authorized to issue these variances, applications should be submitted to the EPA Regional Administrator or to the appropriate delegated official within the Region. All applications should include information required by 40 CFR 260.20(b)(1) - (4) and information documenting compliance with the waste analysis requirements of 40 CFR 268.7.

Applications for site-specific LDR treatability variances will likely require less detail and rigorous analysis than applications for generically applicable variance (e.g., rulemaking variances under 268.44(a)); however, if necessary EPA can use 40 CFR 268.44(j) to request additional information to support a given application. All approvals should emphasize that the variances are site- and waste-specific in nature and do not apply to any other site or waste.

Whenever possible, the decision to approve a site-specific LDR treatability variance should be integrated into other cleanup decision documents (e.g., RCRA Statement of Basis, CERCLA Record of Decision, state corrective action order). As a matter of Agency policy, site-specific LDR treatability variances should undergo public notice and opportunity for comment before approval. See, 53 FR at 31200 (August 17, 1988). Similar to the decision to approve a variance, whenever possible, public notice and opportunity for comment for site-specific LDR treatability variances should be combined with other public notice and opportunity for comment activities that occur during Agency-overseen cleanups (e.g., the public notice and opportunity for comment associated with a CERCLA proposed plan or approval of a corrective action remedy). In the limited circumstances where it is not possible to combine public notice for site-specific LDR treatability variances with other public notice opportunities, public notice and opportunity for comment should be provided consistent with the program goals of full, fair and equitable

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[5] See footnote 4.

public participation. While a variance application is pending the applicant must comply with all applicable land disposal restrictions and requirements (40 CFR 268.44(l)).

As discussed in the National Contingency Plan (55 FR 8760-8762) and the Superfund LDR 6A and 6B guides, EPA presumes that site-specific LDR treatability variances may be granted for contaminated soils; therefore, applications for a site-specific LDR treatability variance for soil do not have to document that the generally applicable LDR treatment standards are unachievable or inappropriate.[6] However, applicants should include information documenting the basis for their application supporting application of the soil presumption to their site- and waste-specific circumstances. Applications for site-specific LDR treatability variances that address cleanup wastes other than soil should include information documenting that either (1) the waste at issue is significantly different from the waste evaluated for the generally applicable treatment standard and, as a result, the regulated constituents cannot be treated to the specified levels or (2) the generally applicable standard is based is not appropriate. Applications should include a statement, signed by the applicant, certifying that the information in the application is true and correct.

Delegation

The authority to approve site-specific LDR treatability variances for contaminated soils was delegated to Regional Administrators in Delegation 8-45-B. For CERCLA removal actions and actions under the solid waste disposal act (which includes RCRA), the authority can be further delegated to regional Division Directors. The authority to approve site-specific LDR treatability variances for one-time only cleanup wastes (non-soil or debris wastes, i.e., sludges managed as part of a cleanup) is under consideration for delegation to Regional Administrators. (See proposed delegation 8-45-C.)

While the authority to approve site-specific LDR treatability variances will rest with the Regions and states, we encourage you to work together and with EPA Headquarters to maintain a national dialogue on variance issues. In particular, we request that Regions (and authorized states) share information on critical or precedent setting variances so we can all benefit from your experiences and so we can assure that issues of national scope or consistency are equitably resolved. This information could be shared at national and regional meetings or through other networking opportunities.

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[6] Of course, if a commenter on any given site-specific treatability variance challenges the presumption, the Agency must address these comments on a site-specific basis, for example, by articulating the site-specific conditions that support the presumption, in response.

State Authorization

EPA has recently clarified its policy on state authorization for site-specific LDR treatability variances and is actively encouraging states to seek authorization for and integrate appropriate use of these variances in their cleanup programs. See, 61 FR18828 (April 29, 1996). Additional information on state-authorization will be provided in an upcoming update to the State Program Advisory.

Disclaimer

This document provides guidance to EPA and State personnel on how to best implement RCRA and EPA's regulations on site-specific treatability variances to facilitate appropriate use of these variances, especially as part of Agency-overseen cleanups. It also provides guidance to the public and the regulated community on how EPA intends to exercise its discretion in implementing these regulations. This document does not, however, substitute for EPA's regulations, nor is it a regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based on specific circumstances. EPA may change this guidance in the future, as appropriate.

Summary/Additional Information

Site-specific LDR treatability variances are an important tool to ensure compliance with appropriate LDR treatment standards. They can be especially useful where application of the generally applicable standard can serve as a disincentive towards aggressive cleanup. We encourage you to continue to integrate site-specific LDR treatability variances into your cleanup activities and to support the use of these variances into state programs. For additional information, please contact Elizabeth McManus or Shaun McGarvey at (703) 308-8657 and (703) 308-8603, respectively.

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federal register

Monday
April 29, 1996

Part II

Environmental Protection Agency

40 CFR Part 260, et al.

Requirements for Management of Hazardous Contaminated Media; Proposed Rule

and would not go into effect unless and until a State adopted and became authorized for them. Normally, less stringent HSWA requirements automatically take effect in non-HSWA authorized States. However, the Part 269 LDR treatment requirements would not take effect because they apply only to cleanup wastes addressed under a Part 269 program. Thus, they would become effective in non-HSWA authorized States only when such States obtain authorization to run a Part 269 program. States authorized for the LDR program that choose to obtain HWIR-media authorization, would have to adopt requirements that would be at least as stringent as the LDR requirements specified in Part 269. States that seek LDR authorization after promulgation of final HWIR-media regulations would have to adopt requirements no less stringent than the existing (non-Part 269) Federal LDR program, if they chose not to seek authorization for today's HWIR-media requirements.

Media treatment variances. Under current regulations at 40 CFR 268.44, EPA may grant waste- or site-specific variances from treatment standards in cases where it can be demonstrated that the treatment standard is inappropriate for the waste, or that the waste cannot be treated to specified levels, or treated by specified methods. Today's proposed rule would retain the availability of treatment variances in the implementation of the HWIR-media program, and establish HWIR-media specific treatment variance procedures for media managed under Part 269. The Agency is clarifying today that States could seek authorization for both the site-specific treatment variance procedures in 40 CFR 268.44, and the HWIR-media specific treatment variance procedures proposed in Part 269. EPA is aware that some States, especially States that chose to adopt the Federal LDR program by reference, could have already received authorization to issue site-specific LDR treatment variances under 40 CFR 268.44. Because there has been some confusion about this issue, and because EPA's current proposal would encourage States to become authorized for treatment variances, EPA requests the States to note in their HWIR-media program revision application, or other authorization application, or in official correspondence, whether or not they believe that they have been authorized for site-specific LDR treatment variances under 40 CFR 268.44. EPA would then evaluate that aspect of a State submittal to confirm the State's authorization for treatment variances. EPA requests comments on this proposal, especially from States that believe they are already authorized to approve LDR treatment variances.

CAMU revocation. EPA is proposing today to revoke the CAMU regulations at 40 CFR 264.552 and to "grandfather" CAMUs approved prior to the publication date of the final HWIR-media rule. Since revocation of the CAMU regulations would remove that option at the Federal level, even States that have adopted CAMU regulations as a matter of State law and/or become authorized for CAMUs would be blocked from approving new CAMUs by this date, when these more stringent Federal rules would go into effect. Of course, States could still use their CAMU regulations for non-hazardous wastes at their discretion, or for media that do not contain hazardous wastes (and that are not subject to LDRs).

In order to ensure that requirements for "grandfathered" CAMUs remain enforceable, States that have already been authorized for the CAMU regulations, and that choose to grandfather CAMUs, should retain their CAMU regulations (for those grandfathered CAMUs) until those CAMUs have expired or are terminated. States would be required, however, to make clear that existing State CAMU regulations would not be used to grant any new CAMUs for management of Federally hazardous waste after the date of publication of the final HWIR-media rule.

c. Examples. The following examples illustrate the effect of today's proposed rule in authorized States.

Example One: The State has received final base program authorization but has not yet been authorized for the land disposal restriction program.

Because the State has received final base program authorization, and the pre-HSWA HWIR-media regulations proposed today are less stringent than the existing program, the pre-HSWA HWIR-media regulations would not be effective in the State unless and until the State adopted and became authorized for them.

Since EPA would still be implementing the LDR program in the State, the Part 269 LDR treatment requirements for hazardous contaminated media and treatment variances for contaminated media would be effective immediately upon approval of the State's HWIR-media program, and would be implemented by EPA until the State received the necessary LDR program authorization. On the other hand, the new remediation pile provisions would become effective immediately in non-HSWA authorized States, because they are HSWA requirements that are not specific to the Part 269 program.

Example Two: The State has received final base program authorization, and is also authorized for the land disposal restriction program through the Third Third LDR rule.

Since the State has received final authorization and the pre-HSWA HWIR-media regulations proposed today are less stringent than the existing program, the pre-HSWA HWIR-media regulations would not be effective unless and until the State adopted and became authorized for them, as discussed in example one. Similarly, since the State would be authorized for the land disposal restriction program, and the remediation pile provisions (which are considered HSWA provisions because they affect LDRs) proposed today are considered less stringent than the existing LDR program, the remediation pile provisions proposed today would not be effective in the State unless and until the State adopted and became authorized for them.

For the less stringent Part 269 treatment standards, as explained in example one, these would not become effective in the State until the State chose to adopt a Part 269 program. Because the State would already be authorized for a sufficient LDR program, the State could also be authorized to run the LDR program of the HWIR-media program.

Example Three: The State is authorized for the corrective action management unit rule.

The CAMU revocation provision proposed today is the only provision that is more stringent than the existing Federal RCRA program and, therefore, mandatory for States to adopt. In addition, because revocation of the CAMU regulations would remove that option at the Federal level, even States that have adopted CAMU regulations as a matter of State law would be blocked from implementing those regulations when more stringent Federal rules take effect (date of publication of final HWIR-media rule).

8. Request for Comment on EPA's Approach to Authorization

EPA requests general comments on the approach to authorization outlined in today's proposal. In addition, as discussed above, EPA specifically requests comments that address the following issues and areas:

a. The use of differential authorization procedures for State program revisions, and whether the Category 2 authorization procedures discussed today would sufficiently recognize the sophistication of State programs while maintaining an appropriate level of EPA review. EPA is specifically interested in the ability of these procedures to adequately address evaluation of a State's capability to implement any given program revision;

b. The effect of differential authorization procedures, if any, on State's and EPA's ability to cluster authorization applications (i.e., the ability to prepare and review program revision applications that address more than one rule at the same time);

c. Whether the Category 2 procedures discussed today would be appropriate for authorization of the HWIR-media regulations, and other types of

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Wednesday
August 17, 1988

Part II

Environmental Protection Agency

40 CFR Parts 264 etc.
[OSW-FR-88-011]
Land Disposal Restrictions for First Third Scheduled Wastes; Final Rule

wastes would be indigenous to metal recovery processes. K061 wastes are generated by the same type of furnace that recovers the K061 dust, furnaces from both the steel industry and the zinc smelting industry are part of the same generic SIC code 331, and the dusts are similar in composition to the virgin ores customarily smelted in zinc smelting furnaces. Not only are the zinc levels the same as found in virgin ores (15% minimum), the other toxic metals (lead and cadmium) are also present in zinc ores in comparable concentrations. Hazardous waste K069 is even more clearly indigenous to the secondary lead smelting process since it is generated directly by the secondary lead process and contains no toxic constituents not already present in the normal feed material to the secondary lead smelting furnace.

It therefore appears to the Agency that these two hazardous wastes would be considered to be indigenous to the respective metal recovery process under any of the definitions that EPA is considering. Because it appears at this time to be clear that under any ultimate regulatory regime these wastes would be indigenous, then the derived from rule would not apply to any of the wastes generated by the metal recovery process. Consequently, the treatment standards EPA is establishing today for K061 and K069 do not apply to wastes from the metal recovery processes because, by virtue of the indigenous principle, the derived from rule would not apply to these processes (i.e., the residuals from such processes would not be derived from a hazardous waste).

K. Nonrulemaking Procedures for Site-Specific Variances from the Treatment Standard

In the November 7, 1986 final rule (51 FR 40572), the Agency established a procedure for obtaining a variance from the applicable treatment standard (40 CFR 268.44). Use of this variance was envisioned in cases where restricted hazardous wastes differ significantly from the wastes evaluated in setting treatment standards and, as a result, cannot be treated to meet the applicable treatment levels or where the technology used to establish the treatment level is not appropriate to the waste. The request for this treatability variance must demonstrate, among other things, that the waste is significantly different from the wastes evaluated in establishing the treatment standard and cannot be treated in compliance with the applicable treatment standard. Prior to today's final rule, the section 268.44 variance procedures were available only through a rulemaking that would amend the regulatory treatment standards each time a variance was granted.

Today's final rule amends § 268.44 by adding procedures for requesting a site-specific variance from the treatment standard. As explained below, opportunity will be provided for public comment on site specific variances.

1. Background

On September 5, 1986, the Agency published a Notice of Availability of Data (51 FR 31783). The notice requested comments on whether EPA should have a variance from the generally applicable treatment standards, and the procedures under which such variances should be processed. Commenters generally supported allowing variances from the treatment standard. Furthermore, in the context of today's modification, some commenters, while recognizing EPA's authority to grant variances through rulemaking procedures, supported the use of nonrulemaking procedures. Because there was insufficient time to fully consider all issues relating to the variance procedure before the November 7, 1986 rule was promulgated, only a procedure for obtaining a variance from the treatment standard which required rulemaking was established (51 FR 40572); however, the Agency noted its intention to raise the nonrulemaking variance issue in the future.

The Agency requested comment on several modifications of the variance procedure in the December 11, 1986 California list land disposal restrictions proposal (51 FR 44729). Specifically, comment was requested on the advisability of allowing nonrulemaking procedures and on the applicability of such procedures. Comment was also requested on establishing a deadline for variance applications, on provisions for public comment, and on the criteria for granting nonrulemaking variances.

Nonrulemaking variance procedures were again presented for public comment in a Notice of Availability of Data published on August 12, 1987 (52 FR 30038). It was noted that the July 7, 1987 California list final rule (52 FR 25780) set forth a treatment method equivalency petition (40 CFR 268.42) that need not be processed through a formal rulemaking in cases where the relief sought would not have generic applicability and effect. In the August 12 Notice, EPA solicited further comment on the advisability of applying the same reasoning to the site-specific variance from the treatment standard so that formal rulemaking procedures are not mandated.

2. Major Comments

The Agency received several comments addressing various aspects of establishing a nonrulemaking procedure for site-specific variances from the treatment standard. The majority of commenters supported the establishment of nonrulemaking procedures; their arguments were based on the need for streamlined procedures so that variances may be reviewed in a timely manner. Several commenters suggested that a site-specific nonrulemaking variance could be included in the permitting process, thus offering an opportunity for public comment. One commenter cited the Supreme Court's decision in *Chemical Manufacturers Association* v. *NRDC*, 470 U.S. 116 (1985), as support for EPA's authority to use a streamlined variance procedure. On the other hand, two commenters expressed concerns about utilizing nonrulemaking procedures. One commented that EPA had the authority to grant variances from the treatment standard, but stated that all petitions must be subject to public review and comment before they are granted. The other commenter strongly opposed the Agency's proposed approach, arguing that nonrulemaking procedures violate RCRA sections 3004(m), 7004, and 7006.

3. Agency Response and Summary of Today's Approach

The Agency believes that nonrulemaking procedures for the variance from the treatment standard are not precluded by the statute in cases where such a determination is site-specific, having no generic applicability and effect. The Agency is taking this position for a number of reasons. First, since a generator-specific treatability variance would not be of general applicability and effect, such administrative action would not be a rule requiring utilization of the Administrative Procedure Act informal rulemaking procedures. Second, to the extent that section 3004(m) creates an independent requirement of rulemaking procedures, this requirement is satisfied by the initial rulemaking in which the BDAT treatment standard is established. In this regard, the Agency notes that there are numerous instances where a statute requires that a generally applicable standard be established by regulation, but that variances from that standard need not be established via rulemaking. Under RCRA, for example, EPA must use rulemaking to establish generally applicable standards for treatment, storage, and disposal facilities (RCRA section 3004(a)). EPA,

however, has also established variances from certain of these generally applicable requirements which can be granted by means other than rulemaking—for example, the variance from the secondary containment requirement for hazardous waste tanks is implemented by nonrulemaking procedures. (See § 264.193 (g) and (h)). Under the Clean Water Act, EPA is required to establish generally applicable effluent limitation guidelines and standards by regulation, but for years has had in place a fundamentally different factors variance from these standards that was implemented by nonrulemaking procedures. This Fundamentally Different Factors variance is now codified in the 1987 amendments to the Clean Water Act, section 301(n). In the land disposal restrictions rules themselves, EPA adopted nonrulemaking procedures for processing demonstrations of equivalency to a specified BDAT method. (See § 268.42(b)).

In fact, it appears that at least in RCRA, where Congress meant to preclude the Agency from using nonrulemaking procedures when granting variances, it said so explicitly. (See RCRA section 3001(f)) that mandates use of informal rulemaking procedures for processing delisting petitions.) In other contexts, most notably RCRA sections 3004(o)(2) and 3005(j) (2), (3), (4), and (13), Congress itself explicitly authorized nonrulemaking procedures for granting other types of variances. It thus appears to the Agency that the brief reference to "regulations" in section 3004(m)(1) does not preclude the use of nonrulemaking procedures to grant individual variances to an already promulgated treatment standard.

Therefore, today's final rule promulgates modifications to 40 CFR 268.44 that allow a site-specific variance from the treatment standard, having no generic applicability and effect, to be granted through nonrulemaking procedures. The Agency agrees as a matter of policy to allow opportunity for public notice and comment prior to granting a nonrulemaking variance from the treatment standard. Because circumstances under which one might apply for a site-specific variance vary, vehicles for public comment will be specified on a case-by-case basis.

The Agency received no requests for variances from the treatment standards promulgated in the solvents and dioxins final rule or the California list final rule. It is difficult to predict how many requests for variances from the treatment standard will be received as a result of today's final rule. Therefore, the Agency is not establishing a specific format for the variance or specifying vehicles for providing public comment at this time. Since the goal of granting site-specific variances from the treatment standard through nonrulemaking procedures is to streamline the process, the Agency will likely provide for public comment through existing public participation vehicles such as permit applications or modifications, CERCLA Remedial Investigation/Feasibility Study documents, or other relevant procedures as appropriate. In cases when there is no existing proceeding which provides the opportunity for public participation, EPA will provide opportunity for notice and comment through publication in local newspapers, by radio broadcast, or through other media, similar to the variance procedures already in place under § 260.33. If necessary, the Agency will issue guidance at a later date on the format for an application and will specify procedures for public comment.

The criteria by which a nonrulemaking site-specific variance from the treatment standard will be evaluated remain the same as those previously promulgated. The demonstration should be made that the waste is significantly different from the wastes evaluated in establishing the treatment standard and cannot be treated in compliance with the applicable treatment standard. On a site-specific basis, it may be possible to determine that BDAT treatment is inappropriate for a particular waste stream. For example, incineration of large volumes of contaminated soil under certain site-specific conditions may be found to be inappropriate treatment. Such an assertion should be supported by analytical data and treatability studies to the greatest extent possible. Each request for a variance from the treatment standard must include a statement signed by the authorized representative of the applicant certifying that the information is correct.

The applicant must apply to the Assistant Administrator for the Office of Solid Waste and Emergency Response, addressing the criteria contained in § 268.44. The authority for granting site-specific variances to the treatment standard may be delegated to the Regional Administrator in the future, at which time the application would be made to the Regional Administrator in the region where the applicant is located.

The Assistant Administrator (or Regional Administrator, if authority is delegated) will evaluate the application and issue a draft notice tentatively granting or denying the application. Notification of this tentative decision will be provided by newspaper advertisement or radio broadcast in the locality where the applicant is located. The Assistant Administrator (or Regional Administrator, if authority is delegated) will accept comment on the tentative decision, usually for 30 days. Public hearings may be held upon request or at his discretion. A final decision will be made after evaluation of comments.

L. Rationale for Immediate Effective Date

The regulations promulgated today will be effective immediately except where the Agency has specified a national variance or otherwise specified an alternative effective date. HSWA requires that today's regulations become effective on or before the August 8, 1988 effective date of the restrictions on the first one-third of the wastes scheduled pursuant to RCRA section 3004(g)(4)(A). If the Agency fails to promulgate regulations for any of these wastes by the statutory effective date, the restrictions on disposal of the waste in a landfill or surface impoundment, stipulated in section 3004(g)(6)(A) take effect automatically on August 8, 1988. If the Agency has not promulgated treatment standards for any scheduled waste by May 8, 1990, that waste is prohibited from all forms of land disposal unless a generator has been granted an extension of the effective date (either a national variance or a case-by-case extension) or a "no migration" finding has been made. Hence, August 8, 1988, is the latest date for EPA to promulgate regulations that will prevent the "soft hammer" in section 3004(g) from falling for all First Third wastes. Section 3004(h) requires that regulations established under sections 3004 (d), (e), (f), or (g) be effective immediately upon promulgation. Furthermore, section 3004(m) specifies that regulations setting treatment standards must have the same effective date as applicable regulations established under sections 3004 (d), (e), (f), or (g). For today's regulations which set treatment standards and are promulgated under section 3004(g), this date will be August 8, 1988. Since the statute clearly states that the regulations implementing section 3004(g) must go into effect on or before August 8, 1988, in order to prevent the "soft hammer" from falling, EPA finds that good cause exists under section 3010(b)(3) to have an immediate effective date. For the same reason, EPA finds that good cause also

Treatability Studies Exemption

federal register

Friday
February 18, 1994

Part VII

Environmental Protection Agency

40 CFR Part 261

Identification and Listing of Hazardous Waste, Treatability Studies Sample Exclusion; Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 261

[FRL-4838-5]

Hazardous Waste Management System: Identification and Listing of Hazardous Waste; Treatability Studies Sample Exclusion

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: On July 7, 1993, the Environmental Protection Agency (EPA) proposed revisions to the Treatability Studies Sample Exemption Rule. The rule conditionally exempts small scale treatability studies from Subtitle C regulation.

EPA is today issuing a final rule. The principal change to the existing rule is to increase the quantity of contaminated media which are conditionally exempt from Subtitle C regulation when used in conducting treatability studies.

EFFECTIVE DATE: This rule becomes effective on February 18, 1994.

ADDRESSES: The public docket for this rulemaking is located in the RCRA docket, located in room M2427 at the U.S. Environmental Protection Agency, 401 M St. SW., Washington, DC 20460. The telephone number for the docket is (202) 260-9327. The record is available for inspection by appointment only, between the hours of 9 a.m. and 4 p.m., Monday through Friday, excluding legal holidays. Viewers may copy up to 100 pages free of charge, after which copies cost $0.15 per page.

FOR FURTHER INFORMATION CONTACT: Questions relating to the technical content of this rule should be directed to Jim Cummings or John Kingscott, Technology Innovation Office (5102W), U.S. Environmental Protection Agency at (703) 308-8796 or (703) 308-8749. Other inquiries should be directed to the RCRA/Superfund Hotline at (800) 424-9346 or (703) 920-9810.

SUPPLEMENTARY INFORMATION:

Outline

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I. Background

On July 19, 1988 (52 FR 27290), EPA issued a rule that conditionally exempted from Subtitle C hazardous waste regulation waste samples collected for purposes of conducting small-scale treatability studies. 40 CFR 261.4 (e)-(f). This rule was promulgated in recognition of the inhibiting effect of the stringent Resource Conservation and Recovery Act (RCRA) Subtitle C requirements on the development of new treatment capacity, and the minimal public health and environmental risks involved in conducting small-scale treatability studies. The rule identified specific quantities of various types of wastes which could be transported, stored and used in treatability studies without the need for RCRA Subtitle C regulation.

On July 7, 1993 (58 FR 36367), EPA proposed amendments to the existing rule which would increase the quantity limits for major classes of contaminated media (specifically soil and debris) which could be employed in treatability studies without triggering RCRA Subtitle C requirements. The proposal was based in part on the recognition that larger quantities of soil and debris were often needed for treatability testing by technology developers. Larger-scale testing also greatly increases the confidence with which remedial action decision-makers make remedy selection decisions, thus improving CERCLA response activities and RCRA corrective actions, see 58 FR 36367, 36370.

EPA also requested comment on the desirability of an amendment to increase the quantity limits for other forms of remediation waste in addition to soil and debris. The proposal also included an amendment which would allow longer time frames for conducting treatability studies involving bioremediation, and solicited comment on appropriate time limits for other technologies. EPA did not request comment on, or reopen the comment period on, the propriety of the existing exemption.

Twenty-seven comments were received in response to the proposed rule. The comments were universally favorable regarding the need for and desirability of increasing the treatability study quantity limits. A substantial majority of the comments favored extending the scope beyond soil and debris to other forms of remediation and/or hazardous waste. General reasons offered by commenters mirror those stated in the proposed rule, e.g., assisting technology development and increasing confidence in remedy selection.

EPA is today issuing a final rule which increases the quantity and time limits for contaminated media to be used in treatability studies. The rule would increase the exempt amounts from 1000 kg up to 10,000 kg of media contaminated with non-acute hazardous waste and from 250 kg to 2500 kg of media contaminated with acute hazardous, when used in treatability studies.

The existing case-by-case variance provision (40 CFR 261.4(e)(3)) is increased from 500 kg to 5000 kg for media contaminated with non-acute hazardous waste and from 250 kg to 2500 kg for media contaminated with acute hazardous waste. The existing variance provision focuses on allowing limited additional quantities after the initial increment of material is processed. EPA is adding criteria to the variance provision to allow the additional quantity to be requested in advance.

EPA is also increasing the time limits for treatability studies involving bioremediation. Treatability studies involving bioremediation have an initial period of two years to complete testing, and under the case-by-case variance provisions discussed below, may request up to an additional two years.

The remainder of the preamble discusses the major comments received on the proposed rule and EPA's response to them. All other comments are discussed in a background document that is available in the RCRA docket.

II. Discussion

A. Summary of the Existing Treatability Sample Exclusion Rule

The existing Treatability Sample Exclusion rule imposes limits on the quantity of material which may be shipped, stored or treated under the exemption. In order to qualify for the conditional exclusion; laboratory and test facilities must comply with the following quantity and time limitations as well as notification, reporting and record-keeping requirements:

Shipment—The mass of each sample shipment may not exceed 1000 kg of "as received" hazardous waste, 1 kg of acute hazardous waste, or 250 kg soils, water, or debris contaminated with acute hazardous waste. 40 CFR 261.4(e)(2)(ii). "As received" refers to the waste

shipped by the generator or sample collector as it arrives at the laboratory or testing facility. 40 CFR 261.4(f)(3).

Storage—The laboratory or testing facility may store up to 1000 kg of non-acute hazardous waste. This limitation can include 500 kg of soils, water, or debris contaminated with acute hazardous waste or 1 kg of acute hazardous waste. 40 CFR 261.4(f)(4).

Treatment—The laboratory or testing facility, on a per waste stream per treatment process basis, may conduct treatability tests on up to 1000 kg of non-acute hazardous waste, 250 kg of soils, water, or debris contaminated with acute hazardous waste, or 1 kg of acute hazardous waste. 40 CFR 261.4(e)(2)(i). The rule imposes a treatment initiation rate limit of 250 kg per day of "as received" waste for the entire laboratory or testing facility.

Time Limits—The existing exclusion requires that the laboratory or testing facility return the sample to the generator or sample collector, or send it to a designated facility within 90 days of completion of the treatability study, or no more than one year from the time the generator or sample collector shipped the sample to the laboratory or testing facility, whichever date first occurs. 40 CFR 261.4(f)(5).

EPA did not seek comment on the propriety of these exemption levels or criteria, but merely sought comment on amendments that would expand the scope of the existing rule.

B. Need and Rationale for Amendments to the Existing Rule

The preamble to the proposed rule contained an extensive discussion of the reasons the Agency felt that amendments to the existing rule were desirable. 58 FR 36367 (July 7, 1993). Interested readers are referred to that document for further information.

C. Response to Major Comments

1. Quantity Limits

All commenters supported an amendment to increase the quantity limits in the exemption for soil and debris samples by at least the quantities proposed. Almost 50% of the comments suggested adopting higher exemption limits on either an across-the-board or a case-by-case basis.

Commenters noted the significant challenges posed in designing and verifying the operational performance of treatment processes. Commenters also noted the challenges encountered in designing and testing ancillary system components—e.g., material handling equipment (getting the waste material into the treatment unit in an appropriate physical state and condition), and emission control equipment. Smaller-scale tests conducted at the laboratory or bench scale often do not involve ancillary system components, or may not utilize sufficient throughput to adequately test these components.

Suggestions to further increase the quantity limits ranged as high as 25,000 kg. Other comments suggested that quantity limits higher than those proposed be set on a case-by-case basis. These comments identified site size, the nature of the waste and/or the remediation technology, the concentration of hazardous constituents in the waste matrix, and the intent of the study as possible factors to be considered in these case-by-case determinations.

EPA is aware that the larger the scale of the technology development or remedy selection treatability study, the more likely the results will represent the performance of full-scale remedial equipment. Furthermore, EPA's proposal identified the need to address materials handling problems as a major basis for the proposed revision.

The data adduced by EPA in the proposed rule support the conclusion that many of the technologies can be tested within the limits proposed. Nevertheless, EPA's own data also confirm that there are situations where additional quantities may be necessary in order to conduct treatability studies at an appropriate scale.

The existing rule has a provision for case-by-case approval of additional quantities. 40 CFR 261.4(e)(3). As discussed further below, EPA is modifying the variance provision to allow advance approval, on a case-by-case basis, of conducting studies on additional quantities of contaminated media. Due to the potential for delay in processing case-by-case applications, laboratory and testing facilities should carefully consider the tradeoffs in seeking advance approval of additional quantities.

2. Scope of the Exemption

All comments supported the basic proposal to increase the quantity limits for soil and debris. In response to EPA's solicitation of comment on increasing the scope of the revision beyond soil and debris, a substantial majority of the comments recommended extending the quantity increases to various other forms of hazardous waste. Comments differed on the exact scope beyond soil and debris—e.g., all hazardous waste, 'remediation waste', wastewater and/or groundwater.

Reasons suggested for increasing the scope beyond soil and debris included the difficulty of determining the boundary between sludge and media in, for example, unlined lagoons; the low concentration of contaminants in groundwater; the need for longer-duration continuous flow tests; and the need to develop integrated, optimized remediation approaches in the case of 'remediation waste' in general. A number of commenters also suggested extending the increases to all forms of hazardous waste, which would include newly-generated industrial hazardous wastes.

In response to these comments, and in light of EPA's own experience regarding the variety of contaminated media encountered in cleanup efforts, EPA is at this time modifying the scope of the exemption to reach contaminated media, including groundwater, surface water, soils, sediment and debris that contain listed hazardous waste or that themselves exhibit a characteristic. However, the proposal did not focus on samples of newly-generated waste or waste sludges, and the Agency is not taking final action of those materials at this time. EPA is considering additional rulemaking to address larger scale treatability studies on other forms of hazardous waste.[1]

3. Time Limits for Sample Retention

As discussed above, EPA proposed to allow up to two years for treatability studies involving bioremediation. EPA solicited comment on whether these time frames were sufficient, and whether testing involving other technologies also required longer time frames. No negative comments were received on this proposal. Comments included suggestions that the allowable time period be even longer and/or that additional technologies (e.g., phytoremediation and solidification/stabilization) be eligible for longer duration studies.

With regard to the time limits, EPA believes that two years should be adequate for most treatability testing involving bioremediation.[2] Nevertheless, as discussed below, EPA is modifying the case-by-case variance provisions to allow up to an additional

[1] As noted by several commenters, sludges will have often become commingled with underlying media, and present difficulty for those attempting to collect media samples for shipment. EPA agrees that it may be difficult to distinguish sludges from underlying media. Where uncontainerized sludges have come into contact with underlying media, EPA does not expect sample collectors to undertake extraordinary efforts to assure that samples consist only of contaminated media.

[2] As a point of clarification, for purposes of this rule, EPA considers phytoremediation to be a form of bioremediation.

two years for completion of such studies.

EPA expects that this provision will be used judiciously. Laboratory and testing facilities cannot exceed the limits in the rule on the amount of material which may be stored and treated. (e.g., 10,000 kg of media contaminated with non-acute hazardous waste plus 5000 kg if a full variance quantity request is granted). On-going studies reduce the quantity of materials which may be stored for use in new studies.

With regard to stabilization/solidification, EPA's experience in the Superfund Innovative Technology Evaluation (S.I.T.E.) program indicates that a one-year time frame is generally adequate. Modifications discussed below which allow retaining small samples of treated materials should address some of the concerns underlying suggestions for allowing longer duration studies for this technology (e.g., to ensure the long-term efficacy of the stabilization).

Several comments addressed the desirability of retaining samples of treated material for future analysis. EPA understands that such a provision may be useful for technologies such as solidification/stabilization where the attributes of treated material such as compressive strength and leachability of contaminants may change over time, or solvent extraction where there may be issues of the long-term biodegradability of residual solvent in treated soil.

In response to these comments, EPA is promulgating a provision allowing up to 500 kg of treated material from a particular wastestream from treatability studies to be stored by the laboratory or testing facility for up to 5 years. Material archived for future analysis must be included in the storage quantity limit for the facility—e.g., a facility which archives two 500 kg samples from separate waste streams may only store up to 9,000 kg (plus 5000 kg if a variance is granted) of additional material, and must be identified as such in facility records and reports.

4. Variances for Requesting Additional Quantities and Extended Time Limits

Several commenters suggested that the variance provisions in the existing rule (40 CFR 261.4(e)(3)) be increased by the same factor applied to the base quantity allowed. For example, under the existing rule laboratories or testing facilities could request approval for further testing on up to an additional 500 kg from a particular wastestream. Comments included raising the variance limit for contaminated media by the same amount as the basic proposal. The variance provisions allow additional quantities of materials to be used in treatability studies on a case-by-case basis if specified conditions are met—e.g., mechanical failure during the initial treatability study or need to verify the results of a previously conducted study. As with the comments relating to quantity limits in general, commenters suggested across-the-board and case-by-case approaches to variances.

EPA finds the suggestion to allow increased quantities of contaminated media to a set maximum on a case-by-case basis to be reasonable. EPA is modifying the variance quantity by the same factor by which it is increasing the basic quantity limit.

Thus, laboratory and testing facilities may request up to an additional 5000 kg of media contaminated with non-acute hazardous waste, or 2500 kg of media contaminated with acute hazardous waste. The Agency considers this to be a conforming change to the general concept of allowing larger quantity studies, and views it as a logical outgrowth of the proposed rule.

Furthermore, as discussed above, in response to comments that quantities beyond those proposed be allowed on a case-by-case basis, EPA is also adding a provision that will allow laboratory and testing facilities to apply for advance authorization for variances. Factors to be considered in reviewing advance requests for additional quantities include the nature of the technology, the type of process (e.g., batch versus continuous), size of the unit undergoing testing (particularly in relation to scale-up considerations), time/quantity of material required to reach steady-state operating conditions, and test design considerations such as mass balance calculations.

Finally, the case-by-case variance provision has been modified to allow laboratory and testing facilities conducting bioremediation treatability studies to request a variance of up to two additional years to complete their studies.

5. Treatability Studies at Federal Facilities

Several comments requested clarification of the status of federal facilities for purposes of eligibility for the treatability study sample exclusion. Federal facilities are often large in size, with numerous different contamination problems for which solutions must be developed and applied. EPA notes that the rule identifies "laboratory or test facilities" as the entities which may take advantage of the conditional exclusion. The Agency would not consider a large federal installation with numerous laboratories or testing sites to be a single "laboratory or test facility" for purposes of this rule. Distinguishing attributes include the requirement to obtain an EPA Identification number for each laboratory or test facility. 40 CFR 261.4(f)(2).

6. Promulgation/State Adoption

Comments on State Authorities are addressed below in the "State Authority" section.

III. State Authority

A number of comments indicated that the efficacy of this rule depends to a considerable extent on the availability of the exclusion at the State level. Since the original treatability sample exclusion rule was promulgated under RCRA and not the Hazardous and Solid Waste Act Amendments of 1984 (HSWA), this revision is also promulgated pursuant to RCRA. As with the existing rule, the revisions promulgated today are not immediately effective in authorized States, since this rulemaking does not impose requirements or prohibitions contained in HSWA. Thus this regulation will be applicable only in those States that do not have final authorization for the non-HSWA base RCRA program.

In a State authorized to implement the base RCRA program, the proposed regulation would not be applicable until the State revises its program to adopt equivalent regulations under State law. However, as with the original rule these proposed changes are less stringent or reduce the scope of the Federal program. Therefore, although EPA strongly encourages timely adoption, authorized States are not required to modify their programs to adopt regulations consistent with and equivalent to this rulemaking. The Agency plans to work with States to encourage timely adoption of this rule because of its benefits to the development of treatment capacity.

IV. Effective Date

This rule is effective immediately upon publication. HSWA amended section 3010 of RCRA to allow rules to become effective in less than 6 months when the regulated community does not need the 6-month period to come into compliance. This is the case here, because this rule reduces the existing requirements for laboratories and test facilities conducting treatability studies on contaminated media. An effective date 6 months after publication would impose unnecessary expense and regulatory burden upon those persons the rule is designed to benefit, and

might delay the achievement of the rule's objective of improving CERCLA response activities and RCRA corrective actions by facilitating treatability studies. These reasons also provide a basis for making this rule effective immediately upon final promulgation under the Administrative Procedures Act, 5 U.S.C. 553(d).

V. Regulatory Analyses

A. Executive Order 12866

OMB has determined that this rule is not a significant rule within the meaning of Executive Order 12866.

B. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.*, whenever an Agency is required to publish general notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the impact of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions).

The purpose of the original rule was to eliminate time-consuming and costly permitting requirements. This revision extends the scope of activities which may be conducted without requirements to obtain permits, and will thus have additional positive effects on small entities.

This amendment will have no adverse economic impact on small entities. In fact, it should reduce the burden imposed on small entities that conduct treatability studies and comply with the provisions of this rulemaking. Accordingly, I hereby certify that this rule will not have a significant economic impact on a substantial number of small entities. This regulation therefore does not require a regulatory flexibility analysis.

C. Paperwork Reduction Act

This rule does not contain any new information collection requirements subject to OMB review under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.*

To the extent that this rule discusses information collection requirements imposed under existing regulations, these requirements have been approved by the Office of Management and Budget (OMB) under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.*, and have been assigned OMB control number 2050–0053.

List of Subjects in 40 CFR Part 261

Hazardous waste, Recycling.

Dated: February 9, 1994.

Carol M. Browner,

Administrator.

For the reasons set out in the preamble, title 40 of the Code of Federal Regulations is amended to read as follows:

PART 261—IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

1. The authority citation for part 261 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921, 6922, and 6938.

2. Section 261.4 is amended by revising paragraphs (e)(2)(i) and (e)(2)(ii), (e)(3), (f)(3), (f)(4), and (f)(5) to read as follows:

§ 261.4 Exclusions.

* * * * *

(e) * * *

(2) * * *

(i) The generator or sample collector uses (in "treatability studies") no more than 10,000 kg of media contaminated with non-acute hazardous waste, 1000 kg of non-acute hazardous waste other than contaminated media, 1 kg of acute hazardous waste, 2500 kg of media contaminated with acute hazardous waste for each process being evaluated for each generated waste stream; and

(ii) The mass of each sample shipment does not exceed 10,000 kg; the 10,000 kg quantity may be all media contaminated with non-acute hazardous waste, or may include 2500 kg of media contaminated with acute hazardous waste, 1000 kg of hazardous waste, and 1 kg of acute hazardous waste; and

* * * * *

(3) The Regional Administrator may grant requests on a case-by-case basis for up to an additional two years for treatability studies involving bioremediation. The Regional Administrator may grant requests on a case-by-case basis for quantity limits in excess of those specified in paragraphs (e)(2) (i) and (ii) and (f)(4) of this section, for up to an additional 5000 kg of media contaminated with non-acute hazardous waste, 500 kg of non-acute hazardous waste, 2500 kg of media contaminated with acute hazardous waste and 1 kg of acute hazardous waste:

(i) In response to requests for authorization to ship, store and conduct treatabilty studies on additional quantities in advance of commencing treatability studies. Factors to be considered in reviewing such requests include the nature of the technology, the type of process (e.g., batch versus continuous), size of the unit undergoing testing (particularly in relation to scale-up considerations), the time/quantity of material required to reach steady state operating conditions, or test design considerations such as mass balance calculations.

(ii) In response to requests for authorization to ship, store and conduct treatability studies on additional quantities after initiation or completion of initial treatability studies, when: There has been an equipment or mechanical failure during the conduct of a treatability study; there is a need to verify the results of a previously conducted treatability study; there is a need to study and analyze alternative techniques within a previously evaluated treatment process; or there is a need to do further evaluation of an ongoing treatability study to determine final specifications for treatment.

(iii) The additional quantities and timeframes allowed in paragraph (e)(3) (i) and (ii) of this section are subject to all the provisions in paragraphs (e) (1) and (e)(2) (iii) through (vi) of this section. The generator or sample collector must apply to the Regional Administrator in the Region where the sample is collected and provide in writing the following information:

(A) The reason why the generator or sample collector requires additional time or quantity of sample for treatability study evaluation and the additional time or quantity needed,

(B) Documentation accounting for all samples of hazardous waste from the waste stream which have been sent for or undergone treatability studies including the date each previous sample from the waste stream was shipped, the quantity of each previous shipment, the laboratory or testing facility to which it was shipped, what treatability study processes were conducted on each sample shipped, and the available results on each treatability study;

(C) A description of the technical modifications or change in specifications which will be evaluated and the expected results;

(D) If such further study is being required due to equipment or mechanical failure, the applicant must include information regarding the reason for the failure or breakdown and also include what procedures or equipment improvements have been made to protect against further breakdowns; and

(E) Such other information that the Regional Administrator considers necessary.

(f) * * *

(3) No more than a total of 10,000 kg of "as received" media contaminated with non-acute hazardous waste, 2500

kg of media contaminated with acute hazardous waste or 250 kg of other "as received" hazardous waste is subject to initiation of treatment in all treatability studies in any single day. "As received" waste refers to the waste as received in the shipment from the generator or sample collector.

(4) The quantity of "as received" hazardous waste stored at the facility for the purpose of evaluation in treatability studies does not exceed 10,000 kg, the total of which can include 10,000 kg of media contaminated with non-acute hazardous waste, 2500 kg of media contaminated with acute hazardous waste, 1000 kg of non-acute hazardous wastes other than contaminated media, and 1 kg of acute hazardous waste. This quantity limitation does not include treatment materials (including nonhazardous solid waste) added to "as received" hazardous waste.

(5) No more than 90 days have elapsed since the treatability study for the sample was completed, or no more than one year (two years for treatability studies involving bioremediation) have elapsed since the generator or sample collector shipped the sample to the laboratory or testing facility, whichever date first occurs. Up to 500 kg of treated material from a particular waste stream from treatability studies may be archived for future evaluation up to five years from the date of initial receipt. Quantities of materials archived are counted against the total storage limit for the facility.

* * * * *

[FR Doc. 94-3745 Filed 2-17-94; 8:45 am]
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9441.1992(30)

United States Environmental Protection Agency
Washington, D.C. 20460
Office of Solid Waste and Emergency Response

September 9, 1992

Joseph S. Paulick
Department of the Army
Tooele Army Depot
Tooele, Utah 84074-5000

Dear Mr. Paulick:

This responds to your letter of November 12, 1991 requesting clarification of the federal Resource Conservation and Recovery Act regulations concerning notification for treatability studies. You ask whether, under 40 CFR 261.4(fl(1), the owner/operator of a facility is required to submit a one-time notification to the Regional Administrator (or State Director if located in an authorized state) no less than 45 days before beginning to conduct treatability studies, or to submit a notification 45 days before conducting each individual treatability study.

To provide some context for the answer to your question, the general intent of this provision is to ensure that the U.S. EPA Regional Office (or state agency) is aware that a facility is conducting treatability studies. More specific information about the individual treatability studies is obtained through the other reporting requirements found in 261.4(f).

More specifically, 261.4(f)(1) requires only that the owner/operator of a facility submit a one-time notification indicating that treatability studies will be conducted at the facility under the provisions of 261.4(f). 261.4(f)(11) then requires that the owner/operator again notify the Regional Administrator (or State Director) when he or she is no longer planning to conduct treatability studies at the locality (see footnote 1).

In addition, there are several other reporting requirements for facilities conducting treatability studies found in 261.4(f). First, records must be maintained for three years demonstrating compliance with the treatment rate limits and the storage time and quantity limits (261.4(f)(7)). Second, copies of treatability study contracts and treatability sample shipping papers must be maintained for three years (261.4(f)(8)). Finally, annual reports must be submitted to the Regional Administrator (or State Director) by March 15 of each year including detailed information about treatability studies conducted the previous year, and estimates of the number of treatability studies to be conducted and the amount of waste to be used in these studies during the current year (261.4(f)(9)).

Please note, however, that state agencies generally implement the RCRA program within each state (although some parts of the program may be implemented by the U.S. EPA Regional Office), and that state regulations may be different (although no less stringent) than the federal regulations. Thus, you should contact

the appropriate state environmental agency or U.S. EPA Regional Office to determine how the regulations of that particular state will apply to any treatability studies you are planning.

Thank you for your interest in the safe and effective management of hazardous waste.

Sincerely,
David Brussard
Director, Characterization and Assessment Branch

1 If treatability studies were later to be resumed at the facility after notifying of the cessation of such studies under 261.4(f)(11), the facility would again be required to notify of the intent to conduct treatability studies 45 days before conducting any studies under 261.4(f)(1).

9432.1991(01)

United States Environmental Protection Agency
Washington, D.C. 20460
Office of Solid Waste and Emergency Response

September 27, 1991

Robert H. Scarberry
Chemical Waste Management
1155 Connecticut Avenue, N.W.
Suite 800
Washington, D.C. 20036

Dear Bob:

In your letter of July 9, 1991, you request clarification of the RCRA definition of "designated facility" with respect to the treatability study exclusion, which was published on July 19, 1988 (53 FR 27290). You also ask the Agency to reconsider whether this exclusion is a HSWA requirement.

On January 23, 1990, EPA clarified the definition of "designated facility" (see 55 FR 2342). This amendment to the definition in 260.10 clarifies that EPA's regulations allow waste shipments from a state where a waste is subject to the hazardous waste regulations as a result of a listing determination to a facility in a state where the waste is not yet regulated as hazardous. In this situation, the designated facility might not need to be permitted or under interim status, provided that the receiving facility is allowed by the receiving state to accept such waste.

In your letter, you describe a situation similar to the one addressed in the January, 1990 clarification notice, regarding "the transportation and management of treatability study samples. In your example, a treatability sample is transported from a state which regulates the treatability sample as a hazardous waste (because it does not have the exclusion), to a state that has adopted the exclusion, and therefore does not regulate the sample as a hazardous waste. You ask whether the hazardous waste manifest, which is required in the originating state, can specify a treatability study facility as the "designated facility" even though it does not have a permit or interim status. Furthermore the

facilities which perform the treatability studies in some cases do not have permits or interim status.

As an initial matter, you should be aware that the interpretation of the definition of "designated facility" in an authorized state is a matter of state law. An authorized state may interpret the provisions of this regulation in a more stringent manner. Therefore, any interpretation of the term expressed in this letter reflects only EPA's interpretation of the definition of "designated facility" and should be confirmed with the appropriate state agency in the authorized state.

The primary reason for the January 23, 1990 amendments was to state clearly that EPA interprets the manifest requirement and the designated facility definition as not prohibiting the shipment of hazardous wastes from states where the waste is hazardous to authorized states where the wastes is not hazardous. The clarifying amendment to the definition of "designated facility" was to address one specific scenario to which this interpretation applies. By adding the clarifying language regarding newly listed wastes, EPA did not intend to preclude the interstate waste shipment of wastes in similar situations. EPA believes that the shipment of treatability samples is directly analogous to the shipment of newly regulated wastes. In both cases, protection of human health and the environment is somewhat assured by the threat of potential future liability for the generator and the receiving facility arising out of management of the wastes and by federal and state standards that apply to the receiving facility. EPA noted that Subtitle D standards would apply to facilities receiving newly listed wastes; facilities conducting treatability studies would have to comply with 261.4(f). Finally, it is plainly apparent that this interpretation is consistent with the purposes of the treatability exemption. If you choose to follow this interpretation, the generator should arrange for the designated facility owner or operator to sign and return the manifest to the generator, and for out of state transporters to sign and forward the manifest to the designated facility. Although the receiving state may not require the completion of the manifest loop, the originating state would likely require the return of the manifest.

You suggest that an alternative approach to address the interstate shipment problem would be to determine that the treatability study exclusion is a HSWA provision. In the course of the rulemaking, the Agency determined that the exclusion was not a "requirement or prohibition" pursuant to HSWA. We believe that any reexamination of this matter would result in the sane conclusion. Furthermore, a HSWA designation would not be a panacea for the transportation of samples since even a HSWA exclusion would not supersede an existing, more stringent state requirement, and therefore would have no practical effect in states where the treatability exclusion has not yet been adopted.

If you have any further questions regarding this clarification of the term "designated facility," please call Wayne Roepe of my staff at (202) 260-2245.

Sincerely,
Sylvia K. Lowrance
Director
Office of Solid Waste

federal register

Tuesday
July 19, 1988

Part IV

Environmental Protection Agency

40 CFR Parts 260 and 261

Identification and Listing of Hazardous Waste Treatability Studies Sample Exemptions; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 260 and 261

[SWH-FRL-3350-4]

Identification and Listing of Hazardous Waste Treatability Studies Sample Exemption

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: On September 18, 1987, the Environmental Protection Agency (EPA) published a Notice of Data Availability, which requested comment on whether the sample exclusion provision should be expanded to include waste samples used in small-scale treatability studies. The sample exclusion provision exempts from regulation under Subtitle C of the Resource Conservation and Recovery Act (RCRA) waste samples collected solely for the purpose of monitoring or testing to determine their characteristics or composition. The Notice also presented information and requested comment concerning the appropriate limitations that could be imposed if the sample exclusion were expanded.

As a result of comments received, EPA is today issuing a final rule that conditionally exempts waste samples used in small-scale treatability studies from Subtitle C regulation. Consequently, generators of the waste samples and owners or operators of laboratories or testing facilities conducting such treatability studies will be exempt from the Subtitle C hazardous waste regulations, including the permitting requirements, when certain conditions are met.

DATE: This regulation becomes effective on July 19, 1988.

ADDRESSES: The OSW Docket is located in the sub-basement at the following address and is open from 9 a.m. to 4 p.m., Monday through Friday, excluding Federal holidays: EPA RCRA Docket (sub-basement), 401 M Street, SW., Washington, DC 20460.

The public must make an appointment (to review docket materials) by calling (202) 475-9327. Refer to Docket number F-88-TSSE-FFFFF when making appointments to review any background documentation for this rulemaking. Copies cost $0.15 per page. Copies of the background document entitled "Summary and EPA Responses to Public Comments on the September 18, 1987 Notice of Data Availability and Request for Comment, and the September 25, 1981 Interim Final Rule" are available for viewing in the OSW Docket Room. For Further documentation and information, see Docket Number F-87-TSEF-FFFFF.

FOR FURTHER INFORMATION CONTACT: The RCRA/Superfund Hotline toll free at (800) 424-9346 in Washington, DC, or at (202) 382-3000. For technical information contact Mike Petruska, Office of Solid Waste (WH-562B), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (202) 475-9888.

SUPPLEMENTARY INFORMATION:

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I. Background

On September 25, 1981 (see 46 FR 47428), EPA issued an interim final rule that conditionally exempted from the Subtitle C hazardous waste regulations any waste samples collected solely for the purpose of monitoring or testing to determine their characteristics or composition. These regulations include the generator and transporter requirements of Parts 262 and 263 and the treatment, storage, and permitting requirements of Parts 264, 265, and 270. In particular, the regulations exempt waste samples from the Subtitle C requirements when: (1) The sample is being transported to the laboratory for testing or is being transported back to the sample collector after the testing; (2) the sample is being stored by the sample collector or laboratory before testing or after testing prior to its return to the generator; (3) the sample is being analyzed to determine its characteristics or composition; or (4) the sample is being stored at the laboratory for a specific purpose such as a court case or enforcement action. However, samples subject to the exemption must still comply with U.S. Department of Transportation (DOT), U.S. Postal Service (USPS), or other applicable shipping requirements. The sample must be packaged so that it does not leak, spill, or vaporize from its packaging.

The Agency granted this exclusion because of the *de minimis* public health and environmental risks involved. In particular, the Agency found that certain incentives already existed that would assure protection of human health and the environment without requiring these samples to be subject to the full set of Resource Conservation and Recovery Act (RCRA) hazardous waste regulations. These incentives include (1) the costs associated with sample collection, shipping, analysis, and storage; (2) the generator's need to obtain results of analyses to determine if and how they must comply with the RCRA hazardous waste requirements; and (3) the considerable likelihood that a testing laboratory would return the sample to the generator as part of a contractual agreement (partly based on the generator's desire to protect proprietary information and partly based on the testing laboratory's desire to avoid the costs of disposal), reducing the concern that the sample would be indiscriminately disposed. The preamble stated that the exclusion did not cover large-size samples that are used in treatability or other testing at pilot scale or experimental facilities. However, the preamble did not specify whether the exclusion applied to small- or bench-scale treatability studies at laboratories or other testing facilities. Today's final rule directly addresses this issue.

The preamble of the 1981 interim final rule also stated that the Agency had considered and rejected a quantity limit for the samples subject to the exclusion. Its basis for this was that the available information indicated that the size of samples shipped for characterization or analytical purposes usually did not exceed 1 gallon. Therefore, the Agency saw no need to set a specific quantity limit. However, the preamble also stated that EPA would consider imposing a

limit on sample size if comments or experience indicated that such a limit was necessary (46 FR 47427).

While the comments received on the 1981 interim final rule generally supported the exclusion for samples shipped for waste characterization, a large percentage of commenters also recommended that the sample exclusion provision be expanded to include waste samples used in treatability studies, including large-size samples used in pilot-scale units or at experimental facilities.

Furthermore, on June 2, 1987, the Hazardous Waste Treatment Council (HWTC) submitted a rulemaking petition requesting that the Agency promulgate regulations to provide limited exemptions from the permitting requirements of RCRA to facilities conducting treatability studies. The petition proposed a three-part solution: (1) Expand the sample exclusion provision to allow treatability tests to be conditionally exempted from regulation; (2) expand the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) permits exclusion at 40 CFR 300.68(a)(3) to include off-site treatability testing when performed at the direction of an EPA or State on-scene coordinator to implement a response consistent with CERCLA section 121; and (3) issue interim guidance to implement, at least in part, the suggested changes described in (1) and (2) above (*i.e.*, interpret the existing sample exclusion in 40 CFR 261.4(d) to include treatability studies, and issue interim guidance to on-scene coordinators regarding off-site treatability studies). The petition proposed several limitations for small-scale treatability studies. The petition also recommended regulatory changes that would allow large-scale treatability studies to be conducted provided that the facility complies with the manifesting requirements and certain interim status standards. (See section II.C., Limitations, discussed below.)

The petition asserted that immediate regulatory relief was needed because the present RCRA Subtitle C permitting requirements unnecessarily interfere with the experimentation and research necessary to evaluate the various treatment options for CERCLA cleanup activities. HWTC further argued that these same problems will have a similar effect on RCRA corrective action. Agency experience with the Superfund Innovative Technology Evaluation (SITE) program and CERCLA cleanup actions support the HWTC's assertion.

Based on these factors (*i.e.*, comments on the sample exclusion interim final rule, the HWTC petition, and EPA's own experience), EPA published a Notice of Data Availability and Request for Comment on September 18, 1987 (50 FR 35279). The Notice reopened the comment period on the earlier interim final rule and specifically asked whether EPA should expand the sample exclusion provision in 40 CFR 261.4(d) to include waste samples used in small-scale treatability studies. The Notice also presented information and requested comment concerning the appropriate limitations that could be imposed if the sample exclusion provision were expanded.

Almost all commenters to the notice recommended that the Agency expand the sample exclusion provision to include waste samples used in small-scale treatability studies. The commenters generally agreed that the Agency could promulgate such an exclusion and allow meaningful studies to be conducted because of the *de minimis* risk to human health and the environment. However, a number of commenters argued that the limitations discussed in the Notice were overly stringent and suggested that higher limitations be allowed.

Based on the Agency's own experience and the comments received, EPA is today issuing a final rule that conditionally exempts waste samples used in small-scale treatability studies from regulation under Subtitle C of RCRA. The Agency will address the second part of HWTC's petition concerning larger scale studies at a later date. The remainder of the preamble discusses the major comments received on the Notice of Data Availability and EPA's response to them. All other comments, both from the Notice of Data Availability and to the original interim final rule, are discussed in a background document that is available in the docket to this rulemaking. (See EPA RCRA docket address in preceding section.)

II. Discussion of Major Issues

A. Introduction

A total of 40 comments were received in response to the Notice of Data Availability. The commenters in general agreed with HWTC that the Agency should expand the sample exclusion provision to apply to waste samples used in small-scale treatability studies. However, there was a wide range of opinion as to the scope of activities that should be allowed under the exemption and the appropriate limitations that the Agency should impose. Before discussing these, however, it is appropriate to discuss the need and rationale for today's rulemaking.

1. *Need and Rationale for Today's Rulemaking*

In the Agency's experience, permitting requirements for offsite treatability studies have resulted in delays in evaluating remediation alternatives for both CERCLA site clean-ups and the RCRA corrective action program. Additionally, the current and upcoming Land Disposal Restrictions Program is another factor arguing strongly for a need to develop alternative treatment technologies.

The overriding objective of Congress in the 1984 RCRA Amendments—to reduce land disposal of hazardous wastes—has already resulted both in heavy demands for existing treatment technologies and in increased urgency for developing new and better treatment methods as an alternative to the land disposal of hazardous waste. In addition, developing techniques to minimize the generation of hazardous waste, and to promote recycling and reuse of waste, are all important Agency goals and Congressional mandates. EPA is committed to facilitating research and development activities that will help meet these objectives.

The Agency believes the current regulatory framework that sets forth RCRA permitting requirements for Subtitle C facilities is unnecessarily stringent for regulating certain activities, *e.g.*, small-scale treatability studies. As noted above, comments in 1981 suggested a need to extend the sample exclusion provision to treatability studies because of the low risk and the large benefits of conducting these studies if RCRA permits were not required.

The HWTC petition summarizes this position on behalf of many facilities that conduct treatability studies as part of their research activities. In addition, HWTC stressed that the development of new treatment capacity, needed to meet the demands placed on industry as the land disposal restrictions take effect, is not facilitated by the current regulations. The potential lack of treatment capacity, using either new or improved existing technologies, means that EPA may have to issue additional variances to the land disposal restrictions, posing an increased threat of ground water and surface water contamination.

Maintaining unnecessary regulatory barriers to conducting treatability studies is, therefore, contrary to the Agency's implementation of the mandated land disposal restrictions. Furthermore, these regulatory barriers send the wrong message to the regulated

community. The Agency intends to promote, not defeat, research and development in support of the national objectives to reduce land disposal of hazardous wastes and to increase reliance on waste minimization and treatment technologies that reduce risk to human health and the environment. However, the Agency remains pledged to carry out its primary statutory obligation to ensure that removing regulatory barriers does not result in unwarranted or increased risks to human health and the environment. The Agency has determined that this balance can be properly maintained in promulgating a RCRA exemption for small scale treatability studies.

2. *Determination of De Minimis Risk*

Since Congress passed RCRA in 1976, the Agency has developed and implemented a "cradle to grave" program to protect human health and the environment from the improper management of hazardous wastes. A principal purpose of the RCRA hazardous waste regulations is to ensure that hazardous wastes are safely transported to facilities properly designed and operated to manage these wastes in a manner that will minimize the threat to human health and the environment. Hazardous waste generators, transporters, and owners and operators of treatment, storage, and disposal facilities (TSDFs) each have specific responsibilities for properly managing those wastes defined as hazardous.

The Agency believes that it can exempt hazardous waste that is used in small-scale treatability studies from the RCRA hazardous waste regulations because a number of factors will combine to ensure that the risks to human health and the environment are *de minimis*. These factors include: (1) A limitation on the size of the sample that is exempted; (2) the high cost of collecting and shipping the sample; (3) a limitation on the quantity of waste that can be shipped at any one time; (4) the applicability of the Department of Transportation (DOT), U.S. Postal Service (USPS), or other regulations governing the transportation of hazardous materials; (5) a limitation on the amount of hazardous waste that can be stored at a laboratory or testing facility; (6) a limitation on the amount of hazardous waste that may be processed (*i.e.*, tested in a treatability unit) in any one day; (7) the prohibitive costs involved in conducting legitimate treatability studies as an alternative to commercial treatment and disposal; (8) a limitation on the time that a waste sample used in a treatability study or any residues generated from such studies may remain at the laboratory or testing facility without being subject to the hazardous waste regulations; (9) the RCRA requirement that any unused sample and residues from a treatability study must still be managed as a hazardous waste (if, in fact, it is still hazardous); and (10) certain reporting and recordkeeping requirements that will enable the Agency to conduct inspections and bring enforcement actions against persons who abuse this exemption. In addition, regulations and requirements administered by other Federal agencies such as the Occupational Safety and Health Administration (OSHA) also ensure proper management.

The Agency believes that all the above factors contribute to an argument for *de minimis* risk. Some factors, such as the sample size, shipment size, transportation standards, and storage limitations, directly relate to the *de minimis* risk in each phase of the treatability study process. Other factors such as the recordkeeping and reporting requirements and the one-time 1000 kg per waste stream limitation ensure that treatment and disposal of hazardous waste do not occur under the guise of conducting treatability studies.

More specifically, under the conditional exemption being promulgated today, the generator or sample collector may not ship more than one of the following in any single shipment: (1) 1000 kg of non-acute hazardous waste; (2) 1 kg of acute hazardous waste (see 40 CFR 261.33(e)); or (3) 250 kg of acute hazardous waste that is contained in contaminated soils, water, or some other contaminated medium. Since the shipments remain subject to DOT, USPS, or other applicable shipping regulations, they must be packaged and labeled in the same manner as other shipments of hazardous materials. One difference is that these waste samples will not require a manifest. EPA believes that a manifest is not required in this situation, since the generator is spending large sums of money to obtain the results of a treatability study. Thus, it is highly unlikely that the sample would be indiscriminately disposed. Furthermore, the generator or sample collector is likely to have a contractual arrangement with the laboratory or testing facility conducting the treatability study either to have the facility return any unused sample and/or any residues that are generated from the treatability study for subsequent manifesting and shipment to a designated facility (see 40 CFR 260.10) or recycling facility or to have the laboratory or testing facility directly manifest and ship the wastes to an appropriate designated facility within specified time limits. Unless the context otherwise requires, the use of this term in today's preamble and rule does not imply that the facility is required to be permitted or to have interim status. The generator must also maintain copies of the shipping papers and the contract with the testing facility for a period ending 3 years from the completion date of the study.

The operator of a vehicle transporting waste samples is still required to comply with the applicable DOT requirements, including notification of the National Response Center in the event of a hazardous material spill of more than a reportable quantity and initiation of cleanup measures in accordance with 49 CFR 171.15.

Owners and operators of a laboratory or testing facility conducting such treatability studies must comply with the limitations regarding shipment, storage, treatment rate, and disposition of unused sample and residues after completion of the studies. The overall limitations on storage and treatment rates, discussed later in today's preamble, are sufficiently restrictive to compel a laboratory or testing facility to carefully coordinate the size and timing of treatability sample shipments. The owners and operators of these laboratories or testing facilities must also comply with applicable regulations promulgated by OSHA.

Further business and financial incentives compelling a laboratory or testing facility to properly handle these samples include the cost-intensive nature of conducting treatability studies, the need to provide the client with documented test results, the desire of the laboratory or testing facility to maintain its corporate reputation, and the desire to avoid any liability. After the treatability study is completed, the owners or operators of a laboratory or testing facility must either return the unused sample and residues to the generator or manifest and ship them to a RCRA designated facility (if the material is a RCRA hazardous waste) within the time limitations specified. A laboratory or testing facility not operating within these limitations must comply with the appropriate RCRA requirements.

Finally, the Agency is stipulating recordkeeping and reporting requirements that will document compliance with the limitations and will allow the Agency to take enforcement action against persons who attempt to abuse the exemption. The specific reporting and recordkeeping

requirements are discussed later in today's preamble.

B. Scope of the Exemption

1. Definition of Treatability Study

In the Notice of Data Availability, the Agency included a definition of "treatability study" similar to that proposed by HWTC. According to this definition, a treatability study is one in which a relatively small amount of hazardous waste is subjected to a known treatment process to determine the following: (1) Whether the waste is amenable to a treatment process; (2) what pretreatment (if any) is required; (3) the optimal process conditions needed to achieve the desired treatment; (4) the efficiency of the treatment process; or (5) the characteristics and volume of residuals from a particular treatment process. (See 52 *FR* 35280.)

The commenters generally agreed with the definition of treatability study. However, many commenters expressed concern that the use of the term "known treatment process" was overly restrictive and might hinder the development of innovative technologies. Thus, these commenters recommended that the word "known" be deleted from the definition in the final rule. HWTC's proposed regulatory language did not include a restriction to "known" technologies.

The Agency agrees with these commenters. As stated earlier, it is important to promote the development of treatment technologies that will reduce the land disposal of hazardous waste and increase the reliance on waste minimization and treatment technologies that reduce risk to human health and the environment. In so doing, EPA does not want to restrict industry to the technologies that are already established or "known"; rather, it wants to promote the development of innovative technologies. Therefore, the Agency has modified the definition of "treatability study" accordingly. At the same time, it is concerned that the treatability study sample exemption may be improperly used as a means to avoid regulation when regulation is warranted. To prevent this, EPA has included specific language in the definition of treatability study to guard against such abuse. This language makes it clear that the exemption is for the evaluation of a treatment process and is not to be used for commercial treatment or disposal of hazardous waste. Furthermore, the Agency emphasizes that the definition of treatability studies covered under the exemption does not apply where the practice could result in a significant uncontrolled release of hazardous constituents to the environment. It would, therefore, include neither open burning nor any type of treatment involving placement of a hazardous waste on the land (*e.g.*, in situ stabilization).

Several commenters also suggested that the Agency list, in the rule, the types of treatment studies to be included in the final definition. Although the Agency can see some merit in this suggestion, it has decided not to incorporate a specific list into the regulations. EPA believes that such a list could hinder the development of innovative technologies. For example, if it included a list in the rule, the Agency would be required to go through rulemaking before new or innovative treatment technologies would get the benefit of the treatability exemption. As previously discussed, the Agency believes that as long as the limitations imposed in today's rule are met, any treatability study will pose a *de minimis* risk. Examples of the types of treatability studies included in the exemption are physical/chemical/biological treatment, thermal treatment (incineration, pyrolysis, oxidation, combustion) solidification, sludge dewatering, volume reduction, toxicity reduction, and recycling feasibility.

2. Inclusion of Liner Compatibility and Other Studies

In the Notice of Data Availability, the Agency solicited comment as to whether the exemption should include other waste testing studies, such as liner compatibility studies. Many commenters agreed that the exemption should be expanded to include other types of studies. The commenters argued that, in addition to liner compatibility studies, the exemption should also include studies of corrosion, toxicological and health effects, and other material compatibility studies (*e.g.* pumps and personal protective equipment). While such studies are not strictly treatability studies under the proposed definition, the commenters argued that waste testing is necessary to develop improved hazardous waste management technologies.

The Agency agrees with the commenters that such studies, although not strictly treatability studies, are necessary for the further development of hazardous waste management technologies. Furthermore, the Agency believes that such studies can be conducted using small quantities of hazardous waste under laboratory conditions. Also, these types of studies are subject to the same financial and business incentives for safe handling as are treatability studies. Therefore, with the imposition of the limitations in this final rule, these studies will involve only *de minimis* risk and need not be subject to RCRA permitting regulations. The Agency is, therefore, allowing the following types of studies to be conducted and exempted under the hazardous waste regulations: liner compatibility studies, corrosion studies, toxicological and health effects studies, and other material compatibility studies (*e.g.*, relating to leachate collection systems, geotextile materials, other land disposal unit requirements, pumps and personal protective equipment).

3. Effects on Exporters of Hazardous Waste

EPA, in today's rule, is exempting samples sent for treatability studies from Subtitle C requirements. These include the requirement to notify EPA prior to export of hazardous waste (40 CFR 262.50 *et seq.*). At the time export requirements were promulgated, EPA discussed in the preamble its rationale for allowing the export, without notification, of wastes exempt from manifesting requirements (51 FR 28664, August 8, 1986). In this discussion on export notification requirements, EPA specifically focussed on the sample exemption in 40 CFR 261.4(d).

The rule promulgated today expands the scope of this exemption as contemplated in 1986. For the same reasons discussed in the August 8, 1986, rule relating to § 261.4(d) samples (51 FR 28664 *et seq.*), exporters of treatability study samples who comply with the limitations of today's rule are also exempt from the export notification requirements of Subpart E of Part 262.

While the Agency is exempting these treatability study samples from the export notification requirements at this time, the Agency is revisiting the question as to whether it should exclude unmanifested waste from the export notification requirements and may modify its position in the future.

C. Limitations

In the Notice of Data Availability, the Agency requested specific comment on what types of limitations should be placed on the exemption if it were to be expanded to include treatability studies. In addition, EPA specifically requested comment on the limitations suggested by the HWTC in its petition. The HWTC suggested quantity limits for shipping, storage, and treatment of hazardous waste samples for the purpose of conducting a treatability study. In particular, the Notice suggested the following limits: (1) No shipment may

exceed 250 kg; (2) no more than 1000 kg of exempted waste (including residues derived from the treatability study) may be present at the laboratory or testing facility conducting the treatability study at any one time; and (3) no more than 250 kg of exempted waste may be introduced into the treatability study in any one day.

A wide range of opinions concerned appropriate limitations that would provide for meaningful treatability studies. While most commenters believed that the limitations they suggested were necessary to conduct treatability studies, no commenters provided data indicating that their suggested limits were protective of human health and the environment. The following indicates the range of quantity limits proposed by commenters for shipment, treatment, and storage:

Shipment:
- mean quantity: 554 kg
- standard deviation: 794 kg
- range: 250 to 4000 kg
- most frequently cited suggestion: 250 kg

Treatment:
- mean: 448 kg
- standard deviation: 417 kg
- range: 250 to 2000 kg
- most frequently cited suggestion: 250 kg

Storage:
- mean: 2000 kg
- standard deviation: 2285 kg
- range: 250 to 10,000 kg
- most frequently cited suggestion: 1000 kg

Many commenters were supportive of the limitations suggested by HWTC in its petition. However, some commenters argued that the limitations suggested in the notice were not sufficient; although these commenters provided no data suggesting that their limits were protective of human health and the environment, they maintained that larger quantities of waste sample were necessary to conduct treatability studies. In particular, some commenters argued that the storage limitations were unnecessarily restrictive. Additionally, some commenters urged that a higher treatability study limit was necessary as some of the treatability tests required quantities of waste in excess of 1000 kg. Finally, some commenters recommended that the Agency include a mechanism for approval of case-by-case variances from the HWTC quantity limitations or the quantity limitations ultimately chosen.

Nevertheless, all commenters generally agreed that suitable limitations combined with economic forces would prevent the exemption from becoming a means to circumvent the RCRA Subtitle C regulations for treatment and disposal of hazardous waste. Additionally, many commenters noted that it would not be economically feasible for a person to perform an endless series of tests, since treatability study costs are much higher than commercial treatment or disposal costs on a per pound basis. In particular, Shirco (TSEF-001) stated that most treatability tests had unit costs greatly in excess of costs associated with treatment and disposal options. Shirco cited an example where treatability study costs were about $1,000 per pound versus $0.80 to $1.20 per pound for disposal at a commercial facility. Numerous other commenters stated that the high costs associated with performing treatability studies would render invalid any concern the Agency had that the exemption could become a "loophole" in the RCRA Subtitle C regulations.

The Agency believes that the limitations established in this exemption will ensure that it does not become a "loophole" and will ensure *de minimis* risk so that no significant threat to human health and the environment will occur. The following sections discuss the limits selected by the Agency and present the rationale for the limitations adopted.

1. Quantity Limits per Waste Stream per Treatment Process

In response to the Notice of Data Availability, several commenters recommended that limits should be set for each generated waste stream to guard against the possibility that generators and facilities might conduct a plethora of treatability studies in lieu of hazardous waste treatment or disposal. While data was provided that would suggest this would not happen, the Agency has decided that some limitations should be imposed as an extra precaution. Thus, to avoid the potential for such an abuse, the Agency has first made it clear in the definition of "treatability study" that the exemption is for the evaluation of a treatment process and is not to be utilized as a commercial treatment option. In addition, the Agency has placed limits on the amount of waste that can be subject to a treatability study evaluation per generated waste stream. Thus, the rule provides for an exemption of 1000 kg of non-acute hazardous waste per waste stream per treatment process; 1 kg of acute hazardous waste per waste stream per treatment process; or 250 kg of soils, water, or debris contaminated by acute hazardous waste per waste stream per treatment process. The Agency, in making this decision, realizes that a generator may need to evaluate alternative treatment processes for a particular waste stream. EPA believes that the limits set will be adequate to allow sufficient studies to be conducted. Furthermore, the quantity limits are consistent with other limits discussed elsewhere in today's preamble.

The Agency is broadly defining "waste stream" such that a waste stream and the quantity limit are not based on the EPA waste code alone; rather, the Agency will interpret and apply the quantity limit for each medium or physical form in which the waste appears. The Agency believes that this broad interpretation is necessary since each medium (*i.e.*, soils, water, or debris) might require a different treatability study and may need to be shipped to a different laboratory or testing facility for such studies to be conducted. The Agency is also broadly defining "treatment process" to allow a generator to evaluate various alternative approaches. For example, a generator could send 1000 kg of non-acute hazardous waste, or 1 kg of acute hazardous waste, or 250 kg of soils, water, or debris contaminated with acute hazardous waste for each generated waste stream to a number of different processes: biological treatment, incineration, fixation, etc. As allowed by this exemption, the generator or sample collector would be limited to a total of 1000 kg of nonacute hazardous waste of a particular waste stream to investigate alternative fixation processes (or, as applicable, 250 kg of soils, water, or debris contaminated with acute hazardous waste, or 1 kg of acute hazardous waste). The Agency has selected the above limits recognizing that in some instances there may be a need to evaluate alternative treatment processes. Finally, the Agency has decided not to put any limits on the number of treatability studies that a laboratory or testing facility can perform per year. However, if this proves to be a problem, the Agency may consider additional regulations.

As noted above, some commenters suggested that higher quantity limits are necessary in order to evaluate certain treatability study processes or that additional amounts of waste may be necessary in instances where unforeseen circumstances have affected the results of all or part of a treatability study evaluation. They suggested that case-by-case allowances in excess of the amounts specified above should be made available if need can be demonstrated. The Agency agrees that some flexibility should be made

available to allow studies to be completed properly. However, the Agency wishes to ensure that adequate controls are placed on all such evaluations to protect human health and the environment. Accordingly, the Agency has included a provision that allows the Regional Administrator to grant requests for waste stream quantity limits in excess of those specified above, up to an additional 500 kg of non-acute hazardous waste, 1 kg of acute hazardous waste, and 250 kg of soils, water, and debris contaminated with acute hazardous waste. The Regional Administrator shall only allow additional quantities of hazardous waste when it can be demonstrated that one of the following circumstances or situations exist: (1) That there has been an equipment or mechanical failure and that additional waste is needed to conduct a study; (2) that there is a need to verify the results of a previously evaluated treatment process; (3) that there is a need to study and analyze alternative techniques within a previously evaluated treatment process; or (4) that there is a need to do further evaluation of an ongoing treatability study to determine final specifications for treatment. These adjustments may be authorized only if the 1000 kg (or 250 kg for soils, water, or debris contaminated with acute hazardous waste, or 1 kg for acute hazardous waste) quantity limit per waste stream per treatment process has been subjected to a treatability study evaluation and insufficient data are available to properly design a treatment process. When authorizing additional quantities, the Regional Administrator will only authorize adjustments for the minimum quantity necessary to complete the treatability study evaluation. The Agency believes that most treatability studies can be completed utilizing an extra 250 kg of sample or less, and only in unusual circumstances will quantities greater than 250 kg be required.

Generators and/or sample collectors seeking such an authorization for additional quantities must furnish sufficient information to the Regional Administrators to verify that they have met the conditions allowing for quantity adjustments. Generators and/or sample collectors will be required to submit, in writing, the specific reason why an additional quantity of sample for the treatability study evaluation is necessary (*i.e.*, one of the four situations described above). He or she shall also provide: (1) Verification of the additional quantity necessary; (2) documentation accounting for all samples of hazardous waste from the waste stream which have previously been sent for treatability study evaluation; (3) a description of the technical modifications or change in specifications which will be evaluated and the expected results; and, (4) if further study is being required due to equipment or mechanical failure, the generator and/or sample collector must include information from the laboratory or testing facility indicating what handling procedures or equipment improvements have been made to protect against further breakdowns.

The Regional Administrator may perform or require additional analyses and investigations as are necessary to determine the minimal amount of additional waste necessary to conduct the study and yield the additional data necessary to properly design and/or evaluate the performance of the treatment process.

2. Transportation Shipment Limits—Generator and Facility

The HWTC, in its petition, suggested that shipments of waste samples weighing less than 250 kg (approximately one standard 55-gallon drum) should be exempted when such samples are being shipped for the purpose of conducting treatability studies. The petition also recognized that larger size samples might be necessary for conducting treatability studies on contaminated soils or water; hence, the HWTC recommended that a provision for exempting larger size samples should be available. A number of commenters indicated that the 250-kg shipment limit was too restrictive and suggested that the limit be increased to 1000 kg. These commenters argued that the risk associated with shipping a larger amount (*e.g.*, 1000 kg) is no greater than that associated with four shipments of 250 kg each when one considers the potential for transportation accidents.

After careful consideration of all the issues, the Agency has decided to set a single shipment limitation of 1000 kg of non-acute hazardous waste; 1 kg of acute hazardous waste; or 250 kg of soils, water, or debris contaminated with acute hazardous waste. These shipment limitations (which, in effect, govern the exemption from the RCRA hazardous waste transporter regulations and manifesting requirements) will apply to the shipment of waste samples from the generator or sample collector to the laboratory or testing facility when such samples are being sent for the purpose of conducting a treatability study. The exemption will also apply when unused waste samples and residues generated by the treatability study are returned to the generator or sample collector following completion of the study.

The Agency is setting this limit to be consistent with the quantity limits set on generators for the amount of waste that can be subject to the treatability study sample exemption as discussed in the previous section. The Agency agrees with commenters that the risk associated with shipping the maximum limit of 1000 kg is no greater than that associated with four shipments of 250 kg each. However, it also believes these levels will pose *de minimis* risk.

In addition, as already discussed, the Agency believes other factors exist that will ensure safe delivery of the waste samples to and from the laboratory or testing facility. For example, the waste samples will still be subject to the applicable DOT or USPS regulations regarding shipment of hazardous materials. If the shipments do not fall under DOT or USPS jurisdiction, the generator or sample collector and the laboratory or testing facility must follow the requirements for labeling and packaging as set forth by EPA in this amendment. The requirements state that a sample must be packaged so that it does not leak, spill, or vaporize from its packaging. In addition, the following information must accompany the sample: (1) The sample collector's name, address, telephone number, and EPA identification number; (2) the laboratory or testing facility's name, mailing address, telephone number, and EPA identification number; (3) the quantity of the sample; (4) the date of shipment; and (5) a description of the sample. Finally, the Agency believes that most shipments will be considerably smaller than the limit, since other forces, such as storage limits and treatment rates at the laboratory or testing facility, will require careful control of the amount of waste shipped to the laboratory or testing facility. The costs to conduct the study and to collect, pack, and ship the sample will tend to limit the sample size to the smallest amount practicable.

3. Treatment Rate Limit

The HWTC, in its petition, suggested that the treatment rate limit should be 250 kg per day per laboratory or testing facility. Many of the commenters agreed; however, others argued that the limit should be larger and that it should be based on either the number of treatment units or the number of treatment processes that the laboratory or testing facility was capable of conducting. For example, if a facility was capable of conducting several soil fixation studies or biological treatment studies at one

time, then the limit should be 250 kg per process. Other commenters argued for even higher limits, indicating that it should be 250 kg per unit.

After reviewing the available information and considering the comments, the Agency has adopted a treatment rate limit of 250 kg per day of "as received" waste for the entire laboratory or testing facility. The term "as received" has been chosen by the Agency because some of the treatment processes involve the addition of non-waste material to reduce the environmental mobility of hazardous constituents. "As received" refers to the waste shipped by the generator or sample collector as it arrives at the laboratory or testing facility. Based on the information provided by the HWTC, information submitted by other commenters in response to the Notice of Data Availability, and EPA's own experience, the Agency believes that most treatability studies can be conducted at or below the treatment rate limit of 250 kg per day.

The Agency believes this level will allow many wastes to be treated and evaluated as part of a treatability study, while posing only a *de minimis* risk to human health and the environment. For example, if a laboratory or testing facility were to conduct a treatability study on a waste using bench-scale incineration and the study achieved a 99% destruction removal efficiency, only a small amount of toxic material would be released into the environment. In most instances, the amount released is much lower than any level of concern. In addition, since in most cases these studies will be conducted on an intermittent basis, there is less concern with repeated exposure.

Laboratories or testing facilities that are conducting treatability studies and that meet the treatment rate limit are exempted from the requirements to obtain a Subtitle C treatment permit. The Agency wants to emphasize that the purpose of the exemption is for conducting treatability studies, not for the commercial management of hazardous waste. The Agency believes that facilities anticipating the need to conduct an excessively large number of studies, or those having numerous treatment units allowing them to conduct many studies concurrently, will probably need to obtain a Research, Development, and Demonstration permit (40 CFR 270.65). It should also be noted that the Agency recently promulgated a new set of permitting standards under Subpart X of Part 264 (52 FR 46946, December 10, 1987) for miscellaneous hazardous waste management units. The Agency is also considering developing regulations under Subpart Y that would establish permitting standards for experimental facilities conducting research and development on the storage, treatment, or disposal of hazardous waste.

4. Storage Limits

The HWTC, in its petition, recommended that a facility be allowed to store 1000 kg of hazardous waste on site without a storage permit, as long as such waste is for the purpose of conducting treatability studies. HWTC argued that this amount is essentially equal to the small quantity generator (SQG) limits and that the 1000 kg of waste included all waste (both received waste and treated residue). Many commenters argued that the 1000-kg storage limit would not allow them sufficient inventory to conduct certain treatability studies or argued that the storage limit should be based on the number of units present at the facility.

After evaluating this issue, the Agency has decided to adopt a storage limitation of 1000 kg per laboratory or testing facility. However, the Agency has also decided to specify the 1000-kg storage limitation for "as received waste. The 1000-kg storage limitation per laboratory or testing facility can include 500 kg of soils, water, or debris contaminated with acute hazardous waste or 1 kg of acute hazardous waste. The Agency is making it clear in this rule that the storage exemption only applies to laboratories or testing facilities conducting treatability studies. The quantity limitations allow sufficient inventory to conduct small-scale treatability studies while ensuring *de minimis* risk to human health and the environment. Higher storage limits would not give us this same assurance. Also the Agency notes, as discussed previously, financial and business incentives are present that help to ensure *de minimis* risk levels are maintained.

The Agency limits for soils, water, and other debris contaminated with acute hazardous waste were selected to allow small-scale treatability studies to be conducted on media contaminated with dioxin wastes and certain pesticides such as aldrin and aldicarb. Although the 500-kg storage limit is higher than that currently established for SQGs, the Agency believes that the 500-kg limit will still be protective of human health and the environment and pose *de minimis* risk, since in most instances the sample will only be stored for a short period of time prior to being utilized in a study. Furthermore, this category is limited to materials in which the acute hazardous waste involves a contaminant in a medium such as water or soil. Therefore, EPA would expect the concentration of the acute hazardous waste to be very low. Furthermore, the contaminant may be bound to the medium itself. For other acute hazardous wastes (*i.e.*, the actual listed waste), the Agency has adopted a 1-kg limit consistent with the SQG regulations.

5. Residues and Unused Samples-Time Limitations

Although the Notice of Data Availability did not propose any time limitations for completion of a treatability study, some commenters strongly recommended that appropriate time limits be placed on the storage of the "as received" waste samples and the residues generated from the treatability study. Suggestions on appropriate time limits varied widely. However, the commenters generally indicated that 1 year provides ample time to complete most treatability studies.

The Agency is in agreement with commenters that specific time limits for completing treatability studies are necessary. Time limitations are necessary to guard against potential abuses such as use of a laboratory or testing facility for long-term storage to avoid treatment and disposal. Any untreated sample and any residue generated during the treatability study must be returned to the generator within 90 days of study completion or within 1 year from the date of shipment by the generator to the laboratory or testing facility, whichever is earlier. Otherwise, these materials must be managed, by the laboratory or testing facility conducting the treatability study, as a RCRA hazardous waste (unless the waste is no longer hazardous). These time limits provide the laboratory or testing facility conducting the treatability study enough time to do the evaluation, but at the same time do not allow persons to store these wastes indefinitely. The 1-year time limit proved to be noncontroversial when adopted in other areas. For example, the 1-year time limit is consistent with the speculative accumulation provision and the closed-loop tank provision. Under these provisions, persons or facilities holding materials have 1 year to accumulate them before they are potentially subject to regulation.

Laboratories or testing facilities that do not return the unused sample or the residues to the generator or sample collector within the specified time limits are subject to appropriate regulation. Facilities must determine if they meet

the SQG requirements of § 261.5 or the accumulation requirements of § 262.34, and they may need to obtain a storage permit and comply with its conditions. Once samples and residues are returned to the generator, they are no longer exempt under today's rule. Ultimately, the unused sample and residues that are still hazardous must be manifested and disposed of in a RCRA-designated facility by the laboratory or testing facility, the waste generator, or sample collector.

6. Mobile Treatment Units

Although the issue of mobile treatment units (MTUs) was not addressed in the Notice of Data Availability and Request for Comment, concern was expressed over how this exemption applies to MTUs. EPA has determined that MTUs conducting treatability studies may qualify for this exemption. However, each MTU or group of MTUs operating at the same location is subject to the treatment rate, storage, and time limitations and the notification, recordkeeping, and reporting requirements that are applicable to stationary laboratories or testing facilities conducting treatability studies. That is, a group of MTUs operating at one location will be treated as one MTU facility for purposes of § 261.4 (e) and (f). Furthermore, these requirements apply to each location where an MTU will conduct treatability studies.

D. Reporting and Recordkeeping Requirements

Although the Notice of Data Availability did not specifically recommend that reporting and recordkeeping provisions be adopted, some commenters suggested that some form of reporting and recordkeeping should be required in the treatability study exemption. They argued that, without some form of reporting or recordkeeping requirements, EPA would not have a means of determining who is violating the exemption or the amount of waste subjected to treatability studies.

The Agency strongly agrees with the commenters and believes that reporting and recordkeeping requirements are necessary to facilitate inspector review and, if necessary, to assist in enforcement action. In fact, 40 CFR 216.2(f) already requires that persons who claim that their waste is conditionally exempt from regulation must provide appropriate documentation that they meet the conditions of the exemption. Therefore, the Agency is stipulating specific reporting and recordkeeping requirements that will document compliance with the quantity and time limitations set forth in this rulemaking. The reporting and recordkeeping requirements stipulated below are the minimum requirements necessary to ensure compliance with the limitations in the treatability sample exemption.

1. The generator of the sample (who may also be the shipper or sample collector) and the laboratory or testing facility conducting the treatability study must keep the following records for 3 years after the completion of the study:

a. A copy of the contract (between the generator and the laboratory or testing facility) to conduct the treatability study;

b. Copies of all shipping documents. (If the waste was shipped to an MTU, copies of the shipping papers must be kept with the unit for inspector review.)

2. Generators and sample collectors must also maintain records indicating the following: (1) The amount of waste (per waste stream and treatment process) shipped under the exemption; (2) to whom the shipment was sent (name, address, and EPA identification number of the laboratory or testing facility conducting the study); (3) the date shipment was made; and (4) whether or not any unused sample or any residue generated from the treatability study was returned. In addition, beginning in 1989, generators must report this information in their biennial reports.

3. In addition, laboratories or testing facilities conducting or intending to conduct treatability studies must accomplish the following:

a. Send a letter to the EPA Regional Administrator or the authorized State informing the Agency that the laboratory or testing facility intends to conduct small-scale treatability studies. This letter must be received no less than 45 days before the facility begins conducting treatability studies. The letter should indicate the address and EPA identification number of the laboratory or testing facility conducting studies and the types of treatability studies anticipated. Owners and operators of facilities that do not have an EPA identification number must obtain one before conducting any treatability studies under this exemption. This reporting requirement and the requirement to obtain an EPA identification number apply to owners and operators of MTUs at every treatability study location (except at CERCLA sites where, under CERCLA section 121(e)(1) and 40 CFR 300.68(a)(3), RCRA permits are not required).

b. Maintain appropriate records and documentation for a period of 3 years following completion of each treatability study that show compliance with the appropriate quantity and time limitations addressed in the final rule. The records must indicate that the laboratory or testing facility is meeting the requirements for shipment limits, treatment rate limits, and storage limits. Specific minimum information, by treatability study, that must be maintained include the following:

- The name, address, and EPA identification number of the generator or sample collector of the waste samples;
- The date the shipment was received;
- The quantity of waste accepted;
- The quantity of "as received" waste in storage each day;
- The date the treatment study was initiated and the amount of "as received" waste introduced to treatment each day;
- The date the treatability study was concluded; and
- The date the unused sample and residue were returned to the generator or, if sent to a designated facility, the name of the facility and its EPA identification number. As noted above, the laboratory or testing facility must keep copies of all shipping documents associated with transport of the waste to and from the facility.

c. By March 15 of each year, submit a report to the authorized State or Regional Administrator that includes an estimate of the number of studies and the amount of waste expected to be used in treatability studies during the current year and the following information for the previous calendar year:

- The name, address, and EPA identification number of the generator or sample collector of each waste sample;
- The date the shipment was received;
- The quantity of waste accepted;
- The total quantity of "as received" waste in storage each day;
- The date the treatment study was initiated and the amount of "as received" waste introduced to treatment each day;
- The date the treatability study was concluded; and
- The date any unused sample and residues generated from the treatability study were returned to the generator or sample collector or, if sent to a designated facility, the name of the facility and the EPA identification number.

d. Notify the Regional Administrator or authorized State by letter when and if the laboratory or testing facility is no longer planning to conduct any

treatability studies at the site. (For example, when an MTU completes a treatability study at a site, the owners or operators must submit the required notice that they will no longer be conducting treatability studies at that site.)

E. EPA Identification Numbers—Applicability of OSHA Training Requirements

Some commenters suggested that any laboratory or testing facility conducting treatability studies should be required to have an EPA identification number. These commenters argued that such a restriction would ensure that the facility is in compliance with the requirements to have a facility contingency plan, has established emergency procedures, and is in compliance with OSHA's hazardous waste workers' training and medical monitoring requirements. (See 29 CFR 1910.120, 51 FR 45654, December 19, 1986.)

The Agency partially agrees and is requiring any laboratory or testing facility conducting treatability studies to notify the Agency and obtain an EPA identification number if the facility does not already have one. However, as already explained, the Agency believes laboratories or testing facilities conducting treatability studies within the limits specified present a *de minimis* risk. For example, the OSHA hazardous waste operators and emergency response requirements (29 CFR 1910.120) are applicable except for SQGs and facilities complying with the accumulation time requirements of 40 CFR 262.34. Other OSHA requirements, such as the OSHA laboratory standards and general duty clause (29 USC 654(a)(1)), may apply depending on the type of laboratory or testing facility and the nature of its activities. Thus, EPA believes requirements such as contingency plans and emergency procedures are not necessary for the protection of human health and the environment.

F. Incentives for Safe Transport

In the Notice of Data Availability, the Agency specifically requested comment on whether the incentives for safe transport and storage of waste characterization samples would also apply to treatability samples. Most commenters agreed that suitable incentives exist to ensure proper handling and shipping of treatability study samples.

The Agency generally agrees. In particular, a principal purpose of the generator and transporter requirements is to assure that shipments of hazardous wastes are safely delivered to an appropriate destination (*i.e.*, a permitted or interim status hazardous waste management facility). This is accomplished through the requirements for manifesting, recordkeeping, packaging, and labeling of hazardous waste. The principal purpose of the manifest system is to ensure "cradle to grave" accountability for shipments of hazardous waste from the generator to a TSDF.

In the case of treatability study samples, EPA wants to ensure that the samples are delivered to the facility conducting the treatability study, and that both the unused sample and all residues generated in the treatability study are sent back to the generator or sample collector or, alternatively, shipped to a designated facility if the waste remains hazardous.

The Agency believes that sufficient incentives and requirements are in place to provide for the safe shipment of samples to and from laboratories and testing facilities conducting treatability studies. In particular, they include:

1. Maintenance of corporate reputation and public confidence;
2. The high cost of these studies coupled with the generator's or sample collector's need for properly documented results;
3. The need for the generator or sample collector to verify results of a treatability study; and
4. Requirements in today's rule for either returning the unused samples and residues to the generator or sample collector, or for manifesting and shipping these materials to a TSDF for ultimate disposal.

The Agency believes that the above incentives and requirements will guard against any facility not complying with the limitations or conducting bogus treatability studies. Furthermore, DOT or other regulations and guidelines control the transportation of such samples even in the absence of EPA regulation. The requirements to comply with DOT shipping regulations regarding packaging and labeling will be substantially the same as present requirements for shipping hazardous waste. Additionally, the USPS has stringent guidelines governing the shipment of hazardous materials, including samples. (See the "Domestic Mail Manual," Part 124 and Publication 52, "Acceptance of Hazardous or Perishable Articles.") For the above reasons, the Agency believes that the transport of small quantities of hazardous waste poses *de minimis* risk during shipment to a laboratory or testing facility or when being returned to the generator or sample collector.

III. Today's Amendment

The Agency believes that the full complement of the hazardous waste regulations found in 40 CFR, Parts 260 through 268 and 270, when applied to waste samples used in small-scale treatability studies, are more comprehensive than necessary to adequately protect human health and the environment. In addition, the Agency believes that it needs to promote research and the development of innovative technologies to manage hazardous wastes. Therefore, EPA is amending the regulations to conditionally exempt waste samples processed in small-scale treatability studies from the hazardous waste regulations under certain conditions.

In particular, EPA is today adding new paragraphs (e) and (f) to 40 CFR 261.4 which accomplish the following: First, persons who generate samples are exempted from the generator and transporter requirements when samples are shipped by the generator, or any other person who collects the sample (the "sample collector"), to a laboratory or testing facility for the purpose of conducting a treatability analysis, or when shipped from the facility back to the sample collector, provided that certain packaging and labeling requirements are met. Second, any laboratory or testing facility that conducts treatability studies may store these waste samples and residues generated from the treatability study within the quantity and time limits specified and not be subject to the requirements of 40 CFR, Parts 264, 265, and 270. Third, the actual testing of the samples does not require a permit, provided the laboratory or testing facility complies with the limitations specified in today's rule.

Laboratories and testing facilities that conduct treatability studies must also keep records and documents regarding each treatability study as enumerated in II.D.3.6. above. Additionally, today's rule requires facilities conducting treatability studies to submit an annual report to the authorized State or Administrator of the EPA Region in which the laboratory or testing facility is located. The required annual report must be a distinct document prepared by the owner and/or operator of the laboratory or testing facility indicating the previous calendar year's activities regarding treatability studies. The report must be submitted by March 15 of each year and must identify the laboratory or testing facility by name, EPA identification number, and the location (site address) at which the treatability

studies were conducted. Paragraph II.D.3.c. above lists specific information required in the report. The obligation to submit annual reports continues until the laboratory or testing facility discontinues treatability studies, returns all unused "as received" samples and any residues generated in the treatability studies back to the generator or sample collector, and notifies the Regional Administrator or State Director that the laboratory or testing facility no longer plans to conduct any treatability studies at the site.

Paragraph (e), Treatability Study Samples, provides an exemption for generators of samples of hazardous waste to be evaluated in treatability studies, while they are being prepared for transport or being transported, provided that these samples and their residues are returned to the generator within specified time limits. The exemption limits the sample collector or generator from shipping more than 1000 kg per non-acute hazardous waste stream per treatment process (or 250 kg of soils, water, or debris contaminated with acute hazardous waste, or 1 kg of acute hazardous waste). Shipments must comply with the applicable DOT, USPS, or other applicable regulations for shipping hazardous materials.

The generator or sample collector must also maintain records indicating the amount of waste shipped under the exemption, the name and address of the laboratory or testing facility, the facility EPA identification number, type of study, and the expected duration of the study. Beginning in 1989, the generator or sample collector must also include the above information in its biennial report.

Paragraph (f), Samples Undergoing Treatability Studies at Laboratories or Testing Facilities, describes the limitations that apply to a facility conducting treatability studies under this exemption. The facility may subject no more than 250 kg of "as received" waste to treatability studies in any one day. The facility may store a maximum of 1000 kg of "as received" waste, of which 500 kg can be soils, water, or debris contaminated with acute hazardous waste or 1 kg of acute hazardous waste. The facility must also return any unused sample and residues to the generator within 90 days after completion of the study or within 1 year after initial shipment (whichever is earlier), or otherwise manage the sample and residue as a RCRA hazardous waste, if the residue is still hazardous.

The facility must meet certain specified reporting requirements. The facility must provide notification (by letter) to the Regional Administrator or authorized State indicating that the facility intends to conduct treatability studies under the exemption. It must obtain an EPA identification number if it does not have one. The facility must also maintain records documenting compliance with the specified time and quantity limits for treatment and storage and must keep records of all shipping documents for 3 years from the completion of the treatability study.

The owner or operator of a facility conducting treatability studies must also submit a report to the Regional Administrator or authorized State indicating the type and number of treatability studies conducted during the previous calendar year, for whom each study was conducted, the quantity of hazardous waste utilized in each treatability study, when each study was conducted, and the final disposition of residue and any unused sample. The report must include an estimate of the number of treatability studies to be conducted and the quantity of hazardous waste expected to be used in treatability studies during the coming year. The facility must also notify the Regional Administrator or authorized State by letter when and if the facility is no longer planning to conduct any treatability studies at the site.

IV. State Authority

A. Applicability of Rules in Authorized States

Under section 3006 of RCRA, EPA may authorize qualified States to administer and enforce the RCRA program within the State. (See 40 CFR, Part 271 for the standards and requirements for authorization.) Following authorization, EPA retains enforcement authority under sections 3008, 7003, and 3013 of RCRA, although authorized States have primary enforcement responsibility.

Prior to the Hazardous and Solid Waste Amendments of 1984 (HSWA), a State with final authorization administered its hazardous waste program entirely in lieu of EPA administering the Federal program in that State. The Federal requirements no longer applied in the authorized State, and EPA could not issue permits for any facilities in the State that the State was authorized to permit. When new, more stringent Federal requirements were promulgated or enacted, the State was obliged to enact equivalent authority within specified time frames. New Federal requirements did not take effect in an authorized State until the State adopted the requirements as State law.

In contrast, under section 3006(g) of RCRA, 42 U.S.C. 6926(g), new requirements and prohibitions imposed by the HSWA take effect in authorized States at the same time that they take effect in nonauthorized States. EPA is directed to implement those requirements and prohibitions in an authorized State, including the issuance of permits, until the State is granted authorization to do so. While States must still adopt HSWA-related provisions as State law to retain final authorization, HSWA applies in authorized States in the interim.

B. Effect of State Authorizations

Today's announcement promulgates regulations that are not effective under HSWA in authorized States, since this rulemaking does not impose requirements or prohibitions contained in HSWA. Thus, the regulations will be applicable only in those States that do not have final authorization. In an authorized State, the regulations will not be applicable until the State revises its program to adopt equivalent regulations under State law.

40 CFR 271.21(e)(2) requires that States having final authorization must modify their programs to include equivalent regulations within a year of promulgation of these regulations if only regulatory changes are necessary, or within 2 years of promulgation if statutory changes are necessary. These deadlines can be extended in exceptional cases (40 CFR 271.21(e)(3)). Once EPA approves the modification, the State requirements become Subtitle C RCRA requirements.

States with authorized RCRA programs may already have regulations similar to those in today's rule. These State regulations have not been compared with the Federal regulations being promulgated today to determine whether they meet the tests for authorization. Thus, a State is not authorized to implement these regulations in lieu of EPA until the State program modification is submitted to EPA and approved. Of course, States with existing regulations may continue to administer and enforce their regulations as a matter of State law.

Authorized States are only required to modify their programs when EPA promulgates Federal regulations that are more stringent or broader in scope than the authorized State regulations. For those changes that are less stringent or reduce the scope of the Federal program, States are not required to modify their programs. This is a result of section 3009 of RCRA, which allows States to impose more stringent or broader regulations than the Federal program. The regulations promulgated today at

§§ 261.4 (e) and (f) are considered to be less stringent than or reduce the scope of the existing Federal regulations because today's rule exempts certain activities now within the purview of RCRA. Therefore, authorized States are not required to modify their programs to adopt regulations consistent with and equivalent to this rulemaking.

Even though States are not required to adopt today's rulemaking, EPA strongly encourages States to do so as quickly as possible. As already explained in this preamble, today's rule is needed to facilitate evaluating remediation alternatives for CERCLA clean-ups and the RCRA Corrective Action Program, and to speed research and development for treatment alternatives to land disposal and waste minimization, recycling, and reuse. States are, therefore, urged to consider the adoption of today's rule; EPA will expedite review of authorized State program revision applications.

States are also encouraged to use existing authorities to provide for comparable treatability exemptions prior to adopting and receiving authorization for today's rule. Some States may have authority comparable to RCRA Section 7003, which allows EPA to order response action in the case of imminent and substantial endangerment to health or the environment "notwithstanding any other provision of this Act." An authorized State may use comparable section 7003-type authority to authorize treatability studies and may waive the generator, transporter, notification, and permit requirements consistent with today's rulemaking.

In addition to, or in lieu of, a section 7003-type authority, a State may have general waiver, permit waiver, or emergency permit authority. Consistent with this rule, states are encouraged to use any such authority to grant treatability exemptions in a manner consistent with today's rule.

V. Effective Date

Section 3010(b) of RCRA provides that EPA's hazardous waste regulations and revisions to those regulations take effect 6 months after promulgation. The purpose of this requirement is to allow facilities that handle hazardous wastes sufficient lead time to prepare for and to comply with major new regulatory requirements. Given the potential of this rule to increase the timeliness of CERCLA remedial clean-up activities, RCRA corrective actions, and compliance with the land disposal restrictions, the Agency believes that an effective date of 6 months after promulgation would unnecessarily disrupt implementation of the regulations and would not be in the public interest. Since this amendment reduces, rather than increases, the existing requirements for facilities that handle waste samples, there is no basis for allowing a lengthy time period to prepare for compliance. The same reasons provide good cause to make this rule effective immediately upon publication notwithstanding section 4(d) of the Administrative Procedure Act, 5 U.S.C. 553(d). Therefore, this amendment takes effect immediately upon publication in the **Federal Register**.

The application of this final rule is prospective only. Any treatability studies covered by this final rule that were conducted before the effective date of this regulation are subject to the Subtitle C hazardous waste regulations, including permitting requirements.

VI. Regulatory Analyses

A. Executive Order No. 12291

Under Executive Order No. 12291, EPA must judge whether a regulation is "major" and therefore subject to the requirement of a Regulatory Impact Analysis. This final regulation is not major because it will not result in an effect on the economy of $100 million or more, and it will not increase costs or prices to industry. Rather, this regulation will reduce the overall costs and economic impact of EPA's hazardous waste management regulations by eliminating permitting requirements for laboratories and testing facilities intending to conduct treatability studies. The Agency estimates that perhaps 400 facilities and laboratories nationwide will be affected by promulgation of this rule. Facilities and laboratories will be spared the time (as much as 2 years) and the costs (estimated to be between $100,000 and $200,000) otherwise necessary to obtain a RCRA permit. In addition, there will be no adverse effect on the ability of U.S.-based enterprises to compete with the non-U.S.-based enterprises in domestic or export markets. Because this amendment is not a major regulation, no Regulatory Impact Analysis has been conducted.

This amendment was submitted to the Office of Management and Budget (OMB) for review as required by Executive Order No. 12291.

B. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.*, whenever an Agency is required to publish general notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the impact of the rule on small entities (*i.e.*, small businesses, small organizations, and small governmental jurisdictions). The Administrator may certify, however, that the rule will not have a significant economic impact on a substantial number of small entities. As noted previously in this preamble, the universe of facilities affected is estimated to total about 400; of these, perhaps 200 are small business entities. By eliminating time-consuming and costly permitting requirements, the Agency anticipates that promulgation of this rule will have a positive effect on small entities.

This amendment will have no adverse economic impact on small entities. In fact, it should reduce the burden imposed on small entities that conduct treatability studies and comply with the provisions of this rulemaking. Accordingly, I hereby certify that this final regulation will not have a significant economic impact on a substantial number of small entities. This regulation therefore does not require a regulatory flexibility analysis.

C. Paperwork Reduction Act

The information collection requirements contained in this rule have been approved by the Office of Management and Budget (OMB) under the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 *et. seq.*, and have been assigned the OMB control number 2050-0088 (Treatability Studies Notification and Recordkeeping).

Public reporting burden for this collection of information is estimated to vary from 90 to 250 hours per response, with an average of 155 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information including suggestions for reducing this burden, to Chief, Information Policy Branch, PM-223, U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

VII. Supporting Documentation

A background document in which EPA responds to any comments not addressed in this preamble, entitled "Summary and EPA Responses to Public Comments on the September 18, 1987 Notice of Data Availability and Request for Comment, and the September 25,

1981 Interim Final Rule," dated June 1988, is available in the RCRA docket at EPA (LG-100), 401 M St., SW., Washington, DC 20460. The docket number for this rulemaking is F-88-TSSE-FFFFFF. The docket is open from 9 a.m. to 4 p.m., Monday through Friday, excluding Federal holidays. The public must make an appointment to review docket materials by calling (202) 475-9327. Copies cost $0.15 per page.

VIII. List of Subjects

40 CFR Part 260

Administrative practice and procedure, Confidential business information, Hazardous waste.

40 CFR Part 261

Hazardous waste, Recycling.

Date: July 11, 1988.

Lee M. Thomas,

Administrator.

For the reasons set out in the preamble, Title 40 of the Code of Federal Regulations is amended as follows:

PART 260—HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL

1. The Authority Citation for Part 260 continues to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921 through 6927, 6930, 6934, 6935, 6937, 6938, 6939 and 6974.

2. Section 260.10 is amended by adding the following definition in alphabetical order:

§ 260.10 Definitions.

* * * * *

"Treatability Study" means a study in which a hazardous waste is subjected to a treatment process to determine: (1) Whether the waste is amenable to the treatment process, (2) what pretreatment (if any) is required, (3) the optimal process conditions needed to achieve the desired treatment, (4) the efficiency of a treatment process for a specific waste or wastes, or (5) the characteristics and volumes of residuals from a particular treatment process. Also included in this definition for the purpose of the § 261.4 (e) and (f) exemptions are liner compatibility, corrosion, and other material compatibility studies and toxicological and health effects studies. A "treatability study" is not a means to commercially treat or dispose of hazardous waste.

* * * * *

PART 261—IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

3. The Authority Citation for Part 261 is revised to read as follows:

Authority: 42 U.S.C. 6905, 6912(a), 6921, 6922, and 6938.

4. Section 261.4 is amended by adding two new paragraphs (e) and (f) to read as follows:

§ 261.4 Exclusions.

* * * * *

(e) *Treatability Study Samples.* (1) Except as provided in paragraph (e)(2) of this section, persons who generate or collect samples for the purpose of conducting treatability studies as defined in section 260.10, are not subject to any requirement of Parts 261 through 263 of this chapter or to the notification requirements of Section 3010 of RCRA, nor are such samples included in the quantity determinations of § 261.5 and § 262.34(d) when:

(i) The sample is being collected and prepared for transportation by the generator or sample collector; or

(ii) The sample is being accumulated or stored by the generator or sample collector prior to transportation to a laboratory or testing facility; or

(iii) The sample is being transported to the laboratory or testing facility for the purpose of conducting a treatability study.

(2) The exemption in paragraph (e)(1) of this section is applicable to samples of hazardous waste being collected and shipped for the purpose of conducting treatability studies provided that:

(i) The generator or sample collector uses (in "treatability studies") no more than 1000 kg of any non-acute hazardous waste, 1 kg of acute hazardous waste, or 250 kg of soils, water, or debris contaminated with acute hazardous waste for each process being evaluated for each generated waste stream; and

(ii) The mass of each sample shipment does not exceed 1000 kg of non-acute hazardous waste, 1 kg of acute hazardous waste, or 250 kg of soils, water, or debris contaminated with acute hazardous waste; and

(iii) The sample must be packaged so that it will not leak, spill, or vaporize from its packaging during shipment and the requirements of paragraph A or B of this subparagraph are met.

(A) The transportation of each sample shipment complies with U.S. Department of Transportation (DOT), U.S. Postal Service (USPS), or any other applicable shipping requirements; or

(B) If the DOT, USPS, or other shipping requirements do not apply to the shipment of the sample, the following information must accompany the sample:

(1) The name, mailing address, and telephone number of the originator of the sample;

(2) The name, address, and telephone number of the facility that will perform the treatability study;

(3) The quantity of the sample;

(4) The date of shipment; and

(5) A description of the sample, including its EPA Hazardous Waste Number.

(iv) The sample is shipped to a laboratory or testing facility which is exempt under § 261.4(f) or has an appropriate RCRA permit or interim status.

(v) The generator or sample collector maintains the following records for a period ending 3 years after completion of the treatability study:

(A) Copies of the shipping documents;

(B) A copy of the contract with the facility conducting the treatability study;

(C) Documentation showing:

(1) The amount of waste shipped under this exemption;

(2) The name, address, and EPA identification number of the laboratory or testing facility that received the waste;

(3) The date the shipment was made; and

(4) Whether or not unused samples and residues were returned to the generator.

(vi) The generator reports the information required under paragraph (e)(v)(C) of this section in its biennial report.

(3) The Regional Administrator, or State Director (if located in an authorized State), may grant requests, on a case-by-case basis, for quantity limits in excess of those specified in paragraph (e)(2)(i) of this section, for up to an additional 500 kg of non-acute hazardous waste, 1 kg of acute hazardous waste, and 250 kg of soils, water, or debris contaminated with acute hazardous waste, to conduct further treatability study evaluation when: There has been an equipment or mechanical failure during the conduct of a treatability study; there is a need to verify the results of a previously conducted treatability study; there is a need to study and analyze alternative techniques within a previously evaluated treatment process; or there is a need to do further evaluation of an ongoing treatability study to determine final specifications for treatment. The additional quantities allowed are subject to all the provisions in paragraphs (e)(1) and (e)(2)(ii)(vi) of this section. The generator or sample collector must apply to the Regional Administrator in the Region where the sample is collected and provide in writing the following information:

(i) The reason why the generator or sample collector requires additional quantity of sample for the treatability study evaluation and the additional quantity needed;

(ii) Documentation accounting for all samples of hazardous waste from the waste stream which have been sent for or undergone treatability studies including the data each previous sample from the waste stream was shipped, the quantity of each previous shipment, the laboratory or testing facility to which it was shipped, what treatability study processes were conducted on each sample shipped, and the available results of each treatability study;

(iii) A description of the technical modifications or change in specifications which will be evaluated and the expected results;

(iv) If such further study is being required due to equipment or mechanical failure, the applicant must include information regarding the reason for the failure or breakdown and also include what procedures or equipment improvements have been made to protect against further breakdowns; and

(v) Such other information that the Regional Administrator considers necessary.

(f) *Samples Undergoing Treatability Studies at Laboratories and Testing Facilities.* Samples undergoing treatability studies and the laboratory or testing facility conducting such treatability studies (to the extent such facilities are not otherwise subject to RCRA requirements) are not subject to any requirement of this Part, Part 124, Parts 262–266, 268, and 270, or to the notification requirements of Section 3010 of RCRA provided that the conditions of paragraphs (f) (1) through (11) of this section are met. A mobile treatment unit (MTU) may qualify as a testing facility subject to paragraphs (f) (1) through (11) of this section. Where a group of MTUs are located at the same site, the limitations specified in (f) (1) through (11) of this section apply to the entire group of MTUs collectively as if the group were one MTU.

(1) No less than 45 days before conducting treatability studies, the facility notifies the Regional Administrator, or State Director (if located in an authorized State), in writing that it intends to conduct treatability studies under this paragraph.

(2) The laboratory or testing facility conducting the treatability study has an EPA identification number.

(3) No more than a total of 250 kg of "as received" hazardous waste is subjected to initiation of treatment in all treatability studies in any single day. "As received" waste refers to the waste as received in the shipment from the generator or sample collector.

(4) The quantity of "as received" hazardous waste stored at the facility for the purpose of evaluation in treatability studies does not exceed 1000 kg, the total of which can include 500 kg of soils, water, or debris contaminated with acute hazardous waste or 1 kg of acute hazardous waste. This quantity limitation does not include:

(i) Treatability study residues; and

(ii) Treatment materials (including nonhazardous solid waste) added to "as received" hazardous waste.

(5) No more than 90 days have elapsed since the treatability study for the sample was completed, or no more than one year has elapsed since the generator or sample collector shipped the sample to the laboratory or testing facility, whichever date first occurs.

(6) The treatability study does not involve the placement of hazardous waste on the land or open burning of hazardous waste.

(7) The facility maintains records for 3 years following completion of each study that show compliance with the treatment rate limits and the storage time and quantity limits. The following specific information must be included for each treatability study conducted:

(i) The name, address, and EPA identification number of the generator or sample collector of each waste sample;

(ii) The date the shipment was received;

(iii) The quantity of waste accepted;

(iv) The quantity of "as received" waste in storage each day;

(v) The date the treatment study was initiated and the amount of "as received" waste introduced to treatment each day;

(vi) The date the treatability study was concluded;

(vii) The date any unused sample or residues generated from the treatability study were returned to the generator or sample collector or, if sent to a designated facility, the name of the facility and the EPA identification number.

(8) The facility keeps, on-site, a copy of the treatability study contract and all shipping papers associated with the transport of treatability study samples to and from the facility for a period ending 3 years from the completion date of each treatability study.

(9) The facility prepares and submits a report to the Regional Administrator, or State Director (if located in an authorized State), by March 15 of each year that estimates the number of studies and the amount of waste expected to be used in treatability studies during the current year, and includes the following information for the previous calendar year:

(i) The name, address, and EPA identification number of the facility conducting the treatability studies;

(ii) The types (by process) of treatability studies conducted;

(iii) The names and addresses of persons for whom studies have been conducted (including their EPA identification numbers);

(iv) The total quantity of waste in storage each day;

(v) The quantity and types of waste subjected to treatability studies;

(vi) When each treatability study w. conducted;

(vii) The final disposition of residues and unused sample from each treatability study.

(10) The facility determines whether any unused sample or residues generated by the treatability study are hazardous waste under § 261.3 and, if so, are subject to Parts 261 through 268, and Part 270 of this Chapter, unless the residues and unused samples are returned to the sample originator under the § 261.4(e) exemption.

(11) The facility notifies the Regional Administrator, or State Director (if located in an authorized State), by letter when the facility is no longer planning to conduct any treatability studies at the site.

(Approved by the Office of Management and Budget under control number 2050-0088)

[FR Doc. 88-16188 Filed 7-18-88; 8:45 am]

BILLING CODE 6560-50-M

Exemption for Ninety Day Accumulation

SQG

federal register

Monday
March 24, 1986

Part II

Environmental Protection Agency

40 CFR Parts 260, 261, 262, 263, 270, and 271

Hazardous Waste: Generators of Hazardous Waste (100 to 1000 Kilograms Per Month), on Site Storage, etc.; Final Rule

40 CFR Part 262

Hazardous Waste: Generators of Hazardous Waste (100 to 1000 Kilograms Per Month), Waste Minimization; Proposed Rule

managed, the Agency has decided to impose manifest requirements on these generators, except in the case of certain reclamation agreements. The existence of a State-approved collection center does not, on its own, provide assurance that the waste would be transported or handled properly prior to or during transportation to such a facility, or indeed, that the shipment would ever reach such a facility. Consequently, development of some recordkeeping and transportation requirements would be needed which would offset any potential savings of such an exemption.

E. Part 264/265 Facility Standard Issues

The requirements for facilities that treat, store, or dispose of hazardous waste are contained in Parts 264 and 265 of the hazardous waste regulations. The Part 265 standards are applicable to facilities under interim status, a condition which allows a facility to continue operating until it receives a full RCRA permit. (See HSWA section 3005(e)). The Part 264 standards establish the minimum standards to be incorporated into a full RCRA permit by EPA or a State with an EPA authorized hazardous waste program.

Section 261.5(b) previously exempted generators of 100–1000 kg/mo of hazardous waste from the facility requirements of Parts 264 and 265 that cover the on-site treatment, storage, or disposal of hazardous waste, provided the facility is at least approved by a State to manage municipal or industrial (non-hazardous) solid waste and no more than 1000 kg of hazardous waste were accumulated at any time. Under the rules promulgated today, this exemption will continue to apply only to generators of less than 100 kg/mo of hazardous waste. Generators of 100–1000 kg/mo of hazardous waste will be subject to full regulation under Parts 264 and 265 if they accumulate hazardous waste on-site for greater than 180 (or 270) days, exceed the 6000 kg accumulation limit, engage in waste treatment in other than tanks, or manage their waste in surface impoundments, waste piles, landfills, or land treatment facilities. In addition, those State-approved municipal or industrial waste facilities that manage wastes only from generators of 100–1000 kg/mo will also no longer be exempted from the Part 264 and 265 permit requirements. In the proposed rule, the Agency requested comments concerning the application of the uniform Part 264 and 265 requirements to generators of 100–1000 kg/mo and to the treatment, storage, and disposal facilities that accept waste from the generators.

1. Activities Requiring Permits

Under today's final rules, 100–1000 kg/mo generators will be required to obtain a permit if they treat or dispose of hazardous waste on-site (except for treatment in tanks or containers during the 180/270 day accumulation period in conformance with Subparts J or I of Part 265, respectively) or accumulate hazardous waste on-site in tanks or containers for more than 180 (or 270) days.

A number of commenters agreed with the need to manage wastes from generators of 100–1000 kg/mo at fully permitted facilities. They argued that no special exemptions or requirements should be applied to the management of waste from these generators because the characteristics of the waste, not the source of the waste, poses the threat to human health and the environment.

Two commenters opposed the requirement for generators of 100–1000 kg/mo who accumulate waste on-site for longer than 180 (or 270) days to obtain RCRA permit, and argued that the accumulation time limit before permitting is required should be extended. One of the commenters also maintained that determining the maximum quantity of hazardous waste that may be accumulated at a non-permitted facility should be based on the degree of hazard posed by the waste and the generator's capacity to transport the waste off-site. The EPA disagrees with both of these positions. As noted in Unit III.C.4.a. of today's preamble, the HSWA of 1984 clearly limit Agency discretion in this matter. The Agency carries a heavy burden in extending the time limits established under section 3001(d)(6), and except for emergency circumstances, the Agency does not believe there to be sufficient justification for extending the limits Congress has established.

Another commenter opposed any permitting requirement due to the economic burden that would be placed on a small number of generators. While some generators of 100–1000 kg/mo may be burdened financially by the requirements promulgated today, Congress has already judged that outside of the accumulation limits allowed for in Section 3001(d)(6), disposal of wastes from these generators at permitted facilities is necessary to protect human health and the environment. In addition, since the rules allow generators to manage their hazardous wastes off-site, they are able to avoid the cost of acquiring a RCRA permit, if they so choose.

Several commenters suggested exemptions from the RCRA permitting requirements or reduced permit requirements for on-site waste treatment. Some commenters stated that there is a need to encourage on-site treatment to reduce the amount of wastes sent off-site and that the permitting requirements may hamper the ability of generators to treat wastes at their facilities.

The Agency disagrees that on-site treatment should be encouraged by exempting those generators of 100–1000 kg/mo from the RCRA permitting requirements. To the extent that these generators are conducting the same treatment/storage or treatment/disposal as other permitted facilities, their on-site treatment activities pose a potential risk to human health and the environment. Therefore, reduced or eliminated permitting requirements would be inappropriate.

Of course, no permitting would be required if a generator chooses to treat their hazardous waste in the generator's accumulation tanks or containers in conformance with the requirements of § 262.34 and Subparts J or I of Part 265. Nothing in § 262.34 precludes a generator from treating waste when it is in an accumulation tank or container covered by that provision. Under the existing Subtitle C system, EPA has established standards for tanks and containers which apply to both the storage and treatment of hazardous waste. These requirements are designed to ensure that the integrity of the tank or container is not breached. Thus, the same standards apply to a tank or a container, regardless of whether treatment or storage is occurring. Since the same standards apply to treatment in tanks as applies to storage in tanks, and since EPA allows for limited on-site storage without the need for a permit or interim status (90 days for over 1000 kg/mo generators and 180/270 days for 100–1000 kg/mo generators), the Agency believes that treatment in accumulation tanks or containers is permissible under the existing rules, provided the tanks or containers are operated strictly in compliance with all applicable standards. Therefore, generators of 100–1000 kg/mo are not required to obtain interim status and a RCRA permit if the only on-site management which they perform is treatment in an accumulation tank or container that is exempt from permitting during periods of accumulation (180 or 270 days).

Two commenters suggested that a mechanism should be created to tailor RCRA permits to the circumstances of individual facilities. For example one commenter specifically asked for a simplified and streamlined permit for the incineration of spent paint spray

Permit Waivers

OSWER POLICY DIRECTIVE #9522.00-2

ONMENTAL PROTECTION AGENCY
GTON, D.C. 20460

16 1987

MEMORANDUM

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

SUBJECT: RCRA Permit Requirements for State Superfund Actions.

FROM: J. Winston Porter
Assistant Administrator

TO: Regional Administrators
Regions I - X

On a number of occasions, the question has been raised as to whether RCRA permits are required for cleanup actions taken by States under State Superfund or other authorities. The answer to this question will depend on whether the State is authorized for the RCRA program and on the details of the State's own statutory and regulatory authority. In general, however, a State authorized to conduct the RCRA base permit program will have the authority to waive RCRA permit requirements for State Superfund actions as long as: (1) the State has the authority under its own statutes or regulations to grant permit waivers, and (2) the State waiver authority is used in no less stringent a manner than allowed under Federal permit waiver authority, for example, §7003 of RCRA or §121(e) of CERCLA.

Some States now authorized to conduct the RCRA program currently have permit waiver authority within their statutes or regulations. For example, some States may have authority comparable to RCRA §7003, which allows EPA to order response action in the case of imminent and substantial endangerment to health or the environment "notwithstanding any other provision of this Act." Assuming the "imminent and substantial" test were met, EPA therefore may require persons contributing to the endangerment to treat, store, or dispose of the hazardous waste without securing a permit. An authorized State that has a §7003-type authority may in the same way use its own authority to compel remedial action at a State Superfund site and may waive RCRA permitting requirements for that action.

Similarly, CERCLA §121(e) grants a RCRA permit waiver for Federal response actions taken under CERCLA §104 (where imminent and substantial endangerment is not always required). A State with its own permit waiver authority, therefore, may waive RCRA

permit requirements for a State Superfund action under similar circumstances. However, the State may exercise this permit waiver only if it does so in a manner no less stringent than allowed under the Federal waiver authority, that is, in a manner consistent with the CERCLA §104 program.

EPA has reviewed and in some cases restricted State permit waiver authority during the RCRA authorization process and, as part of the Memorandum of Agreement with the State, prohibited the State from exercising its waiver authority in a way that would make its program less stringent than the Federal program. This restriction would not prohibit a State from waiving RCRA permit requirements at a Superfund site. As long as the State restricts permit waivers to Superfund site actions and other situations where a comparable Federal waiver exists, the State would be acting within its authorization and within the terms of the Memorandum of Agreement

In general, we believe that States should be encouraged to move ahead on cleanups under their own Superfund authorities, and that it does not make sense to delay action until a RCRA permit can be issued, as long as an appropriate waiver mechanism applies and adequate measures are taken to protect human health and the environment. In these cases, we understand that States may find it desirable to waive RCRA permits for State Superfund site cleanups. When a RCRA authorized State chooses under its own authority to waive RCRA permits for State Superfund actions, EPA Regional Offices should recognize that, under the conditions described above, the State would not be prohibited from doing so, and that such waivers may promote more timely cleanup of contaminated sites.

cc: Regional Counsels, Regions I-X
Waste Management Division Directors, Regions I-X

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

OCT 20 1997

MEMORANDUM

SUBJECT: Transmittal of "Guidance on the Use of Section 7003 of RCRA"

FROM: Steven A. Herman
Assistant Administrator

TO Addressees

Attached is a guidance document developed by the Office of Regulatory Enforcement (ORE) and the Office of Site Remediation Enforcement (OSRE) to update, expand, and supersede the "Guidance on the Use and Issuance of Administrative Orders Under Section 7003 of RCRA" which was issued on September 26, 1984. RCRA § 7003 provides the Agency with broad and effective enforcement tools that can be used to abate conditions that may present an imminent and substantial endangerment to health or the environment. The new guidance addresses the meaning of "imminent and substantial endangerment," the legal requirements for initiating administrative and judicial actions under Section 7003, case screening factors, enforcement against violators of orders issued under Section 7003, and the relationship of Section 7003 to other authorities that allow EPA to address potential endangerments and to respond to the release of materials that may harm health or the environment. In addition to providing legal and policy guidance, the document provides comprehensive practical advice on exercising the Agency's authorities under Section 7003 (for example, by referencing helpful technical documents and explaining when to use administrative versus judicial authorities).

As EPA undertakes its responsibility to protect public health and the environment, the Agency must use its enforcement authorities as efficiently and effectively as possible. The Office of Enforcement and Compliance Assurance therefore encourages the Regions to use Section 7003 and its powerful enforcement tools in all appropriate cases.

For further information, please contact Laura Bulatao in the Office of Site Remediation Enforcement at (202) 564-6028 or Mary Andrews in the Office of Regulatory Enforcement at (202) 564-4011.

Attachment

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Addressees:

Linda Murphy, Director, Office of Site Remediation and Restoration
Region I

Harley F. Laing, Director, Office of Environmental Stewardship
Region I

Richard L. Caspe, Director, Emergency and Remedial Response Division
Region II

Conrad S. Simon, Director, Division of Enforcement and Compliance Assistance
Region II

Thomas C. Voltaggio, Director, Hazardous Waste Management Division
Region III

Richard D. Green, Director, Waste Management Division
Region IV

Norman Niedergang, Director, Waste, Pesticides and Toxics Division
Region V

William Muno, Director, Superfund Division
Region V

Myron O. Knudsen, Director, Superfund Division
Region VI

Samuel Coleman, Director, Compliance Assurance and Enforcement Division
Region VI

William A.J. Spratlin, Director, Air, RCRA and Toxics Division
Region VII

Michael J. Sanderson, Director, Superfund Division
Region VII

Max H. Dodson, Assistant Regional Administrator, Office of Ecosystems
Protection and Remediation, Region VIII

Carol Rushin, Assistant Regional Administrator, Office of Enforcement,
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Julie Anderson, Director, Waste Division
Region IX

Randall F. Smith, Director, Environmental Cleanup Office
Region X

Mike Bussell, Director, Office of Waste and Chemical Management
Region X

Pamela Hill (Acting), Office of Regional Counsel, Region I
Walter Mugdan, Office Regional Counsel, Region II
Marcia E. Mulkey, Office of Regional Counsel, Region III
Phyllis Harris, Office of Regional Counsel, Region IV
Gail C. Ginsberg, Office of Regional Counsel, Region V
Walter L. Sutton (Acting), Office of Regional Counsel, Region VI
Martha R. Steincamp, Office of Regional Counsel, Region VII
Thomas A. Speicher, Office of Regional Counsel, Region VIII
Nancy J. Marvel, Office of Regional Counsel, Region IX
Jackson L. Fox, Office of Regional Counsel, Region X

Exemption from 40 CFR Part 264 Requirements for People Engaged in the Immediate Phase of a Spill Response

View Record Detail

Faxback 13296

9502.1989(03)

United States Environmental Protection Agency
Washington, D.C. 20460
Office of Solid Waste and Emergency Response

June 15, 1989

Ms. Elizabeth M. Powell
Moore & Van Allen
One Hannover Square
Suite 1700
Post Office Box 26507
Raleigh, North Carolina

Dear Ms. Powell:

I am writing in answer to your letter of May 4, 1989, in which you raised several questions concerning the applicability of RCRA to certain situations involving remediation of contamination at a facility. The following response addresses the questions which you have posed:

I. "Is 40 CFR 265.1(c)(11)(iii) applicable to remediation at the facility to require compliance with Part 265 and Parts 122-124, where no treatment, storage, or disposal activities are 'continued or initiated' in such remediation?"

Section 265.1 defines the applicability of "interim status" regulations to facilities which treat, store or dispose of hazardous wastes. Section 265.1(c)(11)(i)) provides an exemption from this requirement for "...a person engaged in treatment or containment activities during immediate response...to (A) A discharge of hazardous waste; (B) An imminent and substantial threat of a discharge of a hazardous waste; or (C) A discharge of a material which, when discharged, becomes a hazardous waste."

This exemption from certain interim status requirements is intended to allow owner/operators to respond to a hazardous waste spill or discharge in a timely manner, without having to comply with procedural and/or technical requirements that could inhibit such response measures, and which may otherwise be inappropriate for such immediate or emergency-type situations. An essentially identical provision is found in the Part 264 regulations (Section 264.1(g)(2)).

An exception to this exemption is found in Section 265.1(c)(11)(iii). This is intended to limit the scope of the exception only to those hazardous waste management activities directly associated with an immediate response to a discharge. (See 53 FR 34085, September 2, 1988). Thus, for example, an owner/operator responding to a discharge might excavate soil contaminated with the spilled hazardous waste and store it temporarily in containers prior to the removal of the material off-site. The container storage area would not be subject to technical interim status standards.

However, if treatment or containment activity were to be continued or initiated after the immediate response is complete, the person performing these activities can no longer take advantage of the Section 265.1(c)(11)(i) exemption and must comply with Part 265 requirements governing treatment, storage, or disposal activities.

It should be understood that Section 265.1(c)(11) applies only to situations involving an immediate response to discharges for hazardous wastes. To the extent that such an immediate response action has not occurred and is not occurring at the facility in question, none of the provisions of this subsection would apply.

II. "Is the presence of soil and groundwater contamination at a facility, standing alone, a sufficient basis upon which a state agency can make a finding that disposal of hazardous waste took place at that facility, thereby resulting in a characterization of that facility as a 'disposal facility' subject to RCRA operational and permitting requirements relevant for TSD facilities?"

II. Past releases of hazardous waste which have occurred any time after November 19, 1980 may constitute "disposal" as defined by RCRA Section 1004. Thus, such releases could constitute a

violation of RCRA (disposal of hazardous waste without a permit under RCRA 3005 or 3006) which could be actionable under RCRA Section 3008(a). Since the situation you described might involve the disposal of hazardous wastes, and since RCRA Section 3005 requires that a person obtain a Subtitle C permit for the treatment, storage, or disposal of hazardous waste, in some cases it may be appropriate to require the owner/operator to obtain a permit for the facility in order to impose Part 264 standards for the disposal unit (i.e., a landfill). Since the facility you describe is no longer an operating facility, the State might decide that a post-closure permit would likely be the appropriate permit mechanism when a permit is required.

III. "Does EPA Office of Solid Waste policy require an entity to prepare, submit and receive approval for a Part B permit and/or post closure permit, where the facility is no longer operational, shows no intention to be operational, and where the present property owner has made clear its intention to voluntarily remediate the soil and groundwater contamination at the property to the specifications of the state agency?"

III. As explained above, the requirement to obtain a RCRA permit for a facility, based on the facts you have presented, is within the authority of EPA or a State, if the State has been authorized for RCRA. The decision as to whether and when this authority may be exercised is at the discretion of the implementing agency; in the case of an authorized State, such decisions would be made according to State program policy.

Finally, it is important to keep in mind that the discussion found in this response contains EPA's interpretations of Federal regulations; authorized States may rely upon State interpretations of State regulatory provisions which may differ from those of the EPA.

I hope that this response has adequately addressed your inquiry. Should you require any further assistance, please contact David Fagan at (202) 382-4497.

Sincerely,
Sylvia K. Lowrance, Director
Office of Solid Waste

Spills

View Record Detail

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View Record Detail

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View Record Detail

FAXBACK 12748

PPC 9471.1986(01)

RESPONSES TO ACCIDENTAL SPILLS OF LISTED OR CHARACTERISTIC HAZARDOUS WASTES

SEP 29 1986

OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE

Mr. Fred Hansen
Director
Department of Environmental Quality
522 S.W. Fifth Avenue, Box 1760
Portland, Oregon 97207

Dear Mr. Hansen:

Thank you for your August 21, 1986, letter regarding accidental spills of listed or characteristic hazardous wastes. Enclosed is the Agency's response to the eight questions and issues that you raised. Please note that we have referred one of your questions to the Superfund Office and will forward a response to you. I hope this clarifies the Environmental Protection Agency's regulation of spills and spill cleanups.

If I can be of further assistance, please let me know.

Sincerely,

Original Document signed

J. Winston Porter
Assistant Administrator

Enclosure

-2-

1. Accidental spills of listed or characteristic hazardous wastes which are cleaned up within a reasonably short time.

The Resource Conservation and Recovery Act (RCRA) regulations in 40 CFR Parts 264 and 265 Subparts C and D require immediate actions to minimize hazards to human health and the environment from any unplanned, sudden or non-sudden releases of hazardous waste or hazardous constituents. Sections 264.1(g)(8) and 265.1(c)(11) provide a regulatory exemption from interim status and permitting standards for treatment and containment activities hazardous waste discharges and imminent and substantial threats of discharges (under 260.10 the term discharge includes both accidental and deliberate spills). The effect of this exemption is to promote hazardous waste discharge prevention and control by relieving persons engaged in immediate response to discharges and serious threats of discharges from time consuming requirements.

Under the exemption, treatment, storage and disposal facilities regulated under RCRA must continue to meet the applicable requirements of Subparts C and D of Parts 264 and 265. Treatment and containment activities conducted after the initial response period are subject to interim status and permitting standards. A facility may qualify for an emergency permit under 270.61 for such treatment and containment activities occuring after the immediate response period.

Accidental spills should be addressed immediately and in accordance with the facility's contingency plan. Sections 264.51 and 265.51 require owner/operators of treatment, storage and disposal facilities to have a contingency plan describing actions facility personnel must take in response to any unplanned sudden or non-sudden releases. Under section 262.34(a)(4), generators are also required to have such contingency plans as a condition of obtaining a permit exemption for 90 day on-site accumulation. Generators are subject to interim status and permitting requirements for treatment and

containment activities conducted after the accumulation period.

2. Accidental spills not cleaned up within reasonably short time.

As stated above, treatment and containment activities conducted after the initial response period are subject to permitting and interim status requirements. In addition, if cleanup activities do not begin promptly, the spill is considered a land disposal site subject to permitting requirements.

The Environmental Protection Agency (EPA) has not established a definition of what constitutes an immediate response to a spill situation. The time frames and extent of immediate response must be judged by persons responding to discharges on an individual basis. Extended responses which are not judged to be immediate in nature may result in: (1) a modification to the facility's contingency plan; (2) an enforcement action for an inadequate contingency
-3-

plan or permit violation; or (3) enforcement action for illegal disposal.

3. Spills where cleanup requires on-site treatment.

As explained in the response to question #1, 264.1(g)(8) and 265.1(c)(11) provide a regulatory exemption from interim status and permitting standards for treatment activities conducted in immediate response to discharges or threats of discharges.

4. Transportation spills cleaned up within a reasonably short time.

263.30 requires the transporter to take appropriate, immediate action to protect human health and the environment. Under 263.30(b), an authorized official may authorize removal of the spill by transporters without an EPA ID number or manifest in an emergency. When an emergency no longer exists, all applicable requirements of the RCRA regulations once again apply to all of the transporter's activities. The Department of Transportation has also issued rules regarding spills occurring during transport.

5. Transportation spills not cleaned up within a reasonably short time.

As discussed above, EPA has not established a definition of

what constitutes an immediate response to a spill situation. The timeframes and extent of immediate response must be judged by persons responding to discharges on an individual basis. Extended responses which are not judged to be immediate in nature may be subject to enforcement action for illegal disposal.

-4-

1. When does a spill become a Superfund candidate versus cleanup under RCRA?

Question has been referred to our Superfund Office for response.

2. When does a spill become a facility as defined in RCRA?

As discussed above, if cleanup activities do not begin promptly, the spill is considered a land disposal site subject to permitting requirements. In addition, spill areas where hazardous waste is treated, disposed or stored past the immediate response phase are subject to all applicable interim status and permitting standards for hazardous waste management facilities receiving waste under 11/19/80 as outlined in Parts 264, 265 and 122.

3. Are there any situations where the cleanup standards are different than background?

RCRA regulations do not specifically identify a level of clean-up required in spill situations. Under 263.31, a transporter must clean up any hazardous waste discharge so that the discharge no longer presents a hazard to human health and the environment. Under the emergency procedures provisions of 264.51 and 265.51, generators, treatment, storage and disposal facilities must take those actions, as outlined in the contingency plan, necessary to minimize hazards to human health and the environment.

hazardous waste, once generated, are safely and properly handled. The Agency requests comments on situations in which the requirements of § 262.34 may be inappropriate and on the manner in which EPA should handle such situations.

IV. Effective Date

Section 3010(b) of RCRA provides that EPA's hazardous waste regulations and revisions thereto take effect six months after their promulgation. The purpose of this requirement is to allow persons handling hazardous wastes sufficient lead time to prepare to comply with major new regulatory requirements. For the amendments to § 262.34 promulgated today, however, the Agency believes that an effective date six months after promulgation would cause substantial and unnecessary disruption in the implementation of the regulations and would be contrary to the interests of the regulated community and the public. The regulatory provision that this amendment modifies takes effect on November 19, 1980. In the absence of the immediate effectuation of this amendment, generators who accumulate wastes for on-site treatment, storage or disposal must prepare to operate these facilities as fully regulated hazardous waste storage facilities on and after November 19, 1980. This would include preparation and submission of a Part A permit application covering the accumulation area.

The Agency believes it makes little sense to allow the requirements promulgated on May 19, 1980, to become effective on November 19, 1980, and then have them substantially modified on a subsequent date, i.e., the six-month effective date for these amendments. Leasing of regulatory requirements is not the type of revision to regulations for which Congress intended a six-month delay occur between its promulgation and effective date. Consequently, the Agency is setting an effective date of November 19, 1980, for the amendment to § 262.34 promulgated in this rulemaking action.

V. Interim Final Promulgation

This regulation is being promulgated in interim final form. The reasons for taking this exceptional procedure are similar to those supporting the immediate effective date. The delay involved in initiating normal rulemaking would cause substantial hardship on generators who treat, store or dispose of their hazardous wastes on-site. During the pendency of rulemaking, these generators would not be able to construct new accumulation areas in their manufacturing facilities without obtaining a RCRA permit. Because such areas are intimately tied to the manufacturing process itself, such a delay might in effect create a prohibition of redesign and reconstruction of these manufacturing units.

Although the Agency does not adopt this procedure lightly, the circumstances indicate that the use of interim final promulgation is appropriate. As one court has noted "[i]t is an appropriate safety valve to be used where delay would do real harm." *U.S. Steel Corp.* v. *EPA*, 595 F.2d 207, 214 (5th Cir., 1979). EPA believes that the effect of delaying promulgation of this amendment would cause substantial, and unnecessary, hardship on a large number of manufacturing operations. In this situation, the use of advance notice and comment procedures would be contrary to the public interest and therefore good cause exists for adopting this amendment in interim final form. See 5 U.S.C. § 553(b)(B).

VII. Request for Comments

The Agency invites comments on all aspects of this amendment to the regulation and on all the issues discussed in this preamble. The Agency has recently requested comments of one aspect of § 262.34, its applicability to product storage tanks. 45 CFR 72024 (October 30, 1980). The Agency will consider all comments received on § 262.34 prior to promulgating this rule in final form. EPA desires to formulate sound and sensible regulations concerning the proper handling of hazardous waste. The requirements of § 262.34 are an important aspect of this broader concern, and, if commenters have suggestions on ways to improve this regulation, the Agency would be receptive to their suggestions.

VIII. Regulatory Impacts

The effect of this amendment is to reduce the overall costs, economic impact and reporting and recordkeeping impacts of EPA's hazardous waste management regulations. This is achieved by removing accumulation areas of generators who send accumulated wastes to on-site disposal facilities from full regulation as storage facilities. The Agency is unable to estimate these cost and impact reductions because it does not have an estimate of the number of such areas that otherwise would be fully regulated. For the reasons already discussed, notwithstanding these cost and impact reductions, the Agency believes that human health and environmental protection will not be reduced by this action.

Dated: November 14, 1980.

Douglas M. Costle,

Administrator.

Title 40 of the Code of Federal Regulations is amended as follows:

§ 262.34 [Amended]

1. In § 262.34, paragraph (a)(1) is revised to read as follows.

(a) A generator may accumulate hazardous waste on-site without a permit or without having interim status, provided that:

(1) All such waste is, within 90 days, shipped off-site to a designated facility or placed in an on-site facility that is permitted under Part 122 of this Chapter, has interim status under Parts 122 of this Chapter, or is authorized to manage hazardous waste by a State with a hazardous waste management program approved under Part 123 of this Chapter.

* * * * *

These amendments are issued under the authority of Sections 1006, 2002(a), 3002, 3003, 3004 and 3005 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 (RCRA), as amended, 42 U.S.C. 6905, 6912(a), 6922, 6923, 6924 and 6925.

[FR Doc. 80-36131 Filed 11-18-80; 8:45 am]

BILLING CODE 6560-30-M

40 CFR Parts 122, 260, 264 and 265

[SWH-FRL 1675-5]

Hazardous Waste Management System

AGENCY: Environmental Protection Agency.

ACTION: Interim final rule and request for comments.

SUMMARY: In regulations promulgated in May of 1980, the Environmental Protection Agency ("EPA") established a comprehensive program for the handling and management of hazardous wastes: 45 FR 33066 (May 19, 1980). The regulations, among other things, set forth substantive requirements for the treatment and storage of hazardous wastes and require owners and operators of treatment and storage facilities to have Resource Conservation and Recovery Act (RCRA) permits or interim status pursuant to Parts 265 and 122 of the regulations. Certain activities which persons may take in response to spills of hazardous wastes or materials which, when spilled, become hazardous waste might be considered treatment (e.g., absorption, neutralization) or storage (e.g., diking, containment). In this action EPA makes clear that the requirements for treatment and storage are not applicable to actions taken to

immediately contain and treat spills of hazardous wastes and materials which, when spilled, become hazardous waste. This action also adds a definition of spill in §§ 260.10 and 122.3.

DATES: Effective date: These amendments become effective on November 19, 1980.

Comment Date: The Agency will accept comments on these amendments until January 19, 1981.

ADDRESS: Comments on these amendments should be addressed to the Docket Clerk (Docket 3004, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460.

FOR FURTHER INFORMATION CONTACT: For general information, contact Amy Mills, Office of Solid Waste (WH-563), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460. For information on implementation, contact:

Region I, Dennis Hueber, Chief, Radiation, Waste Management Branch, John F. Kennedy Building, Boston, Massachusetts 02203, (617) 223-5777

Region II, Dr. Ernest Regna, Chief, Solid Waste Branch, 26 Federal Plaza, New York, New York 10007, (212) 264-0504/5

Region III, Robert L. Allen, Chief, Hazardous Materials Branch, 6th and Walnut Streets, Philadelphia, Pennsylvania 19106, (215) 597-0980

Region IV, James Scarbrough, Chief, Residuals Management Branch, 345 Courtland Street, N.E., Atlanta, Georgia 30365, (404) 881-3016

Region V, Karl J. Klepitsch, Jr., Chief, Waste Management Branch, 230 South Dearborn Street, Chicago, Illinois 60604, (312) 886-6148

Region VI, R. Stan Jorgensen, Acting Chief, Solid Waste Branch, 1201 Elm Street, First International Building, Dallas, Texas 75270, (214) 787-2645

Region VII, Robert L. Morby, Chief, Hazardous Materials Branch, 324 E. 11th Street, Kansas City, Missouri 64106, (816) 347-3307

Region VIII, Lawrence P. Gazda, Chief, Waste Management Branch, 1860 Lincoln Street, Denver, Colorado 80203, (303) 837-2221

Region IX, Arnold R. Den, Chief, Hazardous Materials Branch, 215 Fremont Street, San Francisco, California 94105, (415) 556-4606

Region X, Kenneth D. Feigner, Chief, Waste Management Branch, 1200 Sixth Avenue, Seattle, Washington 98101, (206) 442-1260

SUPPLEMENTARY INFORMATION:

I. Introduction

In May of 1980, EPA promulgated regulations implementing Subtitle C of the Resource Conservation and Recovery Act of 1976, as amended ("RCRA"). These regulations, among other things, identify and list hazardous wastes (Part 261), establish standards for generators and transporters of hazardous waste (Parts 262 and 263), and set standards and permit requirements for owners and operators of facilities that treat, store or dispose of hazardous waste (Parts 264 and 265 and Parts 122 and 124). 45 FR 33066 (May 19, 1980). These regulations are designed to ensure the proper handling and management of hazardous wastes from their generation through their ultimate disposition.

Because wastes may be produced, handled and disposed of in a large number of ways, the regulations necessarily are cast in broad terms. A generator is anyone whose act or process produces a hazardous waste or whose action first causes a hazardous waste to become subject to regulation. Section 260.10(a), 45 FR 72024 (October 30, 1980). This act or process may be the manufacture of goods or materials, service operations such as cleaning with chemical solvents listed in § 261.31, or the discard of commercial chemical products listed § 261.33. Storage is defined as "the holding of hazardous waste for a temporary period . . .", and treatment as "any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to render such waste nonhazardous, or less hazardous; safer to transport, store or dispose of; or amenable for recovery, amenable for storage, or reduced in volume." Section 260.10(a).

This action concerns how the regulations apply to hazardous wastes that are created by spills of hazardous waste or materials which, when spilled, become hazardous waste. For reasons discussed below, the word "spill" is defined in the amendments published today as "the accidental spilling, leaking, pumping, pouring, emitting, emptying, or dumping of hazardous waste or material which, when spilled, becomes hazardous waste into or on any land or water." This definition obviously covers spills of those hazardous waste listed in §§ 261.31 and 261.32 and those solid wastes that exhibit any of the characteristics of hazardous wastes defined in Subpart C of Part 261. This definition also covers spills of the commercial chemical products and manufacturing chemical intermediates listed in § 261.33 (e) and (f). The Agency interprets spills of these materials to constitute discarding of such materials (see definitions in § 261.2 (c) and (d)). These materials, when discarded, are hazardous waste (see § 261.33). In addition, other materials, when spilled, are considered solid waste because spilling constitutes discarding and may exhibit the characteristic of hazardous waste defined in Subpart C of Part 261.

Members of the regulated community have asked whether certain activities taken in immediate response to such spills constitute treatment (e.g., neutralizing the hazardous waste) or storage (e.g., containing the waste in order to prevent its spread). These questions have significant practical implications. Treatment and storage of hazardous wastes, under the regulations, must be carried out in facilities that have interim status under Section 3005(e) of RCRA and 40 CFR Part 122 or that have a storage or treatment permit from EPA or a State authorized to run a hazardous waste program under Section 3006.[1] Spills are sudden, unplanned events. In many cases, the treatment or storage necessary to respond to spills will not be covered by a RCRA permit or interim status. This is particularly true for generators who do not treat, store or dispose of hazardous waste and transporters who would have neither a permit nor interim status. It also may be true for owners and operators of treatment, storage or disposal facilities where their permit or interim status may not cover the types of treatment or storage performed in responding to a particular spill. Persons responding to the spills would be placed in the uncomfortable position of taking actions necessary to protect human health and the environment while being in violation of RCRA.[2]

In addition, Parts 264 and 265 set forth the manner in which persons may treat

[1] Under § 122.27 the Regional Administrator is authorized to issue emergency permits if there is an imminent and substantial endangerment to human health or the environment to allow the treatment, storage or disposal of hazardous waste for a nonpermitted facility or activities not covered by a permit. § 122.27 set forth procedures governing the issuance of emergency permits. EPA is presently developing guidance for the issuance of these permits.

[2] Hazardous wastes produced in small quantities are excluded from full Subtitle C regulation under § 261.5. A condition of that exclusion, however, is that wastes subject to § 261.5 must be managed in Subtitle C facilities, facilities approved by the State, or use, re-use, recycling or reclamation facilites. Thus, even for spills by small quantity generators, the same dilemma is posed for persons whose response might constitute treatment or storage.

or store hazardous wastes. With respect to chemical, physical, and biological treatment, for example, the regulations describe such things as general operating requirements, waste analysis and trail tests, inspections, and closure requirements. See 40 CFR 265 Subpart Q. If, for example, reagents are used to absorb or neutralize a chemical product listed in § 261.33 which has spilled in a plant, the treatment requirements specified in the regulations would technically govern the response to the spill.

This amendment is designed to allow appropriate responses to spills of hazardous wastes without being limited by the treatment and storage standards and the permit and interim status requirements of the regulations. It should be noted that EPA is developing regulations which will address in more comprehensive fashion the application of the RCRA regulations to spill response activities. That rulemaking will clarify, among other things, relationship of RCRA and other Federal statutes, particularly the Clean Water Act and the Hazardous Materials Transportation Act, which concern spill activities.

II. What These Amendments Do

The amendments published today add three new elements to the regulations published in May, 1980: they add a definition of spill; exempt immediate containment and treatment activities from the Part 264 and 265 regulations governing treatment and storage; and, amend Part 122 to indicate that such activities do not have to be covered by a RCRA permit or interim status.

The definition of "spill" is the same as the definition of "discharge" in § 260. 10(a), except that the word "intentional" has been deleted from the definition of spill and the phrase "material which, when spilled, becomes hazardous waste" has been added. The exclusion from regulation provided in today's amendments is designed to allow persons to respond immediately to sudden, unplanned occurrences, i.e., accidents, which release materials or wastes into the environment. There does not appear to be any basis to extend today's action to intentional releases which might occur. Releases which occur from burst pipes and ruptured containers would be considered spills; releases which routinely occur from, for example, scheduled maintenance of machinery would not be. The Agency specifically requests comment on whether the definition of spills provides appropriate scope for the substantive amendments published today. For purposes of the RCRA portions of the consolidated permit regulations, a corresponding definition of spill has been added to § 122.3.

The amendments to Parts 264 and 265 state that treatment and containment actions taken in immediate response to spills are not considered treatment or storage of hazardous waste. These response activities are not subject, therefore, to the detailed requirements of those parts governing treatment and storage. The amendment to § 122.21 indicates that these activities do not have to be covered by a RCRA permit.

The amendments only cover activities during the immediate response to a spill. As discussed below, once this response is accomplished, other regulatory provisions apply. Section IV of this preamble provides examples of how these amendments and the other regulatory provisions apply to spill situations. These amendments are designed to allow persons to respond immediately to spills which may pose dangers to human health and the environment. If the Agency believes that anyone is abusing this provision, it will not hesitate to bring enforcement actions, including, under appropriate circumstances, criminal prosecutions.

III. Regulations not Affected by This Amendment

The purpose of today's amendments is to allow persons to treat and contain spills without having engaged in treatment and storage activities and to recognize that spills occur at places which might otherwise not be treatment and storage facilities. These amendments do not affect whether the spilled substance, residue or debris is a hazardous waste or not; Part 261 will govern. They do not affect in an way the application of the generator and transporter requirements; Parts 262 and 263 will govern these activities. After the immediate response activities are completed, the hazardous waste is subject to all the requirements for transportation, treatment, storage, or disposal.

The regulations promulgated in May, 1980, explicitly place specific requirements for certain spills of hazardous waste—discharges occurring during transportation and releases occurring at on-site accumulation areas and in treatment, storage and disposal facilities. These regulations, described briefly below, are unaffected by the amendments published today. These amendments complement the regulations by clarifying that actions taken in response to spills and in compliance with those regulations are not subject to the treatment and storage regulations and do not have to be carried out at a treatment or storage facility with a RCRA permit or in interim status.

Discharges of hazardous waste during transportation are subject to the provisions of Part 263 concerning immediate action, reporting, and cleanup. 40 CFR 263.30 and 263.31. 45 FR 12744 (February 26, 1980), republished at 45 FR 33152 (May 19, 1980). Discharges of hazardous materials during transportation are also subject to the reporting provisions of DOT regulations under the Hazardous Materials Transportation Act. 49 CFR 171.15, 171.16. These regulations will apply to spills during transportation and these requirements are not affected by today's amendment.

The Part 264 and 265 regulations contain extensive requirements for hazardous waste management facilities concerning preparedness and prevention, and contingency plans and emergency procedures. 40 CFR Part 265, Subparts C and D. 45 FR 33236, 33237 (May 19, 1980). To ensure proper response to explosions, fires, and other releases of hazardous waste, these provisions require owners and operators of regulated facilities to have safety equipment and systems, arrangements with relevant local authorities, a contingency plan and emergency procedures covering response activities. These regulations continue to apply to releases at hazardous waste management facilities which present dangers to human health and the environment. For example, §§ 264.56 and 265.56, concerning emergency procedures, have not been exempted. The emergency coordinator must follow the procedures set forth in those sections. Today's amendment simply means that actions taken, for example, under § 265.56(e), are not subject to the treatment and storage requirements of Part 265.

Regulations promulgated under other Federal, state or local laws may apply to spills of hazardous waste and other materials. On the Federal level, two examples are Section 311 of the Clean Water Act and the Hazardous Materials Transportation Act. Under Section 311 of the Clean Water Act, discharges of oils and hazardous substances (which may also be hazardous wastes) are subject to regulation. Hazardous materials, as regulated by DOT under the Hazardous Materials Transportation Act, include hazardous wastes. See 45 FR 3451 (May 22, 1980). The amendments published today concern only RCRA requirements and in no way affect a person's obligations or responsibilities under any other applicable Federal, state or local law.

IV. Examples of How These Amendments Operate

The following examples illustrate the manner in which the amendments published today operate and tie in with the other RCRA regulations.

1. A manufacturer spills a commercial chemical product listed in § 261.33(e) on the floor of his plant. He immediately uses a reagent to absorb or neutralize the spill, whose residue amounts to more than 100 kilograms. He places the residue in containers for subsequent transportation off-site. What regulations apply?

The manufacturer is a generator of a hazardous waste—the spilled chemical as well as the resulting residue. He is not a small quantity generator because he has generated more than 100 kilograms of § 261.33(e) residue. See 40 CFR § 261.5(e)(2). His use of the reagent is not subject to treatment regulations of Parts 264 and 265 and this use does not have to be covered by a RCRA permit or interim status. Once the immediate response is over, however, he becomes subject to the generator requirements of Part 262. These include requirements for accumulation on-site, use of EPA identification numbers prior to transporting the residue off-site, initiation of the manifest, and use of appropriate packaging, labelling, marking and placarding.[3] Manufacturers who anticipate such spills may, as a precautionary measure, make necessary arrangements to comply with the Part 262 regulations in advance. And, the transportation and subsequent treatment, storage or disposal of the spill residue is subject to the requirements of Parts 263, 264, 265 and 122.

2. A tank used to accumulate hazardous waste (under the requirements of § 262.34) ruptures and the wastes spill on to the ground. Because the tank does not have a secondary containment system, the generator immediately builds an emergency dike to contain the spilled waste. He subsequently pumps the spilled waste into drums and, after several weeks, ships those drums off-site to an incinerator.

The design, construction and operation of the emergency containment dike is not subject to the RCRA Subtitle C regulations (however, the overall response to the spill is subject to the requirements of Subparts C and D of Part 265 which apply by reference through § 262.34). The storage of the cleaned-up wastes in drums is subject to the accumulation requirements of § 262.34 if storage in the drums is for less than 90-days before off-site shipment or in a on-site. If storage in the drums exceeds 90-days, then this must be covered by a RCRA permit (an existing permit, a new permit, or an emergency permit) or be covered by interim status, and must be carried out in compliance with the applicable requirements of Parts 264 or 265. The incinerator that the drummed wastes shipped to, must have a RCRA permit or interim status.

If, as part of the immediate clean-up action, the containment soil of the diked containment area is treated (e.g., decontamination of the soil in a mobile treatment unit) or the spilled waste is treated, such activity also would not be subject to regulation. However, if such treatment extends beyond the immediate clean-up action, EPA will require an emergency RCRA permit to be obtained. If contaminated soil is left in place, this constitutes disposal and will require a RCRA permit.

3. A spill of hazardous waste material listed in § 261.33(e) occurs in transportation. What must the transporter do?

Under § 263.30(a), the transporter must take appropriate immediate action to protect human health and the environment. The spill containment or treatment action taken in immediate response is exempt from the treatment and storage requirements of Parts 264 and 265 and the transporter is not required to have a RCRA permit or interim status for such action. If he has generated hazardous waste, he must comply with Part 262 when the immediate actions are over. If he transports the spill residue from the spill site, he must comply with the transporter requirements of Part 263 and transport the residue to a facility with a RCRA permit or interim status.

If required by DOT regulations (see 49 CFR 171.15) or other federal regulations (see, e.g., 40 CFR 117.21 and 33 CFR 153.201), the transporter must notify the National Response Center. If an on-scene coordinator or other official arrives, that official may undertake response activities which are exempted by today's amendments from the RCRA standards and permit requirements for treatment and storage. Under the present regulations, § 263.30(b), these officials may authorize the removal of the waste by transporters without EPA identification numbers and without the preparation of a manifest. The hazardous waste residue must be sent to a hazardous waste management facility with a RCRA permit or interim status. If long-term containment or treatment occurs at the spill site, the site must have a full RCRA permit, interim status, or an emergency permit.

4. A spill occurs on the site of disposal facility which is in interim status. The operator of the facility undertakes immediate containment and clean up. He subsequently disposes of the waste at his facility.

The immediate containment and clean up activities are exempted from the requirements of Part 264 and storage and treatment. The owners and operators of the facility must, however, carry out the provisions of the contingency plan under § 265.51 and follow the emergency procedures § 265.56. The disposal of the hazardous waste is subject to the disposal requirements of Part 265. If the disposal facility is unable to dispose of the spill residue, the owner or operator of the facility, if he has generated a hazardous waste, may accumulate the waste on-site under the provisions of § 262.34, and must comply with all the Part 262 requirements applicable to generators of hazardous waste.

V. Effective Date

Section 3010(b) of RCRA provides that EPA's hazardous waste regulations and revisions thereto take effect six months after their promulgation. The purpose of this requirement is to allow persons handling hazardous wastes sufficient lead time to prepare to comply with major new regulatory requirements. For the amendments promulgated today, however, the Agency believes that an effective date six months after promulgation would cause substantial and unnecessary disruption in the implementation of the regulations and would be contrary to the public interest. The amendments make clear that persons responding to spills are not engaging in treatment and storage activities and that such activities do not have to be done in facilities with a RCRA permit or in interim status. The effect of the amendments will be to relieve these persons of having to comply with a number of impractical requirements with respect to spills response actions. The Agency believes that this is not the type of regulation revision that Congress had in mind

[3] EPA recognizes that certain persons, including manufacturers and transporters of hazardous materials, may not have EPA identification numbers prior to a spill which creates hazardous waste. At this time EPA has decided not to exempt discharges from the requirement of having an EPA ID number. Generators do not need an EPA ID number at the time of generation but rather at the time of treating, storing or disposing of the waste or transporting or offering the waste for transportation. Generators will have an opportunity to obtain an EPA ID number after the spill. And, persons who anticipate that they may generate hazardous waste in the future may obtain an EPA ID number in advance. For these reasons, EPA believes that at this time there is no reason to exempt these generators from this requirement.

when it provided a six month delay between the promulgation and the effective date of revisions to regulations.

Consequently, the Agency is setting an effective date of November 19, 1980, for these amendments.

VI. Promulgation in Interim Final Form

These amendments operate as a clarification of the hazardous waste regulations published in May of 1980. 45 FR 33066 (May 19, 1980). With certain exceptions, those regulations did not address containment and treatment of spills of hazardous wastes or materials which, when spilled, become hazardous wastes. A literal interpretation of the May regulations, however, would mean that such actions constitute storage and disposal fully subject to regulation. These amendments conform the regulations to their original intent. The Agency believes that good cause exists for promulgation of this rule in final form. See 5 U.S.C. 553(b)(B).

Delaying the application of these rules to allow opportunity for public notice and comment would work substantial hardship on persons handling hazardous waste. The regulatory program goes into effect on November 19, 1980. Spills are everyday occurrences in the real world. Without immediate clarification of the regulations, all persons who might in the future spill a hazardous material or hazardous waste would have to the prepared to be in full compliance with the Part 265 regulations governing treatment and storage. Without these clarifying amendments substantial hardship would be imposed, without appreciable benefit, on the regulated community.

VII. Requests for Comments

The Agency is soliciting comments on all aspects of the amendments and on all issues discussed in this preamble. In addition, the Agency may initiate more comprehensive rulemaking in the near future on RCRA's application to spill responses. The amendments published today will be subject to reconsideration at that time. The public may accordingly be provided additional opportunity to comment on the Agency's regulation of spills.

VIII. Regulatory Impacts

The effect of these amendments is to reduce the overall costs, economic impact and reporting and recordkeeping impacts of EPA's hazardous waste management regulations. The Agency is unable to estimate these reductions.

Dated: November 14, 1980.

Douglas M. Costle,

Administrator.

Title 40 of the code of Federal Regulations is amended as follows:

§ 260.10 [Amended]

1. Add the following definition to § 260.10(a)(64a):

"Spill" means the accidental spilling, leaking, pumping, pouring, emitting, or dumping of hazardous wastes or materials which, when spilled, become hazardous wastes into or on any land or water.

§ 122.3 [Amended]

2. Add the following definition to § 122.3:

"Spill" [RCRA] means the accidental spilling, leaking, pumping, emitting, emptying, or dumping of hazardous wastes or materials which, when spilled, become hazardous wastes into or on any land or water.

§ 264.1 [Amended]

3. Add the following paragraph (g)(8) to § 264.1:

* * * * *

(g) * * *

(8) Persons with respect to those activities which are carried out to immediately contain or treat a spill of hazardous waste or material which, when spilled, becomes a hazardous waste, except that, with respect to such activities, the appropriate requirements of Subpart C and D of this Part are applicable to owners and operators of treatment, storage and disposal facilities otherwise subject to this Part. [Comment: This paragraph only applies to activities taken in immediate response to a spill. After the immediate response activities are completed, the applicable regulations of this Chapter apply fully to the management of any spill residue or debris which is a hazardous waste under Part 261.]

§ 265.1 [Amended]

4. Add the following paragraph (c)(11) to § 265.1:

* * * * *

(c) * * *

(11) Persons with respect to those activities which are carried out to immediately contain or treat a spill of hazardous waste or material which, when spilled, becomes a hazardous waste, except that, with respect to such activities, the appropriate requirements of Subpart C and D of this Part are applicable to owners and operators of treatment, storage and disposal facilities otherwise subject to this Part. [Comment: This paragraph only applies to activities taken in immediate response to a spill. After the immediate response activities are completed, the regulations of this Chapter apply fully to the management of any spill residue or debris which is a hazardous waste under Part 261.]

§ 122.21 [Amended]

5. Add the following paragraph (d)(3) to § 122.21:

* * * * *

(d) * * *

(3) Further exclusions. A person is not required to obtain a RCRA permit for those activities he carries out to immediately contain or treat a spill of hazardous waste or material which, when spilled, becomes a hazardous waste. [Comments: This exclusion is intended to relieve persons of the necessity of obtaining a RCRA permit where the treatment or storage of hazardous waste is undertaken as part of an immediate response to a spill. Any treatment, storage or disposal of spilled material or spill residue or debris that is undertaken must be covered by a RCRA permit, an emergency RCRA permit or interim status.]

These amendments are issued under the authority of Sections 1006, 2002(a), 3004 and 3005 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 (RCRA), as amended, 42 U.S.C. 6905, 6912(a), 6924 and 6925.

[FR Doc. 80-36132 Filed 11-18-80; 8:45 am]

BILLING CODE 6560-30-M

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40 CFR Part 122

[SWH-FRL 1675-2]

Hazardous Waste Management System: General and EPA Administered Permit Programs: The Hazardous Waste Permit Program

AGENCY: United States Environmental Protection Agency.

ACTION: Interim final rule and request for comments.

SUMMARY: The Environmental Protection Agency ("EPA") is today amending its hazardous waste permit regulations to clarify the circumstances under which hazardous waste management facilities may qualify for interim status. Interim status is the condition under which certain facilities would be treated as having been issued a permit until such time as final administrative action was taken on their permit application. These amendments have been prompted by questions from States and the regulated community concerning the eligibility of various types of facilities for interim status.

Changes During Interim Status to Comply With Corrective Action Requirements

OSW-FR-89-002

federal register

Tuesday
March 7, 1989

OSW-FR 89-002

Part III

Environmental Protection Agency

40 CFR Parts 124 and 270

Changes to Interim Status Facilities for Hazardous Waste Management; Modifications of Hazardous Waste Management Permits; Procedures for Post-Closure Permitting; Final Rule

comply with Federal regulations or State or local laws. The corresponding provision in today's rule § 270.72(a)(3), has been amended to clarify that "Federal regulations or State or local laws" encompasses all Federal, State, and local requirements. This includes regulations, orders, statutes, and permit-related requirements such as approved closure plans. EPA received no comments opposing this clarifying amendment.

3. Corrective Action

Section 3008(h) authorizes the Agency to order a facility owner or operator to conduct corrective action during interim status when the Agency determines that there is or has been a release of hazardous waste into the environment. Section 270.72(a)(5) promulgated today allows interim status facilities to make changes in accordance with corrective action orders issued by the Agency under section 3008(h) or other Federal authority (or orders issued by a Director under an equivalent State authority). In today's rule, the Agency has modified the language proposed in § 270.72(a)(5) to clarify that when the Agency or a State seeks corrective action through judicial proceedings and a court, rather than the Agency or State, issues an order requiring corrective action, changes made in accordance with such an order would also be permissible changes under § 270.72(a)(5).

In addition to the new § 270.72(a)(5), today's rule also promulgates § 270.72(b)(5), which removes the reconstruction limit for changes made in accordance with such corrective action orders.

Under the new § 270.72(a)(5), facility changes introduced in accordance with corrective action orders restricted to activities involving wastes associated with the facility. This limitation does not prevent treatment, storage, or disposal of wastes released from within the facility that migrated beyond the facility's boundaries. Rather the limitation prevents the owner or operator from making changes under this authority to manage wastes and materials that have no relationship to the facility. The limitation for unrelated materials is necessary to prevent the owner or operator seeking to manage such materials from evading the permit requirement for new facilities and change in interim status requirements for facility modifications.

Some commenters expressed concern that the new § 270.72(a)(5) limits changes permissible for purposes of corrective action to those made in accordance with a corrective action order. The commenters argued that the provision should be expanded to allow changes necessary for voluntary corrective action to be made as well and that the reconstruction limit should not apply to voluntary corrective action measures. The commenters noted that corrective action done early can decrease the cost of clean-up and provide increased protection of human health and the environment. The Agency, however, limited the changes permissible under new § 270.72(a)(5) to those made in compliance with a corrective action order because voluntary corrective action would not typically involve EPA or State oversight or public notice. By requiring that the changes made under paragraph (a)(5) be made in accordance with a corrective action order, the Agency has assured that those changes will be subject to Agency review and, additionally, to public comment. Therefore, the Agency has not made the modification to § 270.72(a)(5) that the commenter suggested.

The Agency, nevertheless, believes that the regulations already provide significant flexibility for voluntary corrective action at interim status facilities. Section 270.72(a) (2) and (3) allow the Director to approve increases in design capacity or the addition of new processes, if necessary to comply with Federal, State, or local requirements. This would include changes made as part of voluntary corrective action taken in anticipation of a section 3008(h) order or section 3004(u) permit conditions. These changes, however, would be subject to Director approval and would be limited by the reconstruction cap of § 270.72(b).[1]

Sections 270.72(a) (2) and (3) and 270.72(a)(5), therefore, impose somewhat different requirements on different types of corrective action. Where EPA or a State has required specific corrective action as part of a section 3008(h) or similar order, or a court has ordered correction action, approval of that action as a change in interim status is not necessary, and the reconstruction limit does not apply (§ 270.72 (a)(5) and (b)(5)). On the other hand, where the action is not explicitly required in an order, or it is taken merely in anticipation of an order, Director approval is required and the reconstruction limit potentially applies (§ 270.72(a) (2) and (3)).

4. Loss of Interim Status

In some cases, new land disposal units may be added to a facility as a change in interim status. For example, a surface impoundment handling nonhazardous waste at an interim status facility might be brought into the system if EPA subsequently listed the waste as hazardous. In this case, § 270.73(e) of today's rule (proposed as § 270.72(c) but moved in the final rule to § 270.73 for purposes of clarity) would require the facility to certify, 12 months after the effective date of the listing, that the unit was in compliance with all applicable ground-water monitoring and financial responsibility requirements. EPA added this requirement to ensure comparable treatment of land disposal units containing newly identified hazardous wastes at permitted, unpermitted, and interim status facilities.

5. Other Issues

One commenter argued that the Agency should have the authority to approve any change in interim status that would improve environmental quality, decrease costs, or improve safety or efficiency. Another commenter argued that the Agency should allow changes made to: (1) Protect human health and the environment, (2) avoid disrupting ongoing waste management, and (3) enable the permittee to respond to sudden changes in the types or quantities of wastes being managed at the facility. The agency believes that the criteria suggested by these commenters are too broad. In adopting its regulation for interim status facilities, the Agency chose an approach it believed would allow reasonable modification to existing facilities without nullifying the requirements for obtaining a RCRA permit. (See 45 FR 33290 at 33324, May 19, 1980). As part of its approach, the Agency allowed increases in design capacity and addition of or changes in existing processes at interim status facilities only for specified reasons, and made those changes subject to Agency approval and to the reconstruction limit. The Agency continues to follow this approach in its regulations at § 270.72. EPA believes that the criteria suggested by the commenter might result in expansions at interim status facilities that require full public participation and other protections of the permitting process.

[1] The Agency addressed this general issue in the preamble to the proposed Mobile Treatment Unit (MTU) regulation (52 FR 20914 to 20920, June 3, 1987). In that preamble, the Agency explained that MTU's may be allowed to operate at interim status facilities as a change necessary to comply with Federal, State, or local requirements. The Agency then went further to say that the use of an MTU for studies at an interim status facility to determine whether a specific treatment could meet BDAT in accordance with the land disposal restrictions, or to select a remedial measure in anticipation of Agency action under sections 3008(h) or 3004(u) would likely qualify as an acceptable change in interim status.

Emergency Permits

9527.1992(01)

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response
Washington, D.C. 20460

November 3, 1992

Mark Hansen
Facilities Manager
Corporate Office
Environmental Products
& Services, Inc.
P.O. Box 315
Syracuse, NY 13209-0315

Dear Mr. Hansen:

Thank you for your letter of September 28, 1992 in which you ask about the transportation and disposal of shock sensitive or explosive materials. Specifically, you requested EPA guidance on how to handle materials like picric acid and ethyl ether while removing old laboratory chemicals.

Under EPA's RCRA regulations (40 CFR 270.1(c)(3)), all activities taken in immediate response to a discharge of hazardous waste, or an imminent and substantial threat of discharge of a hazardous waste, are exempt from the RCRA permitting and substantive requirements. Since the chemicals in question would be hazardous by virtue of their reactivity, any actions you take to eliminate the imminent and substantial danger would qualify under this exemption. If the response action involves transportation to a remote site for destruction, then the transportation as well as the destruction would be exempt. However, the transportation is exempt only to the extent necessary to respond to the immediate threat. Hence, we expect the transportation would normally cover a relatively short distance and would occur in special transportation equipment such as bomb trailers.

Should there be any question about the exempt or no-exempt status of removing a certain chemical, the RCRA emergency permit regulations (40 CFR 270.61) can be used for destruction activities. As these regulations provide, an emergency RCRA permit can be issued by an EPA Regional Office or by an

authorized State official via telephone or in writing. These permits may be issued when the Region or State finds that an imminent and substantial endangerment to human health or the environment exists, according to the requirements of 40 CFR 270.61. This permit can address both treatment and storage of hazardous waste. If necessary, transportation can be authorized at the same time the emergency permit is authorized by obtaining a provisional identification number. To reiterate, however, a permit is necessary when the safety official determines that an immediate safety threat exists.

The guidance given above is based on the Federal RCRA program as administered by EPA pursuant to 40 CFR Parts 260-271. In authorized States, EPA has delegated the responsibilities of the hazardous waste program. Although each authorized State program must be consistent with and no less stringent than the Federal program, a State is free to be more stringent (e.g., some States may not offer emergency permits). In the end, you should check with the authorized State where your facility is located to ensure that there are not additional (more stringent) management standards.

I trust that this letter provides you with guidance helpful to your efforts to remove old lab chemicals. If you need additional assistance, please call Chester Oszman of my staff at (202) 260-4499.

Sincerely,

Sylvia K. Lowrance, Director
Office of Solid Waste

cc: Chester Oszman, OSW
Ken Gigliello, OWPE
RCRA Permit Section Chiefs, Regions I-X

bcc: Sonya Sasseville
Jim Michael
Jeff Gaines

OSWFR80011

federal register

Monday
May 19, 1980

Environmental Protection Agency

Hazardous Waste and Consolidated Permit Regulations

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attempt to place further restriction on or delay interim status. However, a method is necessary to insure that the Director and applicant know the required information has been submitted.

EPA has revised the proposal at § 122.23(a) to require an applicant to either submit notification and Part A of the application by certified mail or to hand deliver such information to provide assurance to both the applicant and EPA that the information has been sent and received.

One commenter suggested that EPA consider adopting a definite date for termination of all interim status. When a permit application is complete EPA does not have the authority to terminate interim status short of the administrative disposition of the permit application. The time period necessary to take final action on all permits is contingent upon the availability of resources. Therefore a definite date for termination of all interim status cannot be established.

§ 122.24 Contents of Part A of the RCRA permit application.

The comments received on this section are discussed in the preamble to the consolidated application forms, published elsewhere in today's Federal Register.

§ 122.25 Contents of Part B of the RCRA permit application.

The proposed regulation identified six general informational categories for inclusion in Part B of the permit application. These included a master plan for the facility which combined all of the plans required by the section 3004 facility standards. Also included were geological and hydrogeological data, a description of the climate at the site, a list of positions and job descriptions and a listing of the performance bonds and other financial instruments.

This general approach created some confusion because the relationship between the proposed section 3004 regulation and the permit application requirements was not clear. Many commenters believed that they were required to submit all the information included in each category. They suggested that the information needs be limited to the type of facility (e.g. landfill, incinerator). EPA agreed with these comments and restructured the Part B informational requirements. The Part B application requirements now parallel the structure of the section 3004 standards promulgated in Part 264 of this chapter.

Only Subparts B through E of Part 264 have been promulgated to date. This covers requirements which generally apply to all facilities. Subsequent subparts of Part 264 including standards for specific facility types (landfills, incinerators, etc.) will be promulgated later this year. The Part B permit application requirements being promulgated today essentially pertain to information which is common to all hazardous waste facilities as well as the specific plans required of all facilities in Subparts B through E of Part 264. The Part B application requirements will be amended to reflect additional planning requirements and the technical standards (e.g. equipment design, site preparation and design) which will be promulgated in Part 264 later this year.

Section 122.23 of the proposed rules contained provisions for the Director to waive certain application requirements in Part B if the information was not applicable to the facility and was not needed to establish compliance with the section 3004 standards. The Agency received numerous comments on the use of the waiver provision. While the reorganization of the regulation may eliminate the need for this waiver provision, it is not possible to reach a final decision on its use until the full Part 264 standards are promulgated.

§ 122.26 Permits by rule.

The proposed regulation provided for a permit by rule for facilities accepting special wastes, ocean disposal barges and vessels, and certain POTWs. In these instances application for a permit was not required and an actual permit would not be issued. The owner and operator of such a facility would be deemed to have a RCRA permit if certain specific conditions in the regulation were complied with. Many comments were received on this provision.

Comments from industry generally approved of this approach, though some argued that limiting the permit by rule to POTWs was arbitrary and that privately owned treatment works and NPDES industrial surface impoundments should be treated in a similar manner. However some commenters stated that the permit by rule is illegal under RCRA, as section 3005 requires each HWM facility to have a permit. These commenters objected to the permit by rule approach as less environmentally protective than site-specific permits and argued that permit by rule eliminates public notice and public participation and that EPA and the public lose the chance to gain information about such facilities.

Although the scope of the permit by rule provisions has been cut back substantially, EPA continues to believe that such an approach is both legally justified and appropriate in certain cases. The courts have interpreted the Clean Water Act to allow the issuance of "general" or "area" permits covering point sources under that statute. *Natural Resources Defense Council v. Costle*, 568 F.2d. 1369, 1381 (D.C. Cir. 1977). The court recognized that use of such approaches might be the only way to fulfill the legislative intent in a setting of limited resources. Yet the permit provisions of the Clean Water Act against which that case was decided are stronger than those of RCRA, for not only do they affirmatively require every "point source" to have a permit, but unlike RCRA, they underline the implication that source-by-source examination is required by limiting both the time for which a permit application will be acceptable instead of a permit, and the maximum term of the permit once issued. In addition, section 1006 of RCRA directs the Administrator to integrate the administration of that statute "to the maximum extent practicable" with the provisions of other EPA statutes, including the Clean Water Act, the Ocean Dumping Act, and the Safe Drinking Water Act.

Against this background, EPA believes that there can be little question of its ability to issue a permit by rule to facilities where the activities that a RCRA permit would regulate are for the most part already regulated under another EPA permit and the only purely RCRA-related provisions are those that are not site-specific and do not need to be particularized in an individual permit. The choice here is between requiring a duplicate permit proceeding and duplicate paperwork or simply making the missing RCRA provisions applicable through a general regulatory statement. EPA has chosen the latter course.

Despite criticism the permit by rule approach has been retained for POTWs for the reasons discussed above. This provision caused considerable confusion in the proposed regulation. Permit by rule was only to be applicable to the rare situation where a POTW received hazardous waste by rail or truck or by a pipe that did not carry sewage since sewer line influent to a POTW would in most instances be exempted from the RCRA definition of solid waste which includes dissolved or suspended materials in domestic sewage. Many commenters misunderstood this point and argued for extending the permit by rule approach to a wide variety of other operations such as privately owned treatment works and NPDES surface impoundments.

As explained earlier and in the section 3001 preamble, these facilities

do not come under the special Congressional intent applicable to POTWs and there is therefore no reason to exempt them from otherwise applicable RCRA requirements.

The remaining uses of permit by rule are for 1) barges or other vessels for ocean disposal of hazardous wastes with a permit under the Marine Protection, Research and Sanctuaries Act and 2) underground injection of hazardous wastes with a permit under the UIC program of the Safe Drinking Water Act. Both of these situations meet the criteria for permit by rule described previously. In both of these cases the owner or operator is deemed to have a RCRA permit if he or she has a valid permit under the other program, is in compliance with that permit and also complies with the RCRA manifest, recordkeeping and reporting requirements. Shoreside facilities related to ocean disposal activities and surface storage and treatment prior to underground injection are not covered by permits under these other statutes and the RCRA site-specific permit requirements apply to the handling of hazardous waste at such installations.

Owners and operators of facilities with a permit by rule are not required to submit a RCRA permit application. However if an owner or operator of an existing underground injection well does not have a UIC permit he or she must comply with the RCRA notification and permit application requirements in order to qualify for interim status.

Control of UIC Wells Injecting Hazardous Wastes. The RCRA hazardous waste permit program regulates the treatment, storage, and disposal of hazardous wastes. The UIC permit program, governed by Subpart C of this Part and Part 123, governs State programs regulating injection wells, including those which dispose of hazardous wastes by underground injection. The two programs therefore potentially overlap, and could result in duplicative regulation of the same practices. In order to avoid this, in the proposed consolidated permit regulations EPA sought to set clear jurisdictional boundaries for the two programs so that each would regulate the practices it was specifically designed to control, and duplication could be eliminated. In the main, these jurisdictional boundaries are retained in these final regulations, and are discussed below.

In general, UIC permits will be required for the well itself, while RCRA permits will be required for associated above-ground facilities which require permits under this Subpart—for example, those which store hazardous wastes prior to injection. A number of commenters objected to this scheme, and recommended that the UIC program control all facilities associated with a UIC well, even if such facilities might meet RCRA permitting requirements. EPA rejected this approach for two reasons. First, there is no doubt that EPA has authority to regulate surface storage facilities under RCRA; it is less clear that such authority exists under the SDWA. Even if authority is present under the SDWA, the UIC provisions of that statute are ill-suited to control risks associated with surface facilities, including possible explosions, leakage of hazardous waste into the atmosphere, or spills.

The final regulations depart from the proposal in that all UIC wells injecting hazardous waste will for an interim period be subject to regulation under RCRA. RCRA interim status standards have been revised so that they can be applied to wells. Thus, existing UIC hazardous waste wells must notify under RCRA section 3010 and file a Part A application form. Such wells will qualify for interim status, and will be subject to interim status standards like any other HWM facility. Except as noted below (in the discussion of new § 122.30, "Interim RCRA Permits for Class I Wells"), RCRA permits will not be issued for UIC wells injecting hazardous wastes. When UIC programs become effective, all such wells will either be issued UIC permits (in which case they will qualify for the RCRA permit by rule, § 122.28), or they will be required to shut down (see, for example, § 122.36).

There are several reasons why it is necessary to require UIC wells to obtain interim status and comply with RCRA interim status standards during this period. Perhaps most important is that, under section 3005 of RCRA, these facilities will not be allowed to receive hazardous wastes unless they have interim status, a RCRA permit, or a UIC permit which in turn would qualify them for a RCRA permit by rule. Mechanisms for issuing the UIC permits will not be in place for some time. Thus, the only practical alternative is for UIC wells to qualify for interim status.

Moreover, under the SDWA, substantive regulations do not become enforceable until they are incorporated into a UIC program adopted by a State or promulgated by EPA. States are allowed 270 days after the promulgation of UIC regulations to submit a program, and the Administrator may extend this period by as much as another 270 days. If the program submitted is unacceptable, EPA must promulgate one. This could take considerable additional time, resulting in delays of perhaps as much as two years after issuance of UIC program regulations before effective regulation of injection wells begins. EPA sees no reason why wells cannot be regulated during this period under interim status standards. These standards are simple, basic, and will provide some measure of control. The requirement that an application be submitted will also enable EPA to develop early a complete inventory of injection wells disposing of hazardous wastes, forming a basis for prompt and effective regulation of the facilities when UIC programs are in place.

Among other requirements UIC wells with interim status will be required to comply with the manifest system under 40 CFR Part 265, Subpart E when they receive hazardous wastes. Failure to impose manifest requirements on these facilities would create major obstacles to carrying out one of the primary functions of the manifest system: to track the movement of hazardous wastes from generation to disposal.

When a final UIC permit is issued to a UIC hazardous waste injection well, the well will become subject to the general RCRA permit by rule. Thus, they will not be required to obtain individual HWM facility permits. Sections 122.36 and 122.45 identify the requirements for UIC permits for these facilities. Many of the requirements of analogous RCRA regulations are incorporated in their entirety. Others are modified so as to fit wells, or are not applicable to wells. The resulting regulatory scheme provides, in EPA's view, a degree of control which is equivalent to that which would be obtained if the facilities were required to obtain individual permits under RCRA. A more detailed discussion of this issue may be found elsewhere in the preamble to § 122.36 and in the preamble to § 122.45. Thus, nothing would be gained by dual permitting, and a permit by rule carries out the purposes of § 1006(b) of RCRA, which obligates EPA to "avoid duplication, to the maximum extent practical, with the appropriate provisions of * * * the Safe Drinking Water Act" * * *.

§ 122.27 Emergency permits.

Several comments were received on the proposed emergency authorization provision. In general, commenters supported EPA's proposal. Some commenters stated that the 90-day limit for such authorization was too short while another commenter stated this action should not be limited to permitted facilities. Another commenter stated that this provision was unnecessary as

EPA had available to it immediate relief through court action.

EPA continues to believe this provision is fully justified under the statute. Though section 7003 does authorize a court to grant emergency relief, that requirement is independent of permitting authority under section 3005 and is probably better adapted to forbidding certain acts than to permitting disposal. The right of the government to take summary administrative action in response to an emergency is well recognized in other regulatory fields and in the law generally. As the preamble to Part 124 explains, RCRA specifies no explicit requirements for issuing a permit. EPA believes that reading the general RCRA language to allow summary action in a limited and urgent category of cases is the interpretation that best carries out the overall intent of the legislation to protect public health and the environment.

This provision has been extended to include facilities that do not have a permit; however EPA continues to be conservative in defining the scope of this exemption to prevent the possibility of abuse, particularly while the program is still so new, and to restrict the number of cases in which regulatory action will be taken without an opportunity for public comment.

§ 122.28 Additional conditions applicable to all RCRA permits.

Numerous comments were received on the proposed RCRA permit conditions (proposed § 122.24). Many of the comments were in fact comments on the cross-references to the RCRA section 3004 regulations. These comments were received after the close of the comment period for that particular regulation and are not germane to Part 122 Subpart B. To the extent those comments were made during the comment period for the section 3004 regulation, they were considered as part of the rulemaking for that regulation.

Commenters interpreted the proposed permit conditions, § 122.24(e), to mean that an entire facility must be constructed or modified before any given part of that facility could be operated, or that an entire facility must be closed while part of the facility is being modified. EPA's intent was that only those portions of a facility affected by modifications would be covered by this requirement. The regulations have been revised so that this intent is explicit (final § 122.28(c)). The provision also allows for phased construction and operation of a facility over time, if the existing parts can operate alone and in compliance with the permit requirements.

Several commenters objected to the requirement that an engineer registered in the State in which the facility is located certify that the facility has been constructed or modified in compliance with the permit. Some commenters argued that this requirement is too restrictive for Federal facilities. Other commenters argued this requirement is not necessary as most States have reciprocity agreements for registered engineers. EPA agrees that requiring an engineer to be registered in the State in which the facility is located is overly restrictive and the regulation has been changed. Certification by a "registered professional engineer" is still required because a certain level of expertise is required to certify compliance with permits.

Numerous commenters stated that a time limit should be placed on the Director to inspect a completed facility. Suggestions of 10 days and 30 days were offered. Most commenters expressed concern that the Director could unduly delay start-up of a facility by not acting promptly in this regard. EPA has restructured the regulation to help alleviate this problem. If the Director does not notify the applicant of his or her intent to inspect within 15 days of the receipt of certification, he or she waives the right to prior inspection, and authorization to commence operations is automatically granted.

Another commenter stated that EPA had not provided a standard to be applied by the Director to determine whether operation should begin. The regulation now provides that the Director shall authorize commencement of operation if he or she finds the facility is in compliance with the conditions of the permit.

Several commenters also objected to the proposed requirement (§ 122.24(b)) which allowed the Director to establish permit requirements as necessary to protect human health and the environment. Commenters thought this provision allowed the Director too much discretion and would lead to imposition of conditions unrelated to RCRA. EPA agrees that this provision is unnecessary and has deleted it. However, as the preamble to the section 3004 regulations explains, in many cases the permit writer will have to exercise considerable discretion to adapt the requirements of general regulatory provisions to a specific permit. See also § 122.8 and accompanying preamble.

Several State agencies commented that in order to reduce paperwork permits should incorporate specific permit conditions by referencing appropriate sections of Federal regulations rather than list each condition in its entirety. The regulations accommodate this (see § 122.7).

§ 122.30 Interim RCRA permits for UIC wells.

There is an additional respect in which these regulations must be harmonized with those for UIC permits. RCRA prohibits the disposal of hazardous wastes except in a RCRA-permitted facility. This prohibition will take effect this fall, when the second phase of RCRA regulations, including technical standards for HWM facilities, is published. UIC Class I and Class IV wells with interim status may continue to operate. New UIC Class I wells and Class IV wells will be prohibited by RCRA from accepting hazardous waste for disposal because only existing facilities qualify for interim status (under section 3005(e) of RCRA). (See § 122.32 for a discussion of how injection wells are classified under UIC.) If these wells are permitted under UIC, they will be covered by a RCRA permit by rule (§ 122.26). However, many States may require as much as a year after the RCRA prohibition takes effect to develop and submit a UIC program. Until then, there will be no UIC program and therefore no authority to permit new Class I wells (or Class IV wells, if EPA decides to allow them to be permitted). Thus, EPA could inadvertently create a moratorium on the construction of new Class I wells which could last two or more years. Because these wells are, in some cases, the preferred method of disposal of hazardous waste, EPA believes this result is undesirable.

Accordingly, EPA intends to issue standards under RCRA § 3004 which would allow EPA or approved States to issue RCRA permits to new hazardous waste injection wells. Such standards would be patterned closely on 40 CFR Part 146, so that wells would not be subject to possible new or inconsistent construction and operation requirements as their RCRA permits expire and they come under regulation under the UIC program.

The actual issuance of the permits involved can be done either by EPA Regional Administrators or by the States. At their option, States may assume, under section 3006 of RCRA and 40 CFR Part 123, permitting authority for Class I wells during the period after the RCRA permit requirement goes into effect, but prior to approval or promulgation of a UIC program in the State. Accordingly, States may apply to EPA for approval to issue permits under RCRA to Class I wells, as part of their applications either

for interim or final authorization. The technical standards for such permits will be issued this fall at the same time as the other RCRA technical standards, and will be closely modeled upon 40 CFR Part 146, the technical standards for UIC permits. Because EPA continues to view the UIC program as the most effective vehicle for regulation of underground injection, the permits will be limited in duration to not more than two years. At the end of the two year period, either the State will have an approved UIC program or EPA will have promulgated one under the SDWA.

The Regional Administrator will have authority to issue RCRA permits to UIC facilities under the same conditions in the event that the State Director does not seek authority to issue them. EPA does not anticipate that it will be asked to issue such permits except in a very few cases. The total number of Class I UIC wells is small—about 400—and has grown at a slow rate.

Class IV wells are continuing to be studied in connection with the request for comments on Class IV UIC wells (see preamble discussion of §§ 122.36 and 122.45). EPA will announce treatment of these wells this fall at the completion of consideration of comments.

Proposed § 122.25(a), Health Care Facility Permits. The provisions for special permits for health care facilities have been deleted. The section 3001 regulations do not include infectious waste at present and the section 3004 regulation does not have specific standards for the treatment, storage or disposal of infectious waste. If future versions of these regulations cover infectious waste the permit requirements can be revised if necessary.

Proposed § 122.25(b), Experimental Permits. As proposed, RCRA permits were normally to be issued for the designed life of the facility and experimental special permits were to be issued for up to one year with a one year maximum extension. Because EPA will now issue RCRA permits only for up to ten years, and permits can be limited to one year if necessary, the experimental permits section has been deleted.

Proposed § 122.27, Reporting requirements. Comments suggested that the reporting requirements under this section be reviewed to determine if less stringent requirements would suffice. EPA has done this and has reduced the requirements to the minimum it now estimates are necessary to carry out the RCRA program in an adequate and responsible way. Since the program has not started yet, any estimate of the reporting needs is likely to require revision in the light of experience, and EPA will re-examine these requirements once the program has a sufficient degree of operating history behind it. All RCRA reporting requirements for permitting agencies are now contained in § 122.18.

Subpart C—Additional Requirements for UIC Program

These regulations in part establish program requirements for State Underground Injection Control programs under the Safe Drinking Water Act. However, not all the regulations called for under section 1421 of that Act appear in these consolidated permit regulations. The technical requirements for State UIC programs will appear separately as Part 146. The Agency expects to publish Part 146 regulations within a month.

The SDWA requires any State listed under section 1422 of that Act to submit a UIC program for approval within 270 days after "promulgation of any regulation under section 1421 . . . ." The Administrator may grant a 270 day extension. EPA believes, however, that it would be inappropriate for States to be subject to a statutory deadline for preparing and submitting programs when many of the necessary requirements for the programs have not yet been issued. The statute does not specify when "promulgation" takes place. Accordingly, to avoid confusion, EPA is fixing the date of "promulgation" of Part 122, 123, and 124, to the extent that they establish UIC program requirements, to the effective date of the 40 CFR Part 146 regulations. This effective date will be 30 days after the publication in the Federal Register of regulations under Part 146.

§ 122.31 Purpose and scope of Subpart C.

This is intended to be an introductory or "roadmap" section corresponding to sections which have been added to Subparts A, B, and D. One goal of this section is to clarify the connection between the proposed process for "identification" and the regulatory requirements designed to protect underground sources of drinking water (USDWs). The section now emphasizes the fact that USDWs are to be protected regardless of whether they have been accurately mapped or otherwise identified. Mapping or otherwise identifying USDWs will aid the Director in fulfilling this requirement.

The Director may also identify "exempted aquifers" using criteria in Part 146. Such aquifers are those which would otherwise qualify as "underground sources of drinking water" to be protected, but which have no real potential to be used as drinking water sources. Exempted aquifers are treated as exempt only if they have been affirmatively identified as "exempted aquifers" by the Director in the UIC program for the State.

This section also contains a list of "specific inclusions" and "specific exclusions" parallel to similar lists in the other Subparts of Part 122. These lists are designed to give readers a quick indication of whether their facilities come within the scope of the UIC program. These inclusions and exclusions are not exhaustive, but illustrative. The language of the regulations must be applied to determine whether the program applies to a particular activity.

Septic tanks or cesspools used to dispose of hazardous wastes have been specifically included within the definition of an injection well. In House Report No. 93-1185 (page 31) Congress specifically expressed its intentions that EPA include underground injection systems "other than individual residential waste disposal systems" when they are used to inject contaminants, including hazardous waste.

Several commenters questioned whether EPA should impose the same monitoring, reporting, construction and operating requirements for injection wells sited in areas without any USDW to be protected as it does in areas with one or more USDW. One commenter questioned EPA's legal authority to control wells located outside State territorial waters. Several additional commenters asked EPA to clarify the scope of coverage. EPA agrees that the UIC program is a State program and is not applicable to injection wells located outside State territorial waters (i.e., to injection wells at platforms located on the outer continental shelf). A specific provision to this effect has been added to § 122.31(d).

Section 122.43 has been added to allow the Director discretion in reducing regulatory requirements under certain circumstances.

In the proposal, EPA exempted drilling muds and cement from the program, because the Agency did not impose requirements prior to operation. Since preconstruction permits are now required, this exemption has been deleted. When UIC permits are issued, they should routinely authorize emplacement of these materials.

§ 122.32 Classification of injection wells.

In response to several comments the definition of Class I wells (other than hazardous waste wells) has been limited

Temporary Authorizations at Permitted Facilities

federal register

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F-88-PMHF-FFFFF

Part II

Environmental Protection Agency

40 CFR Parts 124, 264, 265 and 270
Permit Modifications for Hazardous Waste Management Facilities; Final Rule

identified in Appendix I to 40 CFR Part 270 and discussed more fully in Section IV.C of this preamble.

Since Class 3 modifications involve substantial changes to facility operating conditions or waste management practices, they should be subject to the same review and public participation procedures as permit applications. The specific procedures for Class 3 modifications are at 40 CFR 270.42(c).

The first steps in the application procedures for Class 3 modifications are similar to the procedures for Class 2. Under § 270.42(c)(1), the permittee must submit a modification request to the Agency indicating the change to be made to the permit; identifying the change as a Class 3 modification; explaining why the modification is needed; and providing applicable information required by 40 CFR 270.13 through 270.21, 270.62, and 270.63. As with Class 2 modifications, the permittee is encouraged to consult with the Agency before submitting the modification request.

Section 270.42(c)(2) requires the permittee to notify persons on the facility mailing list and local and State agencies about the modification request. This notice must occur not more than 7 days before the date of submission nor more than 7 days after the date of submission. The notice must contain the same information as the Class 2 notification, including an announcement of a public informational meeting. The meeting would be held no fewer than 15 days after the notice and no fewer than 15 days before the end of the comment period.

Finally, after the conclusion of the 60-day comment period, the permitting Agency then initiates the permit issuance procedures of 40 CFR Part 124 for the Class 3 modification. Thus, the Agency will prepare a draft permit modification, publish a notice allow a 45-day public comment period on the draft permit modification, hold a public hearing on the modification if requested and issue or deny the permit modification. In addition, the Agency will consider and respond to all written comments received by the Agency during the 60-day public comment period as it conducts the activities required by Part 124.

In the September 23 notice, EPA proposed procedures for a second public meeting, which would be held at the owner or operator's discretion. EPA received several comments objecting to the requirements prescribing how the second meeting would be conducted (e.g., use of a neutral facilitator), particularly since the meeting was voluntary (i.e., the permittee could decide not to hold the meeting at all). In consideration of these comments, the Agency has dropped the reference to a second meeting in the Class 3 process. The purpose of today's rule is to specify the minimum requirements that must be followed for a Class 3 modification. Additional activities beyond those contained in today's rule (e.g., additional public meetings) may take place. In fact, EPA encourages frequent and early communications between the permittee and interested local citizens to informally address and resolve issues these parties may have. However, it is inappropriate to prescribe how such voluntary activities must be conducted.

EPA received very few additional comments on the proposed Class 3 procedures. One commenter wanted a provision for automatic authorization in the absence of Agency decisions on Class 3 modifications. EPA declines to do this because Class 3 modifications may have a significant effect on human health and the environment if the appropriate permit conditions based on Part 264 standards are not developed prior to actual implementation. This situation is unlike that for Class 2 modifications, which are more limited in their potential to adversely impact human health and the environment.

4. Other Permit Modifications

Although EPA has sought to provide a complete list of possible permit modifications and their classifications in Appendix I, there will undoubtedly be permit modification requests that are not included in Appendix I. Therefore, EPA today is establishing procedures that permittees can use under § 270.42(d) where a permittee wishing to make a permit modification not included in Appendix I can submit a Class 3 modification request, or alternatively ask the Agency for a determination that Class 1 or 2 modification procedures should apply. In making this determination, the Agency will consider the similarity of the requested modification to modifications listed in Appendix I, and will also apply the general definitions of Class 1, 2, and 3 modifications. It should be noted that EPA intends to monitor decisions by permitting authorities (both EPA Regional offices and authorized States) on modification request classifications and will periodically amend Appendix I of this regulation to include new classifications.

Several commenters supported this proposed approach. Others stated that there should be a specified time limit on the Agency's classification determination. EPA disagrees because the determinations may be varied in nature and complexity. Also, since the decisions may sometimes be precedential, consultations among authorized States, EPA Regional offices, or EPA headquarters may be necessary. The Agency is committed to making a speedy decision for these classifications, but believes that a deadline will not be beneficial in these circumstances. Therefore, EPA has decided not to set a time limit for decisions of modifications classifications.

When the permittee chooses to request a classification determination instead of following the Class 3 process, then he or she should not initiate the formal modification review procedures until the Agency has decided on the appropriate classification. Otherwise, there may be confusion among the public concerning which process is being followed. Furthermore, the deadlines for Agency decisions in the Class 2 process will not begin until after the Agency has decided that the Class 2 procedures are appropriate for the modification and the permittee then proceeds in accordance with § 270.42(b). In any case, it should not take long for the permitting Agency to assign a classification to the modification request.

The proposal provided that the Agency would notify persons on the facility mailing list after making a determination on an unclassified change, and that the public and the permittee would have the right to appeal the decision. EPA is not adopting these provisions in today's rule, as discussed in section IV.B.6 of the preamble.

5. Temporary Authorizations

Today's rule provides the Agency with the authority to grant a permittee temporary authorization, without prior public notice and comment, to conduct activities necessary to respond promptly to changing conditions. (*See* § 270.42(e).) It is expected that temporary authorizations will be useful in the following two situations: (1) To address a one-time or short-term activity at a facility for which the full permit modification process is inappropriate; or (2) to allow a facility to initiate a necessary activity while its permit modification request is undergoing the Class 2 or 3 review process.

An Agency-issued temporary authorization may be obtained for activities that are necessary to: (i) Facilitate timely implementation of closure or corrective action activities; (ii) allow treatment or storage in tanks or containers of restricted wastes in accordance with Part 268; (iii) avoid disrupting ongoing waste management

activities at the permittee's facility; (iv) enable the permittee to respond to changes in the types or quantities of wastes being managed under the facility permit; or (v) carry out other changes to protect human health and the environment. Temporary authorizations can be granted for any Class 2 modification that meets these criteria, or for a Class 3 modification that is necessary to: (i) Implement corrective action or closure activities; (ii) allow treatment or storage in tanks or containers of restricted waste; or (iii) provide improved management or treatment of a waste already listed in the permit, where necessary to avoid disruption of ongoing waste management, allow the permittee to respond to changes in waste quantities, or carry out other changes to protect human health and the environment. A temporary authorization will be valid for a period of up to 180 days. The term of the temporary authorization will begin at the time of its approval by the Agency, or at some specified effective date shortly after the time of approval. The authorized activities must be completed at the end of the authorization.

Several commenters responded on the subject of temporary authorizations. Several supported the approach contained in the proposal, citing the beneficial flexibility to change certain facility operations with no adverse effect to human health or the environment.

Two other commenters supported the use of temporary authorizations, but for more restricted uses (e.g., for on-site wastes only or for unexpected situations only). One commenter was generally opposed because of a lack of public comment and hearings. EPA disagrees because the use of temporary authorizations is allowed only for specified purposes, which are intended to improve the management of hazardous wastes or respond to a critical situation. The Agency will have the authority to deny any requests which are not protective of human health and the environment or do not meet the criteria for a temporary authorization. Also, as discussed below, the permittee must notify persons on the facility mailing list about the temporary authorization and must comply with Part 264 standards for its duration.

The proposal would not have allowed temporary authorizations for periods of less than 90 days. In today's final rule, however, EPA has eliminated this minimum length to provide that the term of a temporary authorization may be for any period up to 180 days. Although two commenters supported the proposed minimum length, EPA is making today's change for two reasons.

First, the minimum specified period of 90 days seemed arbitrary and would likely result in restricting the Agency's flexibility to allow facilities to respond to temporary situations. For example, if the Agency believed that there was good cause to authorize a facility to conduct a particular activity without a permit modification but that the task should be completed within 30 days under the proposal, the Agency would be limited to approving the activity for 90 days or denying the request. Given that temporary authorizations were developed to allow a rapid response without the limitations of a formal permit modification, to set an arbitrary minimum duration would be needlessly restrictive and likely counterproductive.

Second, the duration of a temporary authorization under proposed § 270.42(e) (i.e., 90 to 180 days) was inconsistent with the temporary authorization which may be granted by the Agency at day 90 or 120 in the Class 2 process which can be granted for 1 to 180 days (see § 270.42(b)(6)(i)(D)). The different treatment of these temporary authorizations could lead to confusion.

The criteria in the final rule for approval of temporary authorizations under § 270.42(e)(3) are the same as proposed on September 23, 1987 except for two changes. First, in response to several requests by commenters, EPA is adding a specific provision for the storage and treatment of wastes subject to the land disposal restrictions of Part 268. This will give the regulated industry the flexibility to treat and store restricted wastes in tanks and containers, while the permit modification process is conducted. The Agency believes that there was sufficient flexibility to approve these changes as a temporary authorization under the proposed criteria; however, commenters wanted an assurance that the activities allowed under the recently promulgated minor modification provision in § 270.42(p)—which will be eliminated with today's new modification process—will be eligible for a temporary authorization under the new system. Therefore, these activities involving restricted wastes are specifically endorsed for temporary authorizations in new § 270.42(e)(3)(ii)(B).

In a second change, EPA decided not to retain the proposed temporary authorization provision for management of newly regulated waste. Instead, management of such waste is addressed solely under § 270.42(g). Although some commenters suggested keeping both alternatives, other commenters believed that the special procedure for new wastes in § 270.42(g) is generally more appropriate. EPA believes that it is preferable to have a single procedure for addressing newly regulated wastes, and agrees that § 270.42(g) is more appropriate since it is designed specifically for that situation. (See preamble discussion in Section IV.B.7.)

Section 270.42(e) (2) through (4) details the procedures for granting temporary authorizations. Under these procedures, the permittee must submit to the Agency a request for a temporary authorization describing the activities to be conducted; explain why the temporary authorization was necessary; and provide sufficient information to ensure compliance with Part 264 standards. In addition, the permittee would be required to notify all persons on the facility mailing list and local and State agencies about the temporary authorization request within seven days of the request.

Section 270.42(e)(3) requires the Agency to approve or deny the temporary authorization as quickly as practical. To approve the authorization, the Agency must find that the request meets the criteria for a temporary authorization. It should be noted that today's rule, like the proposal, require compliance with Part 264 for Agency-initiated temporary authorizations. This is because the procedures for obtaining such an authorization provides for Agency review of the permittee's request and an affirmative Agency action to approve the conditions of the authorization. Therefore, an Agency permit writer will be involved in establishing the appropriate operating conditions based on the Part 264 standards. This is in contrast to the automatic temporary authorizations (discussed in Section IV.B.2.ii above) where Part 265 standards are more appropriate since there are no Agency-prescribed site specific conditions developed.

A denial of a temporary authorization request would not prejudice action on any concurrent modification request. The denial only means that the activities contemplated by the permittee were not eligible for a temporary authorization. The request could still be acceptable as a permit modification.

In today's final rule, EPA has modified the language in § 270.42(e)(4) from the proposal. As proposed, § 270.42(e)(4)(i) required the owner or operator to submit a "complete modification request" within 60 days of obtaining a temporary authorization. This provision assumed

there would be circumstances where the permittee might not have time to provide all the material required under Part 270 (e.g., changes to closure plans or training plans) prior to issuance of the temporary authorization.

Several commenters disagreed with this proposal, pointing out that in many cases a temporary authorization could address a short-term or one-time situation, and would not require a permanent modification to the permit and submission of all the Part 270 information. EPA agrees with these commenters, and finds the 60-day deadline unnecessary, particularly since § 270.42(e)(3)(i) requires the permittee to demonstrate in his or her request that the Part 264 standards will be achieved. Thus, the Director should have all information necessary prior to a temporary authorization decision. In cases where some additional minor information is needed, the Director could make the authorization conditional on the submission of this information on an appropriate schedule.

The proposal allowed the renewal of a temporary authorization (§ 270.42 (e)(1) and (e)(4)(iii)), if the permittee initiated the Class 2 or 3 process for a permit modification. Today's rule modifies and clarifies these provisions. As required in § 270.42(e)(4) today, a temporary authorization cannot be reissued except through the following procedures. First, the permittee must initiate the appropriate Class 2 or 3 modification process for the activity covered in the temporary authorization. In addition, for a Class 2 modification, any extension of the activity approved in the temporary authorization must take place under Class 2 procedures. Finally, for a Class 3 modification, the Director may extend the temporary authorization if warranted to allow the authorized activity to continue while Class 3 procedures are completed.

The result of today's change for a temporary authorization that is concurrently undergoing the Class 2 review is to set a limit, generally, of 300 days for operation under the temporary authorization. The proposal would have allowed, in extreme cases, up to 540 days of temporary authorization before a final Agency decision was required. (For example, a 280-day authorization, reissued for a second 180-day period, and then the Director's decision per § 270.42(e)(4)(ii) to issue an additional authorization of 180 days.) These changes were made in response to commenters, who requested a shorter and clearer schedule for Agency decisions on Class 2 changes subject to temporary authorizations. EPA agrees with these comments, and maintains that Class 2 changes should be reviewed rapidly and incorporated into the permit as a modification. It is not appropriate for these decisions to be postponed for up to a year and a half. For these reasons, today's rule does not allow extension of a temporary authorization for a Class 2 activity, except through the Class 2 procedures that are leading to an Agency decision on the modification request.

For Class 3 modifications, the renewal of the temporary authorization is at the discretion of the Director if he or she believes that it is appropriate for the activities to continue while the Class 3 modification process is completed. In most cases it will be difficult to complete the Class 3 process in the 180 days allowed for the temporary authorization, since there will be at least 105 days of public comment (60 days for comment on the applicant's modification request and 45 days for comment on the draft permit modification prepared by the Agency), as well as one or more public meetings and a public hearing, if requested. Therefore, today's rule allows the extension of a Class 3 temporary authorization for an additional 180 days, for a maximum of 360 days. However, this would be allowed only if the facility is proceeding toward a Class 3 modification.

In summary, the Agency-issued temporary authorization mechanism provides a reasonable balance between the public's right to be informed of and comment on activities at permitted hazardous waste facilities and the facility owner/operator's need to implement certain changes rapidly. More generally, the temporary authorization procedure will provide important flexibility to permitted hazardous waste facilities without sacrifice to public health or the environment. Because temporary authorizations are designed specifically for activities necessary to improve management of hazardous waste or to conduct timely closures and corrective actions, this authority should actually reduce risk and promote safe handling of wastes. For this reason, EPA believes that the temporary authorization procedure will be of benefit to the regulated industry, regulating agencies, and the public.

6. Notification Requirements and Permit Modification Appeals

Under today's rule, the Director will notify persons on the facility mailing list and appropriate state and local government agencies within 10 days of any decision to grant or deny a permit modification request (except for Class 1 modifications and temporary authorizations). (*See* § 270.42(f).) Such notification will also be given within 10 days after a Class 2 automatic authorization takes effect. The permit appeal procedures of 40 CFR 124.19 apply to the Director's decision to grant or deny a Class 2 or 3 permit modification request and to Class 2 automatic authorizations. For Class 1 modifications, temporary authorizations, and classification determinations, the appeal procedures of Part 124 do not apply, although in many cases there are opportunities to seek a change in the modification or authorization, as discussed in more detail below.

The proposal provided that the Agency would notify persons on the facility mailing list after making a determination on an unclassified change, after approving a Class 1 modification (when prior approval is needed), and after granting a temporary authorization. However, EPA received a number of comments from state agencies and industry arguing that there are too many required notices in the proposal, and that numerous notifications add complexity to the process and divert Agency resources to administrative tasks instead of to protection of the environment. EPA agrees with this comment for notifications of temporary authorizations, classification determinations, and Class 1 approvals.

In the case of Agency classification determinations, there will be subsequent public notification of the proposed changes as the facility proceeds with its modification request. The public will be able to raise concerns at that time if they believe that the modification request has been incorrectly classified. For these reasons, EPA believes that the notice regarding a classification determination would be redundant, and therefore is not adopting it in today's rule.

For Class 1 modifications, the permittee is required to provide notice of the change to persons on the facility mailing list within 90 days, including those cases where prior Director approval is required. (See § 270.42(a)(1)(ii).) The proposal would have also required that the Agency send a notice of its decision to the facility mailing list for a Class 1 modification that required prior Agency approval. EPA believes that there is no need for the Agency to mail such a notice since the permittee will be sending a similar notice. Two notifications regarding a single Class 1 modification would be a duplication of effort and could also be confusing to people on the mailing list.

Contained-In Policy

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Part III

Environmental Protection Agency

40 CFR Part 260, et al.
Hazardous Remediation Waste Management Requirements (HWIR-Media); Final Rule

conditions. In contrast, prevention-oriented hazardous waste regulations are generally implemented independently by facility owner/operators through complying with national regulatory requirements.

2. LDRs, MTRs, and Permitting Raise Problems When Applied to Remediation Wastes

In the HWIR-media proposed rule, EPA identified the application of three RCRA requirements to remediation wastes as the biggest problems to address; Land Disposal Restrictions (LDRs), Minimum Technological Requirements (MTRs), and permitting.

The LDRs (which appear in 40 CFR part 268) generally prohibit land disposal (or "placement" in land-based units) of hazardous wastes until the wastes have met the applicable treatment standards. Often this placement is appropriate and desirable when managing remediation wastes to excavate them from their current locations, and temporarily store the wastes before on-site treatment, or to excavate the wastes and accumulate enough volume to ship off-site cost effectively. By not allowing temporary storage and accumulation in land-based units, the LDRs can be a strong disincentive to excavating and managing remediation waste. The staging pile provisions of today's final rule address this issue by allowing temporary storage and accumulation of remediation wastes in a staging pile without being subject to LDR.

Another example of the problems with LDRs in the cleanup scenario is that contaminated media are often physically quite different from as-generated process wastes. Contaminated soils often contain complex mixtures of multiple contaminants and are highly variable in their composition, handling, and treatability characteristics. For this reason, treating contaminated soils can be particularly complex, involving one or sometimes a series of custom-designed treatment systems. It can be very difficult to treat contaminated soils to the LDR treatment levels. The parts of the HWIR-media proposal that addressed this issue have been finalized in the LDR Phase IV rule (63 FR 28556 (May 26, 1998)).

The MTR requirements were designed as preventative standards for wastes generated through industrial processes. They were not designed for the remedial context. For example, under 40 CFR Subpart F, surface impoundments, waste piles, and land treatment units or landfills must have specific detection, compliance monitoring programs, and corrective action programs for potential groundwater contamination from the unit. These are appropriate preventative requirements for units managing process wastes. However, many cleanup actions involve short-term placement of remediation wastes into a waste pile, and all of these requirements may not be necessary. The staging piles provisions of today's rule address this issue by allowing the Director to determine appropriate design criteria for the staging pile based on the site-specific circumstances such as the concentration of the wastes to be placed in the unit and the length of time the unit will operate. EPA also explained in the preamble to the CAMU rule additional reasons why LDR and MTR requirements can be counterproductive when managing remediation waste as opposed to as-generated process wastes. To read about these additional reasons, see 58 FR 8658 (8659–8661)(February 16, 1993).

Finally, another area creating roadblocks is permitting. The time-consuming process for obtaining a RCRA permit can delay cleanups, thereby delaying the environmental and public health benefits of cleaning up a contaminated site. For example, the traditional RCRA permitting process requires the facility owner/operator to submit a great deal of information on activities at the facility to EPA or the State, and the permit must include terms and conditions to protect against any improper waste management practices over the long-term active life of an operating facility. Because of the large volume of information submitted, these permits are huge documents and approval often takes several years. However, in the remedial scenario, cleanup activities are generally a one-time project; once the cleanup is completed and the remediation waste is properly treated and disposed, then the activities are completed. Also, these activities are limited to addressing the contamination at the site, and therefore are often more limited in scope than the operating practices of a facility that is engaged in on-going waste treatment, storage and disposal. To overcome the limitations discussed above from traditional RCRA permits, the new Remedial Action Plans (RAPs) requirements in today's rule streamline the process for receiving a permit for treating, storing and disposing of remediation wastes, and require the facility owner/operator to submit significantly less information than for a traditional RCRA permit. However, the information submitted for a RAP application and RAP terms and conditions must be sufficient to ensure proper waste management of the remediation wastes involved during the life of the cleanup activities.

Furthermore, a facility seeking a traditional RCRA permit to manage remediation wastes on-site must investigate and cleanup their entire facility (facility-wide corrective action). This requirement can deter potential cleanups from happening at all. For instance, facility owners and operators may wish to clean up a small portion of their facility for any number of reasons, such as to avoid future liability, to free the property for sale or other uses, or because they simply wish to restore the environmental health of their property. However, they may not be willing to take on the burden of investigating and cleaning up their entire facility, when it is only a small portion they wish to voluntarily clean up, and they may be reluctant to conduct the cleanup under the RCRA corrective action program. Therefore, to encourage cleanups, under today's final rule, facilities that need a RCRA permit only to treat, store, or dispose of remediation wastes (remediation-only facilities) are not subject to the facility-wide corrective action requirement.

B. How Has EPA Tried to Solve These Problems in the Past?

EPA has tried to solve these problems in the past through a series of regulations and policies; for example;

- The "Area of Contamination" (AOC) policy;
- The "contained-in" policy; and
- The regulations for Corrective Action Management Units (CAMUs), and temporary units.[1]

All of these regulations and policies help alleviate some of the problems facing cleanups, but none have completely solved these problems. (See the October 1997 report by the United States General Accounting Office, "Remediation Waste Requirements Can Increase the Time and Cost of Cleanups."[2])

The AOC policy allows important flexibility for activities done within a contiguous contaminated area. For example, hazardous remediation wastes may be consolidated or treated *in situ*

[1] 61 FR 18780, 18782 (April 29, 1996), memorandum from Michael Shapiro, Director, Office of Solid Waste, Stephen D. Luftig, Director, Office of Emergency and Remedial Response, and Jerry Clifford, Director, Office of Site Remediation Enforcement, EPA to RCRA Branch Chiefs and CERCLA Regional Managers, (March 13, 1996); 55 FR 8666, 8758–8760 (March 8, 1990); and 58 FR 8658 (February 16, 1993).

[2] Hazardous Waste: Remediation Waste Requirements Can Increase the Time and Cost of Cleanups, U.S. General Accounting Office, GAO/RCED–98–4, October 1997.

within an AOC without triggering the LDRs or MTRs. However, the AOC policy does not address the permitting issues today's rule is addressing, nor does it address LDR and MTR for wastes removed from an AOC, or treated *ex situ*.

The contained-in policy defines when some contaminated media can be considered to no longer "contain" hazardous waste. When EPA or an authorized State determines that media do not "contain" hazardous waste, RCRA does not generally pose a barrier to remediation because permitting requirements, LDRs (generally), and MTRs do not apply to media that do not contain hazardous waste. However, the contained-in policy is limited to media only, and does not provide any flexibility for other remediation wastes, nor does it provide needed flexibility for highly concentrated media.

The CAMU and temporary unit rules provide much-needed flexibility for unit-specific standards at cleanup sites. CAMUs and temporary units are not subject to LDRs or MTRs. The requirements for these units are set on a site-specific basis, depending on site-specific factors such as the types of wastes being managed (for example, concentrations, volumes, other characteristics) and the period of time the unit will operate. However, CAMUs and temporary units do not address any of the permitting issues that cause problems for remediation wastes.

Because each of these regulations or policies is limited in solving the problems inherent to managing hazardous remediation waste under the RCRA Subtitle C system, EPA felt it was necessary to propose additional solutions.

C. How Did the Proposed Rule Attempt to Solve These Problems?

EPA recognized a continuing need for further reforms than the regulations and policies discussed above had provided, and yet knew that these reforms would be controversial. In 1993, EPA convened a committee under the Federal Advisory Committee Act (FACA) to provide recommendations to EPA on how to make these reforms. The FACA Committee included representatives from environmental groups, regulated industry, the waste management industry, States, and EPA. The FACA Committee met numerous times between January 1993 and September 1994. EPA based the options in the April 29, 1996 HWIR-media proposal on the recommendations and discussions of the FACA Committee.

EPA presented several options for reforms in the HWIR-media proposal. EPA presented two comprehensive options (the Bright Line and the Unitary Approach), and requested comment on sub-options and issues within those comprehensive options.

1. The "Bright Line" Approach for Contaminated Media

The first comprehensive option, which formed the basis for the proposed rule, was the "Bright Line" option. The Bright Line option would have been limited to "contaminated media" only. Contaminated media was defined to include soils, groundwater, and sediments, but not debris, nor other remediation wastes such as sludges. The Bright Line option got its name from a "line" dividing more highly contaminated media from less contaminated media. That Bright Line was a set of constituent-specific concentrations based on the risks from those constituents. Media found to contain constituents above these concentrations would have remained subject to Subtitle C management requirements (however, the proposal requested comment on some potential modifications to those requirements), and media containing constituents below the concentrations would have been eligible for a determination that it no longer "contained" hazardous waste, thereby generally removing it from Subtitle C jurisdiction.

The determinations of which media were and were not subject to Subtitle C requirements were to be documented in a Remediation Management Plan (RMP) approved by EPA or an authorized State. The RMP would have been an enforceable document that would also have included any requirements for managing media below the Bright Line, and would have served as a RCRA Subtitle C permit for treatment, storage or disposal of media above the Bright Line. The RMP process would have been more streamlined than that required for RCRA permits obtained under the current regulations, and also, at remediation-only facilities, would not have required 3004(u) and (v) facility-wide corrective action, as is required for all RCRA permits before today's rule.

2. Other Options Within the "Bright Line" Approach

Other requirements that EPA proposed to modify were LDR treatment standards for soils that remained subject to Subtitle C requirements, standards applicable to on-site storage and/or treatment of cleanup wastes during the life of the cleanup, and State authorization requirements. New treatment standards would have applied to soils that remained subject to LDRs under the Bright Line approach. EPA also proposed a new unit called a "remediation pile." Remediation piles could have been used temporarily without triggering LDRs and MTRs, for the on-site treatment or storage of remediation wastes subject to Subtitle C. States picking up any revisions to their RCRA programs (the proposal was not limited to the revisions to remediation waste management programs) could have followed new streamlined authorization procedures. Also, EPA proposed to withdraw the CAMU regulations if the final HWIR-media rule would sufficiently replace the flexibility currently available under the CAMU rule.

Finally, EPA proposed excluding dredged materials from Subtitle C if they were managed under permits issued under the Clean Water Act (CWA) or Marine Protection Research and Sanctuaries Act (MPRSA).

3. The "Unitary" Approach—An Alternative to the "Bright Line"

As an alternative to the Bright Line approach, EPA requested comment on the "Unitary Approach." The Unitary Approach excluded all remediation wastes (irrespective of the concentration of hazardous constituents in the waste and including non-media remediation wastes) managed under a Remedial Action Plan (RAP) (which was very similar to a RMP) from Subtitle C management requirements and made them subject to site-specific requirements in the RAP.

Again, EPA requested comment on the two main comprehensive options, the Bright Line and the Unitary Approach, and on all the sub-issues, such as the proposed elimination of CAMUs, and the new requirements for remediation piles, LDR, RMPs and RAPs, dredged materials, and State authorization.

D. What General Comments did EPA Receive About the Two Major Proposed Options?

Some commenters supported the Bright Line option and thought it was appropriate to distinguish between highly contaminated media and media that were less contaminated, and to regulate them differently.

However, most commenters on the Bright Line option believed that the Bright Line would be too difficult to implement, and therefore should not be finalized. There were several elements of the Bright Line option that commenters were concerned about implementing. One concern was sampling to determine whether media was above or below the Bright Line.

Concentrations of contaminants in environmental media typically are not heterogeneous, and it is difficult to make assumptions about the concentrations of large areas of contamination without taking many samples.

Another concern was how to differentiate between media, debris, and other remediation wastes, such as sludges. Commenters stated that often these different types of remediation waste are all found at the same site and they will all need to be managed, and it would be unduly complicated to have to separate the different types of remediation wastes and manage them separately under separate regulatory requirements.

Also, commenters were concerned about the methodology that EPA used to determine the Bright Line levels themselves. EPA received many specific comments on the proposed Bright Line constituent specific numbers, as well as the choice of which constituents were assigned Bright Line numbers.

With regard to the Unitary Approach, many industry and State commenters supported the Unitary Approach, saying that the flexibility would greatly streamline cleanups and allow more appropriate decisions for managing remediation waste. These commenters emphasized that flexibility was needed so that States could develop cleanup programs with oversight and public participation requirements specific to the concerns, needs, and resources of individual States, and felt that the Unitary Approach most closely addressed those concerns. However, some commenters were concerned that the lack of any national requirements was too open-ended and would not guarantee protectiveness. Commenters were also concerned about the resources required for States and Regions to make site-specific determinations of the appropriate management requirements for remediation wastes at each different site.

Finally, commenters had many specific comments on the elements of these options such as RAPs and RMPs, remediation piles, LDRs, etc. Major comments and EPA's responses are summarized under those more specific sections of this preamble, and all comments are answered specifically in the "response to comments" document for today's rule.

E. What did EPA Decide to do After Considering Those Comments?

EPA has decided to promulgate only selected elements of the HWIR-media proposal in today's rule, rather than go forward with a more comprehensive approach as proposed. EPA plans to complement the elements finalized today by leaving the CAMU regulations in place, rather than withdrawing these regulations as proposed.

Although EPA conducted a lengthy outreach process before developing the HWIR-media proposal and made every effort to balance the concerns and interests of various stakeholder groups, public comment on the proposal makes it clear that stakeholders fundamentally disagree on many remediation waste management issues.

EPA agreed with commenters' concerns that the Bright Line approach would be too difficult to implement, and that a Bright Line that would satisfy commenters who wanted the Bright Line levels to consist of very conservative levels would not sufficiently reform the system to remove the existing barriers to efficient, protective remediation waste management. EPA has concluded that pursuing broader regulatory reform would be a time- and resource-intensive process that would most likely result in a rule that would provoke additional years of litigation and associated uncertainty. This uncertainty would be detrimental to the program and have a negative effect on ongoing and future cleanups. Based on these conclusions, the Agency has decided not to finalize either the Bright Line or the Unitary Approach, and recognizes that a purely regulatory response will not solve all of the remediation waste management issues that HWIR-media was designed to solve.

While EPA believes the elements finalized today along with the retention of the CAMU rule, will improve remediation waste management and expedite cleanups, the Agency is also convinced that additional reform is needed to expedite the cleanup program, especially to provide greater flexibility for non-media remediation wastes like remedial sludges, address certain statutory permitting provisions, and more appropriate treatment requirements for remediation wastes (for example, treatment that focuses on "principal threats" rather than all underlying hazardous constituents). Therefore, the Agency continues to support appropriate, targeted legislation to address application of RCRA Subtitle C land disposal restrictions, minimum technological and permitting requirements to remediation waste and will continue to participate in discussions on potential legislation. If legislation is not forthcoming, the Agency may reexamine its approach to remediation waste regulation and may take additional administrative action.

The elements finalized in today's rule are:

- Streamlined permitting for treating, storing and disposing of remediation wastes generated at cleanup sites that, among other things, eliminates the requirement for facility-wide corrective action at remediation-only facilities;
- A variation on the proposed remediation piles, called staging piles, modified in response to public comments;
- A RCRA exclusion for dredged materials managed under Clean Water Act (CWA) or Marine Protection Research and Sanctuaries Act (MPRSA) permits; and
- Streamlined procedures for State authorization.

EPA also finalized, in a separate document (63 FR 28604 (May 26, 1998)), the LDR treatment standards specific to hazardous contaminated soil that were proposed in the HWIR-media proposal. EPA is deferring action on the Treatability Sample Exclusion Rule, that EPA requested comments on expanding in the HWIR-media proposal at 61 FR 18817.

EPA will withdraw all other portions of the proposal, such as the proposal under the Bright Line option to distinguish between lower- and higher-risk contaminated media and give regulatory agencies the flexibility to exempt lower-risk contaminated media from RCRA requirements, and the portion of the proposal that proposed to withdraw the CAMU rule.

Existing areas of flexibility for managing remediation waste, such as the contained-in and AOC policies, and site-specific land disposal restrictions treatability variances, continue to be available.

III. Definitions Used in this Rule (§ 260.10)

Some terms defined in today's rule may be difficult to understand when discussed out of context of the rest of the rule; therefore, readers may wish to read the preamble sections on RAPs and staging piles before reading this section on definitions. To discuss related terms together in this preamble, discussion of the definitions is not in alphabetical order (which is how the terms appear in the rule language). The section discusses:

- First the revised definition of "corrective action management unit" or "CAMU," then
- The definition of "remediation waste," then
- "Remediation waste management site" and "facility," then
- "Staging pile," then finally,
- "Miscellaneous unit."

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 21 1998

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

William R. Weissman
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1200 Nineteenth Street, N.W.
Washington, D.C. 20036-2430

Dear Mr. Weissman:

Thank you for your letter of May 11, 1998 and for meeting with us to discuss the Utility Solid Waste Activities Group's (USWAG's), Edison Electric Institute's (EEI's) and the American Gas Association's (AGA's) concerns regarding the effects the land disposal restrictions (LDR) treatment standards published on May 26, 1998 may have on cleanup of manufactured gas plant sites. Like you, we are interested in encouraging and facilitating cleanup of manufactured gas plant sites in a way that is both efficient, economical and protective of human health and the environment. Before addressing the specific concerns raised in your letter, we will review some of the general principles that govern application of RCRA to contaminated soil.

As you know, contaminated soil, of itself, is not hazardous waste and, generally, is not subject to regulation under RCRA. Contaminated soil can become subject to regulation under RCRA if the soil "contains" hazardous waste. EPA generally considers contaminated soil to contain hazardous waste: (1) when soil exhibits a characteristic of hazardous waste; and, (2) when soil is contaminated with hazardous constituents from listed hazardous waste above certain concentrations. 63 FR at 28617 (May 26, 1998).

If contaminated soil contains hazardous waste, then it is subject to all applicable RCRA requirements until the soil no longer contains hazardous waste (i.e., until the soil is decharacterized or, in the case of soil containing listed hazardous waste, until EPA or an authorized state determines that the soil no longer contains listed hazardous waste). In some circumstances, soil that no longer contains hazardous waste, while generally not subject to RCRA requirements, will remain subject to the land disposal restrictions. See 63 FR at 28618 (May 26, 1998) and other sources cited therein. This may be the case if contaminated soil from manufactured gas plants exhibits a hazardous characteristic when first generated (i.e., when first removed from the land) and is subsequently decharacterized. Note that if contaminated soil from manufactured gas plant sites does not exhibit a characteristic of hazardous waste or contain listed hazardous waste when first generated (i.e., when first removed from the land), then the soil is not subject to any RCRA requirements, including the land disposal restrictions. 63 FR 28618 (May

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26, 1998)[1]

We understand that at some manufactured gas plant cleanup sites, soil is consolidated within an area of contamination prior to being removed from the land (i.e., generated). This practice, and the area of contamination policy generally, is not affected by the May 26, 1998 rulemaking. Contaminated soil may be consolidated within an area of contamination before it is removed from the land (i.e., generated); the determination as to whether the soil exhibits a characteristic of hazardous waste or contains listed hazardous waste may be made after such consolidation. The Agency's most recent guidance on the area of contamination policy is enclosed for your information.

We understand from our discussions that your concerns center around management of contaminated soil that exhibited a characteristic of hazardous waste when first generated but has subsequently been decharacterized. We will address two questions in this letter: (1) what are the Agency's rules and policies concerning land disposal of decharacterized wastes, including decharacterized contaminated soil and (2) when decharacterized contaminated soil remains subject to the land disposal restrictions, what requirements apply prior to land disposal.

1. What are the Agency's rules and policies concerning land disposal of decharacterized wastes, including decharacterized contaminated soil?

Decharacterized waste (and decharacterized contaminated soil) is not hazardous waste, and is generally not subject to the Subtitle C regulations. Nonetheless, as you are aware, under certain circumstances decharacterized wastes (and decharacterized contaminated soils) remain subject to LDR treatment requirements. See generally, Chemical Waste Management v. EPA, 976 F. 2d 2, 13-14 (D.C. Cir. 1992).

When decharacterized wastes (and decharacterized contaminated soils) remain subject to LDR treatment requirements (i.e., as explained above, when the soils exhibit a hazardous waste characteristic when removed from the land) they must meet applicable LDR treatment standards prior to land disposal, before they can be land disposed, (i.e., before they can be placed in a land disposal unit). RCRA 3004(k) defines land disposal to include, but not be limited to, any placement in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave. Furthermore, EPA has found, in other contexts, that open pits, flat or low walled concrete pads that do not effectively

[1] The exception to this general rule is soil contaminated by listed hazardous waste when the listed hazardous waste is land disposed after the effective date of applicable LDR treatment requirements without meeting such applicable requirements. In this case, the contaminated soil would be subject to land disposal restriction treatment requirements regardless of whether it "contained" hazardous waste when first removed from the land unless there is a finding that hazardous constituent levels are sufficiently low so that threats to human health and the environment posed by land disposal of the soil are minimized. See 63 FR at 28618 (May 26, 1998). As we understand the conditions at most manufactured gas plant cleanup sites, we believe this case will seldom be presented during manufactured gas plant cleanups because soil at manufactured gas plant sites is not typically contaminated by listed hazardous waste.

contain hazardous wastes and hazardous constituents may constitute land disposal. See the enclosed letter from Sylvia Lowrance, U.S. EPA to Richard Wasserstrom dated October 29, 1992. However, EPA's longstanding view is that placement in tanks, containers, and containment buildings is not land disposal. See, e.g., 57 FR 37211 (August 18, 1992) (establishing standards for containment buildings). EPA has established design and operating requirements for tanks, containers and containment buildings used to treat and store hazardous waste. Clearly, units used for treatment or storage of decharacterized contaminated soil which meet these requirements would not be considered land disposal units and may be used to treat or store decharacterized contaminated soil without the approval of EPA or an authorized state. However, since decharacterized contaminated soil is no longer subject to regulation as hazardous waste (except, potentially, for land disposal treatment requirements), treatment and storage units used to manage decharacterized contaminated soil are not hazardous waste management units and do not have to be designed or operated in accordance with RCRA Subtitle C hazardous waste regulations or receive hazardous waste permits. If decharacterized contaminated soil will be treated or stored in a unit which is not a tank, container, or containment building, EPA or an authorized state should make a site-specific determination as to whether or not placement of decharacterized contaminated soil in the unit constitutes land disposal. In making such determinations, in addition to the mandatory consideration of the definition of land disposal in section 3004(k), EPA will consider (and recommends that authorized states similarly consider) the relevant requirements established by the Agency for tanks, containers, and containment buildings and, if these requirements are modified, whether the treatment or storage unit will prevent or control unacceptable releases of decharacterized contaminated soil and hazardous constituents to the environment. These determinations should be made in the context of your on-going MGP site cleanups and should be included in the public notices which are typically part of cleanup processes. We recognize that determinations about containment units will likely be made predominantly by authorized states and that due to site- and waste-specific variability containment units will have to accommodate the variety of conditions that may be presented during cleanup of MGP sites.

2. **When decharacterized contaminated soil remains subject to the land disposal restrictions, what requirements apply prior to land disposal ?**

When decharacterized contaminated soil remains subject to the land disposal restrictions, three types of requirements apply. First, the soil must be treated to meet applicable land disposal treatment standards prior to land disposal. Second, as discussed above, prior to land disposal the soil must be treated or stored in an appropriate type of unit (i.e., a unit that is not a land disposal unit). Third, to ensure that applicable land disposal treatment standards are met, certain tracking, paperwork and other requirements must be met.

(a) **Treatment to meet applicable land disposal treatment standards.** As just noted above, like any other material subject to the land disposal restrictions, decharacterized soils from MGP cleanup sites must be treated to meet applicable land disposal restriction treatment standards prior to land disposal. In the case of contaminated soils subject to the land disposal

restrictions, generators may choose between meeting the universal treatment standard for the contaminating hazardous waste or meeting the alternative soil treatment standards. For decharacterized contaminated soils, meeting the universal treatment standard for the contaminating hazardous waste would require treatment of the formerly characteristic constituent and all underlying hazardous constituents to the universal treatment standards. Meeting the alternative soil treatment standards would require treatment of the formerly characteristic constituent and all underlying hazardous constituents to reduce constituent concentrations by 90 percent or to achieve ten times the universal treatment standard. Note that, as with any other material subject to the land disposal restrictions, contaminated soil may qualify for treatment variances under certain circumstances, see 40 CFR 268.44.

(b) ***Storage and treatment prior to land disposal.*** As discussed above, although decharacterized contaminated soil is not hazardous waste and, generally, is therefore not subject to RCRA Subtitle C requirements, because it remains subject to the land disposal restrictions, it must be stored and treated in appropriate units (i.e., units that are not land disposal units) until treatment standards are met.

(c)**Tracking, paperwork and other requirements.** If decharacterized contaminated soil is stored, the storage prohibition of RCRA 3004(j) generally applies. This means that the decharacterized contaminated soil can only be stored for the purpose of accumulating necessary quantities of hazardous wastes to facilitate proper recovery, treatment, or disposal. See 40 CFR 268.50.

For decharacterized contaminated soil, the reporting and record keeping requirements of 40 CFR 268.9 apply. For example, if characteristic soil from an MGP cleanup is decharacterized at the site where it was generated, then sent off-site for further treatment to achieve LDR standards in a thermal desorption unit, the generator of the contaminated soil must complete a one-time notification and certification. The one-time notification and certification provides a description of the soil as initially generated, including applicable hazardous waste codes, treatability groups, and underlying hazardous constituents. It also provides information about the facility which will receive, and treat, the decharacterized soil. Thus, in this example the generator of the contaminated soil would identify the facility operating the thermal desorption unit. A copy of the one time notification and certification must be placed in the generator's files and sent to the appropriate EPA region or authorized state. These requirements create a tracking system so EPA and authorized states can determine that materials subject to the land disposal restrictions arrive at the right place and are appropriately treated prior to land disposal.

Furthermore, the dilution prohibition of 40 CFR 268.3 applies to the decharacterized contaminated soil until applicable LDR treatment standards are achieved. As you are aware, dilution is normally prohibited as a means of achieving the LDR treatment standards, including for characteristic (and decharacterized) wastes. See Chemical Waste Management v. EPA, 976 F. 2d 2, 15-19 (D.C. Cir. 1992).

We understand that often decharacterized contaminated soils from MGP cleanup sites are returned to the utility's power plant and mixed with coal or other combustibles prior to burning in a utility boiler. The Agency does not consider this process a form of impermissible dilution. Mixing MGP waste with coal or other combustibles results in a physical change to the waste stream that makes the waste more amenable to combustion (which, in addition to being a type of energy recovery, is a form of treatment that destroys or removes the hazardous constituents), and thus facilitates proper treatment.

In addition to mixing with coal or other combustibles, other types of mixing or treatment of decharacterized contaminated soil may be permissible prior to final treatment, provided that these processes produce chemical or physical changes and do not merely (1) dilute the hazardous constituents into a larger volume of waste so as to lower the constituent concentration or (2) release excessive amounts of hazardous constituents to the air. If mixing or other pre-treatment is necessary to facilitate proper treatment (e.g., destruction or removal, such as burning in a boiler) in meeting the treatment standards then dilution is permissible. See 51 FR 40592 (November 7, 1986) and 53 FR 30911 (August 16, 1988).

Note that, in some instances, burning decharacterized contaminated soil mixed with coal in a utility boiler may implicate the Bevill amendment. As you are aware, EPA's position is that wastes which are covered by the Bevill amendment are not subject to LDR requirements. 40 CFR 268.1(b); see also Horsehead Resource Development Co. v. Browner, 16 F. 3d 1246, 1260-61 (D.C. Cir. 1994) (upholding EPA's position). Consequently, if decharacterized contaminated soil is burned in utility boilers along with coal and the resulting combustion ash is within the scope of the Bevill amendment, LDR standards do not have to be met for that ash, nor would the decharacterized contaminated soils be considered to be a prohibited waste. In this case, the only reporting and recordkeeping requirement required is a one-time notice kept in the facility's records. See 40 CFR 268.7 (a)(7).

We appreciate your patience with the Agency in responding to your concerns. If you need further assistance, please contact Rita Chow of my staff at (703) 308-6158.

Sincerely,

Elizabeth A. Cotsworth
Acting Director
Office of Solid Waste

Enclosure (2)

530-Z-98-001

federal register

Tuesday
May 26, 1998

Part II

Environmental Protection Agency

40 CFR Parts 148, 261, 266, 268, and 271
Land Disposal Restrictions Phase IV: Final Rule Promulgating Treatment Standards for Metal Wastes and Mineral Processing Wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issues; Treatment Standards for Hazardous Soils, and Exclusion of Recycled Wood Preserving Wastewaters; Final Rule

EPA also emphasizes that any dilution of a prohibited contaminated soil (or of a prohibited hazardous waste with soil) as a substitute for adequate treatment to achieve compliance with LDR treatment standards or to circumvent the effective date of an LDR prohibition is considered a type of impermissible dilution and is illegal. Therefore, any deliberate mixing of prohibited hazardous waste with soil in order to change its treatment classification (i.e., from waste to contaminated soil) is illegal. Existing regulations concerning impermissible dilution already make this point. See 40 CFR 268.3(a) and (b); see also 57 FR at 37243 (Aug. 18, 1992) (adopting the same principle for contaminated debris). The Agency expects that deliberate mixing of hazardous waste with soil (and vice versa) will be rare because such actions are clearly illegal and would subject generators to substantial fines and penalties, including criminal sanctions. In addition, the resulting mixture (hazardous waste impermissible diluted by soil) would continue to be subject to the LDRs for the original hazardous waste (i.e., generally, the universal treatment standards), so no benefit in terms of reduced treatment requirements would occur. The Agency took a similar approach when promulgating treatment standards specific to hazardous debris. See 57 FR at 37224 (August 18, 1992).

The Agency notes that the normal mixing of contaminated soil from various portions of a site that typically occurs during the course of remedial activities or in the course of normal earthmoving and grading activities is not considered intentional mixing of soil with non-media or prohibited soil with non-prohibited soil and, therefore, is not a type of impermissible dilution.

D. Seeking Treatment Variances Because the National Treatment Standard is Unachievable or Inappropriate

Under existing regulations at 40 CFR 268.44, people may obtain a variance from a land disposal restriction treatment standard when a waste cannot be treated to the specified level or when a treatment standard may be inappropriate for the waste. With respect to contaminated soils, EPA has to this point presumed that a treatment variance would generally be needed because the LDR treatment standards developed for process wastes were either unachievable (generally applied to soil contaminated by metals) or inappropriate (generally applied to soil contaminated by organic constituents). See, for example, 55 FR 8760 (March 8, 1990); 58 FR 48092, 48125 (September 14, 1993); 61 FR 18805–18808, 18810–18812 (April 29, 1996); and, 61 FR 55717 (October 28, 1996). This presumption will no longer apply once today's soil treatment standards take effect. This is because today's standards were developed specifically for contaminated soils and are intended to specifically address the past difficulties associated with applying the treatment standards developed for process waste to contaminated soil.

This is not to say that treatment variances based on the "unachievable" or "inappropriate" prongs of the test are now unavailable for contaminated soils. For example, in some cases it may prove that even though an appropriate technology, suited to the soil matrix and constituents of concern was used, a particular soil cannot be treated to meet the soil treatment standards using a well-designed well-operated application of one of the technologies EPA considered in establishing the soil standards. In these types of cases, under existing regulations, the soil treatment standard would be considered "unachievable" and a treatment variance could be approved. In other cases, under existing regulations, application of the soil treatment standards might be "inappropriate" in that, for example, it would present unacceptable risks to on-site workers.

As noted earlier in today's preamble, alternative LDR treatment standards established through treatment variances must, according to 40 CFR 268.44(m), "minimize threats to human health and the environment posed by land disposal of the waste." In cases where an alternative treatment standard does not meet this requirement, a treatment variance will not be approved even though application of a technology more aggressive than the technologies on which the soil treatment standards are based might then be necessary. For example, in cases where the soil treatment standards cannot be achieved through application of a well-designed, well-operated application of one of the model soil treatment technologies and application of the model technology or other non-combustion technologies will not result in constituent concentrations that minimize threats, a variance would not be approved and combustion would be necessary. This is proper given that the soil treatment standards were not developed using the methodology typically used in the land disposal restriction program (i.e., application of the most aggressive treatment technology to the most difficult to treat waste), but, instead are designed to accommodate a variety of soil treatment technologies that are typically used during remediation. Variances for treatment of contaminated soil will be applied during the remedial context, where, as discussed in Section VII.B.3 of today's preamble, EPA and authorized states will typically have detailed information about the risks posed by specific hazardous constituents, direct and indirect exposure routes, risk pathways and human and environmental receptors. This information can be used to inform decisions about whether threats are minimized.

E. The Contained-In Policy

The contained-in principle is the basis for EPA's longstanding interpretation regarding application of RCRA Subtitle C requirements to mixtures of contaminated media and hazardous wastes. Under the "contained-in" policy, EPA requires that soil (and other environmental media), although not wastes themselves, be managed as if they were hazardous waste if they contain hazardous waste or exhibit a characteristic of hazardous waste. See, for example, 53 FR 31138, 31148 (August 17, 1988) and 57 FR 21450, 21453 (May 20, 1992) (inadvertently citing 40 CFR 261(c)(2) instead of 40 CFR 261.3(d)(2)); see also Chemical Waste Management v. EPA, 869 F.2d 1526, 1539–40 (D.C. Cir. 1989) (upholding the contained-in principle as a reasonable interpretation of EPA regulations). In practice, EPA has applied the contained-in principle to refer to a process where a site-specific determination is made that concentrations of hazardous constituents in any given volume of environmental media are low enough to determine that the media does not "contain" hazardous waste. Typically, these so called "contained-in" determinations do not mean that no hazardous constituents are present in environmental media but simply that the concentrations of hazardous constituents present do not warrant management of the media as hazardous waste.[46] For contaminated soil, the result of "contained-in determinations" is that soil no longer "contains" a

[46] Of course, as noted earlier, EPA or an authorized state could determine, at any time, that any given volume of environmental media did not contain (or no longer contained) any solid or hazardous waste (i.e., it's just media). These types of determinations might be made, for example, if concentrations of hazardous constituents fall below background levels, or are at non-detectable levels. Such a determination would terminate all RCRA Subtitle C requirements, including LDRs. See, September 15, 1995 letter from Michael Shapiro (EPA) to Peter Wright (Monsanto Company), making this finding, and 61 FR 18806 (April 29, 1996).

hazardous waste; however, as discussed above, the result is not automatically that soil no longer must comply with LDRs.

In order to preserve flexibility and because EPA believes legislative action is needed, the Agency has chosen, at this time, not to go forward with the portions of the September 14, 1993 or April 29, 1996 proposals that would have codified the contained-in policy for contaminated soils. The Agency continues to believe that legislation is needed to address application of certain RCRA subtitle C requirements to hazardous remediation waste, including contaminated soil. If legislation is not forthcoming, the Agency may, in the future, re-examine its position on the relationship of the contained-in policy to site-specific minimize threat determinations based on implementation experience and/or may choose to codify the contained-in policy for contaminated soil in a manner similar to that used to codify the contained-in policy for contaminated debris.

1. Current Guidance on Implementation of the Contained-in Policy

EPA has not, to date, issued definitive guidance to establish the concentrations at which contained-in determinations may be made. As noted above, decisions that media do not or no longer contain hazardous waste are typically made on a case-by-case basis considering the risks posed by the contaminated media. The Agency has advised that contained-in determinations be made using conservative, health-based levels derived assuming direct exposure pathways. 61 FR at 18795 (April 29, 1996) and other sources cited therein. A compilation of many of the Agency's statements on the contained-in policy has been placed in the docket for today's rulemaking.

The land disposal restriction treatment standards for contaminated soil promulgated today do not affect implementation of the contained-in policy. They are not considered, and should not be used, as de facto "contained-out" concentrations although, in some cases, it may be appropriate to determine that soil treated to the soil treatment standards no longer contains hazardous waste. Remediation project managers should continue to make contained-in decisions based on site-specific conditions and by considering the risks posed by any given contaminated media.

2. Relationship of the Contained-In Policy to Site-Specific, Risk-Based Minimize Threat Determinations

As discussed above, the D.C. Circuit held in the Chemical Waste opinion that the RCRA Section 3004(m) obligation to minimize threats can continue even after a waste would no longer be identified as "hazardous." Chemical Waste Management v. EPA, 976 F.2d at 13–16. The Agency believes that it is prudent to apply the logic of the Chemical Waste opinion to contaminated soil. Therefore, when the contained-in policy is applied to soil that is already subject to a land disposal prohibition, the Agency is compelled to decide if a determination that soil does not or no longer "contains" hazardous waste is sufficient to determine that threats posed by subsequent land disposal of those soils have been minimized. As discussed earlier in today's preamble, EPA is not, at this time, able to make a generic finding that all contained-in determinations will automatically satisfy this standard. This is largely because, for reasons of needed administrative flexibility and because we believe legislation is needed, EPA has not codified standards for approving contained-in determinations and has not codified procedures for making such determinations. Absent such standards and procedures, the Agency cannot, at this time, make a generic finding that all contained-in determinations will result in constituent concentrations that also minimize threats within the meaning of RCRA Section 3004(m). These decisions, of course, could be made on a site-specific basis, by applying the standards and procedures for site-specific, risk-based minimize threat variances, promulgated today.

The regulations governing site-specific, risk-based minimize threat determinations promulgated today are, essentially, the same as the Agency's guidance for making contained-in determinations. See, for example, 61 FR 18795 (April 29, 1996) and other sources cited therein. That is, decisions should be made by considering the inherent risks posed by any given soil, assuming direct exposure (i.e., no post-land disposal controls) and applying conservative information to calculate risk. Therefore, the Agency expects that, in most cases, a determination that soils do not (or no longer) contain hazardous waste will equate with minimize threat levels and, therefore, encourages program implementors to combine contained-in determinations, as appropriate, with site-specific, risk-based minimize threat variances.

F. Relationship of Soil Treatment Standards to the Final HWIR-Media Rule

In the April 29, 1996 HWIR-Media proposal, EPA proposed to establish a comprehensive alternative management regime for hazardous contaminated media, of which the treatment standards for contaminated soil would have been a small part. The HWIR-Media proposal discussed a number of options for comprehensive management standards for hazardous contaminated media.

Today's action resolves and finalizes the portion of the HWIR-Media proposal that addressed land disposal restriction treatment standards for contaminated soil. See 61 FR 18805–18814, April 29, 1996. Other portions of the proposal are not resolved by this action and will be addressed by EPA in future actions. EPA continues to emphasize that, while the soil-specific LDR treatment standards will improve contaminated soil management and expedite cleanups, the Agency also recognizes that additional reform is needed, especially for management of non-media remediation wastes like remedial sludges. The Agency will continue to participate in discussions on potential legislation to promote this additional needed reform.

VIII. Improvements and Corrections to LDR Regulations

Summary: The regulated community has pointed out several examples of the LDR regulations that were unclear or had typographical errors. These sections are clarified and corrected below.

A. Typographical Error in Section 261.1(c)(10)

A typographical error was found in the cross reference in the note in §261.1(c)(10). The first Phase IV final rule ("Minirule," 62 FR 25998) said "They are covered under the exclusion from the definition of solid waste for shredded circuit boards being recycled (261.4(a)(13))." The correct cross reference is to "(261.4(a)(14)." This typographical error is corrected in this final rule.

B. Typographical Error in Section 268.4(a)(2)(ii) and (a)(2)(iii)

These paragraphs have referred to §268.8 for some time. Section 268.8 was where the so called "soft hammer" provisions were once found in the regulations. These provisions expired in 1990, and the provisions have been removed from the regulations; thus there is no need to continue to include references to §268.8.

federal register

Monday
April 29, 1996

Part II

Environmental Protection Agency

40 CFR Part 260, et al.
Requirements for Management of Hazardous Contaminated Media; Proposed Rule

media would again become subject to Subtitle C regulation. Understanding the role of the Bright Line and the contained-in principle is essential to understanding how today's proposal would work. Both the contained-in principle and the Bright Line are explained below.

a. The contained-in principle in today's proposed rule background. The contained-in principle is the basis for EPA's longstanding policy regarding the application of RCRA Subtitle C requirements to mixtures of environmental media (e.g., soils, ground water, sediments) and hazardous wastes. This concept has been discussed previously in several Agency directives and in several RCRA rulemakings. (See, e.g., 58 FR 48092, 48127 (September 14, 1993)). In today's proposed rule the Agency is expanding this concept as the basis for allowing EPA or an authorized State to exempt certain contaminated media from the stringent, prevention-oriented RCRA regulations for hazardous waste management that previously would have applied.

The contained-in concept was originally developed to define the regulatory status of environmental media that are contaminated with hazardous wastes. The mixture rule at 40 CFR 261.3(a)(2)(iv) states that "a mixture of solid waste and one or more [listed] hazardous wastes" constitutes a listed waste itself (emphasis added). Similarly, the derived-from rule at 40 CFR 261.3(c)(2)(i) provides that "a solid waste generated from the treatment, storage, or disposal of a hazardous waste" is a hazardous waste (emphasis added).

Since media are not solid wastes, these rules do not apply to mixtures of media and hazardous wastes. However, two other regulations subject contaminated media to Subtitle C requirements. Under 40 CFR 261.3(c)(1) a "hazardous waste will remain a hazardous waste" unless and until certain specified events occur. Under 40 CFR 261.3(d)(2) a "waste which contains" a listed waste remains a hazardous waste until it is delisted. Together these regulations provide for continued regulation of hazardous wastes even after they are released to the environment and mingled with media.

The U.S. Court of Appeals for the District of Columbia Circuit upheld this interpretation of §§ 261.3(c)(1) and (d)(2) in *Chemical Waste Management Inc.* v. *EPA*, 869 F.2d 1526, 1538–40 (D.C. Cir. 1989), and EPA has explained the policy and its regulatory basis in numerous preambles and letters. (See 53 FR 31138, 31142, 31148 (Aug. 17, 1988); 57 FR 21450, 21453 (May 20, 1992) (inadvertently citing 40 CFR 261(c)(2) in lieu of § 261.3(d)(2)); memorandum from Marcia E. Williams, Director, EPA Office of Solid Waste, to Patrick Tobin, EPA Region IV (Nov. 15, 1986); letter from Jonathan Z. Cannon, EPA Acting Assistant Administrator, Office of Solid Waste and Emergency Response, to Thomas Jorling, Commissioner, New York Department of Environmental Conservation (June 19, 1989); and letter from Sylvia K. Lowrance, Director, EPA Office of Solid Waste, to John Ely, Enforcement Director, Virginia Department of Waste Management (Mar. 26, 1991). Under the contained-in policy, media contaminated with listed hazardous wastes are not wastes themselves, but they contain hazardous wastes and must therefore be managed as hazardous wastes until they no longer contain the waste. This concept is based on the idea that at some point (e.g., at some concentration of hazardous constituents) the media would no longer contain the hazardous waste, or be subject to RCRA Subtitle C regulations.

Because the regulations that serve as the basis for the contained-in policy are part of the "base" RCRA program that was in effect prior to 1984, the Agency has taken the position that EPA or the State agency authorized to administer the "base" RCRA regulations may determine whether media contain listed wastes. Decisions that media no longer contain listed hazardous wastes (or "contained-in" decisions) have typically been made on a case-by-case basis, according to the risks posed by the contaminated media. The Agency has not issued any definitive guidance or regulations for determining appropriate contained-in levels; however, EPA Regions and States have been advised that conservative, health-based levels derived from direct exposure pathways would clearly be acceptable as "contained-in" levels. (See memorandum from Sylvia K. Lowrance to Jeff Zelikson, Region IX, (January 24, 1989)). It has been the common practice of EPA and many States to specify conservative, risk-based levels calculated with standard conservative exposure assumptions (usually based on unrestricted access), or site-specific risk assessments.

With regard to mixtures of media and characteristic wastes, EPA has often stated that media are regulated under RCRA Subtitle C if they exhibit a hazardous waste characteristic. (See 57 FR 21450, 21453, (May 20, 1992)). But, since media generally are not wastes, they become regulated when they have been contaminated with solid or hazardous wastes and the resultant mixture exhibits a characteristic. EPA has also taken the position that contaminated media cease to be regulated as hazardous waste when sufficient quantities of hazardous constituents are removed so that the mixture ceases to exhibit a characteristic[8] (57 FR 21450, 21453, May 20, 1992).

The contained-in concept in today's proposed rule. One of the primary objectives of today's proposal is to remove lower risk contaminated media from Subtitle C jurisdiction so that more appropriate, site-specific management requirements can be specified by the overseeing Agency. For the purpose of this rulemaking EPA has chosen to use the contained-in concept as the basis for allowing these materials to be exempted from Subtitle C requirements. In formulating the proposal, the Agency considered alternative concepts that might be provided under the RCRA statute that would produce the same or similar exemption. Those concepts are discussed in section (VI)(A)(2) of this preamble.

Today's proposal would allow two separate regulatory regimes to be applied to the management of contaminated media under EPA or State-approved cleanups. For media determined to contain hazardous wastes, modified LDR treatment standards would apply, as would other applicable Subtitle C requirements. For media determined not to contain hazardous wastes, Subtitle C requirements would generally not apply, and the State or EPA would have considerable discretion in applying appropriate management standards.

The proposed rule would limit an overseeing agency's discretion to make site-specific decisions that media no longer contain wastes by specifying "Bright Line" concentration levels. Media that are contaminated below Bright Line concentrations would be eligible for contained-in decisions by the overseeing Agency. However, Bright Line concentrations would not constitute an automatic exemption from Subtitle C; rather, they would represent the concentration below which the State or EPA might determine that media do not contain hazardous waste.

As described below, EPA believes it would generally be acceptable to make a decision that media do not contain hazardous waste at the Bright Line concentrations specified in today's proposal. However, the proposed rule is

[8] Recent developments under the RCRA land disposal restrictions (LDRs) may suggest a qualification to this latter point. (See discussion of LDRs in section (V)(C) of today's preamble.)

designed to provide for site-specific discretion in making such decisions. Thus, it is possible that some States might choose to specify—on a site-specific basis, more broadly as a matter of policy, or in regulations—contained-in levels that are lower (i.e., more stringent) than the Bright Line concentrations specified in today's proposal. Moreover, States can be more stringent than the Federal program, and adopt lower Bright Line concentrations.

In applying the contained-in concept, today's proposed rule does not distinguish between media that are contaminated with listed hazardous wastes, and media that exhibit a hazardous waste characteristic. In both cases, it is the concentration levels of the individual hazardous constituents in the media that determine how the media will be regulated under Part 269. The origin of the constituents (i.e., listed wastes or characteristic hazardous wastes) is irrelevant in comparing measured levels in the media with Bright Line concentrations and/or contained-in concentrations.

EPA sees no reason to apply the Bright Line concept differently to media contaminated with listed hazardous wastes and media that exhibit a hazardous characteristic. In either case the media could presumably be contaminated with the same types of hazardous constituents, at similar concentrations, that would present similar potential risks if mismanaged. Thus, applying these rules differently, depending on how the media came to be regulated as hazardous, would be unnecessary and artificial, and would further complicate how these rules would be implemented in the field.

EPA recognizes that today's rule could have the effect of excluding from Subtitle C regulation some media that until now have been considered hazardous—i.e., media that exhibit a hazardous waste characteristic, with constituent concentrations below the Bright Line and EPA or the State makes a determination that the media no longer contain hazardous waste (often based on protective management controls). However, EPA believes that there is no compelling environmental rationale for not including such media in Part 269 regulation. The risk presented even by characteristic wastes is dependent on site-specific circumstances. Therefore, because today's proposal would require the Director to impose any management controls on contaminated media that are necessary to protect human health and the environment, whether the media is contaminated with listed or characteristic waste is unimportant.

Under today's proposed rule, contained-in decisions would be documented in the site's approved Remediation Management Plan (RMP). If an approved RMP expires or is terminated, the provisions of today's proposal would no longer apply. Therefore, all contaminated media that are addressed in the RMP (i.e., media that are contaminated both above and below contained-in concentrations) would again prospectively be subject to the "base" Subtitle C regulations. For example, if a cleanup of contaminated soil was half completed when a RMP was terminated or expired, the half that was completed in compliance with the RMP while it was in effect, would continue to be considered to be in compliance. For example, if contaminated soil was determined not to contain hazardous waste, and was disposed of in a Subtitle D landfill according to the requirements of the RMP, that Subtitle D landfill would not be considered retroactively to have accepted hazardous wastes. The half of the cleanup that was not completed when the RMP was terminated or expired, however, would have to be completed prospectively in compliance with the non-Part 269 Subtitle C regulations.

Effect of contained-in decisions under today's rule. Once the overseeing Agency has made a decision that media with constituents at certain concentrations no longer contain hazardous wastes (i.e., "a contained-in decision"), the media would no longer be regulated as hazardous wastes under Federal RCRA regulations (§ 261.4(g) and § 269.4(a)).[9] The Agency requests comments, however, on whether the Agency should exempt the media instead, only if it were managed in compliance with the provisions of the RMP. The Agency did not propose this approach primarily because it could be unduly harsh, since any violation, no matter how minor, would result in a reversion to Subtitle C. However, this approach could be incorporated into RMPs on a case-by-case basis, where the Director could specify in the RMP the provision(s) who's violation would result in a reversion to Subtitle C regulation. (See discussion below).

A contained-in decision for wastes at a cleanup site would not, however, eliminate the Administrator's authority to require the owner/operator (or other responsible parties at sites not regulated by RCRA) to conduct remedial actions for media that do not contain hazardous wastes. Specifically, Federal cleanup authorities under RCRA section 3004(u) at TSDFs, section 7003, and CERCLA authorities, authorize the Agency to require cleanup of a broad spectrum of hazardous constituents and/or hazardous substances, however, the presence of hazardous waste(s) in media is not a requirement for exercising those authorities. Many State cleanup authorities have similar provisions.

Decision factors for contained-in decisions. Because the Agency does not want to constrain site-specific decision-making, today's proposed rule would not mandate specific factors for making contained-in decisions, but would allow the Director to base these decisions on appropriate site-specific factors. However, EPA requests comments on whether decision factors should be codified for making contained-in decisions. EPA believes that the Bright Line concentrations will generally be acceptable for contained-in decisions; however, decision factors could help authorities determine, on a site-specific basis, what types of management controls (see discussion below), if any, would make the Bright Line concentrations appropriate concentrations at which to make contained-in decisions. Decision factors could also aid in determining other appropriate levels at which to make contained-in decisions.

Given the multiplicity of different types of sites, EPA requests comments on what decision factors, if the Agency decided to include them in the final rule, would ensure consistent decision-making, and yet keep the process efficient and flexible. Although EPA does not believe it would be appropriate to do a risk assessment at every site, particularly if the cleanup is of a relatively simple nature, the Agency does believe that the following factors (adapted from the LDR proposal for hazardous soils) contain the types of information that may be appropriate (depending on the specific circumstances at a given site) to consider in making contained-in decisions:

—Media properties;
—Waste constituent properties (including solubility, mobility, toxicity, and interactive effects of constituents present that may affect these properties);
—Exposure potential (including potential for direct human contact, and potential for exposure of sensitive environmental receptors, and the

[9] The Agency notes, however, that by explicitly providing in § 261.4 that decisions under Part 269 that media no longer contain hazardous waste are not subject to most Subtitle C regulations, EPA would not intend to affect in any way the authority of EPA and authorized States to make contained-in decisions outside of the HWIR-media context.

effect of any management controls which could lessen this potential);
—Surface and subsurface properties (including depth to groundwater, and properties of subsurface formations);
—Climatic conditions;
—Whether the media pose an unacceptable risk to human health and the environment; and
—Other site or waste-specific properties or conditions that may affect whether residual constituent concentrations will pose a threat to human health and the environment.

Most of these factors were proposed in the LDR proposal for hazardous soil (58 FR 48092, September 14, 1993) as decision factors that might be considered by the Director in making contained-in decisions. If the proposal for hazardous soil had been finalized, it would have codified the contained-in principle for hazardous soil. Today's suggested factors differ from those in the hazardous soil proposal in one significant respect. The Agency has determined that it may be appropriate, when assessing "exposure potential," to consider site-specific management controls imposed by the Director that limit potential exposures of human or environmental receptors to media. The Agency made this change because EPA believes that States overseeing cleanups might determine that media that would have traditionally been considered to contain hazardous waste (e.g., media that contained listed wastes and posed an unacceptable risk under traditional exposure scenarios) no longer presented a hazard (and thus did not contain "hazardous" waste), based on site-specific management controls imposed by the Director.

This position is based upon EPA's understanding that RCRA provides EPA and the States the discretion to determine that a waste need not be defined as "hazardous" where restrictions are placed on management such that no improper management could occur that might threaten human health or the environment. (See definition of hazardous waste at RCRA section 1004(5)(B)). The HWIR-waste proposal included a full discussion of the legal basis for this position. For the sake of clarity, it is repeated below (60 FR 66344–469, Dec. 21, 1995).

EPA's original approach to determining whether a waste should be listed as hazardous focused on the inherent chemical composition of the waste, and assumed that mismanagement would occur, causing people or organisms to come into contact with the waste's constituents. (See 45 FR 33084, 33113, (May 19, 1980)). Based on more than a decade of experience with waste management, EPA believes that it is inappropriate to assume that worst-case mismanagement will occur. Moreover, EPA does not believe that worst-case assumptions are compelled by statute.

In recent hazardous waste listing decisions, EPA identified some likely "mismanagement" scenarios that are reasonable for almost all wastewaters or non-wastewaters, and looked hard at available data to determine if any of these are unlikely for the specific wastes being considered, or if other scenarios are likely, given available information about current waste management practices. (See the Carbamates Listing Determination (60 FR 7824, February 9, 1995) and the Dyes and Pigments Proposed Listing Determination (59 FR 66072, December 22, 1994)). Further extending this logic, EPA believes that when a mismanagement scenario is not likely, or has been adequately addressed by other programs, the Agency need not consider the risk from that scenario in deciding whether to classify the waste as hazardous.

EPA believes that the definition of "hazardous waste" in RCRA section 1004(5) permits this approach to hazardous waste classification. Section 1004(5)(B) defines as "hazardous" any waste that may present a substantial present or potential hazard to human health or the environment "when improperly * * * managed." EPA reads this provision to allow it to determine the circumstances under which a waste may present a hazard and to regulate the waste only when those conditions occur. Support for this reading can be found by contrasting section 1004(5)(B) with section 1004(5)(A), which defines certain inherently dangerous wastes as "hazardous" no matter how they are managed. The legislative history of Subtitle C of RCRA also appears to support this interpretation, stating that "the basic thrust of this hazardous waste title is to identify what wastes are hazardous in what quantities, qualities, and concentrations, and the methods of disposal which may make such wastes hazardous." H. Rep. No. 94–1491, 94th Cong., 2d Sess.6 (1976), reprinted in, "A Legislative History of the Solid Waste Disposal Act, as Amended," Congressional Research Service, Vol.1, 567 (1991) (emphasis added).

EPA also believes that section 3001 gives it flexibility in order to consider the need to regulate as hazardous those wastes that are not managed in an unsafe manner (section 3001 requires that EPA decide, in determining whether to list or otherwise identify a waste as hazardous waste, whether a waste "should" be subject to the requirements of Subtitle C). EPA's existing regulatory standards for listing hazardous wastes reflect that flexibility by allowing specific consideration of a waste's potential for mismanagement. (See § 261.11(a)(3) (incorporating the language of RCRA section 1004(5)(B)) and § 261.11(c)(3)(vii) (requiring EPA to consider plausible types of mismanagement)). Where mismanagement of a waste is implausible, the listing regulations do not require EPA to classify a waste as hazardous, based on that mismanagement scenario.

Two decisions by the U.S. Court of Appeals for the District of Columbia Circuit provide potential support for the approach to defining hazardous waste, in *Edison Electric Institute* v. *EPA*, 2 F.3d 438, (D.C. Cir. 1993) the Court remanded EPA's RCRA Toxicity Characteristic ("TC") as applied to certain mineral processing wastes because the TC was based on modeling of disposal in a municipal solid waste landfill, yet EPA provided no evidence that such wastes were ever placed in municipal landfills or similar units. This suggests that the Court might approve a decision to exempt a waste from Subtitle C regulation if EPA were to find that mismanagement was unlikely to occur. In the same decision the Court upheld a temporary exemption from Subtitle C for petroleum-contaminated media because such materials are also subject to Underground Storage Tanks regulations under RCRA Subtitle I. The court considered the fact that the Subtitle I standards could prevent threats to human health and the environment to be an important factor supporting the exemption. *Id.* At 466. In *NRDC* v. *EPA*, 25 F.3d 1063 (D.C. Cir. 1994) the Court upheld EPA's finding that alternative management standards for used oil promulgated under section 3014 of RCRA reduced the risks of mismanagement and eliminated the need to list used oil destined for recycling. (The Court, however, did not consider arguments that taking management standards into account violated the statute because petitioners failed to raise that issue during the comment period.)

The Agency believes, therefore, that EPA and the States may consider site-specific management controls when making contained-in decisions pursuant to proposed Part 269. EPA believes that this approach is especially appropriate in the Part 269 context, because of the significant level of oversight generally given to cleanup actions. Management controls that are tailored to site-specific

circumstances and imposed in enforceable documents, and State or EPA oversight of cleanup activities, would ensure that the site-specific management controls that the Director relied upon in making each contained-in decision would continue to be implemented. In addition (although EPA is not proposing to require it as a federal matter), States may want to consider making such contained-in decisions conditional; i.e., media would only be considered nonhazardous so long as they were managed in the manner considered by the Director in making the contained-in decision. Deviations (any, or specific ones) would result in a reversion to Subtitle C regulation.

EPA specifically requests comments on the following: (1) Should the Agency specify a list of criteria to consider; (2) should the Agency prepare decision factors as guidance; (3) should the Agency promulgate decision factors as part of the final rule; (4) are the above decision factors appropriate for making these decisions; (5) if so, should the criteria listed above be more or less specific regarding the conditions that would allow or preclude contained-in decisions; (6) are there other factors the Director should consider when making contained-in decisions, in addition to those listed above; and (7) should there be fewer factors to consider?

b. Issues associated with hazardous debris. When EPA promulgated land disposal treatment standards for hazardous debris, it also codified the contained-in principle for debris contaminated with listed hazardous waste. (See 57 FR 37194, 37221, (August 18, 1992)). At the time EPA codified the contained-in principle for hazardous debris, it was the Agency's practice to make contained-in decisions at "health-based,"[10] levels, thus a decision that debris no longer contain hazardous waste would clearly also constitute a "minimize threat" determination for purposes of RCRA section 3004(m). Therefore, contained-in decisions under 40 CFR 260.3(f)(3) also eliminate the duty to comply with the land disposal restriction requirements of 40 CFR Part 268. EPA requests comments on whether the contained-in principle codified for hazardous debris is adequate or whether the contained-in policy should be applied to debris in the same way today's proposed rule applies it to hazardous contaminated media. For example, should contained-in decisions for debris incorporate the Bright Line concept? If a Bright Line is established for debris, should it be the same as the Bright Line in today's proposed rule for hazardous contaminated media or would some other Bright Line values or methodology be more appropriate for debris? Are there issues associated with requiring that debris be tested to determine if it has constituent concentrations greater than Bright Line concentrations? Is testing routinely too complicated for debris matrices? Should contained-in decisions for debris be based on determinations made for media co-located with the debris (i.e., if debris were located in the same area as media that was determined not to contain hazardous wastes, should the debris be presumed not to contain hazardous wastes)? Similarly, if debris is located in the same area as media that have constituent concentrations less than Bright Line concentrations, should the debris be presumed to also be below the Bright Line?

Alternatively, should the Director be able to make contained-in decisions, as they are described in today's proposed rule, without application of the Bright Line to debris (as we are proposing for sediment? (See preamble (V)(A)(4)(c)). If allowed, should these contained-in decisions replace the existing contained-in decisions available for debris or should the existing contained-in decisions be maintained with non-Bright Line contained-in decisions (as discussed in today's proposed rules addressing sediments—see preamble (V)(A)(4)(c)) available for debris managed under a RMP? Are other combinations of the existing debris contained-in decision provisions and the contained-in decision provision for media in today's proposed rule appropriate?

While today's proposed rule does not include changes to the existing contained-in principle as applied to debris contaminated with listed hazardous waste, EPA could include revisions to the standard in response to public comment. Issues associated with hazardous debris and the possibility of including debris in the final Part 269 rules are also discussed in sections (V)(C)(10) and (V)(A)(2) of today's preamble.

c. The Bright Line. One of the key features of the "Harmonized Approach" developed through the FACA process was the concept of a "Bright Line." The Bright Line would divide contaminated media into two different categories, which would be subject to two different regulatory regimes. Although straightforward in concept, the Agency has found it challenging to establish a set of numbers to serve this purpose.

As conceived by the FACA Committee, and presented in Appendix A to today's proposal, the Bright Line is a set of constituent-specific, risk-based concentration levels. In agreeing on a Bright Line approach, the FACA Committee anticipated that a substantial proportion of contaminated media would fall below the Bright Line, and thus be eligible, at the Director's discretion, for flexible, site-specific requirements (non-Subtitle C) set by the overseeing Agency. At the same time, the FACA Committee agreed that the Bright Line should ensure that very highly contaminated media (traditionally considered "hot spots") be subject to uniform national protective standards (e.g., treatment). EPA believes that the Bright Line values presented in today's proposal are a reasonable attempt to balance both of these important objectives.

As originally conceived, the Bright Line was intended to represent in some manner the relative risk posed by contaminated media. Simply put, media contaminated above Bright Line concentrations should pose higher risks than media below the Bright Line under a given exposure scenario. Since the Bright Line is only an indicator of relative risk, the levels should not be interpreted as representing what is protective or "clean." The actual risk of any particular contaminated medium depends on the circumstances by which human or environmental receptors may be exposed to the medium. EPA wishes to emphasize that Bright Line concentrations are not cleanup levels. The Bright Line simply is a means of identifying which regulatory regime may be appropriate for the contaminated media at a cleanup site.

The Agency believes that the management of contaminated media would be conducted in a protective manner under either of the regulatory schemes that would be established by the rule. The underlying assumption is that managing contaminated media under the HWIR-media rule would eliminate significant exposures to humans or ecological receptors. This is because the overseeing agency's presence ensures that media will be managed in a way that directly addresses the risk posed by site-specific circumstances. Thus, protection of human health and the environment can be ensured by applying either the national standards for media that contain hazardous waste, or the site-specific standards specified by the overseeing agency for media, which the overseeing agency has determined do not contain hazardous waste, based on the proposed management standards

[10] See memoranda discussed in section (V)(A)(4)(a) of today's preamble.

identified in the RMP. Thus, in establishing Bright Line concentrations, EPA finds it reasonable to consider the potential effect of different sets of Bright Line concentrations in terms of the proportional volumes of media that would fall above and below the Bright Line. EPA believes that unless a substantial amount of contaminated media are eligible for site-specific decision-making, the disincentives for clean-up will not be eliminated (therefore resulting in greater overall risk to human health and the environment).

Thus, EPA's goal was to develop Bright Line concentrations that would remove a significant amount of contaminated media from Subtitle C jurisdiction, while ensuring that "hot spots" would remain subject to mandatory national standards. In deciding how to determine such levels, the Agency considered several approaches that included selecting concentrations based solely on volume. This approach, however, was rejected because there was no way to account for the relative degree of risk posed by different constituents. In other words, because some constituents are more hazardous than others at the same concentration, a Bright Line based purely on volume would not account for this difference.

EPA, therefore, wanted to set Bright Line concentrations for different constituents at different levels in order to account for this variance in relative risk. In order to do this, EPA needed to consider a potential exposure scenario that would account for the difference in relative risk of these different constituents. Because risk occurs only when there is a chance of exposure, at least one set of exposure assumptions would be necessary to establish the Bright Line.

Since one of the goals of the Bright Line was to identify the most highly contaminated media, the FACA Committee recommended using 10^{-3} as a benchmark for setting the Bright Line. Therefore, the Bright Line values in Appendix A were based on a 10^{-3} risk level for carcinogenic constituents (using the assumptions described above), and a health index of 10 for non-carcinogens, (that is, 10 × the concentration at which adverse health effects occur) according to certain exposure assumptions. This approach is consistent with the Superfund Principle Threats concept which uses 10^{-3} as a factor to identify the principle threats at Superfund sites.

Describing the Bright Line theory was relatively easy compared with determining Bright Line concentrations for all media which would be subject to today's Part 269 proposal. Today's rule proposes to define soil, ground water, surface water, and sediments as media. However, the potential exposure assumptions that could be used to determine Bright Line concentrations vary for different types of media. Therefore, EPA established two sets of Bright Line values, one for soils, and one for ground water and surface water.

Today's proposed rule does not include Bright Line numbers for contaminated sediments. The amount of sediment that is classified as RCRA hazardous is very low. Thus, EPA proposes that site-specific contained-in decisions be made for hazardous contaminated sediments. The Agency requests comments on whether to develop a Bright Line specifically for contaminated sediments. The Agency also requests comments on whether it would be appropriate to use the Bright Line for soil for sediments.

Bright Line concentrations for soils. In setting the Bright Line for soils, EPA chose to use exposure scenarios and assumptions that were developed for the Superfund Soil Screening Levels (SSLs), because that effort used standard risk scenarios that have been widely used and accepted by the Agency (and by many States). The SSLs were developed for a purpose different from the Bright Line;[11] however, the exposure scenarios used in that effort are good indicators of relative risk for developing Bright Line values.

The SSLs are based on three human exposure scenarios; direct contact ingestion, inhalation, and drinking contaminated ground water. Each scenario is based on a specific set of assumptions for such things as body weight, frequency of exposure, daily intake rates, and other factors. The inhalation pathway also uses certain models to calculate wind dispersion and the uptake of airborne contaminants by human receptors.

Today's proposed Bright Line numbers for soils are based on only two of those human exposure scenarios—direct contact ingestion and inhalation. The Bright Line value for each constituent is based on whichever pathway yields the more conservative (i.e., lower) concentration. EPA recognizes that protection of ground water is one of RCRA's major goals and that many of the Subtitle C design and operating standards were developed to protect ground water resources. Therefore, EPA considered the possibility of using the ground water exposure pathway in setting Bright Line concentrations for soils. However, the migration of contaminants from soils to ground water is fundamentally site-specific, and influenced by a number of site-specific factors such as depth to ground water; soil porosity; carbon content and other soil characteristics; amount of rainfall; solubility of the contaminants; and numerous other site- and constituent-specific conditions. The Agency has found less variability in fate and transport potential for inhalation and ingestion exposures in residential settings.

EPA is reluctant to use a greatly simplified ground water model that would not take any site-specific or constituent-specific factors into account. In order to address concerns posed to ground water on a more appropriate site-specific basis, EPA prefers to allow for consideration of ground water risks in making site-specific decisions regarding either the contained-in decision and/or the site-specific management requirements. Given the overseeing Agency's discretion to determine these standards on a site-specific basis, and given that EPA believes that site-specific decisions are most appropriate for ground water risk decisions, the Agency has proposed that the ground water exposure pathway should not be considered in setting the national Bright Line values for soils. Finally, EPA proposes two considerations to overlay the soil Bright Line numbers. EPA proposes to cap the Bright Line values at 10,000 ppm, equivalent to 1% of the volume of the contaminated media. EPA believes that it is reasonable to classify media as highly contaminated if 1% of the volume of media is contaminated with a particular constituent. Therefore capping the Bright Line at 10,000 ppm is consistent with the intention that the Bright Line distinguish between highly contaminated and less contaminated media. The second cap on the soil Bright Line values is the saturation limit (Csat). EPA believes it is sound science to compare the concentrations developed through the inhalation and ingestion risk scenarios to the actual concentration that could physically saturate the soil. If the Csat was lower than the concentrations from the inhalation or ingestion scenarios, EPA set the Bright Line concentration at the Csat. For further details on specific assumptions and methodologies used to

[11] Superfund Soil Screening Levels (SSLs) were developed as a screening tool to determine when further investigation is necessary at Superfund sites. Because the SSLs are intended to be conservative, and trigger investigation whenever prudent, they are set at a 10^{-6} level for carcinogens. For more information on SSLs, call David Cooper (703) 603-8763.

determine the Bright Line values for soils, see Appendix A-1.

The Agency also considered several alternatives for establishing exposure assumptions for soil Bright Line numbers. These alternatives are discussed below. Estimates of the impacts of each alternative (in terms of volumes of media exempted) are all based on a 10^{-3} risk for carcinogens, and a health index of 10 for non-carcinogens (that is 10x the concentration at which adverse health effects occur).

Alternative #1—Bright Line for soils based on inhalation, ingestion, and migration to ground water. In addition to inhalation and ingestion pathways, this alternative would use a generic model to derive soil levels that, given certain fate and transport assumptions, would result in transfer of contaminants in the soils to ground water at or below drinking water standards (i.e., maximum concentration levels, or MCL's). EPA did not choose this alternative primarily because of the site-specific variability of calculating ground water exposure scenarios (as discussed above). In addition, this approach would result in Bright Line numbers that were considerably lower than those in the proposed option. The Agency estimated that under this alternative, approximately 50 percent of contaminated media would fall below the Bright Line, compared to 70 to 75 percent under the proposed option.

Alternative #2—Bright Line for soils based on inhalation and ingestion pathways, with concentrations calculated on a site-specific basis for the soil-to-ground water pathway. This option would yield Bright Line numbers that would approximate more closely ground water risks for each site. However, it would have the disadvantage of requiring considerable data gathering and analysis simply to calculate Bright Line concentrations, and these concentrations would obviously differ from site to site. This contradicts the idea of the Bright Line as "bright"—i.e., an easily referenced set of numbers that can be applied in a standard fashion. However, since Bright Line numbers would vary widely across the range of cleanup sites, volume estimates for this alternative are not possible to calculate.

Alternative #3—Bright Line numbers for soils based on a multipathway analysis. Under this alternative, numerous exposure pathways would be considered for each constituent, and Bright Line concentrations would be set for the most conservative pathway (i.e., the pathway that resulted in the lowest concentration level). In some respects this approach would be consistent with the multipathway approach being used in the HWIR proposed rule for as-generated wastes (60 FR 66344-469, Dec. 21, 1995). However, the Bright Line is intended for a very different purpose than the "exit levels" being developed for that proposed rule. For instance, the exit levels in the HWIR-Waste rule (discussed in section (II)(B) of this preamble) generally assume that exited wastes will not be subject to any management requirements, whereas this proposal assumes that these wastes will be managed protectively under State/EPA oversight. In addition, the resulting Bright Line values would be much lower than those proposed today, thus much less media would be regulated "below the line."

Bright Line concentrations for ground water and surface water. Today's proposed rule also establishes Bright Line values specifically for contaminated ground water. (See Appendix A-2 and discussion below). As with contaminated soils, highly-concentrated, contaminated ground water would be subject to specific national management standards, while less-contaminated ground water could be managed according to site-specific requirements imposed by the State or EPA.

To set Bright Line concentrations for ground water and surface water (Appendix A-2), EPA used standard exposure assumptions for human ingestion of contaminated water. EPA believes that it is appropriate to use the same Bright Line values for surface water and ground water. And for the same reasons discussed above for soils, the Agency believes a multi-pathway approach, or "actual risk" approach is not necessary for setting Bright Line concentrations for ground water and surface water.

EPA has used the same philosophical approach for the ground water/surface water Bright Line as it has used for soils, by analyzing relative risk and relying on the oversight of authorized States or EPA to ensure that hazards are addressed on a site-specific basis. In addition, EPA used a 10,000 ppm cap for the ground water/surface water Bright Line, just as for the soil Bright Line. This is explained in the soil Bright Line section of the preamble. Finally, if the concentrations from the ingestion of contaminated water were below the detection limits for that constituent in water (the EQC), EPA set the Bright Line at the EQC. More details on the specific assumptions and methodologies used to determine these concentrations are included in Appendix A-2.

Issues common to both sets of Bright Line numbers. In developing today's proposed Bright Line concentrations, some stakeholders said that EPA would need to calculate a number of additional direct and indirect pathways to evaluate the relative risks of contaminated media completely. The stakeholders also said that the Agency would need to predict risks to ecological receptors (i.e., plants and animals) as well as human health risks. EPA, however, does not believe that evaluation of additional pathways is necessary. The pathways selected already provide a sufficient basis for distinguishing relatively lower-risk contaminated media from relatively higher-risk media. The evaluation of other pathways and receptors would be important and, in some cases, necessary if the Bright Line represented "safe" levels of contamination. As explained above, however, the Bright Line serves no such purpose. It merely identifies which of two regulatory schemes would apply to certain contaminated media. If site-specific factors demonstrate that a decision that media no longer contain hazardous wastes, would be inappropriate, then the overseeing agency has the discretion not to make such a determination.

Some stakeholders have voiced concerns about the land use assumptions that were used to set the Bright Line. The SSLs used residential land use assumptions; therefore, residential land use assumptions form the basis for the proposed Bright Line for soils. EPA recognizes that the residential land use assumptions that underlie the ingestion and inhalation exposure pathways used for today's Bright Line values for soil may be inappropriate for managing risks at many sites that would be subject to these HWIR-media regulations. However, since the purpose of using risk assessment to develop the Bright Line is to differentiate between the relative risks of constituents, and not to establish the risks posed at specific sites, either residential or industrial assumptions would have been equally appropriate. Since the Agency's residential risk assessment methodology is more developed than the industrial methodology, the Agency chose to use residential assumptions for developing the Bright Line. The Bright Line for ground water and surface water does not include assumptions about land use. (See discussion above).

Request for comment. EPA solicits comments on the approaches used to develop today's proposed Bright Lines. The Agency also requests comment on the alternatives described above, as well

as any other possible approaches to developing the Bright Line.

In addition, EPA requests comments on whether it is necessary to have a Bright Line at all. If there were no Bright Line, all media would be eligible for contained-in decisions by the overseeing agency on a site-specific basis. Alternatively, the "unitary approach," discussed in section VI of this preamble, would eliminate the Bright Line, and instead would exempt all cleanup wastes managed under a RMP from Subtitle C requirements.

Technical methodology. As discussed above, the technical methodologies used in calculating Bright Line concentrations for soil ingestion and inhalation are those that were used to develop "soil screening levels" for contaminated sites (59 FR 67706, December 30, 1994). In the proposed soil screening level guidance, values for the soil-to-ground water pathway would generally be calculated with data derived from site-specific factors and conditions, although generic values for this pathway would be presented in situations where site-specific data were unavailable. These technical methods and formulae are available for review in the docket for this rulemaking, and in the docket for the soil screening level proposal since they support both rules.

EPA requests comments on the methods, formulae, and technical underpinnings used for this rulemaking. Comments could include information on particular constituents that could change proposed Bright Line concentrations, information that may be used to determine Bright Line numbers for constituents that currently do not have Bright Line numbers. Commenters should keep in mind that the Agency's objective is to provide regulatory relief by encouraging contaminated media with a lower degree of risk to exit from Subtitle C regulation—provided that adequate safeguards exist to protect human health and the environment.

EPA has often found it necessary to propose sets of risk-based numbers to address contaminated media, for example; Subpart S action levels, (55 FR 30798, July 27, 1990), Superfund Soil Screening Levels (see below), and today's proposed rule. Since the Agency's understanding of risk assessment and the science surrounding risk based numbers is constantly developing, EPA has realized that almost as soon as risk-based numbers are published, they can become outdated. As a very current example, today EPA is proposing Bright Line concentrations based, in part, on the Superfund Soil Screening Levels (EPA/9355.4-14FS, EPA/540/R-94/101 PB95-963529 (December 1994)). After today's proposed Bright Line concentrations were calculated, but before this proposal was published, some of the technical inputs used to calculate the Superfund Soil Screening levels were adjusted in response to public comments (e.g., volatilization factors, cancer slope factors, etc.). EPA did not have time to recalculate the Bright Line concentration before publishing them.

In response to this problem, EPA requests comment on alternatives to keep the Bright Line concentrations up-to-date with the most current Agency risk information and policies (e.g., adjustments to the Soil Screening levels,[12] changes in reference doses or cancer slope factors in the IRIS or HEAST databases). For purposes of comment on this proposal, EPA will update the Bright Line calculations and place them in the docket for this rule.

EPA believes it might be appropriate, instead of promulgating actual Bright Line concentrations in the final rule, to promulgate the methodology that could be used to develop constituent-specific concentrations, in Appendix A to this rule, and to provide guidance on appropriate sources for needed underlying risk-based information. EPA believes it might then be appropriate for States to update their lists of Bright Line concentrations on a regular basis, such as every six months, to remain current with developments in risk information. As an alternative, EPA believes it may be appropriate for States and/or EPA to calculate new Bright Line concentrations for each new RMP at the time it is proposed for public comment. In any case, the Bright Line concentrations being used under a RMP must be stated in the RMP, and available during public comment on the RMP. The Agency requests comment on these alternatives, and any other suggestions for keeping Bright Line concentrations up-to-date.

The Agency also recognizes the problems of trying to comply with a "moving target." A cleanup could be completed or underway using a certain set of Bright Line concentrations that could then change. EPA believes it might be appropriate to protect those past and on-going cleanup operations from the requirement to change course mid-way, or to revisit completed remediation waste management under a RMP which used outdated Bright Line concentrations. In the Superfund program, requirements that are revised or newly promulgated after the ROD is signed must be attained only when EPA determines that these requirements are ARARs and that they must be met to ensure that the remedy is protective (40 CFR 300.430(f)(1)(ii)(*I*)). Another alternative could be a shield such as is provided for RCRA permits in 40 CFR 270.4, which could specify that compliance with a RMP would equal compliance with RCRA. EPA requests comments on this protection issue, and how best to achieve it.

Relationship of the HWIR-media Bright Line to the HWIR-waste exit levels. As described earlier in this preamble (in section (IV)(C)) the objectives for the HWIR-waste exit levels and the HWIR-media Bright Line are different. The HWIR-waste exit levels are intended to identify levels of hazardous constituents that would pose no significant threat to human health or the environment regardless of how the waste was managed after it exited Subtitle C jurisdiction. The HWIR-media Bright Line levels are simply intended to distinguish between (1) contaminated media that are eligible to exit Subtitle C because it is likely that they can be managed safely under cleanup authorities outside of Subtitle C, and (2) media that contain so much contamination that Subtitle C management is warranted. Because of these different objectives, EPA developed the two proposals using different methodologies. For the soil Bright Line, HWIR-media used a calculation based on ingestion and inhalation of soil at 10^{-3} cancer risk, and a hazard index of 10 for non-carcinogens. For the non-wastewater HWIR-waste exit level (which is most readily comparable to the soil Bright Line), EPA used an analysis that evaluates exposures from multiple pathways to identify those pathways that may result in a 10^{-6} cancer risk and hazard index of 1 for non-carcinogens. EPA then selected the most limiting pathway, (most conservative), as the exit criteria. EPA believed that the HWIR-waste levels would be more conservative than the HWIR-media concentrations. However, upon a recent comparison of the two sets of numbers, some HWIR-waste exit levels are at higher concentrations (less conservative) than the HWIR-media Bright Line concentrations. In the comparison of those concentrations, EPA determined that for about 27% of the HWIR-media Bright Line concentrations of chemical constituents for soil, the HWIR-waste exit levels for non-wastewater were higher.

A similar result was found when EPA compared the HWIR-media

[12] The Soil Screening Guidance has addressed this problem by publishing the *methodology* as the guidance itself, and only providing the actual concentrations as examples in the appendix to the guidance.

groundwater/surface water Bright Line concentrations to the HWIR-waste wastewater exit levels. In that case, EPA used direct ingestion of groundwater resulting in a cancer risk of 10^{-3} and hazard index of 10 for non-carcinogens to calculate the HWIR-media Bright Line. For the HWIR-waste wastewater exit level, EPA again analyzed multiple pathways to identify those that would result in a cancer risk of 10^{-6} and a hazard index of 1 for non-carcinogens and then selected the most limiting pathway as the exit criteria. For approximately 20% of the HWIR-media Bright Line concentrations for groundwater/surface water the HWIR-waste concentrations for wastewater were higher.

One of the practical concerns that arises from this difference in concentrations is this: if contaminated media is below the HWIR-waste exit levels, then that media is eligible for exit under that rulemaking just like any other hazardous waste. Therefore, if the HWIR-media rule specified that media at concentrations below the HWIR-waste exit levels were still "above the Bright Line" and not eligible for a contained-in determination, the two rules would be inconsistent. EPA recognizes that this inconsistency must be addressed before promulgation of these two final rules, and requests comments on how to resolve this issue. A preliminary description of the primary differences in the methodologies follows.

One of the most significant differences between the HWIR-waste and the HWIR-media methodologies is that the HWIR-waste methodology was designed to calculate an acceptable concentration at which as-generated waste and treatment residuals could exit the Subtitle C system. A part of that methodology assumed that exited wastes might be managed in such a way as to contaminate soils and groundwater, and calculated the potential risk to receptors from the contaminated soil or groundwater. Therefore, the HWIR-waste analysis models fate and transport between the original waste and the contaminated media, assuming some loss of concentration due to many factors, such as: partitioning of constituents to air, soil, and water; losses of contaminant mass through biodegradation; bioaccumulation through the food chain; and volatilization, hydrolysis, and dispersion of contaminants during transport. The HWIR-media methodology begins at the point where soils and groundwater are already contaminated. Therefore, the HWIR-media Bright Line did not incorporate fate and transport considerations to calculate the Bright Line concentrations, but assumed the receptor was in direct contact with the contaminated media.

Specific comparison of soil Bright Line to non-wastewater exit levels. If contaminated soil were managed under the HWIR-waste proposal, the soil would be subject to the exit criteria for non-wastewaters. That is why EPA compared the soil Bright Line to the non-wastewaters exit level. For this analysis, the HWIR-media Bright Line for soil based on ingestion or inhalation was compared with the exit criterion for non-wastewater identified as the most limiting pathway (e.g., soil ingestion, fish ingestion) in the HWIR-waste proposal. Thus, the analysis was not necessarily a comparison of exit criteria and Bright Lines for similar exposure pathways.

The analysis indicated that for 27 of the HWIR-media Bright Line constituent concentrations for soil, the proposed Bright Line concentration was lower than the exit criterion for HWIR-wastes for non-wastewater. Of these constituents, six of the lower proposed Bright Line concentrations are lower because the HWIR-media number was intentionally "capped" at 10,000 parts per million. EPA decided to propose a 10,000 ppm cap, equivalent to 1% of the volume of the contaminated media, (as discussed above) because EPA believes that it is reasonable to classify media as highly contaminated if 1% of the volume of media is contaminated with a particular constituent. Therefore capping the Bright Line at 10,000 ppm is consistent with the intention that the Bright Line distinguish between highly contaminated and less contaminated media. The HWIR-waste proposal did not propose to cap the exit levels because it was not intended to differentiate wastes based on higher vs. lower concentration, but instead to differentiate based on risk factors.

For 12 of the 27 constituents, HWIR-media Bright Lines are established at soil saturation limits (Csat) that are less than the corresponding HWIR-waste exit level. EPA believes it is sound science for a rule establishing soil concentrations to compare the concentrations developed through the inhalation and ingestion risk scenarios to the actual concentration that could physically saturate the soil. If the Csat was lower than the concentrations from the inhalation or ingestion scenarios, EPA set the Bright Line concentration at the Csat. The HWIR-waste proposal (since it is proposed for as generated wastes, not soils) did not propose to cap the exit levels at the soil saturation limit.

For the other nine of the 27 constituents, differences in the results can be attributed to several factors related to the underlying assumptions of the methodologies used to calculate the criteria.[13] These include the fate and transport differences discussed above, and:

—Receptors. Although many of the exposure assumptions (e.g., exposure duration, exposure frequency, ingestion rate) are common to the analyses, there are still significant differences in the location of the receptors that will affect the exit criteria. The HWIR-media Bright Lines are based on an exposure scenario in which a resident lives directly on the contaminated media and ingests contaminated soil or inhales particulate and volatile emissions. The HWIR-waste exit levels consider several exposure scenarios; however, none are directly comparable to the HWIR-media exposure scenario. These exposure scenarios include an off-site resident, an adult off-site resident, a child off-site resident, an adult and child on-site 10 years after site closure, and an on-site worker.

—Sources. The HWIR-media Bright Lines for soil ingestion and inhalation exposure pathways are based solely on contaminated soils and assume that the soil is an infinite source. The HWIR-waste non-groundwater non-wastewater exposure pathways consider three sources: land application units, waste piles, and ash monofills. Waste piles and ash monofills are assumed to be infinite sources; however, the land application units are assumed to be finite sources. This assumption may result in higher (less conservative) exit criteria under HWIR-waste.

A comparison of the toxicity benchmarks indicates that the HWIR-media Bright Lines and the HWIR-waste exit levels generally start with the same toxicity benchmark (all but three chemicals for oral ingestion and all but four chemicals for inhalation use the same toxicity benchmarks). Thus, the apparent discrepancies in the criteria can be attributed to the significant differences in the fate and transport modeling of the chemicals in the HWIR-process waste analysis, the receptors evaluated, and assumptions related to the sources (as described above).

[13] If the HWIR-media proposed Bright Line concentrations were updated to reflect the updated Soil Screening levels, as discussed above, two of these nine remaining constituents would have higher HWIR-media Bright Line concentrations than HWIR-waste exit levels.

Specific comparison of Groundwater/Surface Water Bright Line to wastewater exit levels. If contaminated groundwater were managed under the HWIR-waste proposal, the groundwater would be subject to the exit criteria for wastewaters. That is why EPA compared the groundwater/surface water Bright Line to the wastewaters exit level. For this analysis, the HWIR-media Bright Line for groundwater/surface water based on ingestion of groundwater was compared with two options for the exit criterion for wastewater for the HWIR-waste proposal, one based on toxicity benchmarks and one based on toxicity benchmarks and MCLs.

The analysis indicated that 38 constituents had higher proposed HWIR-waste exit criteria than proposed HWIR-media Bright Line concentrations.[14] For one of these 38 constituent, only the MCL option for the HWIR-waste exit level was higher. For four of the 38 constituents, only the toxicity benchmark only option for the HWIR-waste exit level was higher. None of these 38 constituents were affected by the HWIR-media 10,000 ppm cap, and there is not a saturation limit cap on the HWIR-media groundwater/surface water Bright Line.

Similar to the comparison of the HWIR-media soil Bright Line to the HWIR-waste non-wastewater exit levels, the HWIR-media groundwater/surface water Bright Line and the HWIR-waste wastewater exit levels use different methodologies, and therefore produce different results. Again, a key difference between the two sets of concentrations is the use of fate and transport modeling. The HWIR-waste proposal assumes some loss through fate and transport, whereas the HWIR-media methodology assumes direct ingestion of the contaminated groundwater (more details on the two methodologies can be found in the dockets for the two proposed rules).

Request for comments. Because of the above comparisons, EPA has determined that for some constituents, because the HWIR-media methodology was *more* conservative than the HWIR-waste methodology, that conservatism outweighed the fact that the HWIR-media risk target (10^{-3} for limited pathways) was *less* conservative than the HWIR-waste risk target (10^{-6} for multiple pathways). Therefore some of the HWIR-waste exit levels, which were intended to be more conservative overall than the HWIR-media Bright Line, are set at higher concentrations. As described above, EPA recognizes that these discrepancies must be resolved before promulgation of the two proposed rules. For further detail on the methodologies used to develop the HWIR-media Bright Line, Soil Screening Levels and the HWIR-waste exit levels, see the docket for the two proposed HWIR rules. EPA requests comments on how to resolve these issues.

B. Other Requirements Applicable to Management of Hazardous Contaminated Media

1. Applicability of Other Requirements—§ 269.10

The purpose of today's proposed rule would be to modify the identification, permitting, management, treatment, and disposal requirements for contaminated media. It is not intended to replace the entire scope of Subtitle C requirements as they relate to media. For that reason, many existing Subtitle C requirements would continue to apply to remedial actions conducted in accordance with this Part. Specifically, 40 CFR Parts 262–267 and 270 would continue to apply when complying with this Part, except as specifically replaced by the provisions of this Part. In addition, when treating media subject to LDRs according to the treatment standards in § 269.30, the following provisions of Part 268 would continue to apply: §§ 268.2–268.7 (definitions, dilution prohibition, surface impoundment treatment variance, case-by-case extensions, no migration petitions, and waste analysis and recordkeeping), § 268.44 (treatment variances), and § 268.50 (prohibition on storage). Again, the Agency does not intend to recreate all of the Subtitle C requirements, but in this case only replace certain requirements themselves as they relate to hazardous contaminated media.

2. Intentional Contamination of Media Prohibited—§ 269.11

EPA recognizes that promulgation of standards for hazardous contaminated media that are less onerous than the requirements for hazardous waste may create incentives for mixing waste with soil or other media to render the waste subject to these provisions. The Agency expressly proposes to prohibit this behavior (§ 269.11).

EPA recognizes, however, that sometimes it is necessary to have some mixing of contaminated media for technical purposes to facilitate cleanup. That mixing is not the prohibited mixing referred to here. This prohibition specifically includes the intent to avoid regulation. If the intent of the mixing is to better comply with the regulations that would apply to the wastes prior to mixing, then it would not be prohibited under this clause. The Agency requests comments on whether further safeguards, in addition to this proposed provision and the civil and criminal enforcement authorities of RCRA, are needed to ensure that no attempts are made to mix wastes with media to take advantage of the reduced requirements of the proposed HWIR-media rule.

3. Interstate Movement of Contaminated Media—§ 269.12

EPA recognizes that media that would be exempted under today's rule, but that previously would have been managed as hazardous wastes, would be transported to and through States that were not the overseeing agency for the remedial action that generated those media. Therefore, the Agency designed the interstate movement requirements of proposed § 269.12 to ensure that receiving (consignment) States—or States through which media would travel—could approve the designation that the media is not hazardous before they accepted the media for transport or disposal.

The default in these requirements is that the media must be managed as Subtitle C waste in the receiving or transporting State if the receiving or transporting State has not been notified of the designation as non-hazardous, or if the receiving or transporting State does not agree with the determination. Receiving and transporting States would also have to be authorized for this Part in order to approve these decisions in their States. If a receiving or transporting State agrees to the redesignation, then the media may be managed as non-hazardous.

EPA requests comments on these interstate movement requirements, specifically on any implementation concerns with this approach, and any suggestions to ease implementation. Several people have expressed concern about notifying the States through which the media would be transported, but not ultimately disposed. The Agency believes that it may be appropriate to limit notification requirements to the States ultimately receiving the media. EPA also feels that it would be necessary to limit the designation of media as non-hazardous only to States that are authorized for this Part. The Agency believes that this would be necessary because the authority to make these contained-in decisions is an integral element for authorization for this Part. EPA believes

[14] If the HWIR-media proposed Bright Line concentrations were updated to reflect current updated risk information, as discussed above, two of these 38 constituents would have higher HWIR-media Bright Line concentrations than HWIR-waste exit levels.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 27 1996

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

T. L. Nebrich, Jr.
Technical Director
Waste Technology Services Inc.
640 Park Place
Niagara Falls, New York 14301

Dear Mr. Nebrich:

Thank you for your letter of November 14, 1995 regarding clarification of the "mixture rule," the "contained-in" policy, LDR issues, and "point of generation" for U096, (a,a,Dimethylbenzylhydroperoxide). The U096 waste itself is subject to the LDR requirements in 40 CFR Subpart 268.42 and must be treated by the methods specified. When wastes exhibiting a RCRA characteristic (such as U096) are mixed with a solid waste, if the resulting mixture does not exhibit the characteristic (in this case of reactivity), then the waste is not required to be disposed in a Subtitle C landfill, but can be disposed in a Subtitle D landfill. However, the waste is still subject to treatment by the methods specified in 40 CFR Subpart 268.42 (see 40 CFR Subpart 261.3(a)(2)(iii)).

If U096 waste was spilled on soil, the EPA or authorized State Agency overseeing the cleanup could determine whether the soil did or did not contain hazardous waste, based on the "contained-in" policy. EPA's "contained-in" policy does not specify levels at which "contained-in" determinations must be made. Those decisions are left to the discretion of the EPA or State program that is making the "contained-in" determination. Therefore, the "contained-in" policy does not require that the U096 be analytically non-detectable in order to be considered non-hazardous, although the EPA or State program could require that (or alternative levels) based on their discretion.

Issues similar to those you raised regarding contaminated soil were discussed in a September 15, 1995 letter that I wrote to Peter C. Wright of the Monsanto Company. That letter is attached. Also, these issues will be discussed more fully in an upcoming EPA proposed rulemaking "Requirements for Management of Hazardous Contaminated Media" commonly referred to as the Hazardous Waste Identification Rule for Contaminated Media or HWIR-media. We plan to publish that proposal in March, and I will forward a copy to you as soon as it is available. We suggest you look to the proposal's preamble discussion for guidance regarding the situation you describe in your letter. Of course, it should be noted that the requirements that apply to contaminated media could change when EPA finalizes that rulemaking.

Thank you for your concern about protecting the environment. I apologize for the delay in responding to your letter that was caused by the

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two government furloughs. Your staff may wish to contact Carolyn Hoskinson at (703) 308-8626, if you have any further questions.

Sincerely Yours,

Bruce R. Weddle

for Michael Shapiro, Director
Office of Solid Waste

Enclosures

cc:
Matt Hale, OSW/PSPD
Barbara Pace, OGC
RCRA Regional Branch Chiefs, Regions 1-10

WASTE TECHNOLOGY SERVICES INC.

Control to PSPD
cc U2
HWMD

November 14, 1995

Mr. Michael Shipiro, Director
Office of Solid Waste
Environmental Protection Agency
401 M Street, S. W.
Washington, DC 20460

Dear Mr. Shipiro:

I am requesting a clarification of the "mixture rule" and "contained-in" policy in regards to U096 (a,a,Dimethylbenzylhydroperoxide) and LDR issues. This material is listed for reactive (R) and as such when mixed with another solid waste would not be a hazardous waste if it did not meet the reactivity requirement in 40CFR261.23. If this material was spilled on soil, the "contained-in" policy kicks in. I understand that with this scenario the identification as a hazardous waste is different than the above scenario (mixture). That is, the U096 would have to be analytically non-detect to be considered as non-hazardous.

If my assumptions are correct, and correct me if I'm wrong, what is the Land Disposal Restrictions (LDR) ramifications? Does this material have to be CMBST under both scenarios? At what point is the "point of generation" under both scenarios.

If you should have any questions, please do not hesitate to call.

Very truly yours,

WASTE TECHNOLOGY SERVICES, INC.

received
11/21/95
TMB

T. L. Nebrich, Jr.
Technical Director

TLN/kjl

640 Park Place, Niagara Falls, New York, 14301

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 15 1995

Mr. Peter C. Wright
Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63167

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

Dear Mr. Wright,

I am writing in response to your letter of January 3, 1995, in which you requested clarification of the RCRA "contained-in" policy. In your letter you asked several specific questions regarding this policy, and we offer our responses below. It should be understood that these responses reflect the Agency's current interpretation of the contained-in concept; in the Hazardous Waste Identification Rule for Contaminated Media (HWIR-media), currently under development, we will be looking closely at the contained-in policy and other issues associated with contaminated media and will be addressing those issues through the rulemaking process.

Question 1. Can a State determine whether or not soils which contained a listed hazardous waste, but were then treated to below health based concentrations, no longer contain the hazardous waste?

The contained-in policy is intended to clarify the application of RCRA hazardous waste regulations to environmental media. As stated in previous guidance on this policy, contaminated media are not considered solid wastes in the sense of being abandoned, recycled, or inherently waste-like as those terms are defined in RCRA regulations. However, environmental media that contain listed hazardous wastes must be managed as hazardous wastes because--and only as long as--they contain listed waste(s)[1]. EPA Regions and authorized states may apply the contained-in policy to determine site-, media- and contaminant-specific levels, such that if the concentration of the hazardous constituents in the environmental media fall below these levels, the environmental media may be determined to no longer contain hazardous waste. Such "contained-in determinations" may be made before or after treatment of the contaminated environmental media and may include consideration of site-specific exposure pathways (e.g., potential for human exposure, soil permeability, depth to groundwater).

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[1] June 19, 1989 letter from Jonathan Cannon, Acting Assistant Administrator of EPA's Office of Solid Waste and Emergency Response to Thomas Jorling, Commissioner of the New York Department of Environmental Conservation.

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Question 2. Are soils that have been treated and then determined not to contain hazardous wastes still subject to the Land Disposal Restrictions (LDRs) Universal Treatment Standards (UTS) prior to land disposal?

Yes. If contaminated environmental media are treated and then determined to no longer contain hazardous waste, the LDR treatment standards still must be complied with prior to land disposal. This means that the media would have to be treated to meet UTS or a treatability variance would have to be obtained[2]. Individuals who believe that the UTS are not appropriate for media containing solid waste are encouraged to work with their State regulatory agency and the appropriate EPA Regional Office to obtain a site-specific treatability variance under 40 CFR §268.44(h). EPA's policy is that site specific treatability variances are presumed to be appropriate for contaminated media. See 55 FR 8760 (March 8, 1990) For more information on site specific treatability variances granted in the context of environmental cleanup, please refer to the Superfund LDR Guides Numbered 6A and 6B, entitled, *Obtaining a Soil and Debris Treatability Variance for Remedial Actions* and *Obtaining a Solid and Debris Treatability Variance for Removal Actions*, respectively. For your convenience, copies of these guidance documents are enclosed.

Of course, if no land disposal will occur, the LDR treatment standards do not apply. Additionally, contaminated environmental media determined not to contain any waste (i.e., it's just media), would not be subject to any RCRA Subtitle C requirement, including the LDRs.

Question 3. If groundwater that originally exhibited a hazardous characteristic is subsequently treated to below a State-determined contained-in level, would the ground water still be subject to the UTS requirements prior to land disposal?

Yes. Once the LDR treatment standards attach to characteristic wastes, even if the characteristic is eliminated, the media remain subject to any applicable LDR treatment standards that have not been met through removal of the

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[2] Nothing in this letter is intended to affect the status of existing regulatory or statutory exclusions to the definition of solid or hazardous waste. Such provisions can prevent the duty to comply with LDRs from attaching in the first instance. See, e.g, RCRA § 1004(27) (exempting industrial point source discharges subject to Clean Water Act permits from the definition of solid waste). In addition, the Agency does not intend in this letter to expand the scope of activities that constitute land disposal and thus trigger LDR treatment requirements. For example, the Agency's positions that in situ treatment and movement of contaminated media within an area of contamination do not constitute land disposal remain unaffected. Similarly, this letter is not intended to affect any statutory or regulatory exclusions to the requirement to comply with LDRs (see e.g., RCRA § 3020(b)).

characteristic. As indicated in the Third Third decision, Chemical Waste Management v. U.S. EPA, 976 F.2d 2 (D.C. Cir. 1992), cert. denied, 1135 S.Ct 1961 (1993), elimination of the characteristic does not necessarily satisfy LDR requirements. If groundwater that exhibits a characteristic is treated prior to land disposal, it must be treated in accordance with applicable LDR treatment standards or pursuant to a treatability variance to meet LDR requirements. As discussed in our response to question 2, individuals who believe that the UTS are not appropriate to their contaminated media are encouraged to apply for a site specific treatability variance.

Of course, if no land disposal will occur, the LDR treatment standards do not apply. Additionally, ground water managed in accordance with one of the existing statutory or regulatory exclusions may not be subject to the LDR treatment standards even when land disposal will occur. For example, under RCRA § 3020(b), contaminated groundwater may be treated in accordance with a cleanup action and then reinjected into the aquifer from which it was withdrawn without meeting LDR treatment standards, provided the treatment substantially reduces the hazardous constituents prior to reinjection and the cleanup action will, upon completion, be sufficient to protect human health and the environment.

Question 4. May a State that is authorized only for the base RCRA program make contained-in determinations, or does the State need to be authorized for the LDRs as well?

In order to make contained-in determinations, a State must only be authorized for the part of the base program under which the waste of concern is identified as hazardous. For example, when determining whether or not a medium contains a particular characteristic waste, the State must be authorized for that characteristic. In the same manner, if the State wishes to determine whether or not a medium contains a particular listed waste, that State must be authorized for that particular waste listing. In regard to the two sites described in your letter, both Massachusetts and Texas are authorized for the base program under which the wastes you mentioned are identified as hazardous, and may, at their discretion, make the contained-in determinations you described.

Question 5. Do contained-in determinations needed to be made under a RCRA permit, or can another mechanism be used?

Authorized states and EPA regions may use any format or mechanism to document contained-in determinations. These mechanisms could include official agency correspondence, orders, and RCRA permits.

We hope this will be of assistance to you in applying the

contained-in policy. If you have any further questions, please contact Elizabeth McManus, of my staff, at (703) 308-8657. In addition, please note that authorized states have their own regulations and policies which may be more stringent than federal regulations and policies. In authorized states, questions about application of the contained-in policy, including the interpretations put forth in this letter, should be referred to the appropriate state agency. In Texas, please contact Paul Lewis of the Texas Natural Resources Conservation Commission at (512) 239-2340; in Massachusetts, please contact John Carrigan of the Massachusetts Department of Environmental Protection at (617) 292-5584.

Sincerely,

Michael Shapiro

Michael Shapiro
Director, Office of Solid Waste

Enclosure

cc: Matt Hale, OSW, PSPD
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Monsanto

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PETER C. WRIGHT
ENVIRONMENTAL ATTORNEY
(314) 694-8609

January 3, 1995

Mr. Michael Shapiro
United States Environmental Protection Agency
Office of Solid Waste and Emergency Response
401 M Street, S.W.
Washington, D.C. 20460

Re: Clarification of the Contained In Rule

Dear Mr. Shapiro:

This letter addresses an urgent issue that arises with the December 19 effective date of he Phase II Land Disposal Restriction (LDR) rule. Your immediate attention and response is requested in order to avoid delay of planned remedial work that has been developed in concert with state authorities.

Monsanto Company has two plant sites that are planning to engage in remediation activities in the near term, which require confirmation of Monsanto's understanding of the operation of the contained in rule. More specifically, as will be described in detail below, these two sites have planned to implement remedial measures that will remove hazardous waste constituents from affected environmental media so that it is Monsanto's understanding (and that of the two RCRA authorized states) that the treated media will no longer "contain" a hazardous waste. The treated environmental media will likely contain traces of hazardous constituents after treatment, at concentrations below health based concentration limits established by the two states. We understand that once the media no longer contains the listed waste (as determined by the State agency) it no longer must be managed as a hazardous waste, i.e. subtitle C no longer applies and the media may be placed on the land without regard to the Land Disposal Restrictions Universal Treatment Standards (UTS). Do you concur? We also understand that a State authorized for the base program is empowered to make the contained-in determination without regard to the State's authorization status for the LDR program. Do you concur?

Overview of the Sites and Remediation Projects

The first plant site is located in Everett, Massachusetts, just north of the City of Boston. This long time chemical manufacturing facility was closed in November, 1992. Currently, the Everett site has been proceeding under the authority of the Massachusetts Contingency Plan (MCP) with proposed remediation scheduled for completion in 1997. In order for the Everett site to proceed on its cleanup schedule, the Agency's interpretation of the contained in rule is important, particularly as the site is currently under a Purchase and Sale Agreement for development as a shopping center with construction scheduled to begin in 1997. This development is critical to the local community because the shopping center will be a major element of Everett's tax base and a significant source of employment in the city.

Due to historic manufacturing operations, areas of the plant site have been contaminated with bis 2-ethyl hexyl phthalate (BEHP), naphthalene and phthalic anhydride still bottoms, materials which carry the RCRA hazardous waste codes U028, U165 and K024, respectively. Concentrations as high as 10,000 mg/kg of BEHP, 30,000 mg/kg of naphthalene, and 60,000 mg/kg of phthalic acid have been detected in soil samples collected at the site. The remediation plan that has been under development would involve the separation of some discreet waste materials, treatment of some soil in place, and excavation and treatment of some soil from hotspot areas with subsequent reuse of the treated soil on-site as backfill. These treatment methods would significantly reduce the concentration of hazardous constituents remaining in the soils. The Everett Plant has held discussions with the Massachusetts Department of Environmental Protection (DEP's) Bureau of Waste Prevention regarding the impact of RCRA regulations on the planned remediation strategy and has assumed that once the soil was remediated to meet health-based concentrations levels established by Massachusetts (a RCRA authorized state), that the soil no longer would contain hazardous waste and could be beneficially reused as backfill on-site with no further RCRA restrictions. The planned remediation strategy would satisfy the Massachusetts Bureau of Waste Site Cleanup Program requirements to achieve a Permanent Solution, addressing potential risks to human health and the environment and eliminate the potential for constituent migration. Attached is a copy of a DEP policy memorandum dated March 4, 1994 and a letter issued on the same date describing DEP's understanding of how it will apply the contained in rule to a particular remediation project.

The other Monsanto site is the Chocolate Bayou plant, located near Alvin, Texas. This is a large diversified chemical manufacturing site that has a RCRA permit, which includes a corrective action component that is administered by the Texas Natural Resource Conservation Commission (TNRCC). Texas is authorized for RCRA corrective action. The particular remediation project at issue, a program to pump, treat and reinject groundwater that has been contaminated by benzene, phenol and acetone, is not being conducted under RCRA permit, but rather these

ctions are being undertaken proactively by Monsanto in consultation with the TNRCC. The plant applied for and has received a groundwater class V reinjection permit from TNRCC for this remedial project.

The groundwater at the point it is brought out of the ground is characteristically hazardous for benzene. The groundwater exhibited measured levels of benzene, phenol and acetone as high as 62 mg/l, 6 mg/l and 6 mg/l, respectively without any treatment. The air stripping treatment system to be installed has been designed to treat the groundwater so that the concentrations of benzene, phenol and acetone are no higher than 0.001 mg/l, 6 mg/l, and 2 mg/l respectively. This treatment of groundwater to these levels would mean that all three contaminants would be below the Texas Risk Reduction Rule Standard 2 Residential levels of 0.005 mg/l benzene, 21.9 mg/l phenol and 2.65 mg/l acetone. The phenol and the acetone would exceed the technology [incineration] based LDR wastewater standards of 0.039 mg/l for phenol and 0.28 mg/l for acetone. The phenol and the acetone are biodegradable organic chemicals and it is believed that the reinjection process will add oxygen to the affected groundwater, assisting in the biodegradation of the organic materials that are not removed by the treatment.

Neither site has considered applying for a Corrective Action Management Unit (CAMU). First, it was believed to be unnecessary to employ a CAMU because of the plan to treat contaminated media to meet health based levels. Second, the time, expense and effort on behalf of Monsanto and the state agencies to put in place the necessary RCRA permits and modifications makes the CAMU option not practical for a timely commencement of remediation activities.

History of the Contained In Rule

Monsanto's understanding has been that treating affected environmental media to meet health based concentration levels that have been applied on a site specific basis by the respective authorized states would free the treated media from further RCRA regulation, including the application of any land disposal restrictions. Monsanto's understanding is based on EPA discussions of the contained in rule. Monsanto's understanding of EPA's position on the "contained in rule" is that it was an interpretative rule long before it was "codified" in rulemakings in the 1990s. EPA has stated that this view of the contained in rule was supported by the 1989 Chemical Waste Management decision. Chemical Waste Management v. EPA, 869 F.2d 1526, 1538 ftnt. 15 (D.C. Cir. 1989).

The contained in rule was first explained in a memorandum from Marcia Williams to Patrick Tobin dated November 13, 1986 . That memorandum stated that "If groundwater is treated such that it no longer contains a hazardous waste, the groundwater would no longer be subject to regulation under Subtitle C of RCRA."

Subsequent memoranda and letters[1] expanded on the application of the contained in rule. These writings refined the concept that if contaminated environmental media was treated so that the levels of hazardous constituents that remained after treatment were below certain levels, which often have been set at health based levels, that EPA would consider that the affected media no longer "contained" a hazardous waste and so no longer was subject to regulation under RCRA Subtitle C. Monsanto is not certain that the contained in rule applies to a situation like what exists at the Chocolate Bayou plant where there are no listed, but only characteristic wastes involved. Yet Monsanto can see no reason why an exit level appropriate for media contaminated with listed waste would not also apply to media contaminated with a characteristic waste.

EPA also made it clear that an authorized RCRA state could determine what the contained in levels could be. EPA guidance to the states in making the contained in determinations has stressed the need to make the contained in determination on a site-specific basis, in accordance with the general State or Federal guidelines, or by means of a site specific risk assessment. It would appear that the Massachusetts regulations, 310 CMR 40.00 (the Massachusetts Contingency Plan) and the associated policy on the contained in rule and the TNRCC's Risk Reduction Rules provide precisely the kind of the decision making framework EPA requires that an authorized RCRA state use for making the contained in rule decision. It is only a requirement for a state to be authorized for the basic RCRA program to be able to make contained in determination, and it is not necessary for the state to be authorized for all or parts of the land disposal program.

The rulemakings "codifying" the contained in rule began with the reference in the Third Third rulemaking in which EPA "clarified" the treatment standards that would apply to soils that had been contaminated with listed waste. 53 Fed. Reg. 31138, 31142 (August 17, 1988). The contained in rule has been addressed in at least five other Federal Register notices.[2] The most involved discussion and greatest reliance on the contained in rule is found in the Contaminated Debris rulemaking. In the proposed rulemaking, EPA stated that debris which had been contaminated with hazardous waste would "no longer be a prohibited waste or a hazardous waste if it achieves levels which debris no longer 'contains' hazardous waste." 57 Fed. Reg. at 982. EPA further explained that the levels would be that at which the potential threat to human health and the environment had been

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[1] See e.g., Sylvia K. Lowrance to Jeff Zelkinson, January 24, 1989; Jonathan Cannon to Thomas Jorling, June 19, 1989 (authorized states can make determination on what the appropriate health based levels are at which media no longer "contains" a hazardous waste); Sylvia K. Lowrance to John Ely, March 20, 1991 (recommended that the state use a risk assessment approach to making contained in determinations) (The Massachusetts letter cites additional letters).

[2] See e.g., 56 Fed. Reg. 24456 (May 11, 1991); 57 Fed. Reg. 958, 961 (January 9, 1992); 57 Fed. Reg. 37194 (August 18, 1992); 58 Fed. Reg. 48092, 48096 (September 14, 1993) and 59 Fed. Reg. 47982, 47986 (September 19, 1994).

minimized. Id. at 985. In the final rulemaking, EPA explained that treated contaminated debris would be considered to no longer "contain" a hazardous waste, if the debris were treated so as to achieve health based concentrations based on considerations of site hydrology and exposure pathways. EPA summarized the regulatory effect of providing treatment to these levels by stating that "[d]ebris found not to contain hazardous waste (and not exhibiting a hazardous waste characteristic) would not be subject to further Subtitle C regulation, and so could be land disposed without further treatment." 57 Fed. Reg. at 37226 (emphasis added).

The contained in rule has also been discussed in context of the rulemaking proposing land disposal restriction standards for soil and in the final UTS rulemaking. EPA stated "the primary function of a contained in determination has been to determine specific constituent concentrations at which the media at a specific site no longer 'contained' hazardous waste and thus would no longer be subject to the management standards for hazardous waste." 58 Fed. Reg. at 48127. EPA's discussion of the contained in rule and its relationship to the concept of minimized threat levels in these rulemakings is unclear to us. Yet it appears to us that a contained in determination based on a site specific determination satisfies any requirement to achieve minimized threat levels. If this is not EPA's position, then EPA has made a major change in policy for which no notice has been given, for which no rationale has been provided and which may mean that the work on the HWIR will be a complete waste of time. More to the point, if this interpretation about the affect of the contained in rule has changed it may bring to a halt the two remedial projects referenced above and undoubtedly countless other projects.

In order to avoid delay and unnecessary additional expense in connection with approving bids from remediation contractors, we request a prompt response. Monsanto would also like an opportunity to meet with the Agency at the Agency's convenience during January to address the matters raised in this letter.

We look forward to the Agency's urgent consideration and response on this important matter.

Very truly yours,

Peter C. Wright

cc: Barbara Pace, Esquire, EPA Office of General Counsel
Steven Silverman, Esquire, EPA
Richard Kinch, EPA

Mr. Thomas Powers, Acting Commissioner
Mr. John Carrigan
Mr. Brian Moran
Commonwealth of Massachusetts
Department of Environmental Protection
One Winter Street
Boston, Massachusetts 02108

Mr. Richard Chaplin
Commonwealth of Massachusetts
Department of Environmental Protection
10 Commerce Way
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Mr. Douglas Crist
Mr. Tom Jecha
Ms. Wendy Ruzacky
Texas Natural Resource Conservation Commission
P.O. Box 13087
Austin, Texas 78711-3087

Lowell Martin, Esquire, RCRA Corrective Action Project

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 17 1995

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: P and U Listed Wastes and the Contained-in Policy

FROM: Devereaux Barnes, Director
Permits and State Programs Division, OSW

TO: Norm Niedergang, Director
Office of RCRA, Region V

Recently your staff contacted us in regard to the Agency's current RCRA contained-in policy as it applies to environmental media that contain P and U listed hazardous wastes. Since this question has been posed several times by other Regions, we would like to take this opportunity to articulate the Agency's position on this matter.

The RCRA contained-in policy applies to P and U listed wastes in the same manner as for other listed wastes. Although §261.33(d) specifies that contaminated soil and water generated from the cleanup of releases of P and U listed wastes must be managed as hazardous waste, such soil or water would not be considered "contaminated" in this particular context if the implementing agency determined that the media did not contain such a listed waste.

As you may know, the Office of Solid Waste is currently developing a new rulemaking--the HWIR Contaminated Media Rule--that will likely codify the contained-in concept in some detail. That rulemaking should hopefully resolve a number of the questions that are often asked regarding the current contained-in policy. Several of your staff are members of the HWIR-Media workgroup, and we will keep them apprised of any further developments regarding this concept.

If you have any questions, please contact Dave Fagan or Carolyn Hoskinson of my staff, at (703) 308-8620 and (703) 308-8626 respectively.

cc: J. Boyle
K. Pierard
B. Pace
T. Kaneen

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LSLW - 026

Hugh Davis

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 22 1994

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

Mr. T. L. Nebrich, Jr.
Technical Director
Waste Technology Services, Inc.
640 Park Place
Niagara Falls, New York 14301

Dear Mr. Nebrich:

I am pleased to respond to your letter of January 10, 1994, in which you requested clarification of the Agency's "contained-in" policy. The specific question that you raise regards soil contaminated with a listed waste that is listed only because of its ignitability. You question whether the contaminated soil is still a hazardous waste when it is not ignitable. The example that you cite involves soil contaminated with U239. You also raise the same question for soils contaminated with other listed wastes (such as F003) that are listed solely for ignitability.

As you correctly state in your letter, under the "contained-in policy", the authorized state or EPA has the discretion to determine contaminant-specific health-based levels, such that if the concentrations of the hazardous waste constituents were below those levels, the media would no longer be considered to contain the waste. The health-based levels used in making contained-in determinations are made on a site-specific basis. EPA has codified the contained-in policy for contaminated debris (see 57 FR 37225, August 18, 1992).

In cases where the waste is listed only for ignitability, and the contaminated soil is not ignitable and does not exhibit any other characteristics, the contaminated soil may contain hazardous constituents and thereby contain the listed waste. The authorized state or EPA may establish health-based levels for any hazardous constituents present in the contaminated soil below which the contaminated soil would no longer contain the listed waste. For example, for a soil contaminated with F003 listed waste, the authorized state or EPA might establish contained-in determination levels for individual solvents as well for any metals that might be present. This interpretation is consistent with the delisting process for wastes that are listed solely because they exhibit a characteristic. To make a delisting determination, the Administrator may examine additional hazardous constituents other than those for which the waste was listed (260.22(c)(2)).

9441.1992(34)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 15 1992

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

Mr. William L. Warren
Cohen, Shapiro, Polisher, Sheikman and Cohen
1009 Lenox Drive, Building Four
Lawrenceville, NJ 08648

Dear Mr. Warren:

I am pleased to respond to your letter of August 26, 1992, in which you requested clarification of several issues relating to the regulatory status of soils contaminated from releases of commercial chemical products.

The example outlined in your letter dealt specifically with leakage of carbon tetrachloride from a tank. Since the carbon tetrachloride has been "discarded" in this case, it would be identified as U-211 listed hazardous waste. The key question posed in your letter is whether the resulting contaminated soil is hazardous waste, and under what circumstances it would be subject to hazardous waste management requirements.

Under EPA's regulatory definition of hazardous waste in §261.3(c)(1), soils that contain hazardous wastes must be managed as if they were hazardous wastes until or unless they no longer contain the listed waste, exhibit a characteristic, or are delisted (see 57 Fed. Reg. 37225, Aug. 18, 1992). Under the "contained-in policy" the authorized State or EPA has the discretion to determine contaminant-specific health-based levels, such that if the concentrations of the hazardous waste constituents were below those levels the media would no longer be considered to contain the waste. This applies to "U" listed wastes, and other listed wastes. The health-based levels used in making contained-in determinations are established on a site-specific basis, in accordance with general State or Federal guidelines, or by means of a site specific risk assessment. This discretion is available to the State Administrator in an authorized State, or otherwise is vested in the EPA Regional Administrator.

In the example outlined in your letter, you state that the contaminant levels are below the State's remedial requirements. As such, it may be that the State would determine that the soils do not contain hazardous wastes. If such is the case, and

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I hope that this has helped to clarify the issues that you have raised. If you have any further questions, please contact Hugh Davis at (703) 308-8633.

Sincerely,

Elizabeth A. Cotsworth

for Michael Shapiro
Director, Office of Solid Waste

530-Z-93-010

federal register

Tuesday
August 18, 1992

Part II

Environmental Protection Agency

40 CFR Part 148 et al.

Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris; Rule

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 148, 260, 261, 262, 264, 265, 268, 270 and 271

[FRL-4132-4]

RIN 2050-AD36

Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is finalizing treatment standards under the land disposal restrictions (LDR) program for certain hazardous wastes listed after November 8, 1984, pursuant to a proposed consent decree filed with the District Court that established a promulgation date of June 1992 (*EDF* v. *Reilly*, Civ. No. 89-0598, D.D.C.). EPA is also finalizing revised treatment standards for debris contaminated with listed hazardous waste or debris that exhibits certain hazardous waste characteristics (hereinafter referred to as hazardous debris), and several revisions to previously promulgated standards and requirements. These actions are being taken as part of the RCRA Reform Initiative, and are expected to facilitate implementation of the LDR program.

EFFECTIVE DATES: This final rule is effective on June 30, 1992, except for §§ 148.17(a), 260.10, 261.3(c)(2)(ii)(C), 268.2, 268.5, 268.7, 268.9, 268.36(a), 268.40, 268.41, 268.42, 268.43, 268.45, 268.46, 268.50, 270.14, 270.42, 270.72, and 271.1, which are effective November 16, 1992; and §§ 262.34, 264.110, 264.111, 264.112, 264.140, 264.142, part 264 subpart DD, 265.110, 265.111, 265.112, 265.140, 265.142, 265.221, and part 265 subpart DD, which are effective February 18, 1993.

ADDRESSES: The official record for this rulemaking is identified as Docket Number F-92-CD2F-FFFFF, and is located in the EPA RCRA Docket, room 2427, 401 M Street SW., Washington, DC 20460. The docket is open from 9 a.m. to 4 p.m., Monday through Friday, except on Federal holidays. The public must make an appointment to review docket materials by calling (202) 260-9327. A maximum of 100 pages from the docket may be copied at no cost. Additional copies cost $.15 per page.

FOR FURTHER INFORMATION CONTACT: For general information, contact the RCRA Hotline at (800) 424-9346 (toll free) or (703) 920-9810 locally. For information on treatment standards for newly listed wastes or hazardous debris, contact the Waste Treatment Branch, Office of Solid Waste (OS-322W), U.S. Environmental Protection Agency, 401 M St., SW., Washington, DC 20460, (703) 308-8434. For information on capacity determinations or national capacity variances, contact the Capacity Programs Branch, Office of Solid Waste (OS-321W), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (703) 308-8440.

SUPPLEMENTARY INFORMATION:

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- A. Summary of the Hazardous and Solid Waste Amendments of 1984
- B. Pollution Prevention (Waste Minimization) Benefits

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I. Background

A. Summary of the Hazardous and Solid Waste Amendments of 1984

The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA), enacted on November 8, 1984, allow hazardous wastes to be land disposed only if they satisfy either of two conditions: (1) They can either be treated, or otherwise satisfy, the requirement of section 3004(m), which provision requires EPA to set levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized; or (2) they can be land disposed in units satisfying the so-called no-migration standard in sections 3004 (d)(1), (e)(1), and (g)(5). Land disposal includes any placement of hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave. RCRA section 3004(k).

EPA was required to promulgate land disposal prohibitions and treatment standards by May 8, 1990 for all wastes that were either listed or identified as hazardous at the time of the 1984

debris even if the equipment was used to treat wastes or wastewaters. The commenters are correct. A discarded pump or filter used to treat a waste is debris, but the waste pumped or filtered *is not debris. Although some filtered or* pumped waste will contaminate the pump or filter (indeed, that is the basis for subjecting the filter or pump to the treatment standards), the contaminated pump or filter will virtually always be comprised primarily of debris rather than waste and so would be classified as debris.

f. *Intact Containers Are Not Debris.* A number of commenters requested comment on the relationship between the proposed treatment standards for debris and the so-called empty container rule in § 261.7. That rule states in essence that with respect to containers holding hazardous waste, what is regulated is the hazardous waste in the container and not the container itself. Thus, empty containers are not regulated, and the hazardous wastes in nonempty containers are. An empty container is one from which all *hazardous wastes have been removed* using practices commonly utilized for waste removal, and in which not more than 2.5 centimeters of waste remains. (Slightly different tests apply to containers holding acutely hazardous wastes.)

Since containers are potentially a form of debris, there is a question whether either empty or nonempty containers are subject to the treatment standards for debris notwithstanding § 261.7. EPA is indicating in this rule that the debris treatment standards do not override the empty container rule, so that rule remains in effect. EPA is taking this step largely because it did not propose the issue for comment, and any fundamental changes to the empty container rule merit fuller public participation than afforded here. In addition, EPA has not fully studied the implications of making changes in the empty container rule to accommodate regulations under the land disposal prohibitions program.

Today's final rule thus indicates that intact containers are never considered to be debris, and thus would never be subject to treatment standards for debris. Intact containers are either *empty or nonempty. If empty they are* not subject to regulation, as provided by § 261.7(a)(1). If nonempty, the hazardous waste within the container is subject to the land disposal prohibitions (as well as the rest of subtitle C regulations). EPA also does not consider intact tanks to be debris, so that any hazardous *wastes in tanks would* be subject to the standards for those wastes, not (potentially) to treatment standards for debris.

It should be noted, however, that EPA is reading the empty container rule in § 261.7 to apply to intact containers. The Agency is doing so because the rule was clearly intended for devices that function as containers, not for crumpled drums that are not easily emptied by normal means. See § 261.7(b)(1)(i). Nonfunctional containers are more naturally classifiable as debris and the treatment standards adopted today are appropriate for such damaged containers being disposed.

By "intact container", the Agency means a container that can still function as a container. The Agency believes that a container that is unbroken and still retains at least 75% of its original holding capacity (i.e., has not been crushed more than 25%) is still intact. The Agency selected the 75% criterion because: (1) It is within a reasonable range of 50% to 90%; (2) selecting an original volume criterion on the high end of the range (e.g., 90%) would result in *containers containing large quantities of* waste being considered debris even though the containers could be readily separated from debris; and (3) selecting an original volume criterion on the low end of the range (e.g., 50%) would subject the waste in containers that have been severely crushed to the treatment standards for the waste. This would require removal of the waste from the container for treatment which may be impracticable for severely crushed containers.

Finally, it should be noted that by observing the empty container rule, EPA is creating a limited exception to the nonsegregation principle discussed above. In situations where intact containers are mixed with true debris (i.e., materials classified as debris under today's rule), the intact containers thus would have to be removed and managed separately.

The following example indicates how these principles would apply. At a remediation site, ruptured drums are discovered still containing some prohibited hazardous waste. Mixed in with these drums are other drums some of which are not significantly damaged or crumpled and all still contain *prohibited hazardous wastes. All of* these drums are going to be disposed of off site.

Under today's rule, the ruptured drums are debris (broken or ruptured containers are always debris if contaminated with prohibited waste) and cannot be land disposed until they are treated by one of the debris treatment methods. If hazardous waste is removed from the drum during treatment, the waste, like all treatment residues, is subject to the treatment standards for the prohibited waste. With *respect to the unruptured drums, those* that are intact (i.e., those that retain at least 75% of their original volume) are nonempty containers under § 261.7. The waste in these drums is subject to the treatment standards for the prohibited waste. Those that are not intact (i.e., those that retain less than 75% of their original volume) are debris.

2. Definition of Hazardous Debris

a. *Which Debris is Hazardous, and of this Debris, Which is Prohibited?* This rule applies only to debris that is subject to subtitle C regulation when it is generated. As EPA proposed, this means: (1) Debris that contains listed hazardous wastes (either on the debris surface, or in its interstices, such as pore structure); or (2) debris that exhibits a characteristic of hazardous. See 57 FR 983. To be prohibited, and hence subject to the treatment standards adopted *today, the debris would have to be* contaminated with listed wastes that are also prohibited, or exhibit a prohibited characteristic. Thus, only debris that is contaminated with a listed waste for which EPA has established a treatment standard, and debris exhibiting the characteristics of ignitability, corrosivity, reactivity, or EP toxicity (plus exhibiting the TC characteristic, since the debris must still be a hazardous waste) are subject to the treatment standards adopted today. (Most of these debris wastes, of course, are already prohibited by virtue of previous rulemakings; only debris contaminated exclusively with the newly listed wastes for which EPA is adopting treatment standards today would be newly prohibited under today's rule.)

b. *Codification of Contained in Principle for Debris.* In adopting the definition that debris containing listed hazardous waste is regulated under subtitle C, EPA is codifying the "contained in" principle, which has heretofore served as an interpretive gloss on the existing mixture and derived from rules. See 57 FR 983, *CMA v. EPA*, 869 F. 2d 1526 (D.C. Cir. 1989). As explained at proposal, *id.* at 986, the contained in concept will apply to both media and nonmedia debris (an approach with unanimous support in the public comments).

Furthermore, EPA is also codifying the corollary part of the contained in principle: That debris which no longer "contains" listed hazardous waste

would no longer be subject to subtitle C regulation, provided that it does not exhibit any hazardous waste characteristic. This involves a case-by-case determination by EPA, made upon request, that debris does not contain hazardous waste at significant levels, taking into consideration such factors as site hydrogeology and potential exposure pathways, but excluding management practices.[21] Debris found not to contain hazardous waste (and not exhibiting a hazardous waste characteristic) would not be subject to further subtitle C regulation, and so could be land disposed without further treatment. In addition, these levels could be achieved by any form of treatment other than impermissible dilution, and thus need not result from application of the debris treatment methods adopted today. *Id.* at 983–84.

3. Relation of Today's Rule to the Hazardous Waste Identification Rule

On May 20, 1992, EPA proposed comprehensive revisions to the regulatory definition of hazardous waste, asking for comment on a series of options for redefining what a hazardous waste is. See 57 FR 21450. These rules could affect which debris is considered to be hazardous when it is generated (both through modifications to the hazardous waste definitions and the contained in principle), and so could affect both the definition of hazardous debris used in this rule, and possibly the extent such debris must be treated by prescribed methods of treatment. EPA has attempted to note in each of the sections below the potential overlap of this proposed rule on the rules adopted today.

Although the Hazardous Waste Identification Rule (HWIR) when promulgated will affect the definition of hazardous debris subject to today's treatment standards, the Agency believes that it is nonetheless appropriate to make the treatment standards effective immediately upon promulgation. The Agency does not believe that today's rule will place an unreasonable burden on generators of hazardous debris that may subsequently be determined by HWIR not to be hazardous because the Agency has provided a national, case-by-case capacity variance for hazardous debris that defers the effective date of today's treatment standards until May 8, 1993. By that time, the Agency believes that the final HWIR will be promulgated and the treatment of debris that HWIR determines is no longer hazardous will be precluded.

C. Treatment Standards for Hazardous Debris

1. Overview

In this section, we discuss: (1) The treatment technologies proposed as BDAT; (2) the contaminants subject to treatment; (3) the debris treatment standards; (4) alternative LDR standard; (5) performance standards that must be met to ensure effective treatment and to comply with the BDAT standards; (6) contaminant restrictions for certain treatment methods; (7) use of treatment trains for multiple contaminants and debris types; (8) treatment of characteristic debris; (9) standards for debris that is inherently toxic (i.e., it fails the TC and EP for metal contamination because it is fabricated from a toxic metal); (10) relationship of TSCA PCB rules to today's rule; (11) relationship of existing agency standards for asbestos to today's rule; (12) special requirements for radioactive debris; and (13) implementation of treatment standards.

2. BDAT Debris Treatment Technologies

a. *Identification of BDAT Treatment Technologies.* The Agency considered a treatment technology to be "available" if the technology itself or the services of the technology are able to be purchased, and the technology substantially diminishes the toxicity of the waste or reduces the likelihood of migration of the waste's hazardous constituents. The technologies that the Agency has identified as best demonstrated available technologies (BDAT) have been used to treat hazardous debris at Superfund sites, to remove radioactive metals from debris, to treat debris-like material contaminated with compounds similar to one or more of the compounds in the debris contaminant categories or, based on engineering judgment, are applicable to debris.

The Agency considered a technology to be demonstrated for a particular waste if the technology currently is in commercial operation for treatment of the waste or constituent of interest or similar wastes or constituents of interest, including wastes not regulated under RCRA, such as PCBs and radioactive waste. The Agency identified demonstrated technologies either through a review of the literature in which current waste treatment practices were discussed, or through information provided by specific facilities currently treating the waste or similar wastes. EPA also considered as demonstrated technologies those used to separate or otherwise process chemicals and other materials which are similar to the waste or constituent of interest.

The Agency also reviewed the properties of debris which may directly affect the efficiency of treatment technologies. Debris characteristics which may affect the performance or effectiveness of treatment technologies to clean various types of debris include:

- Destructibility;
- Hardness and brittleness;
- Moisture content;
- Permeability;
- Size, homogeneity, and location (in situ versus ex situ);
- Surface texture; and
- Total organic carbon (TOC).

Under today's rule, the Agency has identified the following 17 treatment technologies as BDAT for hazardous debris:

- Extraction Technologies:

—Physical Extraction
  —Abrasive blasting
  —Scarification, grinding, and planing
  —Spalling
  —Vibratory finishing
  —High pressure steam and water sprays
—Chemical Extraction
  —Water washing and spraying
  —Liquid phase solvent extraction
  —Vapor phase solvent extraction
—Thermal Extraction
  —High temperature metals recovery
  —Thermal desorption

- Destruction Technologies

—Biodegradation
—Chemical oxidation
—Chemical reduction
—Thermal destruction

- Immobilization Technologies

—Macroencapsulation
—Microencapsulation
—Sealing

Summary descriptions of these technologies are presented in Appendix I of today's preamble and treatment performance standards for each technology are prescribed in Table I, § 268.45. Further, detailed information on the various treatment technologies is presented in the Hazardous Debris Final Rule Technical Support Document.

b. *Changes in Identification of BDAT Technologies From Proposal.* Based on public comment and the Agency's further evaluation, the Agency has determined that two debris treatment technologies proposed as BDAT—electropolishing and ultraviolet radiation—are not BDAT, and an additional technology not proposed as BDAT—high temperature metal recovery—is, in fact, BDAT for

[21] We note that consideration of management practices for exclusion from subtitle C is being evaluated through the proposed Hazardous Waste Identification Rule discussed below in the text.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 26 1991

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

John E. Ely
Enforcement Director
Virginia Department of Waste Management
101 North 14th Street
Richmond, Virginia 23219

Dear Mr. Ely:

At the request of Carlyle C. Ring, Vice President and General Counsel of Atlantic Research Corporation, I am sending this letter to summarize the Agency's current position on the "contained-in" interpretative policy. It is my understanding, based upon Mr. Ring's letter, that there was some question as to whether the "contained-in" interpretative policy applies to all environmental media or only to ground water. Mr. Ring's letter also suggested that a letter from my Office would help resolve this matter. I hope this letter will answer this question and further clarify the policy. I have also enclosed, for your information, a memorandum from Jonathan Cannon to Thomas Jorling dated June 19, 1989. I hope that you will find these helpful.

The "contained-in" interpretation addresses environmental media (i.e., ground water, soil, and sediment) contaminated with RCRA listed hazardous waste. Our federal regulations at 40 CFR Part 261.3 identify hazardous wastes. Among other things, these regulations state that a solid waste mixed with a hazardous waste is a hazardous waste. However, these regulations generally do not specifically address environmental media, which are not solid wastes, mixed with listed hazardous waste. The Agency's position continues to be that mixtures of environmental media and listed hazardous waste (i.e., contaminated ground water, contaminated soil, and contaminated sediments) must be managed as if they were hazardous waste. This position is known as the "contained-in" policy. EPA's application of the "contained-in" policy to contaminated media was upheld by the D.C. Circuit Court of Appeals in Chemical Waste Management, Inc. v. U.S. EPA, 869 F.2d 1526 (D.C. Cir. 1989).

Consistent with this approach, the Agency further interprets the regulations to mean that environmental media contaminated with listed hazardous waste must be managed as if they were hazardous waste until the media no longer contain the listed hazardous waste (i.e., until decontaminated), or are delisted. To date, the Agency has not issued any definitive guidance as to

when, or at what levels, environmental media contaminated with listed hazardous waste no longer contain that hazardous waste. Until such guidance is issued, the Regions or authorized States may determine these levels on a case-specific basis. However, as you know, States that are authorized to implement the RCRA hazardous waste program, as Virginia is, are not bound by EPA's interpretation of the Federal regulations. Although they usually follow Federal interpretations, authorized States may interpret their own regulations more strictly than EPA interprets the Federal regulations.

Related to making a determination as to when contaminated media no longer contains listed hazardous waste, we suggest that a risk assessment approach be used that addresses the public health and environmental impacts of hazardous constituents remaining in the treated soils. And as stated above, the authorized State could apply more stringent standards or criteria for contaminated environmental media than those recommended by the Federal EPA if the authorized state determined it to be appropriate. [Note: However, this approach does not apply to residuals from the treatment of listed hazardous waste or mixtures of solid waste with listed hazardous waste under our current regulations, which must be delisted.]

I hope that this letter will be helpful to you in establishing and implementing Virginia's hazardous waste policies on related issues. Should you have any questions concerning EPA's "contained-in" interpretative policy, please contact Steve Cochran, Acting Chief of the Waste Identification Branch, at (202) 382-4770.

Sincerely yours,

Sylvia K. Lowrance
Director
Office of Solid Waste

cc: C. Ring
D. Freedman

Atlantic Research Corporation

5390 Cherokee Avenue
Alexandria, Virginia 22312
(703) 642-4250

.rlyle C. Ring, Jr.
Vice President and General Counsel

Federal Express

February 21, 1991

Mr. David Bussard
Characterization & Assessment Division
Solid Waste and Emergency Response
Environmental Protection Agency
401 M Street S.W.
Room SE240E
Washington, D.C. 20460

Re: Contained In Rule

Dear Mr. Bussard:

It is our understanding that the enclosed letter of Assistant Administrator Jonathan Z. Cannon of June 19, 1989 states the policy and position of the EPA that the "contained in" rule applies to ground water, soil and sediment.

We would hereby request that a letter be sent to the Virginia Department of Waste Management stating that the "contained in" rule of the enclosed Jorling letter applies to all environmental media. The letter should be sent to:

John E. Ely, Enforcement Director
Virginia Department of Waste Management
101 North 14th Street
Richmond, Virginia 23219.

It is our understanding that VDWM will accept such a letter indicating the EPA Headquarters policy as applicable to all media, including soil, in connection with a number of sites over which both EPA Region III and VDWM have jurisdiction. The letter also would assist in resolving issues relating to a site involving Atlantic Research Corporation (ARC).

Since the 1950's ARC has operated a manufacturing facility for solid propellant rocket motors in Gainesville, Virginia. Currently that plant is manufacturing rocket motors for the Tomahawk and Stinger missiles, among other DoD programs. During the 50's through 70's ARC, like other industrial users, did not handle solvents used for cleaning equipment and painting in the manner that they are now handled. Consequently, it was discovered in 1987 that there was limited soil and groundwater contamination by solvents at ARC's Gainesville facility. This was promptly reported to both VDWM and EPA Region III. A Consent Order under Section 3008 was entered into between Region III and ARC for study and cleanup.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 19 1989

Mr. Thomas C. Jorling
Commissioner
Department of Environmental Conservation
State of New York
Albany, New York 12233-1010

Dear Mr. Jorling:

I am writing in response to your letter of May 5, 1989, in which you ask numerous questions concerning the regulatory status, under the Resource Conservation and Recovery Act (RCRA), of environmental media (ground water, soil, and sediment) contaminated with RCRA-listed hazardous waste.

As you point out in your letter, it is correct that the Agency's "contained-in" interpretation is that contaminated environmental media must be managed as if they were hazardous wastes until they no longer contain the listed waste, or are delisted. This leads to the critical question of when an environmental medium contaminated by listed hazardous waste ceases to be a listed hazardous waste. In your letter, you discuss three possible answers (based on previous EPA positions and documents) which you believe address this question, and request the Agency to clarify its interpretation. Each of these is discussed below.

The first possible answer you cite would be that the contaminated media would be a hazardous waste unless and until it is delisted, based on the "mixture" and "derived-from" rules. As you correctly state in your letter, a waste that meets a listing description due to the application of either of these rules remains a listed hazardous waste until it is delisted. However, these two rules do not pertain to contaminated environmental media. Under our regulations, contaminated media are not considered solid wastes in the sense of being abandoned, recycled, or inherently waste-like as those terms are defined in the regulations. Therefore, contaminated environmental media cannot be considered a hazardous waste via the "mixture" rule (i.e., to have a hazardous waste mixture, a hazardous waste must be mixed with a solid waste per 40 CFR 261.3(a)(2)(iv)). Similarly, the "derived-from" rule does not apply to contaminated media. Our basis for stating that contaminated environmental media must be managed as hazardous wastes is that they "contain"

listed hazardous waste. These environmental media must be managed as hazardous waste because, and only as long as, the "contain" a listed hazardous waste, (i.e., until decontaminat

The second possibility you mention is that environmental media contaminated with a RCRA listed waste no longer have to managed as a hazardous waste if the hazardous constituents ar completely removed by treatment. This is consistent with the Agency's "contained-in" interpretation and represents the Agency's current policy.

The third possibility you discuss comes from Sylvia Lowrance's January 24, 1989, memorandum that you cited in your letter. This memorandum indicates that OSW has not issued an definitive guidance as to when, or at what levels, environment media contaminated with listed hazardous waste are no longer considered to contain that hazardous waste. It also states th until such definitive guidance is issued, the Regions may determine these levels on a case-specific basis. Where this determination involves an authorized State, such as New York, policy is that the State may also make such a determination.

Related to such a determination, you ask whether a risk assessment approach that addressed the public health and environmental impacts of hazardous constituents remaining in treatment residuals would be acceptable. This approach would b acceptable for contaminated media provided you assumed a direct exposure scenario, but would not be acceptable for "derived-fro wastes under our current rules. Additionally, consistent with the statute, you could substitute more stringent standards or criteria for contaminated environmental media than those recommended by the Federal EPA if you determined it to be appropriate.

The Agency is currently involved in a rulemaking effort directed at setting de minimis levels for hazardous constituents below which eligible listed wastes, treatment residuals from those wastes, and environmental media contaminated with those listed wastes would no longer have to be managed as hazardous wastes. The approach being contemplated in the De Minimis program would be similar to that used in the proposed RCRA Clean Closure Guidance in terms of the exposure scenario (direct ingestion), the management scenario (not in a waste management unit), and the levels (primarily health-based).

Your final question related to whether the "remove and decontaminate" procedure set forth in the March 19, 1987 Fede Register preamble to the conforming regulations on closing surface impoundments applies when making complete removal determinations for soil. These procedures do apply when one

chooses to clean close a hazardous waste surface impoundment b removing the waste. The preamble language states that the Age interprets the term "remove" and "decontaminate" to mean remov of all wastes, liners, and/or leachate (including ground water that pose a substantial present or potential threat to human health or the environment (52 FR 8706). Further discussion of these requirements is provided in a clarification notice published on March 28, 1988, (53 FR 1144) and in OSWER Policy Directive # 9476.00-18 on demonstrating equivalence of Part 26 clean closure with Part 264 requirements (copy enclosed).

I hope that this response will be helpful to you in establishing and implementing New York's hazardous waste polic on related issues. Should you have additional questions, plea contact Bob Dellinger, Chief of the Waste Characterization Bra at (202) 475-8551.

Sincerely yours,

Jonathan Z. Cannon
Acting Assistant Administrato

Jane J.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RES

JAN 24 1989

MEMORANDUM

SUBJECT: Status of Contaminated Groundwater and Limitations on Disposal and Reuse

FROM: Sylvia K. Lowrance, Director
Office of Solid Waste

TO: Jeff Zelikson, Director
Toxics and Waste Management Division
Region IX

In your memo of December 16, 1988 and the attached materials, you stated your understanding of the current policy on the classification of contaminated groundwater and described issues which have arisen in California regarding reuse of contaminated groundwater from a Superfund site.

You have accurately stated the effects of the "contained in" policy which governs situations such as the one you have described. Briefly, a contaminated groundwater which has been treated such that it no longer contains hazardous constituents, need not be considered to be a hazardous waste, and beneficial reuse of the water is permissible. We have not yet issued definitive guidance on levels below which the groundwater is no longer considered to contain hazardous wastes. Until such definitive guidance is issued, the Regions may determine these levels on a case-specific basis.

It is our expectation that ultimately the guidance on levels of hazardous wastes which may remain will mirror the levels in the De Minimis rule which is now under development by OSW. I know that Region IX has been participating in the Work Group discussions and reviews of this proposal and I urge you to continue this involvement.

In its present form, the De Minimis approach contemplates levels based on health-based standards (where available), assuming direct exposure. With respect to the constituents of concern at the Fairchild Superfund site -- trichloroethane

Pursuant to that Consent Order, as an approved interim measure, a pilot treatment unit was authorized using above ground bioaugmented soil venting. That pilot unit has been eminently successful, testing non-detect in three of the four soil piles. It is anticipated that further testing may show non-detect in the fourth pile. EPA Region III, applying the "contained in" rule, is prepared to authorize ARC to use the soil as clean fill on site.

VDWM asserts independent RCRA jurisdiction and has stated that it applies the "contained in" rule to groundwater only. VDWM, however, has also indicated that a letter from EPA headquarters stating that the "contained in" rule applies to all media would be accepted by VDWM as a basis for expanding the "contained in" rule to soil treatment.

Because the pilot study was a success, ARC, under the Corrective Measures Study, contemplates using the above-ground pilot study and similar technologies for remediation of soil on the Gainesville site. Obviously it would be of no merit to incur the substantial cost of such remediation if VDWM under the "mixture" and "derived from" rules, requires the treated soil to be hauled to a licensed disposal facility or requires delisting after treatment.

In the event you have any questions concerning this request or need further information we would like to have a meeting with you. Robert Stroud, who has cognizance of ARC's Consent Order with EPA Region III, would like to be included in any meeting. I will give you a call in a few days to see whether you can respond favorably to our request or whether a meeting would be appropriate.

I had had a conversation yesterday with Mike Tetruska of your office and he suggested that I should put my request in writing.

Sincerely,

Carlyle C. Ring

Carlyle C. Ring, Jr.

c.c. Robert Stroud
Michael Tetruska
Robert Greaves
John Ely
Patricia Tan

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

JAN 3 1989

MEMORANDUM

SUBJECT: Status of Personnel Protective Equipment as a RCRA Waste

FROM: Sylvia K. Lowrance, Director
Office of Solid Waste

TO: Timothy Fields, Jr., Director
Emergency Response Division

This memo is in response to your inquiry about our planned "de minimis" rule and about the status of personnel protective clothing and other debris in the interim.

The "de minimis" rule is intended to define levels of contamination below which wastes are not hazardous. In concept, this could apply to any type of material, including clothing and debris. However, there could be some difficulty in applying this approach to all of the materials of concern to you since test methods needed to determine the level of contamination may not be appropriate for all of the materials encountered. I have asked the staff responsible for developing the rule to consider this aspect of the "de minimis" determination as they proceed.

Until the time that a "de minimis" approach is available, there are several options for dealing with contaminated clothing and other similar debris.

Since clothing and the other materials of concern are not considered solid wastes, they can be dealt with through the "contained in" policy. That is, if the hazardous contaminant can be removed, the underlying material is no longer considered to be a hazardous waste and its disposal is not restricted. As you noted in your memo, this may not be appropriate in all situations, since it may generate large volumes of contaminated rinsate which must be treated before disposal.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Where it is impossible or impractical to remove the contamination, the materials must be treated in accordance with the applicable land disposal restriction (LDR) standards and other applicable requirements of Subtitle C. If the waste is one for which treatment standards have been set, the material must be treated to the applicable LDR levels, or a treatability variance must be granted. The determination of which option is more appropriate will depend on the nature of the underlying material and on the treatment methods available.

If the method of treatment necessary to meet the LDR treatment standards is inappropriate for the material in question, another method of treatment can be proposed through a treatability variance. Since the underlying materials vary greatly, it is not possible to give general guidance on what methods of treatment are appropriate in these circumstances. This decision must be made on a case by case basis.

If the waste in question is a soft hammer waste, as is the case in the situation described in the Region V memo which you attached, then the soft hammer provisions described in the August 17, 1988 Federal Register Notice on the First Third Final Rule should be followed. You should note that, although cost may be used to some extent in determining the practicability of treatment for soft hammer wastes, it is not a consideration in determining treatment for wastes which have standards in effect.

Finally, you cite the empty container rule as relevant here. While it is possible that the amount of hazardous waste remaining in a container could exceed that contained in clothing or other materials there is no "empty" rule for anything but containers, and that concept would not apply to the situations you have described.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 13 1986

OFFICE OF
SOLID WASTE AND EMERGENCY

MEMORANDUM

SUBJECT RCRA Regulatory Status of Contaminated Ground Water

FROM: Marcia E. Williams, Director
Office of Solid Waste

TO: Patrick Tobin, Director
Waste Management Division, Region IV

This is in response to your memorandum of September 18, 1986, regarding the regulatory status of ground water contaminated with hazardous waste leachate. To answer this question, one first has to determine the status of ground water. Under the regulations, ground water contained in the aquifer is not considered a solid waste, since it is not "discarded" in the sense of being abandoned, recycled, or inherently waste-like as those terms are defined in the regulations. See 40 CFR 261.2(a)-(d). Therefore, contaminated ground water cannot be considered a hazardous waste via the mixture rule (i.e., to have a hazardous waste mixture, a hazardous waste must be mixed with a solid waste; see 40 CFR 261.3(a)(2)(iv)). Nevertheless, ground water contaminated with hazardous waste leachate is still subject to regulation since it contains a hazardous waste. Therefore the treatment, storage, or disposal of ground water contaminated with hazardous waste leachate must be handled as if the ground water itself were hazardous since hazardous waste leachate is subject to regulation under Subtitle C of RCRA. 1/ However, if the ground water is treated such that it no longer contains a hazardous waste, the ground water would no longer be subject to regulation under Subtitle C of RCRA.

1/ This memo more precisely explains the position on ground water contamination presented in John Skinner's memo dated December 26, 1984.

Taking this interpretation and applying it to the example in your memorandum, the ground water containing a listed hazardous waste, once collected, is subject to regulation under the hazardous waste regulations. However, if as a result of treatment, the ground water no longer contains the hazardous waste leachate, the ground water would no longer be subject to the hazardous waste rules.

Your letter also raises the question of treatment of ground water within the context of corrective action. If the corrective action is taken at an interim status facility in compliance with a §3008(h) order, treatment can take place. We are considering the possibility of amending the regulations to clarify the relationship between corrective action and the reconstruction ban (§270.72(e)). More broadly, the Agency is currently examining the issue of whether permits should be required for any corrective actions. We are also developing rules for corrective action under RCRA §3004(u). Until this analysis is completed, if the corrective action takes place at a permitted facility, it can be handled as a permit modification.

Please feel free to call Matt Straus, of my staff, if you have any further questions; his telephone number is 475-8551 (FTS).

cc: Hazardous Waste Division Directors,
Regions I-III and V-X
Gene Lucero, OWPE
Lloyd Guerci, OWPE
Mark Greenwood, OGC
Steve Silverman, OGC

Soil Treatment Standards

DATE: October 19, 1998

MEMORANDUM

SUBJECT: Phase IV Land Disposal Restrictions Rule – Clarification of Effective Dates

FROM: Elizabeth A. Cotsworth, Acting Director /S/
Office of Solid Waste

TO: RCRA Senior Policy Advisors, Regions I - X

The Phase IV Land Disposal Restrictions (LDR) final rule, published on May 26, 1998, establishes or revises treatment standards for metal and mineral processing wastes, amends the definition of solid waste for mineral processing wastes, and promulgates treatment standards for contaminated soil subject to the LDRs (63 FR 28556). My office has received a number of questions regarding the dates by which the individual provisions in the rule become effective. The purpose of this memo is to clarify the effective dates for the major provisions of the Phase IV rule. It is supplemental to the final rule preamble at page 28556 ("Effective Dates") and pages 28634-5 ("State Authority"). I invite you to share this information with enforcement personnel, members of the public, and other interested parties.

The Phase IV rule presents an unusually complex set of effective date considerations because portions of the rule are promulgated under the authority of the Hazardous and Solid Waste Amendments of 1984 (HSWA) and some are not, and because some of the provisions of the rule are more stringent than current Federal regulations and some are not. To assist the public's understanding of how these factors come into play and to be precise about when various parts of the Phase IV final rule become effective, I have attached four items to this memorandum. These attachments are:

(1) A matrix showing the various types of wastes covered by the Phase IV rule and when and how they are regulated in States at different stages of RCRA authorization;

(2) A matrix showing the different parts of the Phase IV rule and when and how they are effective in States at different stages of RCRA authorization; and

(3) A general discussion of considerations that come into play in determining the effective

dates of RCRA rules. These involve not only the normal practice of EPA regarding the effective dates of regulations we adopt, but also consideration of whether: (1) a regulation is promulgated under the HSWA; (2) a regulation is new or modifies previous regulations that may or may not have already been adopted by a State and for which the State has (or has not yet) been authorized; and (3) a regulation is more or less stringent than any preceding regulation it may modify; and

(4) A copy of an OSW memorandum dated December 19, 1994 explaining one circumstance in which EPA will not override authorized State treatment standards.

Please note that the first two documents contain essentially the same information, but are organized quite differently so that audiences with different types of questions can use whichever document better suits their needs. The third attachment is a more general background discussion, with some examples from the Phase IV rule used to illustrate various scenarios. Attachment Four is referenced in the other attachments.

On a related, but separate matter, I would like to highlight a separate point of confusion in the "effective dates" section of the Phase IV rule at 63 FR 28556. The word "except" was inadvertently omitted in the first line. EPA plans to correct this point of confusion in an upcoming Federal Register technical correction to the Phase IV rule. For your information, the section should have read as follows, with the missing word shown in italics:

"EFFECTIVE DATES: This final rule is effective on August 24, 1998 *except:*

- Prohibition on underground injection of certain wastes at 40 CFR Section 148.18, which is effective May 26, 2000;
- Definition of solid waste provisions at Section 261.2, 261.4(a)(15), and 261.4(b), which are effective November 27, 1998;
- Exclusion of recycled wood preserving wastewaters at Section 261.4(a)(9), which is effective May 26, 1998;
- Prohibition on land disposal of wastes from elemental phosphorus processing and on mixed radioactive wastes at Section 268.34(b), which are effective May 26, 2000; and
- Land Disposal Restrictions treatment standards at Section 268.49 for soil contaminated with previously prohibited wastes, which are effective on May 26, 1998."

I hope this information will be useful in implementing the Phase IV Rule. If you have questions, please direct them to Sue Slotnick, in the Waste Treatment Branch of the Office of Solid Waste, at (703) 308-8462.

Attachments

ATTACHMENT ONE

Table A: Waste Treatment Requirements by Waste Type and State Authorization Status

DEFINITIONS: 1. "Fed" means the federal Part 268 requirements in the Phase IV final rule apply, including the §268.48 universal treatment standards (UTS) for underlying hazardous constituents (UHCs).
2. "State" means that there is an existing authorized State treatment standard and that the existing State standard applies until the State adopts the Phase IV final rule. (Note: for wastes for which there is no existing State standard, "Fed" applies.)

	Status of State authorization for LDR rules							
WASTE	State not authorized for LDRs	State authorized for LDRs up to but not including the Third Third rule	State authorized for Third Third rule	State authorized for 1993 rule for ignitable and corrosive wastes	State authorized for Phase II	State authorized for Phase III	Material is a haz waste in State's authorized program	Material is not a haz waste in State's authorized program
D004 - D011 TC metal waste	Fed	Fed	Fed	Fed	Fed	Fed	N/A	N/A
Characteristic mineral processing wastes with metal constituents	Fed	N/A	N/A	N/A	N/A	N/A	Fed	State
D001 ignitable and D002 corrosive wastes required to meet 268.48 for metal UHCs.	Fed	Fed	Fed	State	State (the State UTS apply until State adopts Phase IV metal UTS)	State (the State UTS apply until State adopts Phase IV metal UTS)	N/A	N/A
D003 reactive wastes required to meet 268.48 for metal UHCs	Fed	Fed	Fed	State	State	State	N/A	N/A
D012 to D043 required to meet 268.48 for metal UHCs	Fed	Fed	Fed	Fed	State	State	N/A	N/A
Listed wastes with regulated metal constituents	Fed	State	State	State	State	State	N/A	N/A

ATTACHMENT ONE

Table B: Applicability of Soil Treatment Standards

DEFINITIONS: 1. "Fed" means the soil standards in Phase IV are applicable unless the State has a more stringent treatment standard in which case the State standard applies.

2. "State" means an existing State treatment standard applies.

SOIL CONTAMINATED WITH: 1/	State not authorized for LDRs	State authorized for LDRs up to but not including the Third Third rule	State authorized for Third Third rule	State authorized for 1993 rule for ignitable and corrosive wastes	State authorized for Phase II	State authorized for Phase III	Material is a haz waste in State's authorized program	Material is not a haz waste in State's authorized program
D004 - D011	Fed	Fed	State	State	State	State	N/A	N/A
Characteristic mineral processing wastes	Fed	Fed	Fed	Fed	Fed	Fed	Fed	N/A
D001, D002	Fed	Fed	Fed	State	State	State	N/A	N/A
D003	Fed	Fed	Fed	Fed	Fed	State	N/A	N/A
D012 to D043	Fed	Fed	Fed	Fed	State	State	N/A	N/A
Listed wastes	Fed	State	State	State	State	State	N/A	N/A

1/ For all characteristic and listed wastes below, the treatment standards apply to all hazardous constituents subject to treatment, including underlying hazardous constituents. See §268.49 (d).

ATTACHMENT TWO

Table of Effective Dates of Major Phase IV Provisions

Description of provision	*Effective date*	*Effect of State authorization status on effective date*	*40 CFR citation in Phase IV rule*
Land Disposal Restrictions for wastes, soil, and debris exhibiting the Toxicity Characteristic (TC) for metals. This includes both the characteristic metal wastes regulated in the Third Third LDR rule and those not regulated in that rule because they passed the Extraction Procedure (EP) test then in effect. The Phase IV LDRs state that wastes exhibiting the Toxicity Characteristic (TC) for metals are prohibited from land disposal unless they meet LDR treatment standards, and that all underlying hazardous constituents (UHCs) in the waste must meet the new Universal Treatment Standards (UTS).	August 24, 1998	These LDR requirements are HSWA regulations that are more stringent than previous federal requirements, and therefore took effect in all States, regardless of authorization status, as of 90 days after publication of the Phase IV final rule. Even in States authorized for the Phase II LDR rule and thus with authorized UTS for metal constituents, the new concentration levels for metals in the Phase IV rule apply to TC metal and characteristic mineral processing wastes because these wastes have never had UHC requirements before. [Note: the new Phase IV concentration levels for metal constituents will also apply to TC metal wastes *without* underlying hazardous constituents, i.e., to the key metal that makes the waste characteristic. This is true even in States that are authorized for the old (Third Third) treatment standards for EP/TC metal wastes. The reason is that the Phase IV LDRs require meeting UTS standards different than the metal characteristic level.] [For detail on the effect of State authorization on the effective date for soil contaminated with TC metal wastes and mineral processing wastes, see the section concerning soil standards below.]	Prohibition at §268.34; requirement to treat UHCs at §268.40 (e); and treatment standards at §§268.40, 268.48, and 268.49.

ATTACHMENT TWO

Table of Effective Dates of Major Phase IV Provisions

Description of provision	*Effective date*	*Effect of State authorization status on effective date*	*40 CFR citation in Phase IV rule*
Land Disposal Restrictions for Characteristic mineral processing wastes, soil, and debris (including manufactured gas plant waste).	August 24, 1998	The LDRs are effective in all States, provided the material is a solid waste and a hazardous waste under a State's authorized program. Phase IV treatment standards apply to any characteristic mineral processing wastes, whether ignitable, corrosive, reactive, organic TC, or metal TC. These are newly prohibited in this rule.	Prohibition at §268.34; requirement to treat UHCs at §268.40 (e); and treatment standards at §§268.40, 268.48, and 268.49.

ATTACHMENT TWO

Table of Effective Dates of Major Phase IV Provisions

Description of provision	*Effective date*	*Effect of State authorization status on effective date*	*40 CFR citation in Phase IV rule*
Modified UTS for all metal hazardous constituents in listed and in non-Phase IV characteristic wastes. (Non-Phase IV characteristic wastes are ignitable, corrosive, reactive, and TC wastes *except* the TC metal and characteristic mineral processing wastes.)	August 24, 1998 in unauthorized States. See next column for authorized States.	The effective date depends not only on the State's authorization status, but on the particular waste. 1. In States that are authorized for LDR rules promulgated prior to the Phase II rule (e.g. the Solvents and Dioxins rule, or the Third Third rule) but are not authorized for the Phase II rule, treatment standards are in effect as follows: • For *listed* wastes regulated by a federal rule for which the State is authorized, the existing authorized treatment standards, including the particular constituent concentration levels appearing in the State rules, remain in effect until the State is authorized for the Phase II rule. This is consistent with the December 19, 1994 memo (Attachment Four) which states: "the States authorized for some or all of the LDRs will continue to implement those portions of the program for which they are authorized." • For *listed* wastes regulated by a federal rule but not under an authorized State rule and which contain metal constituents (e.g. newly-listed wastes such as K088), the new Phase IV UTS concentration levels apply. This is because there is no authorized State-established treatment standard for these wastes. • For *non-Phase IV characteristic* wastes containing metal UHCs, the UTS promulgated in the Phase IV rule at 40 CFR 268.48 apply to the UHCs because the State has no authorized requirement to treat UHCs.	§§268.40 and 268.48

ATTACHMENT TWO

Table of Effective Dates of Major Phase IV Provisions

Description of provision	*Effective date*	*Effect of State authorization status on effective date*	*40 CFR citation in Phase IV rule*
Modified UTS, contd.		2. In States that are authorized through the Phase II or Phase III LDR rules and thus have authorized treatment standards for some or all *non-Phase IV characteristic* wastes, the existing State treatment standards remain in effect for such wastes until the States are authorized for Phase IV. This is true for all *listed* and *characteristic* wastes for which the State has an authorized treatment standard, and is consistent with the December 1994 memorandum (Attachment Four). One result is that the numerical UTS level for a metal constituent in a non-Phase IV waste (e.g., D018) may differ from the level for that same constituent in a Phase IV waste (e.g., D008) until Phase IV authorization occurs. [Note: if a waste has multiple waste codes, the more stringent standard applies. 40 CFR 268.40 (c).]	
Conditional exclusion for secondary materials from mineral processing, and other changes to the definition of solid waste for mineral processing materials.	November 27, 1998 in unauthorized States. See next column for authorized States.	Since the definition of solid waste is a non-HSWA provision, the Phase IV changes are effective November 27, 1998 in unauthorized States. In authorized States, the Phase IV changes are not effective until the States adopt and become authorized for them. States are required to become authorized for changes to the status of characteristic by-products and sludges at §261.2 because those changes are more stringent than existing federal regulations. States are not required to become authorized for the change to the status of spent materials at §261.2, because that provision is less stringent.	§261.2, §261.4

ATTACHMENT TWO

Table of Effective Dates of Major Phase IV Provisions

Description of provision	*Effective date*	*Effect of State authorization status on effective date*	*40 CFR citation in Phase IV rule*
Wood preserving wastewater exclusion.	May 26, 1998 in unauthorized States. See next column for authorized States.	Since the provision is deregulatory, EPA used a good cause finding to set a shorter date than the six months usually allowed for compliance. In unauthorized States, the exclusion was effective upon publication of the Phase IV rule. In States that are authorized for the definition of solid waste (50 FR 614, January 4, 1985), the exclusion is not effective until the State adopts it and is authorized for it. However, States are not required to become authorized for the exclusion because it is a less stringent requirement than existing regulations.	§261.4

ATTACHMENT TWO

Table of Effective Dates of Major Phase IV Provisions

Description of provision	*Effective date*	*Effect of State authorization status on effective date*	*40 CFR citation in Phase IV rule*
Soil treatment standards	Prior to adoption by States of the Phase IV soil treatment standards, other LDR standards (including Phase IV) apply. See above sections in this table. The soil treatment standards are effective only for soil: (1) in States not authorized for the LDR program; and (2) in all States if the soil fails the TCLP test for one or more metal constituent (TC metal soil) (3) in all States if the soil is contaminated with a characteristic mineral processing waste See next column.	Because the soil treatment standards are less stringent then existing Federal requirements, they are generally not available in authorized States unless and until the States adopt the standards. To the extent they do not conflict with any independent State land disposal restrictions or treatment requirements, the soil treatment standards are also available in States in which EPA is responsible for implementation of the LDR program as follows: (1) <u>States in which EPA is responsible for implementing the land disposal restriction program in its entirety.</u> In these States, there are no authorized State LDR requirements against which to assess the relative stringency of the soil treatment standards. Therefore, as new HSWA requirements in a non-authorized State, the soil treatment standards are effective and implemented by EPA unless and until the State adopts and becomes authorized for the standards. (2) <u>States that are authorized to implement the LDR program but in which EPA is responsible for implementation of the land disposal restriction treatment standards for certain wastes.</u> Soil treatment standards are available for soil contaminated by the wastes for which EPA is responsible for implementation of land disposal restriction treatment standards, provided the State does not have a treatment standard in State law that is more stringent then the soil treatment standards. For example, for TC metal wastes, EPA is responsible for implementing the LDR treatment standards. Therefore, for TC metal soil, the soil treatment standards are available. However, many States have treatment standards for metals that are more stringent than the soil treatment standards; in this case the more stringent State treatment standards would control in lieu of the federal soil standards.	§268.49

ATTACHMENT TWO

Table of Effective Dates of Major Phase IV Provisions

Description of provision	*Effective date*	*Effect of State authorization status on effective date*	*40 CFR citation in Phase IV rule*
Soil standards, contd.		For example, the soil treatment standard for lead is 90% reduction or 7.5 ppm (whichever is less stringent), but many States have a treatment standard for lead of 5 ppm (which they adopted from the LDR Third Third rule). In this case, the more stringent State treatment standard of 5 ppm would apply to TC characteristic levels of lead in contaminated soil unless and until the State adopted the soil treatment standards. Note, soil contaminated with TC metal wastes must meet LDRs for underlying hazardous constituents in all States. [Note: if a State becomes authorized only for Phase II and not yet for Phase IV, the soil standards for D012 -D043 in Phase IV (i.e., 10 X UTS or 90% reduction) will be superseded at the time of authorization by the Phase II treatment standards, which provide no special standards for contaminated soils.]	

ATTACHMENT THREE: Considerations Bearing Upon the Effective Dates of RCRA Rules

A number of competing considerations come into play in determining the effective dates of RCRA rules. These involve not only the normal practice of EPA regarding the effective dates of regulations we adopt, but also consideration of whether: (1) the regulation is promulgated under the Hazardous and Solid Waste Amendments of 1984 (HSWA); (2) the regulation is new or modifies previous regulations that may or may not have already been adopted by a State and for which the State has (or has not yet) been authorized; and (3) the regulation is more or less stringent than any preceding regulation it may modify. The discussion below should provide you with the general framework for how these factors apply to various scenarios, including those presented in the Phase IV final rule, 63 FR 28556 (May 26, 1998). More specific guidance on the effective dates of major Phase IV requirements is provided in Attachments One and Two.

Effective dates of RCRA regulations in general

RCRA rules normally take effect six months after they are published, as provided in RCRA section 3010 (b). However, under that provision, EPA may establish a shorter effective date where there is good cause to do so. In addition, other statutory provisions -- among them, the LDR provisions -- mandate particular effective dates.

Effective dates of RCRA regulations in unauthorized States

In the small number of States and territories that are not authorized for any part of the RCRA program, RCRA regulations take effect on the effective date stated in the rule, and are implemented exclusively by EPA. This is true for both non-HSWA and HSWA regulations and for EPA modifications to those regulations, regardless of whether the modification makes the original regulation more or less stringent. A regulation in this category goes into effect on the date specified in the final rule.

More commonly, a State or territory will be authorized for some parts of the RCRA program, but not others. These States are typically referred to as "base-program authorized." In a base-program authorized State, the effective dates of new RCRA regulations are governed primarily by whether the regulation is promulgated under a HSWA or non-HSWA statutory provisions, as discussed below.

Authorized States implement the authorized State RCRA program in lieu of the Federal RCRA program. However, sometimes a base-program authorized State or territory may have adopted a new RCRA regulation but not yet received authorization to implement the regulation. This means the State would implement the State program, including any new RCRA regulations it may have adopted, and, at the same time, EPA would implement any parts of the Federal program for which the State is not yet authorized, subject to two main factors: (1) whether a regulation is promulgated under HSWA or under non-HSWA statutory provisions; and (2) whether a new regulation is more or less stringent than existing regulations. These two factors are discussed below. Generally speaking, however, under RCRA EPA does not preempt more stringent State

requirements so the more stringent of the State or Federal program applies. Thus, modifications to Federal requirements that make the requirements less stringent, such as the soil treatment standards, are not effective in any State that has either adopted or become authorized for more stringent treatment standards (such as the treatment standards in the Third Third LDR rule) unless and until the State adopts the modified regulations.

Effective dates of non-HSWA regulations in authorized States

Non-HSWA regulations are those that implement portions of RCRA enacted prior to the 1984 Hazardous and Solid Waste Amendments (HSWA). If a State is authorized for the RCRA program and EPA promulgates a *new, non-HSWA requirement,* the requirement does *not* become effective in the authorized State at the time specified in the promulgated regulation. Rather, the authorized State must adopt the regulation and receive EPA authorization for the new, non-HSWA regulation before it becomes effective in that State. (RCRA section 3006(b) and 40 CFR 271.3 (b).) Similarly, if a State is already authorized for a non-HSWA regulation and EPA *modifies* the federal counterpart of that regulation, the modification is not effective in that State until the State adopts and becomes authorized for it. An example of a modification to a non-HSWA requirement is the Phase IV change to the definition of solid waste for mineral processing wastes.

States are required to adopt and become authorized for modifications to non-HSWA requirements that make the regulations more stringent. Therefore, all modifications that make the federal program *more stringent* will eventually become effective in all States. However, if a modification makes the federal regulation *less stringent* than the existing authorized State regulation, the State is not required to change its program. (RCRA section 3009) An example of a less stringent modification to a non-HSWA requirement is the new Phase IV exclusion from RCRA for recycled wastewaters from wood preserving.

Effective dates of HSWA regulations in authorized States

In contrast to the case of non-HSWA regulations, when EPA promulgates a *new HSWA requirement* (such as new LDR treatment standards for a waste that had none before), the new HSWA requirement takes effect in all States on the effective date stated in the rule, and is implemented exclusively by EPA until States become authorized for it. (RCRA section 3006 (g)). Also in contrast to the case of non-HSWA regulations, when EPA *modifies* a HSWA regulation to make it *more stringent*, the modification goes into effect on the effective date stated in the rule (and under EPA implementation) *regardless of the State's authorized status or program.* An example is the part of the Phase IV rule requiring that underlying hazardous constituents meet LDRs in a characteristic waste for which a treatment standard already exists. But, as with modifications to non-HSWA regulations, if the HSWA modification is *less stringent* than a State's authorized program, an authorized State may choose not to adopt the federal change and EPA will not implement the less stringent federal regulation in that State.

Effective dates of LDR regulations

As noted above, the RCRA statute provides for particular effective dates for some types of EPA regulations. One such provision is RCRA section 3004 (h) (1), which states that Land Disposal Restriction prohibitions and treatment standards ordinarily are to take effect immediately, or at the first time (not to exceed two years) that treatment capacity is available. EPA has typically made LDR prohibitions and treatment standards effective within 90 days of promulgation, the 90 days serving as a period during which administrative arrangements for treatment are finalized, i.e., the period it takes for treatment capacity to become available as a practical matter.

Special case of effective dates when EPA changes LDR treatment standard levels --the EPA Guidance Memorandum of December 19, 1994

Shortly after EPA promulgated the Universal Treatment Standards (UTS) in the Phase II LDR rule, the Agency issued a guidance memorandum dated December 19, 1994 stating that when EPA changes only numerical treatment standard levels, the changes can be regarded as neither more nor less stringent for State authorization purposes (Attachment 4). For States authorized for the Phase II rule, the memorandum indicates that an existing authorized State treatment standard will continue to apply unless and until a State chooses to adopt the new federal LDR numerical standard . (Of course, the 1994 guidance memorandum has no application in unauthorized States.)

Application of the December 1994 Guidance Memorandum to the Phase IV final rule

The situation just described, in which EPA changes the numerical treatment standard levels for wastes with existing State-authorized treatment standards, is in contrast to the case in which EPA establishes, for a class of wastes, an entire set of new Land Disposal Restrictions that goes beyond mere changes in required constituent concentration levels. The Phase IV rule presents both situations and therefore some additional explanation is needed for how the approach in the 1994 memorandum applies to Phase IV.

For the TC metal and characteristic mineral processing wastes ("Phase IV wastes"), EPA promulgated a new set of LDRs including new prohibitions for some of the wastes (a subset of the TC metal wastes were already prohibited in the Third Third LDR rule), a new requirement that underlying hazardous constituents meet UTS for all wastes in the set, and revised UTS for metal hazardous constituents. EPA views these regulations, which are essentially inseparable, as an entire set of new and more stringent LDRs for the purposes of determining State authorization requirements and effective dates. Therefore, this set of more stringent, HSWA LDR regulations apply in all States 90 days after publication of Phase IV and are implemented by EPA until States become authorized. The other situation, the one in which only the numerical levels change, occurs in Phase IV as well because EPA modified the UTS for metal constituents in all wastes, based on new data. Some of those wastes, of course, have existing authorized treatment standards, for example, D018 through D043 organic TC wastes with underlying hazardous metal constituents in States authorized for the Phase II LDR rule, plus metal constituents in listed wastes. Therefore, under the approach taken in the 1994 memorandum, the Phase IV

modifications to UTS for metal constituents in "non-Phase IV wastes" are considered neither more nor less stringent for State authorization purposes and are not effective until a State adopts and is authorized for them. The affected "non-Phase IV wastes" are listed and characteristic metal-bearing wastes, excluding TC metal and characteristic mineral processing wastes, that have numerical treatment standards.

Phase IV soil treatment standards

Like all LDR treatment standards, the soil treatment standards are promulgated pursuant to HSWA. Therefore, the rules for effective dates for HSWA regulations apply but have limited impact because the soil treatment standards are generally less stringent than the treatment standards for pure hazardous wastes, which currently apply to contaminated soil. Because the soil treatment standards are generally less stringent than current Federal requirements, they will not go into effect in authorized States until the States adopt and become authorized for them -- even though the soil treatment standards are promulgated pursuant to HSWA.

More specifically, if a State is authorized to implement the LDR treatment standards for any given waste or constituent, and that waste or constituent is contained in contaminated soil that is subject to LDRs, the more stringent treatment standard for the pure waste or constituent continues to apply to contaminated soil until the State adopts and becomes authorized for the soil treatment standards. Similarly, if a State has adopted, under State law, an LDR treatment standard for any given waste or constituent but has not yet received authorization for the requirement, and that waste or constituent is contained in contaminated soil that is subject to LDRs, the more stringent State requirement continues to apply until the State adopts, under State law, the soil treatment standards. This occurs because, under RCRA, EPA does not preempt more stringent State requirements, whether or not those State requirements are authorized.

Despite this convention, if a State were, through implementation of State waiver authorities or other State laws, to allow compliance with the soil treatment standards in advance of adoption or authorization, EPA would not generally consider such application of the soil treatment standards a concern for purposes of enforcement or State authorization. Thus, by using State law to waive authorized or non-authorized State requirements, a State can allow immediate implementation of the soil treatment standards without jeopardizing their RCRA authorization. (This is similar to the approach the Agency took in promulgation of the corrective action management unit rule. See 58 FR 8677, February 16, 1993.)

ATTACHMENT FOUR

December 19, 1994

MEMORANDUM

SUBJECT: Universal Treatment Standards Authorization Implications

FROM: Michael Shapiro, Director /S/
Office of Solid Waste (5301)

TO: Waste Management Division Directions
Regions I - X

The purpose of this memorandum is to clarify State implementation of the Universal Treatment Standards (UTS) promulgated as part of the Phase II Land Disposal Restrictions (LDR) rule (September 19, 1994, 59 FR 47980).

As described in the Phase II LDR final rule, UTS will simplify the LDR program by establishing one set of concentration based treatment standards for each hazardous constituent, regardless of the restricted waste the constituent is a component of. This is in contrast to the previous system where treatment levels for a particular constituent could vary between different restricted wastes. EPA believes that the simplification provided by the UTS will greatly assist compliance with and enforcement of the LDR program.

The UTS are promulgated pursuant to HSWA authority, and traditionally more stringent HSWA standards are immediately effective in authorized States. In most cases, the UTS limits are the same as the previous treatment standards, while about forty percent of the standards either went up or down. In reviewing the treatment standards, we concluded that a numerical comparison exaggerates the degree of change. In particular, the differences in numerical values for many of the organic constituents actually reflect adjustments in the limits of analytical detection. Thus, actual treatment will likely continue to destroy or remove organic to nondetectable levels. Even in those cases where the numerical limits have actually changed, the technology basis has not. Therefore, the changes to the treatment standards should not be viewed as more or less stringent.

As a result, EPA has decided not to implement the UTS separately for those wastes for which the state has received LDR

authorization. Under this approach, the States authorized for some or all of the LDRs will continue to implement those portions of the program for which they are authorized, whether or not they have adopted the new standards, and, in EPA's view, the regulated industry will be subject to the state standards, regardless of whether they differ from the new UTS. EPA strongly urges states to implement the new UTS standards as quickly as possible, both for simplicity of implementation and national consistency. But, state law (as interpreted by the state) would determine which standards applied. This approach would avoid the dual regulatory problem which would occur during the time before new HSWA requirements are adopted and authorized in the State.

EPA proposed a similar approach to state adoption of HSWA rules in the Subpart S rule (55 FR 30860), and did not receive any negative comments. EPA believes that Congress did not intend for the authorized State program's authority to return, in part, to EPA every time EPA promulgates modifications to HSWA program requirements. At the same time, however, this memo is not relinquishing EPA's statutory responsibility to implement significant new HSWA rules in States as soon as the rules become effective. Thus, this new approach will be reserved only for areas of the hazardous waste program already authorized and regulated by the state, not new areas of HSWA regulations. For example, the September 19, 1994 Phase II rule established treatment standards for several newly listed wastes; these new requirements are immediately effective in all the States and will be enforced by EPA.

The authorization approach discussed in this memo will be available only when changes to the treatment standard occur to existing HSWA programs in States authorized for those programs. As we develop rules in the future, we will address issues of applicability of the new approach in the preamble.

EPA has a strong interest in uniformity and consistency of regulations and believes that the improvements in the UTS meet these objectives. Thus, please encourage the States in your Region to adopt and apply for authorization of the Phase II rule. States that are currently authorized for portions of the LDRs may submit an abbreviated authorization revision application to the Region for the UTS. This application should consist of a letter from the State to the appropriate Regional office, certifying that it has adopted treatment standards equivalent to the UTS for those restricted wastes which are a part of the State's authorized LDR program. The State should also submit a copy of its final rule or other authorizing authority. A revised Program Description, Memorandum of Agreement and Attorney General's statement is not necessary because the only change the State would be making is to the treatment standards it is already authorized for. We expect the Regions will be able to act

530-Z-98-001

federal register

Tuesday
May 26, 1998

Part II

Environmental Protection Agency

40 CFR Parts 148, 261, 266, 268, and 271
Land Disposal Restrictions Phase IV: Final Rule Promulgating Treatment Standards for Metal Wastes and Mineral Processing Wastes; Mineral Processing Secondary Materials and Bevill Exclusion Issues; Treatment Standards for Hazardous Soils, and Exclusion of Recycled Wood Preserving Wastewaters; Final Rule

other reactions generating titanium gases. This reaction alone would classify the process as mineral processing since the ore and titanium gas are clearly physically and chemically dissimilar from that point on in the process. The Agency stated in 1989 that once mineral processing began, all wastes generated after that point would be classified as mineral processing wastes, even those wastes which are similar to those generated in beneficiation.

Thus, all wastes associated with the chloride-ilmenite production of titanium tetrachloride are mineral processing wastes. They are neither high volume nor low toxicity and therefore are not eligible for the Bevill exemption.

VII. LDR Treatment Standards for Soil

This section discusses final regulations establishing land disposal treatment standards specific to contaminated soil. Contaminated soil is subject to the land disposal restrictions, generally, when it contains a listed hazardous waste or when it exhibits a characteristic of hazardous waste. (Throughout this discussion, the specific term "hazardous contaminated soil" refers to soil which contains a listed hazardous waste or exhibits a characteristic of hazardous waste; the more general term "contaminated soil" refers to both hazardous contaminated soil and other soils—such as decharacterized soil—which may be subject to the land disposal restrictions.) Prior to today's rule, contaminated soil subject to LDRs was subject to the same land disposal restriction treatment standards that apply to industrial hazardous waste: soil contaminated by listed hazardous waste was subject to the standards that apply to those listed wastes and soil that exhibited a characteristic of hazardous waste was subject to the same standards that apply to the characteristic waste. Today's final rule establishes a new treatability group—contaminated soils—and establishes land disposal restriction treatment standards specifically tailored to that treatability group. Although EPA believes generators of contaminated soil will typically choose to comply with the new soil treatment standards promulgated today, under today's final rule, they have the option of complying either with the existing treatment standards for industrial hazardous waste (i.e., the universal treatment standards) or the soil treatment standards. This is consistent with the approach the Agency took in promulgating LDR treatment standards for hazardous contaminated debris. 57 FR 37221, August 18, 1992.

EPA first proposed tailored land disposal restriction treatment standards for contaminated soil in September 1993. 59 FR 48122—48131 (September 14, 1993). In the September 1993 proposal, EPA requested comment on three soil treatment standard options. These three options involved various combinations of percent reduction requirements for hazardous constituents (typically ninety percent—90%) and multipliers of the universal treatment standards (typically ten times the UTS—10 x UTS). In response to comment on the September 1993 proposal, EPA deferred a final decision on soil treatment standards to the Agency's broader evaluation of application of RCRA requirements to remediation wastes, the Hazardous Waste Identification Rule for Contaminated Media, or HWIR-Media.

On April 29, 1996, as part of the HWIR-Media proposal, EPA again proposed tailored land disposal restriction treatment standards for contaminated soils. 61 FR at 11804 (April 29, 1996). In the April 29, 1996 proposal, soil-specific treatment standards would have required reduction in concentrations of hazardous constituents by 90% with treatment for any given constituent capped at ten times the universal treatment standard. *Id.* This is commonly referred to as "90% capped at 10 times UTS."

In 1995, 1996 and 1997, EPA proposed new land disposal restriction treatment standards for waste identified as hazardous because of metal content and for mineral processing wastes. 60 FR 43654 (August 22, 1995) for metal wastes; 61 FR 2338 (January 25, 1996) for mineral processing wastes; and, 62 FR 26041 (May 12, 1997) supplemental proposal for both types of waste. In these proposals, soil contaminated with metal or mineral processing waste would have been subject to the new treatment standards for those wastes. This was consistent with the way EPA had historically addressed contaminated soil and, at the time, considered proper given that the proposals to establish soil-specific treatment standards were not yet resolved.

EPA did not reopen the issue of whether LDRs apply to contaminated soil or whether it is appropriate to require that contaminated soil achieve the same LDR treatment standards as the contaminating waste (soil contaminated by listed waste) or the characteristic property (soil that exhibits a characteristic of hazardous waste) in the August 22, 1995, January 25, 1996, or May 12, 1997 proposals. Commenters, nonetheless, strongly opposed application of the new LDR treatment standards for metal and mineral processing wastes to soil contaminate, with those materials. At about the same time, EPA decided to go forward with the soil-specific LDR treatment standards proposed in April 1996. Therefore, the Agency is promulgating the land disposal restriction treatment standards tailored to contaminated soils proposed on April 29, 1996 (i.e., 90% capped at 10xUTS) today, with the new LDR treatment standards for metal and mineral processing wastes. The soil-specific treatment standards promulgated today may be applied to any contaminated soil that is restricted from land disposal, including but not limited to soil contaminated by metal and mineral processing wastes.

The land disposal restriction treatment standards for contaminated soil promulgated today differ from the standards proposed on April 29, 1996 in three major ways. First, the Agency proposed that the soil treatment standards would be available only for contaminated soil that was managed under an approved cleanup plan (termed a remediation waste management plan, or RMP). In today's final rule, the Agency is making the soil treatment standards available for all contaminated soil that is restricted from land disposal. Second, the Agency proposed that, for soil contaminated by listed hazardous waste, treatment would be required only for the hazardous constituents that originated from the contaminating listed hazardous waste. When the soil treatment standards are used, today's final rule requires all hazardous contaminated soil, including soil contaminated by listed hazardous waste, to be treated for each underlying hazardous constituent reasonably expected to be present when such constituents are initially found at concentrations greater than ten times the universal treatment standard. Third, in response to comments asserting that the proposed regulations governing the applicability of LDRs to contaminated soils were difficult to understand, the Agency has reformatted these regulations into an easier-to-read table. These changes, as well as other significant issues associated with the soil treatment standards and responses to comments, are discussed below.

Today's promulgation of land disposal restriction treatment standards specific to contaminated soil is largely based on the April 29, 1996 proposal (62 FR at 18804–18818). It also relies on the Agency's first effort to establish soil-specific treatment standards, the LDR Phase II proposal (58 FR 48092, September 14, 1993). Today's action

resolves the portions of the April 29, 1996 and September 14, 1993 proposals that address land disposal restriction treatment standards for contaminated soil. However, other elements of the April 29, 1996 proposal remain open and will be acted on in a future rulemaking. Responses to comments submitted on the soil treatment standards proposals are included in the Soil Treatment Standards Response to Comments Background Document, available in the docket for today's action.

A. Application of Land Disposal Restriction Treatment Standards to Contaminated Soil and Justification for Soil Specific LDRs

Prior to today's rule, soil that contained listed hazardous waste or exhibited a characteristic of hazardous waste were prohibited from land disposal unless they had been treated to meet the treatment standards promulgated for pure industrial hazardous waste. This means the same treatment standards which apply to a pure, industrial hazardous waste were also applied to contaminated soil. 61 FR at 18804 (April 29, 1996) and other sources cited therein. In most cases then, contaminated soils were subject to the treatment standards listed in 40 CFR 268.40, and the associated treatment standards in 40 CFR 268.48(a) table Universal Treatment Standards (UTS).[14]

As EPA has discussed many times, the treatment standards developed for pure, industrial hazardous waste may be unachievable in contaminated soil or may be inappropriate for contaminated soil due to particularities associated with the soil matrix and the remediation context under which most contaminated soil is managed, as discussed below. For that reason, EPA is promulgating today's LDR treatment standards specifically tailored to contaminated soil and to the remedial context.

With respect to the soil matrix, the treatment standards developed for pure hazardous waste (i.e., the universal treatment standards) are generally either technically unachievable or technically or environmentally inappropriate. For metal constituents, the UTS may not be achievable in contaminated soil even using model technologies such as stabilization or high temperature metal recovery. Stabilization technologies are sensitive to soil characteristics such as the presence of oxidizing agents and hydrated salts, the distribution of soil particle size and the concentrations of sulfate and chloride compounds. Various combinations of soil characteristics can impair the effectiveness or rate of reaction in stabilization technologies. For example, insoluble materials, such as materials that will pass through a number 200 mesh sieve, can delay setting and curing during stabilization, or small soil particles can coat larger soil particles weakening bonds between particles and cement or other reagents. High temperature metal recovery technologies may not be appropriate for some contaminated soil given the low concentrations of metals that might be present in the soil. In addition, clay and silt content in some soil matrices may add undesired impurities to the metal concentrates or alloys that are formed during high temperature metal recovery.

Although EPA has data showing that some soils can be treated to the existing universal treatment standards for metals using stabilization[15] and high temperature metals recovery, the Agency continues to believe that tailored soil treatment standards are appropriate for metal contaminated soil to ensure that the wide variety of soils can be effectively treated to meet the treatment standards. In addition, the soil treatment standards will have the added environmental benefit of encouraging greater use of innovative soil treatment technologies such as soil or enhanced soil (acid) washing. See, Proposed BDAT Background Document for Hazardous Soils, August 1993; Technical Resource Document: Solidification/Stabilization and its Application to Waste Materials, EPA/530/R-93/012, June 1993; and, Technology Screening Guide for Treatment of CERCLA Soils and Sludges, EPA 540/2-88/004, September 1988.

For soil contaminated with organic constituents, EPA has noted many times that, notwithstanding the fact that such soils can be treated by combustion to meet the universal treatment standards, it is generally unsuitable or impractical from a technical standpoint to combust large volumes of mildly contaminated soil. See, for example, 55 FR at 8760 and 8761 (March 8, 1990) and 61 FR 18806-18808 (April 29, 1996). In addition, the Agency has documented potential difficulties that may arise from the combustion of soil due to soil/contaminant characteristics that affect incineration performance such as the concentrations of volatile metals, the presence of alkali salts, fine particles of soils such as clays and silts, and the ash fusion point of the contaminating waste. For example, operation of an incinerator at or near the waste ash fusion temperature can cause melting and agglomeration of inorganic salts; the loading of clays and silts in some soils may also result in high loadings of particulate matter in flue gases. Proposed BDAT Background Document for Hazardous Soils, August 1993 and Technology Screening Guide for Treatment of CERCLA Soils and Sludges, EPA 540/2-88/004, September 1988.

With respect to the remedial context, EPA, the states, and the regulated and environmental communities have long recognized that application of the LDR treatment standards developed for pure, industrial hazardous waste to contaminated soil can be counterproductive. See, for example, "Hazardous Waste: Remediation Waste Requirements Can Increase the Time and Cost of Cleanups" U.S. General Accounting Office, GAO/RCED-98-4, October 1997. Application of LDRs developed for pure, industrial hazardous waste to contaminated soil often presents remediation project managers with only two choices: pursue a legal option of capping or treating hazardous contaminated soil in place thereby avoiding a duty to comply with LDRs, or excavate the soil and treat it to the full extent of best demonstrated available technology, usually, for organic constituents, incineration. EPA has found that this situation often creates an incentive to select remedies that minimize application of LDRs (e.g., remedies that involve capping or leaving untreated soil in place) a result obviously not contemplated by Congress in enacting the LDR program.[16] 62 FR at pages 64505-64506 (Dec. 5, 1997) and 61 FR at 18808 (April 29, 1996) and other sources cited therein.

Because of the differences between the remedial context (responding to wastes which have already been released to the environment) and

[14] The exception is when waste contaminating soil is subject to a specified treatment method; in that case, the contaminated soil would also be subject to the specified treatment method.

[15] These soil treatment data have been claimed as confidential business information.

[16] As discussed in the April 29, 1996 proposal, EPA has, in the past, justified the existing treatment standards, in part, because they create an incentive to generate less of the affected waste in the first instance. See, Steel Manufacturers Association v. EPA, 27 F.3d 642, 649 (D.C. Cir. 1994). In the remedial context, the waste is already in existence; therefore waste minimization is not an issue. Thus, application of the current LDR treatment standards to remediation waste can have the perverse effect of creating an incentive to avoid "generating" waste by leaving it in the ground. The Agency believes that the goals of remediation are better served by more aggressive remedial approaches, such as excavation and management (including some degree of treatment) of remediation wastes, that generally result in more permanent remedies. Such approaches should, therefore, be encouraged.

regulation of wastes generated by on-going industrial process (preventing wastes from being released into the environment in the first instance), EPA has rejected the conclusion that treatment standards for soil must be based upon the performance of the "best" demonstrated available treatment technology in the way the Agency has historically interpreted these terms. Instead, the Agency has chosen to develop soil treatment standards that can be achieved using a variety of treatment technologies which achieve substantial reductions in concentration or mobility of hazardous constituents and, because they are generally used to treat contaminated soils in remedial settings, do not present site managers with the type of dilemma described above. As EPA has long maintained, the strong policy considerations that argue for using the traditional BDAT analysis as the basis for LDR treatment standards for hazardous wastes generated by on-going industrial operations do not apply when evaluating BDAT in the remedial context. In the remedial context, for example, waste minimization is not an issue and the additional increment of treatment necessary to achieve traditional BDAT may yield little if any environmental benefit over other treatment options that adequately protect human health and the environment. 54 FR 41568 (October 19, 1989). Indeed there is a legitimate question as to whether a technology whose use results in foregoing other substantial environmental benefits (such as more aggressive, permanent remedies) can be considered a "best" technology. *Portland Cement Association* v. *Ruckelshaus*, 486 F. 2d 375, 385–86 at n. 42 (D.C. Cir. 1973); Essex Chemical Corp. v. Ruckelshaus, 486 F. 2d 427, 439 (D.C. Cir. 1973). This issue was discussed fully in the April 29, 1996 proposal and in a number of other EPA documents, see, for example, 54 FR 41568 (October 19, 1989) and 61 FR at 18808 (April 29, 1996) and other sources cited therein.

The soil treatment standards promulgated today will significantly improve management of contaminated soil and remediations that involve contaminated soil. However, the Agency emphasizes that today's rule does not resolve the larger, more fundamental issues associated with application of RCRA Subtitle C to remediation generally. The Agency maintains that additional reform is needed to address, more fundamentally, the application of certain RCRA subtitle C requirements to all remediation wastes, including contaminated soil. The Agency will continue to participate in discussions of potential legislation to promote this additional needed reform. If legislation is not forthcoming, the Agency may reexamine its approach to remediation waste management, including the soil treatment standards.

B. Detailed Analysis of Soil Treatment Standards

All land disposal restriction treatment standards must satisfy the requirements of RCRA section 3004(m) by specifying levels or methods of treatment that "substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from that waste so that short-term and long-term threats to human health and the environment are minimized." As EPA has discussed many times, the RCRA Section 3004(m) requirements may be satisfied by technology-based standards or risk-based standards. This conclusion was upheld in Hazardous Waste Treatment Council v. EPA, 886 F.2d 355, 362–64 (D.C. Cir. 1989), where technology-based LDR treatment standards were upheld as a permissible means of implementing RCRA Section 3004(m) provided they did not require treatment beyond the point at which threats to human health and the environment are minimized. Today's treatment standards for contaminated soils are primarily technology-based; however, a variance from the technology-based standards is allowed when EPA or an authorized state makes a site-specific determination that threats posed by land disposal of any given volume of contaminated soil are minimized at higher concentrations.

1. Technology Basis for Soil Treatment Standards

The land disposal restriction treatment standards for soil require that concentrations of hazardous constituents subject to treatment be reduced by ninety percent (90%) with treatment for any given constituent capped at ten times the universal treatment standard (10 X UTS). In other words, if treatment of a given constituent to meet the 90% reduction standard would reduce constituent concentrations to less than 10 X UTS, treatment to concentrations less than 10 X UTS is not required. This is commonly referred to as "90% capped by 10xUTS."

As first discussed in the September 14, 1993 proposal, the Agency has not used the statistical methods historically used in the land disposal restriction program to establish the soil treatment standards. In the past, the Agency has typically evaluated treatability data to identify the "most difficult to treat" waste and established treatment standards based on a statistical analysis of data from the best demonstrated available treatment technology for that waste. See, for example, 55 FR 26594 and 26605, June 23, 1989. While the existing regulations allow treatment using any technology that will satisfy the treatment standards, the practical impact of that approach is that treatment using the most aggressive treatment technology available (i.e., for organic constituents, destruction of organic constituents based upon the performance of incineration) is often necessary to achieve the treatment standards.

For contaminated soil, the Agency has chosen to establish technology-based soil treatment standards at levels that are achievable using a variety of common remedial technologies which destroy, remove or immobilize substantial amounts of hazardous constituents. 58 FR 48129 (September 14, 1993). The levels chosen—90% reduction capped at 10 X UTS—are within the zone of reasonable levels the Agency could have selected as treatment standards for contaminated soil.

Soil treatability data from EPA's Soil Treatment Database indicate that the soil treatment standards are achievable and that the Agency has selected a reasonable level of performance for the standard. After screening the Database to eliminate data from tests reflecting poorly designed or operated treatment, tests where EPA believes inappropriate technologies were applied (for example, data from "immobilization" of organic constituents), and other inappropriate data, the Agency was left with 2,541 data pairs representing treatment of eighty hazardous constituents including nine BDAT list metals.[17] EPA then analyzed these data to determine if the soil treatment standards could be reliably achieved using demonstrated soil treatment technologies. Based on this analysis, the Agency concluded that the soil treatment standards can be reliably achieved using a variety of available soil treatment technologies. The Agency concluded that the soil treatment standards can be reliably achieved using: biological treatment, chemical extraction, dechlorination, soil washing, stabilization and thermal desorption. Of course, since soil treatment is generally matrix dependent, the exact treatment technology which

[17] A complete discussion of the Agency's method for screening the Soil Treatment Database can be found in the LDR Phase II proposal (58 FR 48129—48131, September 14, 1993) and the Best Demonstrated Available Technology Background Document for Hazardous Soil (August 1993).

might be applied to any given contaminated soil will depend on the specific properties of the soil and the hazardous constituents of concern. Choices about which soil treatment technology to apply should be informed by appropriate use of bench and pilot scale studies and good engineering judgement. EPA acknowledges that the treatment efficiency necessary to achieve the soil treatment standards will depend on, among other things, the initial concentrations of hazardous constituents in any given volume of contaminated soil. Thus, not all soil treatment technologies will be capable of treating every contaminated soil to meet the standards adopted in this rule. However, the Agency finds that the soil treatment standards typically can be achieved by at least one of the demonstrated technologies, even in the case of hard-to-treat hazardous constituents such as dioxins and furans, polychlorinated biphenyls, and polynuclear aromatics.

Furthermore, the Agency has concluded that it is appropriate to express the soil treatment standards as a treatment performance goal capped by specific treatment levels. More specific standards, for example, a single numerical standard for all soil, could be counterproductive—less often achievable—given the varying combinations of hazardous constituents and soil properties that might be encountered in the field. 58 FR 48130 (September 14, 1993). An express objective of this rule is to increase the range of appropriate treatment alternatives available to achieve the LDR treatment standards in soil to increase the likelihood that more remediations will include treatment as a component of the remedy. This objective could be impeded by adopting single numeric values as treatment standards, since that approach would reduce needed flexibility. The resulting soil treatment standards, while still technology-based, thus depart from EPA's past methodology developed for process wastes in that they are not based exclusively on the application of the most aggressive technology to the most difficult to treat waste and are not expressed as a single numeric value.

Like any land disposal restriction treatment standard, the soil treatment standards may be achieved using any treatment method except treatment methods which involve impermissible dilution (e.g., addition of volume without destroying, removing or immobilizing hazardous constituents or transfer of hazardous constituents from soil to another medium such as air). For organic constituents, the soil treatment standards for volatile organic constituents are based on the performance of biotreatment, chemical extraction, dechlorination, thermal desorption or soil vapor extraction. The standards for semivolatile organic constituents are based on the performance of biotreatment, chemical extraction, dechlorination, soil washing, thermal desorption, or soil vapor extraction. The standards for organochlorine pesticides are based on the performance of biotreatment, dechlorination, hydrolysis, or thermal desorption. The standards for phenoxyacetic acid pesticides are based on the performance of dechlorination. The standards for polychlorinated biphenyls are based on the performance of chemical extraction, dechlorination, or thermal desorption. The standards for dioxins and furans are based on the performance of dechlorination or thermal desorption. EPA does not have specific data in the record on treatment of organophosphorous insecticides. Because they are based on a similar chemical structure, these contaminants, however, are likely as difficult to treat as other polar nonhalogenated organic compounds and are expected to respond to treatment in a manner similar to other polar nonhalogenated phenols, phenyl ethers, and cresols. Therefore, EPA believes that organophosphorous insecticides can be treated using the same technologies as would otherwise be used to treat polar nonhalogenated organics, i.e., biotreatment, chemical extraction, or thermal desorption. For all organic constituents the soil treatment standards are also achievable using combustion. EPA notes also that a number of judicial opinions have upheld EPA's extrapolation of achievability results for technology-based treatment standards based on chemical structure and activity similarity, as has been used here. See, e.g., *Chemical Manufacturers Ass'n* v. *EPA*, 870 F. 2d 177, 248 (5th Cir. 1989) and *National Ass'n of Metal Finishers* v. *EPA*, 719 F. 2d 624, 659 (3d Cir. 1983). For metals, the soil treatment standards are based on the performance of stabilization, and for mercury, chemical extraction. Achievability of the soil treatment standards is discussed, in detail, in section VII.B.8 of today's preamble.

a. Measuring Compliance With the Soil Treatment Standards For hazardous constituents which have a treatment standard measured by total waste analysis (i.e. standards for organic constituents and for cyanide), compliance with the 90% reduction standard should generally be measured using total constituent concentrations. For hazardous constituents which have a treatment standard measured based on concentrations in a TCLP extract (i.e., standards for metals and for carbon disulfide, cyclohexanone and methanol), compliance with the 90% reduction standard should generally be measured in leachate using the toxicity characteristic leaching procedure. The exceptions to these rules would be, for example, if soils contaminated with metal constituents were treated using a technology which removed or destroyed, rather than stabilized, metals. In an example like this, compliance with the 90% reduction standards should generally be measured using total constituent concentrations.

EPA takes this opportunity to clarify that when establishing the concentrations of hazardous constituents in any given volume of contaminated soil from which the 90% reduction will be measured, normal soil characterization techniques and procedures for representative sampling should be used. For example, it is not necessary to measure the 90% reduction from the soil sample with the lowest concentrations of hazardous constituents. EPA will publish additional guidance on establishing and validating 90% reduction levels for contaminated soil in the near future.

Today's rule does not change existing policies or guidance on soil sampling or site characterization. Although soil is often characterized using composite sampling, EPA notes that, consistent with the way the Agency measures compliance with other LDR treatment standards, compliance with the soil treatment standards will be measured and enforced using grab samples. This is appropriate because well-designed and well-operated treatment systems should ensure that soil is uniformly treated.

b. Major Comments A number of commenters expressed concern about the achievability of the soil treatment standards and/or the methodology EPA used to develop the soil treatment standards. These concerns are discussed in Section VII.B.8 of today's preamble and in the response to comments document, available in the docket for today's rulemaking.

2. The Soil Treatment Standards Satisfy RCRA Section 3004(m) Requirements

The technology-based "90% capped by 10 X UTS" treatment standard for contaminated soil is sufficiently stringent to satisfy the core requirement of RCRA Section 3004(m) that short-term and long-term threats to human health and the environment posed by

land disposal are minimized. Technology-based standards provide an objective measure of assurance that hazardous wastes are substantially treated before they are land disposed, thus eliminating the "long-term uncertainties associated with land disposal." Eliminating these uncertainties was a chief Congressional objective in prohibiting land disposal of untreated hazardous wastes. Hazardous Waste Treatment Council v. EPA, 886 F.2d at 361–64. In addition, the extent of treatment required, 90 % reduction capped at treatment to concentrations within an order of magnitude of the UTS, "substantially" reduces mobility or total concentrations of hazardous constituents within the meaning of RCRA Section 3004(m)(1).

EPA has made two changes from proposal which strengthen the soil treatment standards to assure that they minimize threats to human health and the environment. First, the Agency has modified its approach to which hazardous constituents will be subject to treatment. In today's rule, when the soil treatment standards are used, EPA requires treatment for all hazardous constituents reasonably expected to be present in contaminated soil when such constituents are initially found at concentrations greater than ten times the universal treatment standard. This treatment is required both for soil contaminated by listed hazardous waste and soil that exhibits (or exhibited) a characteristic of hazardous waste. Constituents subject to treatment are discussed further in Section VII.B.4 of today's preamble.

To further ensure that contaminated soil treated to comply with the soil treatment standards is safely managed, EPA has included additional restrictions on the use of treated contaminated soil in hazardous waste-derived products that are used in a manner constituting disposal (i.e., when such products will be placed on the land). The restrictions on use of treated contaminated soil in hazardous waste-derived products that are used in a manner constituting disposal are discussed in Section VII.B.5 of today's preamble.

Finally, the Agency reiterates that, in the remediation context, in assessing whether threats posed by land disposal have been minimized, one should appropriately consider the risks posed by leaving previously land disposed waste in place as well as the risks posed by land disposal of waste after it is removed and treated. 62 FR at 64506 (December 5, 1997). For example, if a treatment standard for organic constituents based on performance of incineration typically results in already land disposed materials such as contaminated soils being capped in place rather than more aggressively remediated, threats posed by land disposal of the waste ordinarily would not be minimized. Conversely, a treatment standard that results in substantial treatment followed by secure land disposal can be said to minimize threats, taking into account the totality of threats posed (i.e. including those posed if the soil were left in place untreated). *Id.* The soil treatment standards will ordinarily ensure that contaminated soil is appropriately treated within the meaning of RCRA Section 3004(m), considering both the threats posed by new land disposal of treated soil and the threats posed by on-going land disposal of existing contaminated soil (e.g., if the soil were left in place untreated).

EPA recognizes that some people may be concerned that a situation may arise where the soil treatment standards are at levels that are higher than those that EPA or an authorized state believes should be required for soil cleanup under a cleanup program. The Agency acknowledges that this may occur. The soil treatment standards, like other land disposal restriction treatment standards, are based on the performance of specific treatment technologies. As discussed earlier in today's preamble, technology-based standards have been upheld as a permissible means of implementing RCRA Section 3004(m). Most soil cleanup levels are based not on the performance of specific treatment technologies but on an analysis of risk. For this reason, technology-based treatment standards will sometimes over-and sometimes under-estimate the amount of treatment necessary to achieve site-specific, risk-based goals.

The purpose of the land disposal restriction treatment standards is to ensure that prohibited hazardous wastes are properly pre-treated before disposal (i.e., treated so that short- and long-term threats to human health and the environment posed by land disposal are minimized). As discussed above, the Agency believes the soil treatment standards promulgated today fulfill that mandate for soil that contains prohibited listed hazardous waste or exhibits a characteristic of prohibited hazardous waste. However, technology-based treatment standards are not necessarily appropriate surrogates for site-specific risk-based cleanup levels. In a circumstance where the soil treatment standards result in constituent concentrations that are higher than those determined, on a site-specific basis, to be required for soil cleanup, existing remedial programs such as RCRA Corrective Action, CERCLA and state cleanup programs could be applied to ensure that remedies are adequately protective. These programs already ensure protection of human health and the environment when managing most contaminated soils—i.e., soils that are not subject to the LDRs—and other remediation wastes. Furthermore, as discussed later in today's rule, treated contaminated soil would remain subject to regulation under RCRA Subtitle C unless and until EPA or an authorized state made an affirmative decision that the soil did not contain hazardous waste or, in the case of characteristic soil, no longer exhibited a hazardous characteristic.

3. Variance From the Soil Treatment Standards at Risk-Based Levels

EPA has long indicated that its preference would be to establish a complete set of risk-based land disposal treatment standards at levels that minimize short- and long-term threats to human health and the environment. See, for example, 55 FR at 6641 (Feb. 26, 1990). However, the difficulties involved in establishing risk-based standards on a nationwide basis are formidable due in large part to the wide variety of site-specific physical and chemical compositions encountered in the field and the uncertainties involved in evaluating long-term threats posed by land disposal. *Id.*; 60 FR 66380—66081 (Dec. 21, 1995). For these reasons the Agency has chosen to establish land disposal restriction treatment standards based on the performance of specific treatment technologies. Although technology-based treatment standards are permissible, they may not be established at levels more stringent than those necessary to minimize short and long-term threats to human health and the environment. Hazardous Waste Treatment Council, 886 F. 2d at 362 (land disposal restriction treatment standards may not be established, "beyond the point at which there is not a "threat" to human health or the environment").

While using risk-based approaches to determine when threats are minimized on a national basis has proven extremely difficult, these difficulties will diminish when evaluating risks posed by a specific contaminated soil in a particular remediation setting since, during remediation, one typically has detailed site-specific information on constituents of concern, potential human and environmental receptors, and potential routes of exposure. For this reason, EPA is establishing a site-specific variance from the technology-based soil treatment standards, which

can be used when treatment to concentrations of hazardous constituents greater (i.e., higher) than those specified in the soil treatment standards minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the technology-based soil treatment standards. This approach was first discussed in the September 14, 1993 proposal, where EPA proposed that determinations that contaminated soil did not or no longer contained hazardous waste could supersede LDR treatment standards, if the "contained-in" level also constituted a "minimized threat" level. It was repeated in the April 29, 1996 proposal where the Agency proposed that, in certain circumstances, variances from land disposal restriction treatment standards could be approved in situations where concentrations higher than the treatment standards minimized threats.[18] 58 FR at 48128 (September 14, 1993) and 61 FR at 18811 and 18812 (April 29, 1996).

At this time, EPA is allowing the risk-based variances only for contaminated soils. The Agency believes this limitation is appropriate for a number of reasons. First, contaminated soils are most often generated during agency overseen cleanups, such as CERCLA cleanups, RCRA corrective actions or state overseen cleanups. This type of involvement in cleanups positions EPA and authorized states to appropriately consider site-specific, risk-based issues. Second, during remediation, experts and field personnel typically gather detailed site-specific information on risks posed by specific hazardous constituents or combinations of hazardous constituents, potential direct and indirect exposure routes, risk pathways and human and environmental receptors. Through application of this information, overseeing agencies can eliminate many of the long-term uncertainties associated with land disposal and, therefore, make appropriate risk-based decisions regarding the extent of treatment needed to minimize short- and long-term threats to human health and the environment from any given hazardous constituent or combination of hazardous constituents. EPA and state officials already routinely make these types of decisions when developing site-specific, risk-based cleanup levels and when making decisions about whether any given contaminated medium contains hazardous waste.[19] After experience implementing the site-specific minimize threat variance for contaminated soil, the Agency may consider extending it to other environmental media and remediation wastes.

Some commenters expressed concern that allowing site-specific, risk-based minimize threat determinations would abrogate the Agency's responsibilities under RCRA Section 3004(m). The Agency strongly disagrees. RCRA Section 3004(m) requires EPA to establish "levels or methods of treatment, if any, * * *." In the case of contaminated soil, EPA is establishing those levels today based on the performance of available, appropriate soil treatment technologies. Providing a variance process to modify a level or method of treatment on a case-by-case basis reduces the likelihood that in any particular situation technology-based treatment standards will result in treatment beyond the point at which threats are minimized. The Agency is requiring that minimize threat variance determinations for contaminated soils be evaluated using the existing site-specific variance process set out in 40 CFR 268.44(h). EPA recently added language to this provision to clarify that variances cannot be approved without opportunity for public participation, including notice by appropriate means, opportunity for public comment and adequate explanation of an ultimate determination. 62 FR at 64507 (Dec. 5, 1997).

While not required, EPA anticipates that decisions about site-specific minimize threat decisions variances will often be combined with decisions that soil no longer contains hazardous waste. As discussed later in today's preamble, Agency guidance on "contained-in" determinations is essentially the same as the requirements for site-specific, risk-based minimize threat determinations promulgated today. For that reason, EPA believes it will always be appropriate to combine a contained-in determination with a site-specific, risk-based minimize threat variance. In these cases, EPA encourages program implementors and facility owners/operators to include information about the "contained-in" decision in the public notice of the site-specific minimize threat variance. In cases where a site-specific minimize threat variance is combined with a decision that a soil no longer contains hazardous waste, once treated to comply with the treatment standard imposed by the variance, the soil would no longer have any obligations under RCRA Subtitle C and could be managed—including land disposed—without further control under RCRA Subtitle C. The contained-in policy is discussed in more detail in Section VII.B.8 and Section VII.E of today's preamble.

EPA reminds program implementors that, consistent with the rest of the land disposal restriction program, site-specific determinations that threats are minimized cannot be based on the potential safety of land disposal units, or engineered structures such as liners, caps, slurry walls or any other practice occurring after land disposal. American Petroleum Inst. v. EPA, 906 F.2d 729, 735–36 (D.C. Cir. 1990) (land treatment cannot be considered in determining whether threats posed by land disposal have been minimized because land treatment is a type of land disposal and section 3004(m) requires that threats be minimized before land disposal occurs); see also S. Rep. No. 284, 98th Cong. 1st sess. at 15, stating that engineered barriers cannot be considered in assessing no-migration variances because "[a]rtificial barriers do not provide the assurances necessary to meet the standard." This means that site-specific minimize threat determinations must be based on the inherent threats any given contaminated soil would pose. The Agency recognizes that this will have the effect of precluding site-specific minimize threat variances for remedies that rely, even in part, on capping, containment or other physical or institutional controls. In

[18] In the April 29, 1996 proposal, the Agency proposed to limit variances based on a site-specific minimize threat determination to contaminated soils where all concentrations of hazardous constituents were below a "bright line," that is, below a certain risk level. The Agency also requested comment on extending site-specific minimize threat variances to other contaminated soils. Based on further consideration and consideration of comments, the Agency is persuaded that a site-specific minimize threat variance should be available to all contaminated soils. The Agency believes this is proper because the outcome of a site-specific, risk-based minimize threat variance—alternative, site-specific LDR treatment standards based on risk—will be the same regardless of the initial concentrations of hazardous constituents. In any case, the Agency is not, at this time, taking action on the portion of the April 29, 1996 proposal that would have established a "bright line" to distinguish between higher- and lower-risk media. If, in the future, the Agency takes action to establish a bright line, it will address the relationship of a bright line to site-specific minimize threat variances.

[19] While not forbidden, the Agency believes that site-specific, risk-based minimize threat determinations will rarely be made in the context of an independent or voluntary cleanup action, since, in these types of actions, an overseeing Agency will not, typically, have been involved in the identification exposure pathways and receptors of concern or the calculation of site-specific, risk-based cleanup levels. Of course, generators could apply for a site-specific, risk-based minimize threat variance during an independent or voluntary cleanup and, provided EPA or an authorized state agreed that the proposed alternative treatment standards minimized threats considering appropriate exposure pathways and receptors, a variance could be approved.

addition to being compelled by the statute, the Agency believes this approach is proper, in that it may encourage remedy choices that rely more predominantly on treatment to permanently and significantly reduce the concentrations (or mobility) of hazardous constituents in contaminated soil. The Agency has a strong and longstanding preference for these types of more permanent remedial approaches.

In addition, at a minimum, alternative land disposal restriction treatment standards established through site specific, risk-based minimize threat variances should be within the range of values the Agency generally finds acceptable for risk-based cleanup levels. That is, for carcinogens, alternative treatment standards should ensure constituent concentrations that result in the total excess risk from any medium to an individual exposed over a lifetime generally falling within a range from 10^{-4} to 10^{-6}, using 10^{-6} as a point of departure and with a preference, all things being equal, for achieving the more protective end of the risk range. For non-carcinogenic effects, alternative treatment standards should ensure constituent concentrations that an individual could be exposed to on a daily basis without appreciable risk of deleterious effect during a lifetime; in general, the hazard index should not exceed one (1). Constituent concentrations that achieve these levels should be calculated based on a reasonable maximum exposure scenario—that is, based on an analysis of both the current and reasonably expected future land uses, with exposure parameters chosen based on a reasonable assessment of the maximum exposure that might occur. The Agency believes these represent an appropriate range of minimum values for site-specific, risk-based minimize threat determinations because sites cleaned up to these levels are typically released from regulatory control under the Federal CERCLA program and the RCRA corrective action program. See, for example, the National Contingency Plan (55 FR 8666, March 8, 1990) the 1990 RCRA Corrective Action Subpart S Proposal (55 FR 30798, July 27, 1990), and the 1996 RCRA Corrective Action Subpart S ANPR (61 FR 19432, May 1, 1996). In addition to achieving protection of human health, alternative treatment standards must ensure that environmental receptors are protected and must also ensure that no unacceptable transfer of contamination from one medium to another, for example, from soil to ground water, will occur.[20] Protection of environmental receptors and against cross-media contamination may, in some cases, require more stringent (i.e., lower) alternative treatment standards than would be necessary to protect human health alone. The Agency recognizes that this approach is different from the approach used in developing national risk-based minimize threat levels proposed in the Hazardous Waste Identification Rule (HWIR-Waste). 60 FR 66344 (December 21, 1995). This difference is proper, in that the HWIR-Waste proposal contemplated nationally-applicable risk-based LDR treatment standards and, therefore, had to consider the myriad of potential exposure pathways and receptors which might occur at any given site, nation wide. A site-specific minimize threat determination is informed by actual and reasonable potential exposure pathways and receptors at a specific land disposal location.

Although not expressly limited to land disposal of contaminated soil on-site, EPA anticipates that site-specific minimize threat variances will, most often, be applied to these activities. The basis for developing an alternative land disposal restriction treatment standard during the site-specific minimize threat variance is application of risk information about specific exposure pathways and receptors of concern. To apply such a variance to off-site land disposal, the treatment standard would have to be informed by the exposure pathways and receptors present at the off-site land disposal areas (assuming no physical or engineered structures or other post-land-disposal controls). While such an analysis is allowed, this information is not, to the Agency's knowledge, routinely gathered during site remediation.

Most commenters supported the concept of using a treatment variance to reduce the likelihood that, in any particular case, technology-based soil treatment standards might prompt treatment beyond the point at which threats to human health and the environment are minimized.

One commenter was concerned that establishing a risk-based minimize threat variance without adequate minimum standards would be contrary to law and impossible to oversee. EPA was, in part, persuaded by these comments and has added a requirement that, at a minimum, alternative LDR treatment standards approved through a site-specific minimize threat variance be within the range of acceptable values the Agency typically uses for cleanup decisions, as discussed above. In addition, as discussed above, the Agency has clarified that, unlike some CERCLA or RCRA corrective action remedies, site-specific minimize threat variances may not rely on post-land disposal controls.

4. Constituents Subject to Treatment

For soil contaminated by listed hazardous waste, EPA proposed that treatment would be required for each hazardous constituent originating from the contaminating waste. For soil which exhibits (or exhibited) a characteristic of hazardous waste, EPA proposed that treatment would be required: (1) in the case of TC soil, for the characteristic contaminant; (2) in the case of ignitable, reactive or corrosive soil, for the characteristic property; and, (3) in both cases, for all underlying hazardous constituents. 61 FR at 18809 (April 29, 1996). Under the 1996 proposal, treatment would have been required only when those constituents were initially present at concentrations greater than ten times the universal treatment standard. EPA also requested comment on, among other things, whether, for soil contaminated by listed hazardous waste, treatment should be required for all underlying hazardous constituents present at concentrations above ten times the UTS. Underlying hazardous constituent is defined in 40 CFR 268.2(i) as, "any constituent listed in 40 CFR 268.48 table UTS, except fluoride, sulfides, vanadium, selenium, and zinc, which can reasonably be expected to be present at the point of generation of the hazardous waste, at a concentration above the constituent-specific UTS treatment standards."

Many commenters supported the proposed approach. Some commenters, however, expressed concern that, because contaminated soil often contains numerous hazardous constituents from a variety of sources, limiting treatment of soil contaminated by listed hazardous waste to constituents originating from the contaminating waste might result in soil contaminated with listed waste undergoing less treatment than soil which exhibits (or exhibited) a characteristic of hazardous waste. One commenter also asserted that the proposed approach to constituents subject to treatment was, in the case of soil contaminated by listed hazardous waste, inconsistent with the Chemical Waste opinion. On further consideration, EPA was persuaded that it is prudent to apply the logic of the

[20] Unacceptable cross-media transfer would include, for example, transfer of contaminants from soil to air in excess of applicable air emission standards.

Chemical Waste opinion both to soil contaminated by listed hazardous waste and to soils which exhibit a characteristic of hazardous waste.

As the Agency explained in the 1996 proposal, contaminated soils are potentially contaminated with a wider range of hazardous constituents than most pure hazardous wastes generated by on-going industrial processes—in no small part because contaminated soils generally reflect uncontrolled disposal settings. 58 FR at 48124 (September 14, 1993). Since the Chemical Waste opinion addressed a similar situation (certain characteristic hazardous wastes that might contain a variety of hazardous constituents), the Agency is persuaded that it is prudent to apply the logic of the Chemical Waste opinion to contaminated soil and require treatment of all underlying hazardous constituents. See Chemical Waste Management v. US EPA, 976 F.2d at 16–18 (D.C. Cir 1992). Therefore, when the soil treatment standards are used, today's final rule requires that all contaminated soil subject to the LDRs be treated to achieve the soil treatment standards for each underlying hazardous constituent reasonably expected to be present in the soil when such constituents are initially found at concentrations greater than ten times the universal treatment standard. In addition to treatment of all underlying hazardous constituents as discussed above, as proposed, characteristic soil must also be treated, in the case of TC soil, for the TC constituent and, in the case of ignitable, corrosive, or reactive soil, for the characteristic property.

Although, when the soil treatment standards are used, treatment is now required for each underlying hazardous constituent when such constituents are initially found at concentrations greater than ten times the universal treatment standard, it will not be necessary to monitor soil for the entire list of underlying hazardous constituents. Generators of contaminated soil can reasonably apply knowledge of the likely contaminants present and use that knowledge to select appropriate underlying hazardous constituents, or classes of constituents, for monitoring. This is consistent with the approaches EPA typically takes in remedial programs, where it emphasizes that remediation managers should focus investigations on constituents of concern and with regulations that allow generators to rely on knowledge to determine whether any given solid waste is hazardous. *Cf.* 61 FR at 19444 where EPA encouraged remediation managers to "tailor [facility investigations] to the specific conditions and circumstances at the facility and focus on the units, releases, and exposure pathways of concern."

For nonanalyzable constituents, EPA is promulgating the approach discussed in both the September 14, 1993 and the April 29, 1996 proposals. In situations where contaminated soil contains both analyzable and nonanalyzable organic constituents, treating the analyzable constituents to meet the soil treatment standards is also reasonably expected to provide adequate treatment of the nonanalyzable constituents. In situations where contaminated soil contains only nonanalyzable constituents (i.e., soil contaminated only by nonanalyzable U or P listed wastes), treatment using the specified method for the appropriate U or P listed waste is required. 61 FR at 18810, April 29, 1996. Most commenters supported this approach.

5. Relationship of Soil Treatment Standards to Naturally Occurring Constituents

In the April 29, 1996 proposal EPA requested comment on whether concentrations of naturally occurring constituents should be evaluated when identifying constituents subject to treatment. Commenters who addressed this issue overwhelmingly recommended that, for naturally occurring constituents, EPA cap LDR treatment requirements for soil at natural background concentrations. After considering these comments, EPA was persuaded that treatment to comply with LDRs should not be required if constituent concentrations fall below naturally occurring background concentrations, provided the soil will continue to be managed on site or in an area with similar natural background concentrations. If soil will be sent for land disposal off-site, compliance with LDRs is required, since the Agency believes that natural background concentrations on-site will not automatically correspond to natural background concentrations at a remote land disposal facility.

The Agency notes that, for purposes of this discussion, natural background concentrations are constituent concentrations that are present in soil which has not been influenced by human activities or releases. Since these constituent concentrations are present absent human influence and EPA has determined that soil (like other environmental media) is not, of itself, a waste but may be regulated as hazardous waste under RCRA only when it contains (or contained) waste, EPA is not convinced the Agency would have the authority to require compliance with LDRs when constituent concentrations fall below background concentrations even if it felt compelled to do so. (Of course, such constituents could be regulated as hazardous constituents under state and Federal cleanup authorities, including RCRA corrective action and other authorities.)

Since natural background concentrations may vary across geographic areas, and to ensure that LDRs will only be capped at background where appropriate, EPA will require that individuals who wish to cap LDR treatment at natural background concentrations apply for and receive a treatment variance. EPA will presume that when LDRs would require treatment to concentrations that are less than natural background, such a variance will be appropriate, based on the finding that it is inappropriate, for contaminated soil, to require treatment to concentrations less than natural background concentrations. This issue has been clarified in today's final regulations, see 40 CFR 268.44(h)(4).

6. Restrictions on Use of Treated Hazardous Contaminated Soil in Products Used in a Manner Constituting Disposal

Although, as discussed earlier in today's preamble, EPA believes the soil treatment standards satisfy the requirements of RCRA Section 3004(m), EPA has determined that additional restrictions are necessary for hazardous contaminated soils that are used to produce products which are, subsequently, used in a manner constituting disposal (i.e., used to produce products which are placed in or on the land). Under current regulations, hazardous waste-derived products that are used in a manner constituting disposal must, among other things, comply with the applicable land disposal restriction treatment standards in 40 CFR part 268.40, that is, the Universal Treatment Standards. See 40 CFR 266.23(a). EPA has concluded that hazardous contaminated soil used to produce products which are, subsequently, used in a manner constituting disposal must continue to meet the universal treatment standards. Such products, then, are not eligible for the soil treatment standards promulgated today. EPA has made this decision for several reasons. First, EPA has chosen technology-based treatment standards (such as today's soil treatment standards) as a means of implementing the LDR statutory requirements in order to eliminate as many of the uncertainties associated with land disposal of hazardous waste as possible.

55 FR at 6642 (Feb. 26, 1990). These uncertainties increase sharply when one considers possible dispositions of hazardous waste-derived products used in a manner constituting disposal. These products can be placed virtually anywhere, compounding potential release mechanisms, exposure pathways, and human and environmental receptors. 62 FR at 64506 (Dec. 5, 1997) and 53 FR at 31197–98 (August 17, 1988). For these reasons, the Agency in 1988 determined that these wastes should be treated to reflect the best treatment available, 53 FR at 31197–98, and the Agency believes this reasoning continues to hold with respect to contaminated soils. Second, EPA has determined that the soil treatment standards adopted in today's rule are justified, in many instances, in order to encourage remediation involving treatment over remedies that involve leaving un-treated contaminated soils in place. The Agency is less sure that this is a desirable incentive if the contaminated soils are to be used in a manner constituting disposal, again because of the uncertainties posed by this method of land disposal.

Note that EPA has explained, however, that remediation activities involving replacement of treated soils onto the land is not a type of use constituting disposal, in part, because it is a supervised remediation instead of an unsupervised recycling activity. 62 FR 26063 (May 12, 1997). This interpretation is not affected by today's rulemaking.

7. Availability of Soil Treatment Standards

EPA proposed that soil-specific land disposal restriction treatment standards would be available only for contaminated soils managed under an agency approved, site-specific cleanup plan termed a Remediation Management Plan or "RMP." The Agency also specifically requested comment on whether soil-specific treatment standards should be made available to all contaminated soil. 61 FR at 18813 (April 29, 1996). The majority of commenters who addressed this issue strongly supported extending the soil treatment standards to all contaminated soil. These commenters argued that extending soil-specific LDRs to all contaminated soil would encourage voluntary and independent cleanups, especially at low and medium priority sites where a regulatory agency might not have the resources to provide real-time oversight through a "RMP." After considering these comments, EPA is persuaded that the soil treatment standards should be available for all contaminated soil and has revised the regulations accordingly.

EPA's thinking in proposing to require a site-specific remediation management plan to take advantage of the soil treatment standards was that site-specific oversight, and potentially modification of the treatment standards, would be necessary to ensure that all contaminated soils were appropriately treated. 61 FR at 18807 (April 29, 1996). However, EPA now concludes that the soil treatment standards will ensure adequate treatment of all contaminated soils for two reasons.

First and primarily, the residuals from treatment of hazardous contaminated soil will typically continue to be regulated as hazardous waste and will remain subject to applicable RCRA Subtitle C requirements. 61 FR at 18810 (April 29, 1996). Non-soil residuals, such as wastes generated during application of separation technologies, will be regulated as hazardous wastes if they exhibit a characteristic of hazardous waste or if they derive from treating a soil which contains listed hazardous waste. Therefore, these types of non-soil residuals will typically be subject to the universal treatment standards in 40 CFR 268.40. See 57 FR at 37240 (Aug. 18, 1992) where EPA took the same approach for residues from treating contaminated debris. Soil residuals will also be regulated as hazardous waste unless it is determined that the soil does not contain hazardous waste.[21] For example, application of a thermal desorption technology would likely generate two types of residuals: treated soil (soil residual) and concentrated contaminants removed from the soil and captured in an air pollution control device (non-soil residual). If the contaminated soil contained a listed hazardous waste or exhibited a characteristic of hazardous waste at the time of treatment, both residuals would continue to be subject to RCRA Subtitle C regulations. The non-soil residual would be required to comply with applicable universal treatment standards prior to land disposal; the soil residual would generally require land disposal in a Subtitle C unit unless a "contained-in" determination was made. Therefore, although a remediation management plan is no longer required to take advantage of the soil treatment standards, a site-specific decision is still required before treated contaminated soil can exit the system of RCRA regulations.

Second, as noted earlier, EPA has extended the treatment requirement to all underlying hazardous constituents reasonably expected to be present in contaminated soils when such constituents are found at initial concentrations greater than ten times the universal treatment standard and retained current treatment requirements for hazardous contaminated soils used to produce products that are subsequently used in a manner constituting disposal.

8. Achievability of Contaminated Soil Treatment Standards

The soil treatment standards promulgated today are based primarily on the data for soil treatability found in EPA's Soil Treatment Database (SDB). See, Best Demonstrated Available Treatment Background Document for Hazardous Soils, August 1993 and LDR Phase 2 proposal at 58 FR 48122, Sept. 14, 1993. Data from the soil treatment database are corroborated by more recent performance data for non-combustion treatment of remediation wastes. See Soil Treatability Analysis: Analysis of Treatability Data for Contaminated Soil Treatment Technologies (April 1998, USEPA) and references cited in note 5 below.

The soil treatment data base contains 6,394 pairs of data points (for the same sample, one datum for untreated soil and one datum for treated soil) describing the treatment of hazardous constituents in contaminated soils managed under the RCRA and the Superfund programs. After screening the database to eliminate data from tests reflecting poorly designed or operated treatment, tests where EPA believes inappropriate technologies were applied (for example, data from immobilization of organic constituents) and other inappropriate data, the Agency was left with 2,541 pairs of data points. These data pairs depict treatment of ninety-four hazardous constituents, including eighty-five organic constituents and nine BDAT list metals. The retained 2,541 pairs of data points from the soil treatment database represent the treatment of organic and metal constituents by various technologies including: combustion, biological treatment, chemical/solvent extraction, dechlorination, thermal desorption, air/steam extraction, photolysis, soil washing, stabilization, and vitrification. The soil treatment database includes performance data from bench, pilot, and full scale technologies. A complete discussion of the Agency's method for

[21] The exception would be soil residuals from treatment of soils which were determined no longer to contain a listed hazardous waste or were decharacterized and yet remained subject to LDRs. In this case, since the treatment would be performed on non-hazardous soil, the soil residuals would also be considered non-hazardous.

screening the Soil Treatment Database can be found in the LDR Phase II proposal (58 FR 48129–31, September 14, 1993) and the Best Demonstrated Available Technology Background Document for Hazardous Soil (August 1993).

A number of commenters were concerned that aggregated data, i.e., the 2,541 pairs of data points representing the combined performance of combustion and non-combustion technologies, may mask the performance of non-combustion technologies alone. Commenters urged EPA to disaggregate these performance data to allow for more accurate analysis of non-combustion technology performance. As a result, EPA has disaggregated the combustion and non-combustion treatment data for purposes of analyzing the achievability of today's soil treatment standards. See generally, Soil Data Analysis: Soil Treatability Analysis of Treatability Data for Contaminated Soil Treatment Technologies (April 1998, USEPA) and Additional Information on Treatability of Contaminated Soils as Discussed in Section VII.B.8. of Phase IV Final Rule Preamble (April 1998, USEPA).

After separating out combustion data, the remaining non-combustion soil treatment data base is reduced from 2,541 to 2,143 paired data points. These 2,143 [22] data pairs depict the treatment of 72 organics [23] and nine metals in contaminated by biological treatment, chemical and solvent extraction, chlorination, thermal desorption, air and steam stripping, hydrolysis, photolysis, soil washing, and stabilization.

As discussed earlier in today's preamble, EPA did not use the traditional BDAT approach to develop the soil treatment standards. Instead, the Agency evaluated data from the 2,143 non-combustion data pairs in the soil treatment database to identify, generally, the level of performance non-combustion soil treatment technologies achieve. In light of our multi-faceted objectives regarding remediation of contaminated soils (discussed earlier in this preamble), this approach and methodology are appropriate. As noted earlier in today's preamble, the numerical values chosen for soil treatment standards—90% reduction capped at ten times the UTS—are within the zone of reasonable values from which the Agency can properly select.

For soil contaminated with organic constituents, the retained 2,143 data pairs from the soil treatment database show generally that soils with moderate levels of contamination are more amenable to treatment by non-combustion technologies than soils with high levels of contamination. However, the data also show that the soil treatment standards promulgated today can be achieved by non-combustion technologies even in cases when soils contain elevated levels of harder-to-treat organic hazardous constituents, such as dioxins and furans, polychlorinated biphenyls (PCBs), and polynuclear aromatics (PNAs). The available data on the performance of non-combustion technologies suggest that some technologies are more effective with certain organics within specific families or chemical functional groups. For example, while many organic treatment technologies were effective in removing volatile organics from the soils, dechlorination is more effective than other non-combustion treatment technologies for treating chlorinated organics. For soil contaminated by metals, the retained 2,143 data points from the soil treatment database show that metals can typically be treated via stabilization to meet the soil treatment standards.

Although, for the reasons discussed earlier in today's preamble, EPA has elected to base the soil treatment standards on the performance of non-combustion technologies, combustion of soil is not prohibited. This is consistent with all other numerical treatment standards, which can likewise be achieved through use of any technology (other than impermissible dilution). It may be that combustion is, in fact, chosen as the remedial treatment technology at certain sites, most likely because of economic considerations (such as in the case of low soil volumes where on-site treatment units are not economically viable). Selection of the best treatment technology for the specific soil type and range of contaminants present at any given remediation site is a site-specific decision assuming, for soils subject to the LDRs, that the selected technology does not involve impermissible dilution and that today's soil treatment standards are met. Further details about the results of EPA's examination of treatment technologies for different groups of contaminants are discussed in the succeeding sections.

a. Comments. Many commenters expressed concern that the retained 2,541 data points from the soil treatment database might not adequately address the many types of soils and contaminated site scenarios that may arise in the field. Among other things, these commenters asserted that: (1) the list of chemical organic constituents for which EPA has data may be too small to extrapolate to other organics in the list of underlying hazardous constituents that must meet treatment standards; (2) for organic constituents, many of the treatment test results examined by EPA involved mostly combustion rather than non-combustion technologies; (3) for soils with multiple hazardous constituents and other complex soil matrices, the soil treatment standards could only be met via incineration; and, (4) EPA should not pool data from bench, pilot, and full scale treatment applications. For the most part, these commenters suggested that EPA either exempt hazardous contaminated soil entirely from a duty to comply with land disposal restriction treatment standards or, if hazardous contaminated soil were to remain subject to LDRs, allow risk-based treatment standards to be developed entirely on a site-by-site basis pursuant to state oversight.

EPA closely considered these comments and carefully re-evaluated the data from the soil treatment database as well as other data from more recent sources. These evaluations are summarized in the background documents for today's final rule. EPA is not, at this time, taking action to categorically exempt large volumes of hazardous remediation waste (including contaminated soil) from RCRA hazardous waste management requirements and, therefore, the issue of achievability of today's soil treatment standards is germane.

Notwithstanding the treatment results described in this section below, which support the achievability of today's soil treatment standards, EPA realizes that national, technology-based treatment standards are sometimes not achievable because of site- and waste-specific characteristics. Thus, EPA has long provided for treatment variances under these circumstances (see 40 CFR 268.44). In addition, because EPA and authorized states are in a position during remediation to make site-specific risk-based minimize threat determinations, the Agency is also adopting in today's rule a new type of variance for contaminated soils. This variance can be granted if, on a case-by-case basis, it is determined that the technology-based treatment standard

[22] One single datum from the vitrification of p,p'DDT was not included since it appears to have resulted from treatment that was not optimally designed or conducted.

[23] Out of 85 organic constituents, only 13 were treated exclusively by combustion. See, however, the discussion later in this preamble with regard to presence of data from incineration and extrapolation of data among organic constituents.

would prompt treatment beyond the point at which threats are minimized.

Fundamentally, EPA agrees with many commenters that today's land disposal treatment standards for contaminated soil may not remove all of the barriers RCRA can impose on efficient and aggressive site remediation. As discussed earlier in today's preamble, the Agency hopes the application of RCRA Subtitle C requirements to remediation of contaminated soils and other wastes will be addressed through legislation. If there is no legislative action, EPA may choose to take additional regulatory action, which may include either a re-examination of the application of LDRs to contaminated soil or other remediation wastes or a re-evaluation of today's soil treatment standards, or both. In the meantime, today's rule represents a significant improvement over the current practice of applying the treatment standards developed for pure industrial hazardous waste to contaminated soil.

b. Analysis of Data from the Soil Treatment Database. The soil treatment standards promulgated today are based EPA's Soil Treatment Database (SDB). See, Best Demonstrated Available Treatment Background Document for Hazardous Soils (August 1993); LDR Phase 2 proposal (58 FR 48122, Sept. 14, 1993); and Soil Treatability Analysis: Analysis of Treatability Data for Contaminated Soil Treatment Technologies (April 1998, USEPA) (hereinafter, this document is referred as the "Soil Treatability Analysis Report"). General concerns about the soil treatment database (and in particular, concerns about achieving the 10 times UTS or 90% reduction standard) are addressed here. Results of our analysis of the soil treatment database data on treatment performance for various technologies are shown in Table 1 below. Results of additional analysis for various organic and metal contaminant groups are shown in Tables 2–5 below. Further details of the analysis and additional findings are contained in the technical background documents in this docket.

TABLE 1.—SUMMARY OF TREATMENT RESULTS PER TECHNOLOGY IN SOIL DATA BASE[24]

Treatment technology	Total paired data points in the soil data base	Untreated	Treated			
		Data points meeting 10 times UTS standard	Data points meeting 10 times UTS but not 90% reduction standard	Data points meeting 90% reduction but not 10 times UTS standard	Data points meeting both 10 times UTS and 90% reduction standards	Data Points failing both 10 times UTS and 90% reduction standards
Biological Treatment	250	86	176	168	109	15
Chemical Treatment	242	58	226	206	200	10
Dechlorination	154	53	134	100	84	4
Stabilization	269	140	250	239	232	12
Stripping	236	88	206	103	103	30
Washing	35	10	21	14	11	11
Thermal Desorption	957	338	833	759	692	57
Total	2143[25]	773	1846	1589	1431	139

In aggregate, the results on Table 1 indicate that the Agency's selection of standards are within the range of reasonable values for non-combustion technologies to achieve. These data show that 139 (or 6%) paired data points out of 2143 would fail to meet the 10 times UTS or 90% reduction standard. Among possible reasons for these treatment performance deviations are that some soil samples represent cases in which the selected technology was not appropriate for the range of hazardous constituents in an organic chemical admixture. A better selection of treatment technology may include either a more aggressive non-combustion technology or may involve use of two or more technology trains in order to meet the soil treatment standards. It is common practice to employ multiple treatment trains at facilities that have complex chemical mixtures or soil textures at a site. As further explained in succeeding sections of this preamble and in various background documents, EPA believes that the hazardous soil treatment standards promulgated today are within a regime of reasonable treatment levels normally achieved by non-combustion technologies. See, e.g., Soil Treatability Analysis Report and Extrapolation of Treatment Performance Data in the Soil Data Base Among Hazardous Constituents in Contaminated Soils (April 1998, USEPA).

(1) Concerns About Presence of Data from Incineration and Extrapolation of Data to Other Constituents. As mentioned earlier, EPA has segregated the available treatment data (2,541 paired data points) so that we can better examine the 2,143 paired data points describing the treatment of hazardous soils by non-combustion technologies. Although 50 organic constituents in the original 2,541 paired data points were treated by combustion (i.e., incineration), only 13 of these 50 organics were treated exclusively by combustion. These 13 hazardous constituents are: 1,2,4-trichlorobenzene; p,p'-DDD; p,p'DDE; 2,4-dichlorophenol; methoxychlor; 2,4,6-trichlorophenol; 2,4,5-trichlorophenol; carbon tetrachloride; chloroform; hexachloroethane; 1,2-dibromo-3-chloro-propane; isodrin; and gamma-BHC. None of the data describing combustion of these 13 constituents or the other 37 organics (for which there are some combustion results) were relied upon in assessing achievability of today's hazardous soil treatment limits.

With respect to commenters' concerns about extrapolating the SDB data to organic and inorganic constituents that will need to be treated, EPA analyzed the various non-combustion technologies and their average treatment efficiencies against various chemical clusters and chemical functional groups of hazardous constituents. See: (1) Extrapolation of Treatment Performance Data in the Soil Data Base Among Hazardous Constituents in Contaminated Soils (April 1998, USEPA); (2) Derivation of Treatment Achievability Results of Organic Functional Groups and Types of Compounds (April 1998, USEPA); (3) Soil Treatability Analysis Report (USEPA, 1998); and (4) Additional

[24] For discussion of these treatment data, see Soil Treatability Analysis Report, and Extrapolation of Treatment Performance Data in the Soil Data Base Among Hazardous Constituents in Contaminated Soils (April 1998, USEPA).

[25] As noted earlier, EPA examined in detail up to 2,541 pairs of data points in total, and the number of non-combustion data pairs examined is 2,143.

Information on Treatability of Contaminated Soils as Discussed in Section VII.B.8. of the Final Rule Preamble (April 1998, USEPA).

The results are summarized in Tables 1–5 below. These results show that non-combustion technologies can achieve today's soil treatment standards. 93.5% (2,004 of the 2,143 data pairs) of the treatment test results meet the 10 times UTS or 90% reduction standard. Furthermore, non-combustion technologies can meet the soil treatment standards even in cases when soils contain elevated levels of harder-to-treat organic hazardous constituents, such as dioxins and furans, polychlorinated biphenyls (PCBs), and polynuclear aromatics (PNAs). See Appendix D in Soil Treatability Analysis Report.

As noted earlier, available data on the performance of non-combustion technologies treating organics also show that some technologies are more effective with certain organics within specific families or chemical functional groups, e.g., organic treatment technologies removing volatile organics from the soils and dechlorination removing halogenated organics. Treatability tests at certain complex sites corroborate these findings of achievability from the SDB.

Regarding organics, at the Ninth Avenue Dump Site in Indiana, hazardous soils were contaminated with low to moderate concentrations of PNAs, aromatics, chlorinated aliphatics, and phthalates. Untreated constituents showed concentrations that were about the same or up to two orders of magnitude higher than today's soil treatment standards.[26] Among the volatiles were toluene (1,100 ppm), total xylene (2,100 ppm), ethylbenzene (420 ppm), 1,1,1-trichloroethane (120 ppm), trichloroethene (93 ppm), tetrachloroethene (380 ppm), 1,1-dichloroethane (81 ppm), and methylene chloride (800 ppm). The following semivolatile organics-PNAs (and their highest concentration) were phenanthrene (92 ppm) and naphthalene (84 ppm). Bis(2-ethylhexyl) phthalate, a semivolatile phthalate, was reported at 110 ppm. The soil particle distribution of the contaminated soil was not quantified, but the soil was reported as comprised primarily of sand and silt. Biotreatment achieved the following average treatment reduction efficiencies:

- Volatile chlorinated aliphatics—99.9%;
- Ethylbenzene—100%;
- Volatile aromatics—99.9%;
- Semivolatile PNAs—97.4%;
- Bis(2-ethylhexyl)phthalate—93.2%.

Regarding complex metal remediations, the full-scale stabilization study conducted at the Portable Equipment Salvage Company, a transformer and metal salvage operation in Oregon, involved untreated levels of lead up to 880 mg/l (TCLP) and zinc up to 71 mg/l (TCLP). Organics were also present—the highest sample showing 610 mg/l lead (TCLP), 14,000 ppm oil and grease, 41,000 ppm total organic carbon, and 7.1 pH. The facility conducted treatability studies on three soil textures found at the site: (1) sandy loam, (2) loamy sand, and (3) loam. The stabilized sandy loam sample showed a concentration of 0.5 ppm lead, a 99.72% reduction efficiency. The facility also treated two samples of loamy sand, one to 47 mg/l lead (TCLP) (a 93.65% reduction efficiency) and the other to 2.5 mg/l lead (TCLP) (a 99.72% reduction efficiency). The treated loam sample showed 0.10 mg/l lead, a 99.97% reduction.

More information underlying EPA's rationale for extrapolating the available treatment performance data to other organic and inorganic hazardous constituents regulated under the land disposal restrictions can be found in the RCRA Docket for this rule (see Appendix D in Soil Treatability Analysis Report) and memorandum to docket on extrapolation of treatment performance data among different hazardous constituents.

Finally, we note that even though there were treatment data on soils containing cyanide in the larger data base (6,394 paired data points), none of the retained 2,541 or 2,143 paired data points included treatment data on cyanide. However, the current UTS for cyanide is based on the performance of alkaline dechlorination, a non-combustion technology. Cyanides can form complexes with metals and organics and, therefore, technologies capable of removing both organic and metals are also able to remove cyanide from contaminated soils. As a result, it is reasonable to expect that the average treatment performance attained by treating organics in soils will also be achieved for cyanide-bearing contaminated soils. We note that, for example, 90% reduction can be achieved based on the performance efficiency that thermal desorption attained in removing PNA's (with more than five rings) and chlorinated organics from contaminated soil. These constituents are among the hardest chemical species to remove via thermal desorption. For these reasons, the Agency has concluded that today's soil treatment standard for cyanide can be achieved by a non-combustion technology as well.

(2) Technology Scale and Soil Variability Issues. As noted earlier, several commenters objected to EPA's pooling of treatment data from pilot, bench, and full scale processes, and urged EPA to consider only performance data from full-scale field studies characterizing the treatment of soil volumes. EPA prefers, generally, to rely on full scale studies for the purpose of developing and promulgating treatment standards, and this is true with respect to the soil treatment standards as well. However, in this case as well as in many prior LDR treatment standard efforts, EPA's data base includes more than just full scale data upon which EPA can properly rely. Bench and pilot scale technologies can be appropriately considered by EPA (and EPA has historically done so) in setting treatment limits as long as full scale operations of the treatment system under consideration exist or have been demonstrated on wastes/soils. Except for hydrolysis,[27] the technologies in the SDB are demonstrated full scale, and the administrative docket contains bench, pilot, and full scale studies that reflect the Agency's field experiences at contaminated sites.

Furthermore, in this rulemaking, given the variability of hazardous soils (in terms of types, concentrations and numbers of hazardous constituents and soil matrices), plus the special policy considerations associated with remediations, the Agency is adopting treatment standards from the zone of reasonable values that could be permissibly selected based upon the treatment performance data. Thus, the data are not being used so much to establish a precise performance level as to confirm the typical achievability of the promulgated standards, i.e., ten times UTS or 90% reduction.

With respect to the SDB and commenters' concerns about the impact of soil variability on achievability of the soil treatment standards by non-combustion technologies, EPA collected 6,394 pairs of data point describing the treatment of various hazardous soils.

[26] The following constituents were present at levels below the soil treatment standards: fluorene, fluoranthene, pyrene, acenaphthalene, benzo(a)anthracene, chrysene, di-n-butyl phthalate, and diphenylnitrosamine.

[27] Hydrolysis can be of normal occurrence or intentionally induced at hazardous waste sites. EPA does not have full-scale ex-situ demonstration studies on this technology but considers the data in the SDB to be indicative of what levels can be achieved.

The retained 2,143 non-combustion paired data points are reasonably sufficient to adequately describe the treatment of metal, organics, and multiple metal and organic contaminants that are frequently found at different type of sites, including both Superfund and RCRA sites. For instance, the SDB has treatment data on soils with varying textures including top soils, silty/loam soils, and clay soils. For the 14 different soil type groupings analyzed, only 139 out of 2,143 data pairs (about 6.5%) would not meet today's soil treatment standards (see Appendices C and D in Soil Treatability Analysis Report).

With respect to these 6.5% data pairs, several potential reasons exist to explain why 90 % reduction or 10 times UTS level might not have been achieved. First, the treatment study objectives may not primarily have been to test whether these standards could be met. For example, the treatment study may have been designed either to assess the feasibility of using a particular (but not necessarily optimum) technology on a particular contaminated soil, or to meet a prescribed risk-based level under a RCRA or CERCLA site remediation plan.

Second, a treatment technology may have been applied to soils contaminated with multiple hazardous constituents where the technology may have been inappropriate for a subset of those contaminants (and for which data were reported anyway). For example, air stripping is a technology that operates best on volatile organics within a given range of Henry constant values. In contrast, air stripping of semivolatile organics and metals is expected to be much poorer. (In this type of situation, a technology amendment or treatment train may be appropriate, i.e., air stripping may be improved if steam stripping is applied first to enhance the pool of semivolatiles that can respond to the physical separation treatment process.)

Third, these treatment data likely include instances when a treatment technology encountered soil heterogeneities that resulted in undertreatment of portions of the soil. For instance, during the clean up of contaminated debris and soils, detailed sampling protocols are typically developed to ensure that desired treatment constituent concentrations are met because of the deleterious impact of heterogeneous soil strata and the presence of debris on treatment technology performance. Re-processing can often be required to comply with the applicable treatment standards.

Another alternative is to optimize specific technology operating parameters that can enhance the ability of the technology to meet the prescribed treatment limits. Optimization can involve: (1) feeding the correct soil/debris particle size fractions to the treatment system, (2) creating more turbulence between soil and gaseous/liquid treatment fluids, (3) using a greater-than-normal amount of chemical agents, (4) operating at the higher end of an operating temperature range, (5) adjusting the pH of the soil, (6) adding adequate pre-/post-treatment steps that address specific contaminants that may be expected to receive sub-optimal treatment, or (7) allowing longer residence time in the treatment unit.

It is not possible to determine precisely how many of these techniques were used in the 139 instances that failed the 90% reduction or 10 times UTS levels. However, EPA expects that not all optimization measures were used since the operators of the treatment technologies did not have as their primary objective the attainment of these particular levels, which are being adopted today as the soil treatment standard. On balance, the weight of evidence and analysis from the SDB are believed to reasonably indicate that today's standards are achievable for soils that may exhibit variability, particularly if optimization techniques or treatment technology trains are fully considered. Of course, should an unusual situation present itself in which these measures are not successful, a treatment variance can be sought under 40 CFR 268.44(h) or under the risk-based variance provisions being adopted in today's rule.

Furthermore, EPA has a number of bench and pilot studies on the treatment of contaminated soils from wood preserving, petroleum refining, and electroplating sites, which contain a wide range of constituents such as polynuclear aromatic, phenolic, chlorinated organics, spent solvents, creosote, and metals. It is reasonable to expect that these treatment results, showing achievability, also lend support to the conclusion that treatment at other RCRA and Superfund sites, containing these types of complex contaminant and soil variability scenarios, can be expected to achieve today's soil treatment standards.[28] See also Chapter 4 in Soil Treatability Analysis Report.

Pooled bench, pilot, and full scale data in the SDB are expected to depi what the various treatment technolo, can achieve for other hazardous soils managed under CERCLA and RCRA. As noted earlier, non-combustion technologies will behave better on a given range or class of organic and metal constituents. A given range of soil characteristics that may inhibit treatment performance can be amended to facilitate the treatment of hazardous soils. Available information on other full scale operations of the tested technologies demonstrate that optimization techniques can be used to overcome potential soil interferences and thus attain, generally, treatment design objectives. Hence, it is important to carefully evaluate the characteristics of each site against the expected capabilities of various non-combustion technologies, which are summarized below.

(3) Performance Data for Organic Constituents. EPA's conclusions with respect to achievability of soil treatment standards for organics in hazardous soils are based on the performance of biological treatment, chemical extraction, dechlorination, soil washing thermal desorption, and soil vapor extraction. Other treatment technologi capable of achieving the treatment limits (such as combustion) are not prohibited except for those that may constitute impermissible dilution. Tables 2 and 3 below provide an overview of the number of data points and the average treatment efficiency ranges that each of the technology categories achieved. Also, each Table below reports the range of test scales as well as the available treatment performance data per major chemical family category/cluster assigned to chemical constituents in the BDAT List. (For the whole list of BDAT constituents and their classification, see Appendix B in the BDAT Background Document for Hazardous Soils, August 1993.) Further details and discussion on the results for major chemical family categories/clusters is contained in the docket.

[28] See (1) *Remediation Case Studies: Bioremediation and Vitrification*, July 1997, EPA 542-R-97-008 or PB97-177554; (2) *Remediation Case Studies: Soil Vapor Extraction and Other In Situ Technologies*, July 1997, EPA 542-R-97-009 or NTIS PB97-177562; (3) *Analysis of Selected Enhancements for Soil Vapor Extraction*, September 1997, EPA-542-R-97-007; (4) *Remedial Case Studies: Thermal Desorption, Soil Washing, and In Situ Vitrification*, March 1995, EPA 542-R-95-005 or NTIS PB95-182945; (5) *Remediation Case Studies: Soil Vapor Extraction*, March 1995, EPA 542-4-95-004 or NTIS PB95-182937; and (6) *Remediation case Studies: Bioremediation*, March 1995, EPA 542-R-95-002 or NTIS PB95-182911.

TABLE 2.—SUMMARY OF NONTHERMAL TREATMENT PERFORMANCE DATA ON GROUPS OF ORGANIC HAZARDOUS CONSTITUENTS[29]

BDAT organic cluster	Biotreatment scale: 0.01 kg to 1,250,000 kg		Chemical extraction scale: 0.0075 kg to 37,000 kg		Dechlorination scale: 0.1 kg to 127,913 kg		Soil washing scale: 0.05–204 kg		Hydrolysis scale: 0.1 kg to 2.75 kg	
	Data points	Average removal efficiency	Data points	Average removal efficiency	Data points	Average removal efficiency	Data points	Average removal efficiency	Data points	Average removal efficiency
[illegible]tiles	48	>99%	9	>99%	13	96.3 to 99.3%	None	None	None	None
[illegible]atiles	185	55–98.2%[30]	163	62–98.8%	2	99.8%	13	81.8–97.2%	None	None
[illegible]chlorine	12	16.7–70.2%	None	None	13	>95.2%	None	None	2	67.9–91.7%
Phenoxyacetic Acid Pesticides	None	None	None	None	9	98.6–99.0%	None	None	None	None
Organo Phosphorous Insecticides[31]	None	None	None	None	None	None	None	None	None	None
Polychlorinated Biphenyls	None	None	52	71.5%–99.9%	69	68.8–97.1%	1	88.5%[32]	None	None
Dioxins and Furans	None	None	12	40–>97%	48	73.7–>99.8%	7	84.8%	None	None
Total Number of Data Points	245		236		154		21		2	

TABLE 3.—SUMMARY OF THERMAL PERFORMANCE DATA ON GROUPS OF ORGANIC HAZARDOUS CONSTITUENTS[33]

BDAT organic cluster	Thermal desorption[34] scale: 21.6 kg to 3,823,000 kg		Soil vapor extraction scale: 4.5 kg to >1,000 kg	
	Data points	Average removal efficiency	Data points	Average removal efficiency
Volatiles	293	79.2–99.9%	189	44–99.2%
Semivolatiles[35]	614	50–99.4%	47	0–57.2%
Organochlorines	12	88.5–98.8%	None	None
Phenoxyacetic Acid Pesticides	None	None	None	None
Organo Phosphorous insecticides[36]	None	None	None	None
Polychlorinated Biphenyls	1	87.5%	None	None
Dioxins and Furans	37	85.6–97.6%	None	None
Total Number of Data Points	957		236	

As shown on Tables 2 and 3, EPA lacks performance data for the thermal or non-thermal treatment of four organic constituents classified in the BDAT list as organophosphorous insecticides. These four constituents are disulfoton, famphur, methyl parathion, and phorate. However, we can determine achievability for these four organic constituents based upon the transfer of treatment data for other, similarly difficult to treat organics. Because of structural and chemical similarities, these four organophosphorous compounds are expected to behave similarly during treatment to other polar nonhalogenated phenols, phenyl ethers, and cresols. Thus, EPA believes that these four organophosphorus compounds can be treated by the same technologies as other polar nonhalogenated organic compounds, for which EPA has data. Therefore, based on the available data for polar nonhalogenated compounds, EPA concludes that the treatment standards for soils contaminated with these four organophosphorous compounds can be achieved by biodegradation, chemical extraction, and thermal desorption (semivolatiles).

(4) Other Indicia of Achievability for Organic Constituents

EPA also re-analyzed certain portions of the SDB with regard to ability of various technologies to meet today's soil treatment standards by looking more closely at organic treatability groups based on the structural features of the hazardous constituents of concern. The results of this analysis, presented in Table 4 below, corroborate those in Tables 1–3 and EPA's conclusion that the soil treatment standards—ten times UTS or 90% reduction—are within the zone of reasonable values that could have been selected. For further information on the derivation of Table 4, see the background document entitled "Derivation of Treatment Achievability Results for Organic Functional Groups and Types of Compounds."

[29] For a discussion of these treatment data, see the Soil Treatment Achievability Report: Extrapolation [illegible] Treatment Performance Data in the Soil Data [illegible] Among Hazardous Constituents in [illegible]tinated Soils (April 1998, USEPA); and the [illegible]onal Information on Treatability of Contaminated Soils as Discussed in Section VII.B.8. of Phase IV Final Rule Preamble, (April 1998, USEPA). These documents indicate the numbers and types of data pairs that meet the 10 times UTS level, both prior to treatment and after the treatment described in the table.

[30] Cyclical hydrocarbons with more than five rings undergo lower reduction efficiencies.

[31] EPA is transferring the available performance data from the chemical extraction and the biological treatment of (semivolatile) polar nonhalogenated organics in the hazardous solid treatment data base. Thus, the columns are intentionally left blank.

[32] Only one test was performed.

[33] For a discussion of these treatment data, see the Soil Treatment Achievability Report: Extrapolation of Treatment Performance Data in the Soil Data Base Among Hazardous Constituents in Contaminated Soils (April 1998, USEPA) and the Additional Information on Treatability of Contaminated Soils as Discussed in Section VII.B.8. of Phase IV Final Rule Preamble, (April 1998, USEPA). These documents indicate the numbers and types of data pairs that meet the 10 times UTS level, both prior to treatment and after the treatment described in the table.

[34] The term thermal desorption, as used in this table, is a general description of various thermal techniques. No conclusion may be drawn about the regulatory status or classification of a particular thermal desorber from the inclusion of treatment data from that device in this column.

[35] The performance of combustion and soil vapor extraction is less effective in treating semivolatile organics that contain aromatic and heterocyclical structures. The same is true for and nonvolatile chlorinated organics.

[36] EPA is transferring the available performance data from the chemical extraction and the biological treatment of (semivolatile) polar nonhalogenated organics in the hazardous soil treatment data base.

TABLE 4.—TREATMENT EFFICIENCY—PERCENT REDUCTION RANGES BY TECHNOLOGY FOR VARIOUS FUNCTIONAL GROUPINGS

[Average percent reduction in brackets; number of data points analyzed in parenthesas][37]

Treatability group	Biological treatment	Chemical extraction	Dechlorination	Thermal desorption[38]	Soil washing	Other technologies[39]
Halogenated Nonpolar Aromatics	52.05–99.97 [76.01] (2)	80.42 [80.42] (1)	99.05–100 [99.53] (2)	29.19–100 [95.31] (29)	66.21–95.6 [85.41] (4)	30.13—49.68 [42.41] (3)
Dioxins, Furans, PCBs, and Precursors	none	14.88–99.97 [90.13] (40)	91.66–99.88 [97.94] (20)	98.9–100 [99.57] (17)	none	none
Halogenated Phenols, Cresols, and Other Polar Aromatics	45.1–95.14 [81.05] (5)	63.83–93.18 [79.46] (3)	none	2.71–99.93 [56.21] (15)	8.25–99.06 [73.71] (6)	96.21 [96.21] (1)
Halogenated Aliphatics	99.87–99.99 [99.91] (3)	86.62–94.81 [91.09] (3)	89.06–100 [97.54] (7)	36.88–100 [96.49] (80)	58.68–99.4 [90.58] (9)	72–99.68 [95.66] (6)
Halogenated Cyclic Aliphatics, Ethers, Esters, and Ketones	9.76–99.77 [60.99] (8)	none	none	none	none	none
Nitrated Aromatics and Aliphatics	none	none	none	none	none	none
Simple Nonpolar Aromatics and Heterocyclics	99.97–100 [100] (10)	77.41–99.92 [90.77] (6)	96.39–100 [98.61] (10)	22.68–100 [94.3] (158)	47.74–99.91 [82.39] (14)	97.7 [97.7] (1)
Polynuclear Aromatic Hydrocarbons	5.13–99.85 [67.15] (75)	51.55–99.98 [95.72] (125)	10.92–97.42 [67.47] (3)	10.14–100 [94.19] (301)	81.83–92.19 [85.74] (3)	95.9–99.55 [97.73] (2)
Other Nonhalogenated Polar Organics	none	75.96–99.82 [98.35] (28)	90.81–99.89 [95.13] (10)	2.6–99.98 [82.04] (36)	51.07–99.97 [88.67] (10)	94.59–99.89 [97.24] (2)

(5) Performance Data for Metal Contaminants

Performance data for metals contaminants are based on the performance of stabilization and chemical extraction (mercury) of soils contaminated with metals. Other metal treatment technologies are not prohibited (except if impermissible dilution were to occur). The results of EPA's analysis of the data on treatment of metals in soils are summarized in Table 5 below.

TABLE 5.—SUMMARY OF PERFORMANCE DATA FOR HAZARDOUS METALS CONSTITUENTS[40]

BDAT metals cluster	Stabilization scale: bench, pilot, and full scale		Chemical extraction scale: pilot		Soil washing scale: bench & pilot	
	Data Points	Average removal efficiency	Data points	Avarage removal efficiency	Data points	Average removal efficiency
Metals	269	91.1–99.8%	4	97.7%[41]	14	17.9–97.2%
Total	269		4		14	

The results in Table 5 corroborate EPA's conclusion that the soil treatment standards—ten times UTS or 90% reduction—are within the zone of reasonable values that could have been selected. For further information on the derivation of Table 5, see Soil Treatability Analysis Report.

With respect to multiple metal constituents or organometallic constituents in a contaminated soil, we

[37] Table based on data from "*Delivery of Graphs and Data Tables Showing Corrected Treated Concentrations vs. Data Point Number Index for Selected Constituents*," February 19, 1992 (Administrative Record of the proposed LDR Phase 2 rules as F-93-CS2P-S0597). See also (1) Derivation of Treatment Achievability Results for Organic Functional Groups and Types of Compounds, April 1998 (USEPA); (2) Additional Information on Treatability of Contaminated Soils as Discussed in Section VII.B.8. of Phase IV Final Rule Preamble, (April 1998, USEPA); (3) Extrapolation of Treatment Performance Data in the Soil Data Base Among Hazardous Constituents in Contaminated Soils (April 1998, USEPA); and (3) Soil Treatability Analysis Report (April 1998, USEPA). These documents indicate the numbers and types of data pairs that meet the 10 times UTS level, both prior to treatment and after the treatment described in the table.

[38] The term thermal desorption, as used in this table, is a general description of various thermal techniques. No conclusion may be drawn about the regulatory status or classification of a particular thermal desorber from the inclusion of treatment data from that device in this column.

[39] These include air stripping, photolysis, and treatment trains.

[40] For a discussion of these treatment data, see the Soil Treatment Achievability Report; Extrapolation of Treatment Performance Data in the Soil Data Base Among Hazardous Constituents in Contaminated Soils (April 1998, USEPA); and the Additional Information on Treatability of Contaminated Soils as Discussed in Section VII.B.8 of Phase IV Final Rule Preamble, (April 1998, USEPA). These documents indicate the numbers and types of data pairs that meet the 10 times UTS level, both prior to treatment and after the treatment described in the table.

[41] Available data are exclusively for the treatment of mercury on soils.

recognize that a situation may call for two or more treatment technology trains to achieve the treatment standards promulgated today (e.g., one treatment for organics and another for metals). This must include proper consideration of the order in which various treatment processes should be applied to the contaminated soil so that treatment effectiveness is optimized. However, if these considerations have been properly made and the required treatment standards are not being met because, for example, of unique soil matrices or difficult to treat sites, then we expect that entities may elect to seek a treatment variance pursuant to 40 CFR 268.44(h) or a risk-based soil treatment variance, which is being adopted in today's rule.

c. Data Submitted by Commenters

At least four commenters submitted treatment data from studies describing the performance of innovative and conventional treatment technologies on hazardous soils. DuPont submitted bench, pilot, and full scale treatment data from various vendors describing the operation of soil washing. DuPont asserts these data supports the viability of soil washing as an innovative technology for hazardous soils.

The Environmental Technology Council (formerly the Hazardous Waste Treatment Council) submitted full, pilot, and bench scale treatment data from various vendors of innovative treatment technologies and provided an extensive review of EPA's soil treatment data base. See document entitled, Evaluation of Proposed BDAT Soil and Process Treatment Technologies—Report to the Hazardous Waste Treatment Council, November 1993 (filed as document number CS2P00060.E in Docket No. F-92-CS2P-FFFFF). Based on the ETC's technical report and the subsequent comments of the ETC to the HWIR-Media rule (see comments from the Environmental Technology Council, filed as comment number MHWP 00088 in Docket No. F-92-CS2P-FFFFF), the ETC believes that today's treatment standards for hazardous soils are achievable using thermal treatment. Although the ETC report stated that EPA may lack full-scale treatment data for several innovative or alternative technologies, the ETC data support EPA's view that the many full scale operations of non-combustion technologies demonstrated in the field were sufficient to support a view that the soil treatment standards were achievable. Further, the ETC pointed to various examples of how various non-combustion treatment technologies can be better optimized. EPA concurs with many of those observations on how non-combustion technologies can be optimized.

Two other commenters submitted data in the Phase 2 rule regarding the performance of non-combustion technologies—USPCI and Sierra Environmental Services. USPCI's performance data describe the treatment of polynuclear organics in soils via chemical oxidation followed by stabilization. These data were determined to be insufficient to support a broad national determination that stabilization of organics can be considered BDAT for organics. However, use of organic stabilization may, in some situations, be a permissible treatment option since the LDRs do not specifically prohibit the use of stabilization or solidification to treat nonwastewaters containing hazardous organic constituents. See Response to Comment Document, Comment from Chemical Waste Management, Inc. (No. PH4P-00048). There are, however, specific circumstances in which stabilization or solidification would be considered impermissible dilution. We expect that, for these types of situations to be properly evaluated, it will be necessary to petition for a treatment variance under 40 CFR 268.44(h) or under the provisions for a risk-based soil treatment variance being adopted in today's rule. The Agency also is currently considering whether, in the near future, to issue guidance on when stabilization or solidification of organic-bearing waste is appropriate and when it may constitute impermissible dilution.

Sierra Environmental Services submitted performance data regarding the treatment of carcinogenic polyaromatic hydrocarbons (cPAH) via bioremediation. These data are based on in-situ treatment of a 7.5 acre lagoon which was divided into two cells. Although the facility remediated 35 volatile, 65 semivolatile organics, PCBs, and pesticides, the facility only submitted data describing the treatment of major PAHs. Based on the performance of the biotreatment process applied to this site, the commenter argued the proposed treatment standards, if promulgated as proposed, would eliminate biotreatment as an alternative at this facility. EPA disagrees. Remediation processes that are applied in-situ do not trigger land disposal restrictions. If the facility were biotreating the lagoon sludges ex-situ, EPA concurs that the facility may be unable to land dispose the treated lagoon sludges. We also note that, under the existing regulations and regulations being adopted today, the commenter may be able to avail itself of a treatment variance, depending on the site-specific circumstances involved.

9. Applicability of Soil Treatment Standards and Readability of Final Regulations

Many commenters asserted that the proposed regulations governing applicability of LDRs to contaminated soil were difficult to understand and apply. EPA was persuaded by these comments and has reformatted the applicability regulations into an easier-to-read table. The Agency recognizes that determining whether or not LDRs apply to any given volume of contaminated soil can be complicated. To further assist program implementors and facility owners/operators, we will review and discuss the principles that govern LDR applicability for contaminated soil in this section of today's preamble.

The following principles informed EPA's decisions concerning application of LDRs to contaminated soils.

First principle: land disposal restrictions only attach to prohibited hazardous waste (or hazardous contaminated soil) when it is (1) generated and (2) placed in a land disposal unit.[42] Therefore, if contaminated soil is not removed from the land (i.e., generated), LDRs cannot apply. Similarly, if contaminated soil is removed from the land (i.e., generated) yet never placed in a land disposal unit, LDRs cannot apply.[43] In other words, LDRs do not apply to contaminated soil *in situ* or force excavation of contaminated soil. If soils are excavated, however, LDRs may apply, as discussed below.

Second principle: once a decision has been made to generate and re-land-dispose contaminated soils, LDRs generally only apply to contaminated soils that contain hazardous waste. The Agency considers soil to contain hazardous waste: (1) when it exhibits a

[42] As discussed earlier in today's final rule, all hazardous wastes that were listed or identified at the time of the 1984 Hazardous and Solid Waste Amendments to RCRA have been prohibited from land disposal. EPA is required to prohibit hazardous wastes listed or identified after 1984 within six months of the wastes' listing or identification. RCRA Section 3004(g)(4). A table in 40 CFR Part 268 Appendix VII. outlines the dates of LDR applicability for hazardous wastes.

[43] Note that, as discussed later in today's preamble, nothing in today's final rule affects implementation of the existing "area of contamination" policy. Therefore, soil managed within areas of contamination, even if it is "removed from the land" within such an area, would not be considered to be "generated." See the discussion of the area of contamination policy later in today's preamble.

characteristic of hazardous waste; and, (2) when it is contaminated by certain concentrations of constituents from listed hazardous waste. The contained-in policy is discussed in Section VII.E of today's preamble.

Third principle: once LDRs attach (generally, at the point of generation, see principle (1)) to any given hazardous waste or volume of hazardous contaminated soil, the LDR treatment standards continue to apply until they are met. This principle comes from application of the logic of the Chemical Waste opinion. In that opinion, the D.C. Circuit held that land disposal prohibitions attach at the point that a hazardous waste is generated and continue to apply until threats posed by land disposal of the waste are minimized. Chemical Waste Management v. EPA, 976 F.2d at 13, 14 and 24. In illustration of this principle, the court held that (in the case of characteristic hazardous waste) elimination of the property that caused EPA to identify a waste as hazardous in the first instance does not automatically eliminate the duty to achieve compliance with LDRs. As discussed later in this section of today's preamble, EPA has determined that, although the Chemical Waste opinion did not address contaminated soils *per se*, it is prudent to apply the logic of the Chemical Waste opinion to contaminated soils.

Using these principles, EPA created the regulations and table that govern application of LDRs to contaminated soils, as discussed below.

The regulations that address application of LDRs to soil that exhibits a characteristic of hazardous waste are relatively straightforward. Soil that exhibits a characteristic of hazardous waste when it is generated is subject to LDRs and must be treated to meet LDR treatment standards prior to land disposal. EPA's conclusion that soil that exhibits a characteristic of hazardous waste must be treated to meet LDRs prior to land disposal derives from a simple application of the principles above. First, LDRs have the opportunity to attach to contaminated soil at the point of generation (principle (1)) and, second, under the contained-in policy, soil that exhibits a characteristic of hazardous waste must be managed as hazardous waste (principle (2)) and, therefore, must comply with LDRs. Note that, once LDRs have attached to soil that exhibits a characteristic of hazardous waste, LDR treatment standards must be met prior to land disposal of the soil, even if the characteristic is subsequently eliminated (principle (3)).

The remainder of today's regulations on application of LDRs to contaminated soil, which are in table form, apply to soil contaminated with listed hazardous wastes. The table lists four scenarios.

In the first scenario, soil is contaminated with untreated listed hazardous waste that was prohibited from land disposal when first land disposed (e.g., prohibited hazardous waste that was illegally placed or prohibited hazardous waste that was spilled). In this case, LDRs have already attached to the hazardous waste. Therefore, since LDRs have attached to the waste and threats have not yet been minimized (i.e., treatment standards have not been met), under principle (3) LDRs continue to apply to the waste and, automatically, to any contaminated soil.[44] The Agency has concluded that LDRs apply to soils contaminated in this way regardless of whether the soil is determined not to (or no longer to) "contain" hazardous waste either when first generated or at any time in the future. This conclusion comes from application of principle (3): once something is prohibited from land disposal, LDRs continue to apply until threats to human health and the environment posed by land disposal are minimized regardless of whether the material is at some point determined no longer to be "hazardous."

In the next two scenarios, soil is contaminated with hazardous wastes that were not prohibited from land disposal when first land disposed, but, sometime after land disposal, LDRs have gone into effect. In these cases, whether or not LDRs apply to contaminated soil is governed by a determination of whether or not any given volume of contaminated soil "contains" hazardous waste at its point of generation. If any given volume of soil is determined to contain hazardous waste at its point of generation, LDRs attach (principles (1) and (2)) and, therefore, the LDR treatment standards must be met prior to placement of such soil in a land disposal unit (principle (3)). If any given volume of soil is determined not to contain hazardous waste at its point of generation, there is no hazardous waste to which a land disposal prohibition could attach and the soil, thus, would not be prohibited from land disposal (principles (1) and (2)). (It would be the same if a hazardous waste land disposed before the effective date of an applicable land disposal prohibition were delisted when first re-generated. In that case too, there would be no hazardous waste to which a land disposal prohibition could attach and the delisted waste, thus, would not be prohibited from land disposal.) Note that, under principle (3), once LDRs attach to contaminated soil, the treatment standards must be met prior to land disposal even if the soil is, subsequently, determined no longer to contain hazardous waste.

The final scenario requires no elaboration; it simply makes clear that if soil is contaminated by hazardous waste that was never prohibited from land disposal, LDRs do not apply. This is through application, primarily, of principle (2)—LDRs attach only to hazardous wastes or soil that contains hazardous waste.

Note that, because LDRs apply to the waste "contained-in" soil, and not the soil itself (see principle (2)), LDRs do not apply to soil that is at any time completely separated from its contaminating waste (i.e., the soil contains no solid or hazardous waste, it's "just soil"). One might determine that soil contained no solid or hazardous waste, for example, if concentrations of hazardous constituents fall below natural background levels or are at non-detectable levels. Such a determination would terminate all RCRA Subtitle C requirements, including LDRs, since waste would not longer be "contained-in" the soil. See September 15, 1996 letter from Michael Shapiro (EPA) to Peter Wright (Monsanto Company), making this finding; see also, 61 FR 18806 (April 29, 1996) and other sources cited therein.

The following examples illustrate application of LDRs to contaminated soil:

1. Generator A is excavating soil mildly contaminated with wastewater treatment sludge (listed waste F006). The sludge was land disposed before 1980. The soil does not exhibit a characteristic of hazardous waste and has been determined by an authorized state not to contain listed hazardous waste. The soil is not prohibited from land disposal. This is because, for LDR purposes, the point of generation is when the soil is first excavated from the land (principle (1)). Since no prohibited hazardous waste existed before that time (i.e., the contaminating waste was not prohibited) and the soil does not contain listed hazardous waste or exhibit a characteristic of hazardous waste at its point of generation, there is

[44] EPA is assuming that the waste did not meet a treatment standard when it was placed on the soil. Wastes which meet a treatment standard are no longer prohibited from land disposal and, unless it is determined to "contain" hazardous waste at its point of generation and are subsequently land disposed, soils contaminated by these wastes are, likewise, not prohibited from land disposal. See, RCA section 3004(m)(2) (hazardous wastes meeting treatment standards are no longer prohibited from land disposal).

no hazardous waste to which a land disposal prohibition could attach (principle (2)).

2. Generator B is excavating soil contaminated by leaks from a closing hazardous waste surface impoundment. The surface impoundment received listed hazardous wastes K062 (spent pickle liquor) and characteristic hazardous waste D018 (wastes that fail the TCLP test for benzene). The surface impoundment stopped receiving K062 waste in 1987 and D018 waste in 1993. The soil does not exhibit a characteristic of hazardous waste and has been determined by an authorized state not to contain listed hazardous waste. The soil is not prohibited from land disposal. This is because, for LDR purposes, the point of generation is when the soil is first excavated from the land (principle (1)). Since no prohibited hazardous waste existed before that time (i.e., the contaminating wastes were not prohibited) and the soil does not contain listed hazardous waste or exhibit a characteristic of hazardous waste at its point of generation, there is no hazardous waste to which a land disposal prohibition could attach (principle (2)).

3. Generator C is excavating soil contaminated with listed hazardous waste F024. The F024 waste was land disposed after 1991, after it was prohibited from land disposal, and was not first treated to meet applicable land disposal treatment standards (i.e., it was illegally land disposed or accidentally spilled). Since the contaminating waste was prohibited from land disposal and treatment standards were not achieved prior to land disposal, the LDR prohibition continues to apply to any soil contaminated by the waste (principle (3)) regardless of whether the soil "contains" hazardous waste when generated. The soil is prohibited from land disposal and, before land disposal, must be treated to meet applicable technology-based treatment standards or until a site-specific, risk-based minimize threat determination is made through the variance process.

4. Generator D is excavating soil contaminated by an accidental spill of benzyl chloride, which, when discarded, is listed hazardous waste P028 and is prohibited from land disposal. The accidental spill occurred yesterday. The contaminating waste was prohibited from land disposal and, since the treatment standards were not achieved prior to the accidental spill, the prohibition continues to apply to any soil contaminated by the waste (principle (3)). Thus, the soil is prohibited from land disposal and, before land disposal, must be treated to meet applicable technology-based treatment standards or until a site-specific, risk-based minimize threat determination is made through the variance process.

5. Generator E is excavating soil contaminated by listed hazardous waste F004 (generally, spent non-halogenated solvents). The F004 waste was land disposed in 1984, prior to the effective date of an applicable land disposal prohibition; however, on generation the soil contains high concentrations of cresols constituents, so that an authorized state determines it "contains" hazardous waste. The soil is prohibited from land disposal. Although the contaminating waste was not prohibited from land disposal, since the soil contained hazardous waste at the point of generation (and the waste had since become prohibited from land disposal), the land disposal prohibition attaches to the contaminated soil and, before land disposal, the soil must be treated to meet applicable technology-based treatment standards or until a site-specific, risk-based minimize threat determination is made through the variance process (principles (1), (2), and (3)).

EPA acknowledges that the reading of LDR applicability to contaminated soil discussed above creates potential administrative difficulties, since, in many cases, a factual determination will be required as to when hazardous wastes were land disposed in order to determine whether they were prohibited at that time and whether, therefore, the prohibition continues to apply to contaminated soil. The Agency expects that these difficulties will be minimal because, in most cases, contamination will be caused by hazardous wastes placed before the effective date of applicable land disposal prohibitions since land disposal after prohibition would be illegal. The exception is accidental spills of hazardous waste, which the Agency believes are (1) rare, and (2) known, so determining dates of land disposal should not be problematic. This issue was discussed in detail in the HWIR-Media proposal, 61 FR 18805 (April 26, 1996).

As discussed in the April 29, 1996 proposal, the Agency continues to believe that, if information is not available or inconclusive, it is generally reasonable to assume that contaminated soils do not contain untreated hazardous wastes placed after the effective dates of applicable land disposal prohibitions. This is because placement of untreated hazardous waste after applicable LDR effective dates would be a violation of RCRA, subject to significant fines and penalties including criminal sanctions. 61 FR at 18805 (April 29, 1996). Of course, program implementors and facility owners/operators cannot make the determination that information on the types of waste contamination or dates of waste placement is unavailable or inconclusive without first making a good faith effort to uncover such information. By using available site- and waste-specific information such as manifests, LDR records required under 40 CFR 268.7, vouchers, bills of lading, sales and inventory records, storage records, sampling and analysis reports, accident reports, site investigation reports, spill reports, inspection reports and logs, EPA believes that program implementors and facility owners/operators will typically be able to make informed decisions about the types of waste contamination and dates of waste placement. Most commenters supported this approach.

EPA notes that it is not critical for a decision about whether contaminated soil contains listed hazardous waste or exhibits a characteristic of hazardous waste to be made without removing any of the soil (other than the sample volume) from the land. In an area of generally dispersed soil contamination, soil may be consolidated or managed within the area of contamination to facilitate sampling, for example, to ensure that soil samples are representative or to separate soil from non-soil materials. However, care should be taken not to remove hazardous contaminated soils from separate areas of contamination at a facility and place such hazardous contaminated soil into a land disposal unit unless, of course, the soil meets applicable LDR treatment standards. The area of contamination policy is discussed later in this section of today's preamble.

A few commenters expressed concern or confusion over the application of LDRs to soil contaminated by accidental spills of hazardous wastes. The Agency clarifies that accidental spills of hazardous wastes (or products or raw materials) are not considered placement of hazardous waste into a land disposal unit since, in the case of a spill, prohibited waste is not being placed in one of the identified units named in RCRA Section 3004(m).[45] See, 45 FR 76626 (Nov. 19, 1980), issuing clarifying regulations at 40 CFR 264.10(g) to provide that hazardous waste treatment

[45] Although, if such a spill were not cleaned up in a timely way, EPA or an authorized state could determine that the contaminated area should be considered a land disposal unit for purposes of requiring cleanup under RCRA Subtitle C. 55 FR at 20809 (July 27, 1990).

and storage activities undertaken in immediate response to an accidental spill are exempt from the 40 CFR Part 264 and 265 regulations governing treatment and storage and do not require permits and Sept. 29, 1986 memo from J. Winston Porter (EPA Assistant Administrator) to Fred Hansen interpreting the 40 CFR 264.10(g) regulations; also see, 55 FR at 30808–30809 (July 27, 1990) ("a one-time spill of hazardous waste would not be considered a solid waste management unit.") However, contaminated soils generated through remediation of spills of untreated listed prohibited hazardous wastes are, as discussed above, subject to land disposal prohibitions since the LDR prohibition that had attached to the contaminating hazardous waste continues to apply until threats are minimized, and, therefore, any contaminated soil remains subject to LDRs (see principle (3)).

A number of commenters expressed concern that EPA's interpretation of LDR applicability to contaminated soil might preclude application of the existing area of contamination policy. In the area of contamination policy, EPA interprets RCRA to allow certain discrete areas of generally dispersed contamination to be considered a RCRA unit (usually a landfill). 55 FR 8758–8760 (March 8, 1999). This interpretation allows hazardous wastes (and hazardous contaminated soils) to be consolidated, treated *in situ* or left in place within an area of contamination without triggering the RCRA land disposal restrictions or minimum technology requirements—since such activities would not involve "placement into a land disposal unit," which is the statutory trigger for LDR. EPA clarifies that its interpretation of LDR applicability for contaminated soil does not, in any way, affect implementation of the area of contamination policy.

Finally, many commenters expressed concern over EPA's application of the LDR treatment standards to soil that is determined no longer to contain hazardous waste or exhibit a characteristic of hazardous waste. As discussed in detail in the 1996 proposal, at this time EPA has concluded that although the Chemical Waste opinion did not speak to contaminated soil specifically, it is prudent to apply the Chemical Waste logic—that a duty to comply with LDRs attaches to hazardous waste when it is first generated and elimination of the indicia of "hazardousness" does not, necessarily, fulfil the statutory land disposal restriction treatment standard—to contaminated soil. See Chemical Waste Management v. EPA, 976 F.2d at 13–16. Although, as discussed later in today's preamble, EPA believes that contained-in determinations will rarely, if ever, be made at constituent concentrations which do not minimize threats, without codifying the contained-in policy, the Agency cannot make the generic finding that this will be the case at every site. For this reason, EPA is requiring that the standards and procedures promulgated today for site-specific, risk-based minimize threat variances alone be used to make minimize threat determinations. This issue is discussed in section VII.E of today's preamble.

C. Conforming and Supporting Changes

To support the land disposal restriction treatment standards for contaminated soil, the Agency is today promulgating a number of conforming and supporting regulations, as follows.

1. Recordkeeping Requirements

A number of commenters expressed confusion over the recordkeeping and reporting requirements that would apply to contaminated soil. The Agency is today clarifying that contaminated soil subject to the land disposal restrictions must comply with the same recordkeeping and reporting requirements as other wastes subject to the land disposal restrictions. That is, the recordkeeping and reporting requirements of 40 CFR 268.7 will apply.

EPA has clarified this in the final regulations by adding appropriate recordkeeping requirements for contaminated soils to the tables in 40 CFR 268.7(a) and 40 CFR 268.7(b). These rules specify that, for contaminated soil, generators and/or treaters must include the following information with their land disposal restriction paperwork: the constituents subject to treatment as described in 40 CFR 268.49(d) and this statement, "this contaminated soil [does/does not] contain listed hazardous waste and [does/does not] exhibit a characteristic of hazardous waste and [is subject to/complies with] the soil treatment standards as provided by 268.49(c) or the universal treatment standards." Note that because in some cases contaminated soil will continue to be subject to LDRs even after it has been determined not to or no longer to contain listed hazardous waste (or de-characterized), the statement includes a notification of whether the soil is still considered hazardous. This is consistent with the approach the Agency used when establishing land disposal restriction treatment standards for hazardous contaminated debris.

2. Definition of Soil

The Agency is promulgating the definition of soil from the April 29, 1996 proposal with one change made in response to comments. Soil is defined as, "unconsolidated earth material composing the superficial geologic strata (material overlying bedrock), consisting of clay, silt, sand, or gravel size particles as classified by the U.S. Soil Conservation Service, or a mixture of such materials with liquids, sludges or solids which is inseparable by simple mechanical removal processes and is made up primarily of soil by volume, based on visual inspection." The Agency has added the phrase "by volume, based on visual inspection" in response to comments recommending that EPA explicitly conform the definition of soil with the definition of debris. See 57 FR 37222 (August 18, 1992). This clarification is consistent with the Agency's intent, as discussed in the 1996 proposal, that determinations of whether any material was "soil," "debris," or "waste" to be made in the field. 61 FR 18794 (April 26, 1996).

The definition of soil includes the concept that mixtures of soil and other materials are to be considered soil provided the mixture is made up predominantly of soil and that the other materials are inseparable using simple physical or mechanical means. This approach allows program implementors and facility owners/operators to determine whether any given material is soil, waste, or debris based on the results of simple mechanical removal processes commonly used to separate materials, such as pumping, dredging, or excavation by backhoe, forklift or other device. It avoids requiring chemical analysis for soil properties in order to differentiate precisely between wastes, soil and debris. As discussed in the April 29, 1996 and September 14, 1993 proposals, the Agency believes that attempting to distinguish more precisely between waste, soil or debris using chemical analysis or other tests would be prohibitively difficult to develop and support and cumbersome to administer. *Cf.* 57 FR at 37224, August 18, 1992, where the Agency adopted a similar classification system for hazardous debris. Most commenters supported this approach. Note that any non-soil that is separated from contaminated soil that contains listed hazardous waste or is found to exhibit a characteristic of hazardous waste should be considered hazardous waste and is subject to the applicable universal treatment standard.

EPA also emphasizes that any dilution of a prohibited contaminated soil (or of a prohibited hazardous waste with soil) as a substitute for adequate treatment to achieve compliance with LDR treatment standards or to circumvent the effective date of an LDR prohibition is considered a type of impermissible dilution and is illegal. Therefore, any deliberate mixing of prohibited hazardous waste with soil in order to change its treatment classification (i.e., from waste to contaminated soil) is illegal. Existing regulations concerning impermissible dilution already make this point. See 40 CFR 268.3(a) and (b); see also 57 FR at 37243 (Aug. 18, 1992) (adopting the same principle for contaminated debris). The Agency expects that deliberate mixing of hazardous waste with soil (and vice versa) will be rare because such actions are clearly illegal and would subject generators to substantial fines and penalties, including criminal sanctions. In addition, the resulting mixture (hazardous waste impermissible diluted by soil) would continue to be subject to the LDRs for the original hazardous waste (i.e., generally, the universal treatment standards), so no benefit in terms of reduced treatment requirements would occur. The Agency took a similar approach when promulgating treatment standards specific to hazardous debris. See 57 FR at 37224 (August 18, 1992).

The Agency notes that the normal mixing of contaminated soil from various portions of a site that typically occurs during the course of remedial activities or in the course of normal earthmoving and grading activities is not considered intentional mixing of soil with non-media or prohibited soil with non-prohibited soil and, therefore, is not a type of impermissible dilution.

D. Seeking Treatment Variances Because the National Treatment Standard is Unachievable or Inappropriate

Under existing regulations at 40 CFR 268.44, people may obtain a variance from a land disposal restriction treatment standard when a waste cannot be treated to the specified level or when a treatment standard may be inappropriate for the waste. With respect to contaminated soils, EPA has to this point presumed that a treatment variance would generally be needed because the LDR treatment standards developed for process wastes were either unachievable (generally applied to soil contaminated by metals) or inappropriate (generally applied to soil contaminated by organic constituents). See, for example, 55 FR 8760 (March 8, 1990); 58 FR 48092, 48125 (September 14, 1993); 61 FR 18805–18808, 18810–18812 (April 29, 1996); and, 61 FR 55717 (October 28, 1996). This presumption will no longer apply once today's soil treatment standards take effect. This is because today's standards were developed specifically for contaminated soils and are intended to specifically address the past difficulties associated with applying the treatment standards developed for process waste to contaminated soil.

This is not to say that treatment variances based on the "unachievable" or "inappropriate" prongs of the test are now unavailable for contaminated soils. For example, in some cases it may prove that even though an appropriate technology, suited to the soil matrix and constituents of concern was used, a particular soil cannot be treated to meet the soil treatment standards using a well-designed well-operated application of one of the technologies EPA considered in establishing the soil standards. In these types of cases, under existing regulations, the soil treatment standard would be considered "unachievable" and a treatment variance could be approved. In other cases, under existing regulations, application of the soil treatment standards might be "inappropriate" in that, for example, it would present unacceptable risks to on-site workers.

As noted earlier in today's preamble, alternative LDR treatment standards established through treatment variances must, according to 40 CFR 268.44(m), "minimize threats to human health and the environment posed by land disposal of the waste." In cases where an alternative treatment standard does not meet this requirement, a treatment variance will not be approved even though application of a technology more aggressive than the technologies on which the soil treatment standards are based might then be necessary. For example, in cases where the soil treatment standards cannot be achieved through application of a well-designed, well-operated application of one of the model soil treatment technologies and application of the model technology or other non-combustion technologies will not result in constituent concentrations that minimize threats, a variance would not be approved and combustion would be necessary. This is proper given that the soil treatment standards were not developed using the methodology typically used in the land disposal restriction program (i.e., application of the most aggressive treatment technology to the most difficult to treat waste), but, instead are designed to accommodate a variety of soil treatment technologies that are typically used during remediation. Variances for treatment of contaminated soil will be applied during the remedial context, where, as discussed in Section VII.B.3 of today's preamble, EPA and authorized states will typically have detailed information about the risks posed by specific hazardous constituents, direct and indirect exposure routes, risk pathways and human and environmental receptors. This information can be used to inform decisions about whether threats are minimized.

E. The Contained-In Policy

The contained-in principle is the basis for EPA's longstanding interpretation regarding application of RCRA Subtitle C requirements to mixtures of contaminated media and hazardous wastes. Under the "contained-in" policy, EPA requires that soil (and other environmental media), although not wastes themselves, be managed as if they were hazardous waste if they contain hazardous waste or exhibit a characteristic of hazardous waste. See, for example, 53 FR 31138, 31148 (August 17, 1988) and 57 FR 21450, 21453 (May 20, 1992) (inadvertently citing 40 CFR 261(c)(2) instead of 40 CFR 261.3(d)(2)); see also Chemical Waste Management v. EPA, 869 F.2d 1526, 1539–40 (D.C. Cir. 1989) (upholding the contained-in principle as a reasonable interpretation of EPA regulations). In practice, EPA has applied the contained-in principle to refer to a process where a site-specific determination is made that concentrations of hazardous constituents in any given volume of environmental media are low enough to determine that the media does not "contain" hazardous waste. Typically, these so called "contained-in" determinations do not mean that no hazardous constituents are present in environmental media but simply that the concentrations of hazardous constituents present do not warrant management of the media as hazardous waste.[46] For contaminated soil, the result of "contained-in determinations" is that soil no longer "contains" a

[46] Of course, as noted earlier, EPA or an authorized state could determine, at any time, that any given volume of environmental media did not contain (or no longer contained) any solid or hazardous waste (i.e., it's just media). These types of determinations might be made, for example, if concentrations of hazardous constituents fall below background levels, or are at non-detectable levels. Such a determination would terminate all RCRA Subtitle C requirements, including LDRs. See, September 15, 1995 letter from Michael Shapiro (EPA) to Peter Wright (Monsanto Company), making this finding, and 61 FR 18806 (April 29, 1996).

hazardous waste; however, as discussed above, the result is not automatically that soil no longer must comply with LDRs.

In order to preserve flexibility and because EPA believes legislative action is needed, the Agency has chosen, at this time, not to go forward with the portions of the September 14, 1993 or April 29, 1996 proposals that would have codified the contained-in policy for contaminated soils. The Agency continues to believe that legislation is needed to address application of certain RCRA subtitle C requirements to hazardous remediation waste, including contaminated soil. If legislation is not forthcoming, the Agency may, in the future, re-examine its position on the relationship of the contained-in policy to site-specific minimize threat determinations based on implementation experience and/or may choose to codify the contained-in policy for contaminated soil in a manner similar to that used to codify the contained-in policy for contaminated debris.

1. Current Guidance on Implementation of the Contained-in Policy

EPA has not, to date, issued definitive guidance to establish the concentrations at which contained-in determinations may be made. As noted above, decisions that media do not or no longer contain hazardous waste are typically made on a case-by-case basis considering the risks posed by the contaminated media. The Agency has advised that contained-in determinations be made using conservative, health-based levels derived assuming direct exposure pathways. 61 FR at 18795 (April 29, 1996) and other sources cited therein. A compilation of many of the Agency's statements on the contained-in policy has been placed in the docket for today's rulemaking.

The land disposal restriction treatment standards for contaminated soil promulgated today do not affect implementation of the contained-in policy. They are not considered, and should not be used, as de facto "contained-out" concentrations although, in some cases, it may be appropriate to determine that soil treated to the soil treatment standards no longer contains hazardous waste. Remediation project managers should continue to make contained-in decisions based on site-specific conditions and by considering the risks posed by any given contaminated media.

2. Relationship of the Contained-In Policy to Site-Specific, Risk-Based Minimize Threat Determinations

As discussed above, the D.C. Circuit held in the Chemical Waste opinion that the RCRA Section 3004(m) obligation to minimize threats can continue even after a waste would no longer be identified as "hazardous." Chemical Waste Management v. EPA, 976 F.2d at 13–16. The Agency believes that it is prudent to apply the logic of the Chemical Waste opinion to contaminated soil. Therefore, when the contained-in policy is applied to soil that is already subject to a land disposal prohibition, the Agency is compelled to decide if a determination that soil does not or no longer "contains" hazardous waste is sufficient to determine that threats posed by subsequent land disposal of those soils have been minimized. As discussed earlier in today's preamble, EPA is not, at this time, able to make a generic finding that all contained-in determinations will automatically satisfy this standard. This is largely because, for reasons of needed administrative flexibility and because we believe legislation is needed, EPA has not codified standards for approving contained-in determinations and has not codified procedures for making such determinations. Absent such standards and procedures, the Agency cannot, at this time, make a generic finding that all contained-in determinations will result in constituent concentrations that also minimize threats within the meaning of RCRA Section 3004(m). These decisions, of course, could be made on a site-specific basis, by applying the standards and procedures for site-specific, risk-based minimize threat variances, promulgated today.

The regulations governing site-specific, risk-based minimize threat determinations promulgated today are, essentially, the same as the Agency's guidance for making contained-in determinations. See, for example, 61 FR 18795 (April 29, 1996) and other sources cited therein. That is, decisions should be made by considering the inherent risks posed by any given soil, assuming direct exposure (i.e., no post-land disposal controls) and applying conservative information to calculate risk. Therefore, the Agency expects that, in most cases, a determination that soils do not (or no longer) contain hazardous waste will equate with minimize threat levels and, therefore, encourages program implementors to combine contained-in determinations, as appropriate, with site-specific, risk-based minimize threat variances.

F. Relationship of Soil Treatment Standards to the Final HWIR-Media Rule

In the April 29, 1996 HWIR-Media proposal, EPA proposed to establish a comprehensive alternative management regime for hazardous contaminated media, of which the treatment standards for contaminated soil would have been a small part. The HWIR-Media proposal discussed a number of options for comprehensive management standards for hazardous contaminated media.

Today's action resolves and finalizes the portion of the HWIR-Media proposal that addressed land disposal restriction treatment standards for contaminated soil. See 61 FR 18805–18814, April 29, 1996. Other portions of the proposal are not resolved by this action and will be addressed by EPA in future actions. EPA continues to emphasize that, while the soil-specific LDR treatment standards will improve contaminated soil management and expedite cleanups, the Agency also recognizes that additional reform is needed, especially for management of non-media remediation wastes like remedial sludges. The Agency will continue to participate in discussions on potential legislation to promote this additional needed reform.

VIII. Improvements and Corrections to LDR Regulations

Summary: The regulated community has pointed out several examples of the LDR regulations that were unclear or had typographical errors. These sections are clarified and corrected below.

A. Typographical Error in Section 261.1(c)(10)

A typographical error was found in the cross reference in the note in § 261.1(c)(10). The first Phase IV final rule ("Minirule," 62 FR 25998) said "They are covered under the exclusion from the definition of solid waste for shredded circuit boards being recycled (261.4(a)(13))." The correct cross reference is to "(261.4(a)(14)." This typographical error is corrected in this final rule.

B. Typographical Error in Section 268.4(a)(2)(ii) and (a)(2)(iii)

These paragraphs have referred to § 268.8 for some time. Section 268.8 was where the so called "soft hammer" provisions were once found in the regulations. These provisions expired in 1990, and the provisions have been removed from the regulations; thus there is no need to continue to include references to § 268.8.

18. Subpart D is amended by adding § 268.49 to read as follows:

§ 268.49 Alternative LDR treatment standards for contaminated soil.

(a) Applicability. You must comply with LDRs prior to placing soil that exhibits a characteristic of hazardous waste, or exhibited a characteristic of hazardous waste at the time it was generated, into a land disposal unit. The following chart describes whether you must comply with LDRs prior to placing soil contaminated by listed hazardous waste into a land disposal unit:

If LDRs	And if LDRs	And if	Then you
Applied to the listed waste when it contaminated the soil*.	Apply to the listed waste now		Must comply with LDRs
Didn't apply to the listed waste when it contaminated the soil*.	Apply to the listed waste now	The soil is determined to contain the listed waste when the soil is first generated.	Must comply with LDRs.
Didn't apply to the listed waste when it contaminated the soil*.	Apply to the listed waste now	The soil is determined not to contain the listed waste when the soil is first generated.	Needn't comply with LDRs.
Didn't apply to the listed waste when it contaminated the soil*.	Don't apply to the listed waste now		Needn't comply with LDRs.

*For dates of LDR applicability, see 40 CFR Part 268 Appendix VII. To determine the date any given listed hazardous waste contaminated any given volume of soil, use the last date any given listed hazardous waste was placed into any given land disposal unit or, in the case of an accidental spill, the date of the spill.

(b) Prior to land disposal, contaminated soil identified by paragraph (a) of this section as needing to comply with LDRs must be treated according to the applicable treatment standards specified in paragraph (c) of this section or according to the Universal Treatment Standards specified in 40 CFR 268.48 applicable to the contaminating listed hazardous waste and/or the applicable characteristic of hazardous waste if the [illegible] is characteristic. The treatment [illegible]rds specified in paragraph (c) of [illegible]ction and the Universal Treatment Standards may be modified through a treatment variance approved in accordance with 40 CFR 268.44.

(c) Treatment standards for contaminated soils. Prior to land disposal, contaminated soil identified by paragraph (a) of this section as needing to comply with LDRs must be treated according to all the standards specified in this paragraph or according to the Universal Treatment Standards specified in 40 CFR 268.48.

(1) All soils. Prior to land disposal, all constituents subject to treatment must be treated as follows:

(A) For non-metals, treatment must achieve 90 percent reduction in total constituent concentrations, except as provided by paragraph (c)(1)(C) of this section.

(B) For metals, treatment must achieve 90 percent reduction in constituent concentrations as measured in leachate from the treated media (tested according to the TCLP) or 90 percent reduction in total constituent concentrations (when a metal removal treatment technology is used), except as provided by paragraph (c)(1)(C) of this section.

(C) When treatment of any constituent subject to treatment to a 90 percent reduction standard would result in a concentration less than 10 times the Universal Treatment Standard for that constituent, treatment to achieve constituent concentrations less than 10 times the universal treatment standard is not required. Universal Treatment Standards are identified in 40 CFR 268.48 Table UTS.

(2) Soils that exhibit the characteristic of ignitability, corrosivity or reactivity. In addition to the treatment required by paragraph (c)(1) of this section, prior to land disposal, soils that exhibit the characteristic of ignitability, corrosivity, or reactivity must be treated to eliminate these characteristics.

(3) Soils that contain nonanalyzable constituents. In addition to the treatment requirements of paragraphs (c)(1) and (2) of this section, prior to land disposal, the following treatment is required for soils that contain nonanalyzable constituents:

(A) For soil that also contains analyzable constituents, treatment of those analyzable constituents to the levels specified in paragraphs (c)(1) and (2) of this section; or,

(B) For soil that contains only nonanalyzable constituents, treatment by the method specified in § 268.42 for the waste contained in the soil.

(d) Constituents subject to treatment. When applying the soil treatment standards in paragraph (c) of this section, constituents subject to treatment are any constituents listed in 40 CFR 268.48, Table UTS—Universal Treatment Standards that are reasonably expected to be present in any given volume of contaminated soil, except fluoride, selenium, sulfides, vanadium and zinc, and are present at concentrations greater than ten times the universal treatment standard.

(e) Management of treatment residuals. Treatment residuals from treating contaminated soil identified by paragraph (a) of this section as needing to comply with LDRs must be managed as follows:

(1) Soil residuals are subject to the treatment standards of this section;

(2) Non-soil residuals are subject to:

(A) For soils contaminated by listed hazardous waste, the RCRA Subtitle C standards applicable to the listed hazardous waste; and

(B) For soils that exhibit a characteristic of hazardous waste, if the non-soil residual also exhibits a characteristic of hazardous waste, the treatment standards applicable to the characteristic hazardous waste.

19. Table 1 in Appendix VII to Part 268 is amended by removing the entries for waste code F033; revising the second entry for waste code F032, the second entry for F034, and the first entry for K088; revising the entries for D003-D011 and two entries for waste code F035; and, Table 2 is amended by revising entry number 9 and adding entries 12 and 13 to read as follows:

TABLE 1.—EFFECTIVE DATES OF SURFACE DISPOSED WASTES

[(Non-soil and Debris) Regulated in the LDRS—Comprehensive List]

Waste code	Waste category	Effective date
*	*	*
D003	Newly identified surface-disposed elemental phosphorus processing wastes	May 26, 2000.
D004	Newly identified D004 and mineral processing wastes	August 24, 1998.
D004	Mixed radioactive/newly identified D004 or mineral processing wastes	May 26, 2000.
D005	Newly identified D005 and mineral processing wastes	August 24, 1998.
D005	Mixed radioactive/newly identified D005 or mineral processing wastes	May 26, 2000.
D006	Newly identified D006 and mineral processing wastes	August 24, 1998.
D006	Mixed radioactive/newly identified D006 or mineral processing wastes	May 26, 2000.
D007	Newly identified D007 and mineral processing wastes	August 24, 1998.
D007	Mixed radioactive/newly identified D007or mineral processing wastes	May 26, 2000.
D008	Newly identified D008 and mineral processing waste	August 24, 1998.
D008	Mixed radioactive/newly identified D008 or mineral processing wastes	May 26, 2000.
D009	Newly identified D009 and mineral processing waste	August 24, 1998.
D009	Mixed radioactive/newly identified D009or mineral processing wastes	May 26, 2000.
D010	Newly identified D010 and mineral processing wastes	August 24, 1998.
D010	Mixed radioactive/newly identified D010 ormineral processing wastes	May 26, 2000.
D011	Newly identified D011 and mineral processing wastes	August 24, 1998.
D011	Mixed radioactive/newly identified D011or mineral processing wastes	May 26, 2000.
*	*	*
F032	All others	August 12, 1997.
*	*	*
F034	All others	August 12, 1997.
F035	Mixed with radioactive wastes	May 12, 1999.
F035	All others	August 12, 1997.
*	*	*
K088	All others	October 8, 1997.
*	*	*

* * * * *

TABLE 2.—SUMMARY OF EFFECTIVE DATES OF LAND DISPOSAL RESTRICTIONS FOR CONTAMINATED SOIL AND DEBRIS (CSD)

Restricted hazardous waste in CSD	Effective date
*	*
9. Soil and debris contaminated with K088 wastes	October 8, 1997.
*	*
12. Soil and debris contaminated with newly identified D004–D011 toxicity characteristic wastes and mineral processing wastes.	August 24, 1998.
13. Soil and debris contaminated with mixed radioactive newly identified D004–D011 characteristic wastes and mineral processing wastes.	May 26, 2000.

20. Appendix VIII to Part 268 is amended by revising the title and adding in alpha numeric order the entry "NA" to read as follows:

Appendix VIII to Part 268—LDR Effective Dates of Injected Prohibited Hazardous Wastes

NATIONAL CAPACITY LDR VARIANCES FOR UIC WASTES

Waste code	Waste category	Effective date
*	*	*
NA	Newly identified mineral processing wastes from titanium dioxide production and mixed radioactive/ newly identified D004–D011 characteristic wastes and mineral processing wastes.	May 26, 2000.
*	*	*

"reasonably expected to be present" guidance

View Record Detail

FAXBACK 13748

PPC 9554.1995(01)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

June 14, 1995

Roy F. Weston, Inc.
Ms. Janell B. Bergman, P.G., CPG
Senior Project Manager
215 Union Boulevard, Suite 550
Lakewood, CO 80228-1842

Dear Ms. Bergman:

It is a pleasure to respond to your letter dated April 27 1995, regarding the Land Disposal Restrictions Phase II final rule (59 FR 47982). Specifically, you requested an interpretation of the phrase "which can reasonably be expected to be present" as it applies to underlying hazardous constituents in soil that exhibits the toxicity characteristic.

The preamble to the final phase II rule states: "regulated entities do not have to ascertain the presence of all hazardous constituents for which EPA is promulgating a universal treatment standard. Generators may base this determination on their knowledge of the raw materials they use, the process they operate, and the potential reaction products of the process, or upon the results of a one-time analysis of the entire list of constituents at 268.48." (See 59 FR 48015.)

In the case of contaminated soil, however, the "generator" may not be the party that caused the contamination, but rather may be the one performing the cleanup. As you point out, it may be difficult to determine exactly what constituents are reasonably expected to be present in the soil because of the lack of records about the site and the absence of anyone who has institutional memory about the cause of the contamination. It is appropriate, therefore, to use the constituents that are at levels above the Universal Treatment Standards, based on monitoring at the site, provided analysis has been conducted for the entire list of constituents at 268.48. These would be the constituents reasonably expected to be present at the point of generation (in a remediation, the point of generation is the point the contaminated

soil is picked up).

I hope you find this information helpful. If you have further questions, please call Rhonda Craig of my staff on (703) 308-8771.

Sincerely,

Michael Shapiro
Director
Office of Solid Waste

Attachment

Weston
215 Union Boulevard, Suite 550
Lakewood, CO 80228-1842
303-980-6800 FAX: 303-980-1622

27 April 1995

Mr. Michael Shapiro
Director, Office of Solid Waste
United States Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

SUBJECT: Land Disposal Restrictions - Phase II

Dear Mr. Shapiro:

Roy F. Weston, Inc. requests an interpretation of a phrase pertaining to the recently published Land Disposal Restrictions - Phase II (59 FR 47982). Specifically, we request an interpretation of the phrase "which can reasonably be expected to be present" as it applies to underlying hazardous constituents that may be found in soil that exhibits the toxicity characteristic (TCLP). (Sections 268.2(i) and 268.40(e))

Application of this concept is straightforward as it applies to industrial waste streams; however, it becomes difficult when referring to contaminated soil where unknown wastes were deposited years ago. Weston requests EPA's interpretation of this concept as it applies to contaminated soils. Is it sufficient to use the list of constituents that have been detected at the site as the list of constituents reasonably expected to be present?

Thank you for your attention to this matter. We look forward to

your response to this question.

Sincerely,

ROY F. WESTON, INC.

Janell B. Bergman, P.G., CPG
Senior Project Manager

cc: Mr. Jim Thompson
Office of Regulatory Enforcement
RCRA Enforcement Division

RCRA Section 3020(b) Exemption for Reinjection of Contaminated Groundwater

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

DEC 27 1989 OSWER Directive # 9234.1-06

MEMORANDUM

SUBJECT: Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26

FROM: Don R. Clay, Assistant Administrator
Office of Solid Waste and Emergency Response

TO: Waste Management Division Directors
Regions I - X

Regional Counsel
Regions I - X

Purpose

There has been some question as to whether ground water contaminated with restricted RCRA hazardous wastes, which is extracted during a RCRA corrective action or CERCLA response action, must meet the best demonstrated available technology (BDAT) identified for that waste under the RCRA land disposal restrictions (LDRs) prior to each reinjection, in a pump-and-treat reinjection remediation system. (See RCRA sections 3004 (f), (g) and (m), and 40 C.F.R. Parts 148 and 268.) This memorandum explains EPA's interpretation of whether the LDRs are applicable or (under CERCLA response actions only) relevant and appropriate to such reinjections or to the remediation as a whole.

Background

RCRA LDRs prohibit land disposal of restricted RCRA hazardous wastes that do not meet treatment standards after the effective date of the restrictions. Treatment standards for RCRA hazardous wastes are based upon the best demonstrated available technology (BDAT) identified for that waste. See 40 C.F.R. 268. Because placement of hazardous waste into underground injection wells constitutes "land disposal" under LDR (see RCRA section 3004(k)), and the ground water undergoing reinjection may contain a restricted waste, the issue has been raised as to whether each reinjection of contaminated ground water should meet BDAT during response or corrective actions.

RATIONALE

Ground water restoration under RCRA corrective actions and CERCLA response actions often involves withdrawal, treatment of the contaminated water, and reinjection of the treated water into the ground. The land disposal restrictions (LDR) of the Resource Conservation and Recovery Act (RCRA) prohibit land disposal of restricted RCRA hazardous wastes that do not meet treatment standards after the effective date of the restrictions. Treatment standards for RCRA hazardous wastes are based upon the best demonstrated available technology (BDAT) identified for that waste. See 40 C.F.R. 268. Because placement of hazardous waste into underground injection wells constitutes "land disposal" under LDR (see RCRA section 3004(k)), and the ground water undergoing reinjection may contain a restricted waste, the issue has been raised as to whether each reinjection of contaminated ground water should meet BDAT during response or corrective actions.[1]

Section 3020 of RCRA [previously section 7010[2]] specifically addresses waste injection in the context of CERCLA and RCRA cleanups. RCRA section 3020(a) bans hazardous waste disposal by underground injection into or above an underground source of drinking water (within one-quarter mile of the well). However, RCRA section 3020(b) exempts from the ban all reinjections of treated contaminated ground water into such formations undertaken as part of a CERCLA section 104 or 106 response action, or a RCRA corrective action. To qualify for the exemption, the following three conditions must be met: (1) the injection is a CERCLA response action or a RCRA corrective action, (2) the contaminated ground water must be treated to substantially reduce hazardous constituents prior to such injection, and (3) the response action or corrective action must be sufficient to protect human health and the environment upon completion.

Although RCRA section 3020 and the LDR provisions at RCRA sections 3004(f), (g) and (m) arguably can address the same activity, RCRA section 3020 specifically applies to all CERCLA and

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[1] CERCLA remedial actions are required to meet Federal requirements and standards at completion of the remedial action if the Federal standards are applicable or relevant and appropriate requirements (ARARs), absent invocation of a statutory waiver. See CERCLA section 121(d). Agency policy and the proposed National Contingency Plan (NCP) require the Agency to comply with all ARARs pertinent to the action during the course of a remedial action, as well as upon its completion. See the proposed NCP (published at 53 Fed. Reg. 51,394 (Dec. 21, 1988)(to be codified at 40 C.F.R. 300.435(b)(2)), and CERCLA Compliance with Other Laws Manual: Part I, I-8 (OSWER Directive number 9234.1-01, August 8, 1988).

[2] RCRA section 3020 was section 7010 in the Hazardous and Solid Waste Amendments of 1984, but was re-numbered in 1986.

RCRA ground water treatment reinjections into Class IV injection wells.[3] Consistent with traditional principles of statutory construction, RCRA section 3020 -- which is directly focused on injections of treated contaminated ground water into Class IV wells during cleanups -- should be controlling for such injections; a contrary reading would render section 3020(b) meaningless. Where Congress has provided two potentially applicable statutory provisions, a choice between them is both necessary and appropriate, and within the discretion of the expert agency. Accordingly, EPA construes the provisions of RCRA section 3020 to be applicable instead of LDR provisions at RCRA sections 3004(f), (g), and (m), to reinjections of contaminated ground water into an underground source of drinking water (USDW), which are part of a CERCLA response action or RCRA corrective action.

As a result, the three conditions of RCRA section 3020(b) must be met during response or corrective actions involving ground water treatment reinjection into or above underground sources of drinking water. Failure to meet these conditions bans the activity under RCRA section 3020(a).[4] First, the injections must be part of a CERCLA response action or a RCRA corrective action. Second, each reinjection has to be treated to "substantially reduce hazardous constituents prior to such injection..." (RCRA section 3020(b)). Until guidance is prepared addressing the issue, steps necessary to "substantially reduce" hazardous constituents during a RCRA corrective action or a CERCLA response action should be decided on a case-by-case basis. Third, the response or corrective action upon completion must "be sufficient to protect human health and the environment" (RCRA section 3020(b)). RCRA and CERCLA statutes, regulations and policies should be reviewed to determine protectiveness.

The issue may also arise under CERCLA as to whether LDRs are relevant and appropriate requirements when treated ground water is reinjected into Class IV wells as part of a CERCLA response action. In order to be considered to be both "relevant" and "appropriate," a requirement must address problems or situations similar to the circumstances of the release or remedial action contemplated, and be well-suited to the site. A key factor in determining the potential relevance and appropriateness of a

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[3] Class IV injection wells are used to inject contaminated ground water into or above an underground source of drinking water. See 40 C.F.R. 146.5(d). In most situations, ground water treatment reinjection involves only Class IV injection wells because treated ground water is recharged back into an underground source of drinking water (USDW) during pump-and-treat activities, not beneath it. Other classes of wells are not subject to section 3020's special provisions.

[4] Note, however, that an ARARs waiver may be appropriate in certain cases for actions taken under CERCLA.

Separate from the restrictions found in RCRA LDRs, an independent provision of the statute, RCRA Section 3020, bans hazardous waste injection into drinking water formations (Class IV injection wells), unless the conditions in subpart (b) are met. Subpart (b) permits reinjection of contaminated ground water that has been treated if: (1) the injection is a CERCLA response action or a RCRA corrective action, (2) the contaminated ground water is treated to substantially reduce hazardous constituents prior to each injection, and (3) the response action or corrective action is sufficient to protect human health and the environment upon completion. (See RCRA section 3020(b).)

Resolution

For the reasons specified in the attachment to this memorandum, LDR is not applicable to these activities. Instead of LDR, RCRA section 3020 applies to reinjection of treated contaminated ground water into Class IV injection wells during CERCLA response actions or RCRA corrective actions. Moreover, for CERCLA response actions where the goal is to clean up ground water to drinking water levels, the Agency believes that health-based drinking water standards (e.g. MCLs) -- rather than LDRs -- will generally be the relevant and appropriate cleanup standard. See the attachment.

Until guidance addresses the issue, what is required to "substantially reduce" hazardous constituents prior to each injection in a CERCLA response action or RCRA corrective action should be determined on a case-by-case basis. RCRA and CERCLA program policies and guidance should be reviewed to determine protectiveness upon completion of the action.

Attachment

cc: CERCLA and RCRA Branch Chiefs
Office of Drinking Water

requirement is to compare the CERCLA response objective with the purpose and objective of the requirement. See "CERCLA Compliance with Other Laws Manual" at p. 1-65 (EPA, August 8, 1988); proposed NCP, 53 FR at 51436 (Dec. 21, 1988) (proposed section 300.400(g)(2)).

The ultimate purpose of treating and reinjecting ground water into Class IV wells is to restore the formation to drinking water quality. EPA believes that standards that have been specifically developed to establish drinking water quality levels (such as MCLs[5]) are particularly well-suited to the accomplishment of that purpose. Although LDRs also prescribe treatment levels, those levels were not specifically developed to achieve drinking water quality (although they may often have that result). Thus, where drinking water standards are available, the Agency believes that they will generally be the relevant and appropriate requirement to use in setting treatment standards for CERCLA cleanups of drinking water formations.

In situations where no drinking water standard has been promulgated for the contaminants to be treated, the Region should consider potentially relevant and appropriate requirements (including any available health-based standards, LDR treatment standards, etc.) and attain the standard, if any, that the Agency finds is "relevant and appropriate under the circumstances of the release" (or justify a waiver).[6] EPA guidance sets out a number of factors for deciding if a requirement is relevant and appropriate under the circumstances of the release. See CERCLA Compliance with Other Laws Manual, at p. 1-67.

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NOTICE: The policies set out in this memorandum are intended solely for the guidance of Government personnel. They are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this memorandum, or to act at variance with the guidance, based on an analysis of specific site circumstances. The Agency also reserves the right to change this guidance at any time without public notice.
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[5] See the discussion of MCLs and MCLGs in the proposed and final NCP.

[6] If no such standards are relevant and appropriate, TBCs may be used as cleanup levels; use of a TBC should be explained and justified for each specific case.

LDR Treatment Standards for the Contaminated Debris

View Record Detail

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

June 3, 1994

Mr. Kenneth M. Kastner
Bryan Cave
700 Thirteenth Street, N.W.
Washington, D.C. 20005-3960

Dear Mr. Kastner:

Thank you for your letter of February 24, 1994, on behalf of Rohm and Haas Company, requesting clarification of the Resource Conservation and Recovery Act (RCRA) regulations applicable to hazardous debris. Specifically, you asked EPA to clarify how the "contaminated debris" rule applies to the removal of contaminants from an intact manufacturing building prior to its demolition.

You state that removing contaminants from a standing, intact building before demolishing the structure often provides the most environmentally sound and technically practical approach to decontaminating the building. Your question is whether removal of contaminants from a building prior to demolition constitutes RCRA treatment for which a permit is required. You also ask if incidental holding of removed contaminants within the building could be considered to be "storage." The answer depends primarily on whether the contaminants are considered a newly generated waste upon removal or are hazardous wastes prior to their removal from the building. RCRA defines "generation" as any activity that first causes a material to become "subject to RCRA regulation." In the situation you describe, involving physical removal of contaminants from a standing building, EPA considers the actual removal of the contaminants to be the point of waste generation and consequently, the point at which the RCRA regulations become applicable.

We take this position because we believe that an intact, standing building continues to perform the essential functions of a building and so need not, and should not be considered to be "discarded" under §261.2(a)(2)(i) until it is actually destroyed. We also note that the situation is analogous to that of wastes removed from product storage units in which wastes do not become subject to regulation until they are removed from those units. §261.4(c).

In this case, after the contaminating materials have been removed from a building and are

destined for disposal, RCRA requirements apply if the contaminating chemicals are RCRA hazardous wastes. The Part 262 Generator standards would apply, which do allow accumulation of waste for up to 90 days without a permit, if the conditions of §262.34 are met. Further, if the materials meet the definition of debris, such "hazardous" debris may be treated to meet the applicable treatment standard for the contaminating hazardous wastes found at 40 CFR 268.41, 268.42, and 268.43, or it may be treated to comply with the alternative hazardous debris treatment standards of 268.45. If the materials do not meet the definition of debris, they would be subject to the treatment standards for the contaminating hazardous wastes §§ 268.41, 268.42, and 268.43. The facility performing treatment to meet these treatment standards would be subject to applicable RCRA permit requirements.

Having explained how the RCRA regulations apply in the situation you describe, I should note that I realize that the preamble to the hazardous debris rule may be somewhat misleading regarding how the removal of contaminants from a building prior to demolition is regulated. The preamble language you cite, which states that physical extraction of contaminants from a contaminated building prior to demolition is subject to permit requirements, presumes that the building itself is determined to be a hazardous waste prior to demolition. As stated earlier in this letter, an intact building would not yet be a solid waste, and therefore, extraction of contaminants would not involve hazardous waste treatment.

Finally, you should note that EPA Regions and States authorized to implement the hazardous waste program make determinations regarding the requirements that apply to specific materials and facilities. Some States have programs more stringent than the Federal hazardous waste program. I hope this addresses your concerns. If you have any further questions, please contact Richard Kinch of the Waste Treatment Branch at (703) 308-8434.

Sincerely yours,

Michael Shapiro,
Director
Office of Solid Waste

530-Z-93-010

federal register

Tuesday
August 18, 1992

Part II

Environmental Protection Agency

40 CFR Part 148 et al.

Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris; Rule

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 148, 260, 261, 262, 264, 265, 268, 270 and 271

[FRL-4132-4]

RIN 2050-AD36

Land Disposal Restrictions for Newly Listed Wastes and Hazardous Debris

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is finalizing treatment standards under the land disposal restrictions (LDR) program for certain hazardous wastes listed after November 8, 1984, pursuant to a proposed consent decree filed with the District Court that established a promulgation date of June 1992 (*EDF* v. *Reilly*, Civ. No. 89-0598, D.D.C.). EPA is also finalizing revised treatment standards for debris contaminated with listed hazardous waste or debris that exhibits certain hazardous waste characteristics (hereinafter referred to as hazardous debris), and several revisions to previously promulgated standards and requirements. These actions are being taken as part of the RCRA Reform Initiative, and are expected to facilitate implementation of the LDR program.

EFFECTIVE DATES: This final rule is effective on June 30, 1992, except for §§ 148.17(a), 260.10, 261.3(c)(2)(ii)(C), 268.2, 268.5, 268.7, 268.9, 268.36(a), 268.40, 268.41, 268.42, 268.43, 268.45, 268.46, 268.50, 270.14, 270.42, 270.72, and 271.1, which are effective November 16, 1992; and §§ 262.34, 264.110, 264.111, 264.112, 264.140, 264.142, part 264 subpart DD, 265.110, 265.111, 265.112, 265.140, 265.142, 265.221, and part 265 subpart DD, which are effective February 18, 1993.

ADDRESSES: The official record for this rulemaking is identified as Docket Number F-92-CD2F-FFFFF, and is located in the EPA RCRA Docket, room 2427, 401 M Street SW., Washington, DC 20460. The docket is open from 9 a.m. to 4 p.m., Monday through Friday, except on Federal holidays. The public must make an appointment to review docket materials by calling (202) 260-9327. A maximum of 100 pages from the docket may be copied at no cost. Additional copies cost $.15 per page.

FOR FURTHER INFORMATION CONTACT: For general information, contact the RCRA Hotline at (800) 424-9346 (toll free) or (703) 920-9810 locally. For information on treatment standards for newly listed wastes or hazardous debris, contact the Waste Treatment Branch, Office of Solid Waste (OS-322W), U.S. Environmental Protection Agency, 401 M St., SW., Washington, DC 20460, (703) 308-8434. For information on capacity determinations or national capacity variances, contact the Capacity Programs Branch, Office of Solid Waste (OS-321W), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (703) 308-8440.

SUPPLEMENTARY INFORMATION:

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I. Background

A. Summary of the Hazardous and Solid Waste Amendments of 1984

The Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA), enacted on November 8, 1984, allow hazardous wastes to be land disposed only if they satisfy either of two conditions: (1) They can either be treated, or otherwise satisfy, the requirement of section 3004(m), which provision requires EPA to set levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized; or (2) they can be land disposed in units satisfying the so-called no-migration standard in sections 3004 (d)(1), (e)(1), and (g)(5). Land disposal includes any placement of hazardous waste in a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, or underground mine or cave. RCRA section 3004(k).

EPA was required to promulgate land disposal prohibitions and treatment standards by May 8, 1990 for all wastes that were either listed or identified as hazardous at the time of the 1984

closure, commenters pointed out (correctly) that this would entail removal not only of accumulated sludges but subsurface contaminated soils as well which are not the focus of the treatment requirements, and that forcing clean closure could interfere with otherwise available and potentially more cost-effective types of closure options.

EPA finds many of these comments persuasive and believes that the following interpretation best resolves these issues. First, EPA is not interpreting these provisions as necessitating annual dredging of accumulated sludges. Either the impoundment will close in a short time (no more than four years), or it will be retrofitted and become subject to the annual dredging requirement in section 3005(j)(11) (as implemented by § 268.4(a)(2)(ii)). If the impoundment closes, EPA is interpreting the provisions to allow closure with wastes in place (unless the unit operator chooses to clean close the impoundment). Thus, under this reading, continued use of the impoundment would be allowed during the four-year retrofit/closure period (as explained in section 1 above), use of the impoundment during that time would not be disrupted by a dredging requirement, and the impoundment would be allowed to close with wastes in place. These are the same options that were available to impoundments in 1984 managing wastes already identified or listed as hazardous.

3. Technical Analysis

a. *Introduction.* Owners or operators of surface impoundments managing newly listed or characteristic hazardous wastes have several options for complying with the minimum technological requirements. Facilities may retrofit the surface impoundments with liners and leak detection systems in compliance with the requirements of section 3004(o)(1)(A)(i). Alternatively, facilities may replace their treatment surface impoundments with wastewater treatment tanks regulated under the Clean Water Act or may opt to close the surface impoundments and send the waste off-site.

EPA believes that very few facilities managing newly regulated wastes in surface impoundments will choose to retrofit their impoundments. For example, the Chemical Manufacturers Association (CMA) conducted an informal survey of 582 chemical manufacturing facilities in the fall of 1989 to obtain information about the management of "non-hazardous wastes" in surface impoundments. Twenty-seven facilities reported that 85 surface impoundments would be newly regulated as a result of the Toxicity Characteristic rule (55 FR 11798, March 29, 1990); of these 85, only 9 would be retrofitted with liners and leak detection systems. Replacing surface impoundments with tank systems was the most frequently planned method of compliance for the respondents to this survey. Past experience also indicates that surface impoundment owners or operators are more likely to replace their surface impoundments with tank systems than to retrofit the impoundments. RCRA section 3005(j)(1) required surface impoundments that were in existence and that qualified for interim status on the date of enactment of HSWA to come into compliance with the MTRs by November 8, 1988. Most facilities with surface impoundments replaced their impoundments with tanks in response to this deadline. Less than five percent of these facilities actually retrofitted their surface impoundments.

To support today's rulemaking, EPA undertook an analysis to determine how much time is needed for owners or operators of newly regulated surface impoundments to comply with the MTRs either by replacing the impoundments with wastewater treatment tanks exempt from RCRA subtitle C standards, or by retrofitting the surface impoundments with liners and leak detection systems according to the requirements of section 3004(o)(1)(A)(i). EPA collected information from a variety of sources, including facilities that have implemented these practices in the past or plan to do so in the future (e.g., in response to the TC), tank manufacturers, and engineers. The results were summarized in the proposed rule (57 FR 4170), and are available in the background document.[8]

4. Conclusion

EPA found that the time needed to comply with the MTRs varies considerably based on case-by-case factors (e.g., current waste management practices, land availability) and regional factors (e.g., climate). According to EPA's information sources, six months appears not to be enough time to either retrofit a surface impoundment or replace the impoundment with a wastewater treatment tank. Replacing a surface impoundment with a tank frequently takes two to four years, and retrofitting a surface impoundment frequently takes two to three years.

EPA believes that most interim status surface impoundments managing wastes newly identified or listed as hazardous will be able to comply with the surface impoundment MTRs within four years of the date promulgating the listing or characteristic. Thus, the four-year period allowed in section 3005(j)(6) is a reasonable period within which to come into compliance.

V. Detailed Discussion of Final Rule: Hazardous Debris

A. Overview

The Agency is today promulgating a final rule for the treatment of hazardous debris. Until today, debris destined for land disposal that was contaminated with a prohibited RCRA hazardous waste or that exhibited a prohibited RCRA hazardous characteristic was subject to the treatment standard for that listed waste or characteristic. See, e.g., 55 FR 22649 and RCRA sections 3004 (d)(3) and (e)(3). Although hazardous waste debris (as well as contaminated media) is subject to the LDR prohibitions, there is no requirement that it have the same treatment standards as the wastes with which it is contaminated. Indeed, because hazardous debris may be a matrix significantly different from the underlying prohibited waste, it is appropriate as a technical matter to determine whether different treatment standards were appropriate.

Today, EPA is promulgating treatment standards for hazardous debris prohibited from land disposal. Under today's rule, hazardous debris must be treated by specified technologies based on the type of debris and type of contaminant(s) present or, as an alternative, meet the LDRs for the specified prohibited listed or characteristic waste with which it is contaminated.

EPA has specified a number of BDAT technologies for hazardous debris, with the choice of technology left up to the generator and/or treater managing the waste. The technologies include widely used treatment methods. EPA thus believes that it is preserving in this rule as much flexibility for the treatment of hazardous debris as possible.

[8] It should be noted that the potential statutory conflict at issue in this rulemaking is most immediately relevant to wastes newly regulated as a result of the Toxicity Characteristic (TC) rule (55 FR 11798, March 29, 1990). According to the regulatory impact analysis for the TC, about 730,000,000 metric tons per year of wastewaters managed in surface impoundments at over 2,000 facilities are estimated to exhibit the TC (U.S. EPA, OSW. U.S. EPA Background Document. Toxicity Characteristic Regulatory Impact Analysis. Final Report. March 1990). This potential conflict will also arise with respect to all future newly identified or listed hazardous wastes; however, the TC rule is used as an example throughout this section.

Prohibited hazardous debris is defined generally as solid material (that is not a process waste) having a particle size of 60 mm or larger and that is intended for land disposal and exhibits a prohibited characteristic of hazardous waste or that is contaminated with a prohibited listed hazardous waste. Hazardous debris must be treated by one of the specified treatment technologies for each "contaminant subject to treatment" defined as: (1) The BDAT constituents for the listed waste that are subject to land disposal restriction standards (as found in § 268.41 and 268.43); and (2) the RCRA hazardous waste constituent(s) for which the hazardous debris fails the Extraction Procedure toxicity - characteristic, in addition to any other characteristic which causes the debris to be hazardous (i.e., ignitability, reactivity). As an alternative, the generator of the hazardous debris may choose to treat the hazardous debris to the existing waste-specific treatment standards for the waste contaminating the debris. However, in choosing this alternative, the generator or treater would be required to sample and analyze the treated debris to ensure compliance with the treatment standards prior to disposal in a Subtitle C land disposal unit.

To ensure effective treatment, the treatment unit would be required to meet performance standards or design and operating conditions specified in the rule. In addition, the treatment unit would generally be subject to the Part 264 and 265 standards for treatment facilities to ensure protection of human health and the environment.

The rule addresses not only the issue of when hazardous debris is sufficiently treated, but the further question of when it is a hazardous waste. Under the rule, treated hazardous debris would be excluded from the definition of hazardous waste provided that: (1) The debris is treated to the performance or design and operating standards by an extraction or destruction technology rather than an immobilization technology [9]; and (2) the treated debris does not exhibit a characteristic of hazardous waste. If an immobilization technology is used, the treated debris would not be automatically deemed a nonhazardous waste. In addition, the Agency could determine on a case-by-case basis under today's rule that debris no longer "contains" hazardous waste and is excluded from Subtitle 6 regulation.

Residuals generated by the treatment of hazardous debris are subject to the numerical treatment standards for the waste contaminating the debris.

B. Definitions of Debris and Hazardous Debris

1. Definition of Debris

EPA is today defining debris as solid material exceeding 60 mm (2.5 inch) particle size that is: (1) A manufactured object; or (2) plant or animal matter; or (3) natural geologic material (e.g., cobbles and boulders), except that any material for which a specific treatment standard is provided in Subpart D, part 268, is not debris.[10] A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if the mixture is comprised primarily of debris by volume, based on visual inspection. Process residuals such as smelter slag and residues from the treatment of waste (e.g., incinerator ash), wastewater, sludges, or air emissions residues (e.g., collected particulate matter) are not debris. We discuss below that debris must be intended for discard (i.e., rather than continued use), that debris must be a solid material, the rationale for selecting a 60 mm particle size criterion for debris (i.e., as opposed to the 9.5 mm particle size proposed) and for applying the size criterion to all debris (i.e., not just to geologic materials as proposed), the rationale for regulating as debris mixtures of primarily debris and other materials, the rationale for not regulating process residuals as debris, and the rationale for regulating nonempty containers as hazardous waste subject to existing LDRs rather than as debris.

a. *Debris Must Be Discarded or Intended for Discard.* Debris must of course be either a solid waste or media (e.g., boulders) that is discarded or intended for discard to be subject to the treatment standards in today's rule. Those commenters on the proposed rule expressing concern that the proposed rule in some way vitiated (or was intended to vitiate) this basic principle were mistaken. This means that such materials that might at some later time become debris, such as equipment or building structures, but that are still in use are not subject to the treatment standards. Such in-use material is not a solid waste because it has not been discarded or intended for discard, as these terms are used in § 261.33 (i.e., likely abandoned, as defined in § 261.2 (a)(2)(i) and (b))

Media debris (e.g., boulders) is also not subject to regulation as solid waste unless discarded or intended for discard and so is not automatically subject to the treatment standards.

Once debris becomes a solid waste by virtue of being discarded (including media debris that becomes subject to regulation as solid waste by virtue of being discarded), it is not necessarily subject to the treatment standards. For example, contaminated debris that is not actively managed after the effective date of the prohibitions (i.e., the effective date of the LDRs for the hazardous waste contaminating the debris) would not be subject to the standards. See 53 FR 31148 (Aug. 17, 1988). On the other hand, debris which is contaminated with hazardous waste disposed before the hazardous waste listing effective date and which is actively managed is subject to the prohibitions and so would have to be treated to satisfy the treatment standards promulgated today before the debris could be land disposed (assuming disposal will not occur in a no-migration unit). *Chemical Waste Management v. EPA*, 869 F. 2d 1526 (D.C. Cir. 1989).

b. *Debris Must Be a Solid Material.* The rule defines debris as a "solid material." This means solid in a literal sense as defined in a common dictionary. A solid material is a material that retains its volume at room temperature without the need for support by a container. Examples of solid materials that are debris if intended for discard and if their particle size is 60 mm (2.5 inches) or greater include: (1) Glass; (2) concrete (excluding cementitious or pozzolanic stabilized hazardous wastes); (3) masonry and refractory bricks; (4) nonintact containers [11] e.g., crushed drums); (5) tanks; (6) pipes, valves, appliances, or industrial equipment; (7) scrap metal (as defined in 40 CFR 261.1(c)(6)); (8) animal carcasses; (9) tree stumps and other plant matter; (10) rock (e.g., cobbles and boulders); and (11) paper, plastic, and rubber. Not only is defining debris as solid material in accord with the common-sense view of what debris is, but, more importantly, it is geared to the treatment standards adopted today that ensure effective decontamination of solid materials by removal or destruction of hazardous waste. Clearly, if a liquid could be

[9] In the Phase II land disposal restrictions rule, the Agency will reopen and request comment on the issue of whether immobilized debris should be excluded from Subtitle C regulation. (See discussion in Section V.D.2.)

[10] For example, lead acid or cadmium batteries are not debris because they are subject to specific treatment standards under § 268.42.

[11] See discussion in section V.B.1.f of the text regarding regulation of intact and nonintact containers.

considered debris, the concept of cleaning off the outer surface to remove contamination does not make sense.[12]

Even though debris must be a solid material, it may contain or be mixed with free liquids.[13] The liquids may be waste or ground or surface water that may be entrapped in the debris (e.g., in partially crushed containers (see discussion below on regulation of containers)) or may be still oozing from the debris if the debris was newly generated or newly excavated from a remediation site. (If liquids separate from hazardous debris prior to treatment of the debris, they must be managed as hazardous waste.) Liquids that are entrapped in debris will be effectively treated under today's treatment standards for extraction or destruction technologies. If an extraction technology is used, the toxic constituents in the liquid will be removed from the debris as a treatment residue and is subject to the LDRs for the waste contaminating the debris. If a destruction technology is used, the toxic constituents in the liquid should be destroyed.

We note, however, that debris that is immobilized prior to land filling may not contain free liquids as provided by §§ 264.314 and 265.314. Thus, free liquids (including liquids in crushed containers) cannot be present in debris that is macroencapsulated or sealed, and cannot be present in debris that has been micorencapsulated.

c. *Debris Has a Particle Size Larger Than 60 mm.* Today's rule defines debris as solid material with a particle size of 60 mm (2.5 inches) or greater. We discuss below the rationale for increasing the particle size to 60 mm from the proposed 9.5 mm particle size, the rationale for applying the size criterion to all debris, not just to geologic matter as proposed, the rationale for defining 60 mm or larger clumps of fine-grained materials (e.g., clumps of compacted clay) as nondebris material, and how the particle size criterion is to be implemented.

(1) Rationale for Increasing the Particle Size of Debris From 9.5 mm to 60 mm. The Agency is today defining debris as solid material with a particle size of 60 mm (2.5 inches) or greater for a number of reasons: (a) Fine grain materials (e.g., soil, glass cullet) are not amenable to the surface removal technologies specified in today's rule and are not commonly thought of as debris; (b) fine grain materials are likely to be amenable to the treatment technologies that were the basis for the LDRs for the waste contaminating the material; (c) fine grain materials, unlike large particle size materials, can be reasonably sampled for analysis to document compliance with the concentration-based LDRs for the waste contaminating the material; (d) material normally considered to be soil should be subject to the Agency's planned LDRs for contaminated soil rather than defined as debris [14]; (e) the selection of a 60 mm particle size criterion is within the range of reasonable particle sizes the Agency could have selected for defining debris; and (f) many commenters suggested a larger particle size, and the only commenters that suggested a particular size suggested 60 mm.

We note that a number of commenters suggested that the Agency consider raising the particle size breakpoint as the Agency is doing here. Two commenters suggested an alternative sieve size of 60 mm, stating that existing soil-washing equipment such as rotary screens and wet vibratory screens are capable of handling particles sizes of several inches, and the suggested 60 mm cut-off size would result in more soil being subject to the existing LDRs which require sampling and analysis to document compliance with concentration-based treatment standards.

While the Agency believes that it could have selected other particle sizes, the Agency selected the 60 mm (2.5 inch) particle size from the range of 9.5 mm (⅜ inch) to 200 mm (8 inches) because: (1) It is a commonly used sieve size that is commercially available, (2) it would define as soil pebbles and smaller particles, and define as debris cobbles and boulders [15] in accord both with common understanding and with materials most amenable to effective treatment by the methods adopted today; and (3) it meets the criteria discussed above (e.g., smaller particle size material can be readily sampled to document compliance with the numerical LDR treatment standards for the waste contaminating the material).[16] In addition, this size object is normally readily amenable to effective treatment by the methods specified in today's rule.

(2) Rationale for Applying the Particle Size Criterion to All Debris. The Agency has broadened the particle size test to apply to all debris, not just to geologic debris as proposed. We believe that the reasons enumerated above for increasing the particle size to 60 mm apply equally to applying the particle size to all debris (e.g., small particle size objects—e.g., glass, metal fragments—can be readily sampled representatively to document compliance with the LDRs for the waste contaminating the material).

(3) Compacted Clumps of Fine Grained Materials are not Defined as Debris. The Agency is basing the size criterion on the particle size of the solid material rather than the sieve size to ensure that 60 mm (or larger) compacted clumps of materials with a particle size less than 60 mm are not defined as debris. The most common example is clayey soil. Clay particles are extremely cohesive and can form clumps during normal excavation and handling operations. The contaminated debris treatment methods are not intended to clean clumps of clay. Clumps of agglomerated clay soil are subject to the treatment standards for the waste contaminating the soil.

In addition, the Agency is concerned that generators may have the incentive to intentionally agglomerate small particle size materials (e.g., soil or even manufactured materials) so that they would meet the definition of debris and so be excluded from regulation under subtitle C upon treatment by an extraction or destruction technology. If such contaminated materials were not

[12] While most of the debris treatment methods are extraction methods, some methods destroy the hazardous constituents; although these would be applicable to liquid material, most of the treatment methods simply remove the contamination from the debris for subsequent detoxification treatment.

[13] To determine otherwise would result in large quantities of solid materials being subject to the existing LDRs for the waste contaminating the materials. Those solid materials would be very difficult to sample representatively to document compliance with the LDRs. Further, the solid materials would be readily amenable to the debris treatment standards promulgated today notwithstanding the presence of free liquids, and hence appropriately classified as debris.

[14] We note that numerous commenters were concerned that the proposed particle size criterion of 9.5 mm would inappropriately define most soil as debris. (We note further that the proposed rule could have been interpreted to define as debris geologic material that was comprised of only one particle (e.g., a rock) with a particle size of 9.5 mm or greater. Thus, fine grain soil containing one 9.5 mm or greater sized rock could have been considered debris. The final rule addresses mixtures by defining as debris mixtures of primarily debris with other materials. See discussion in the text in Section V.B.1.d).

[15] See the May 11, 1992, memorandum from Kerry Rice, Radian to Mark Mercer, EPA, entitled "Particle Size Definitions and Sieve Sizes"; and the May 18, 1992, memorandum from Peter Shields, Radian, to Mark Mercer, EPA, entitled "Sieves with Openings Greater than Four Inches".

[16] We note that the Agency is considering proposing Phase II land disposal restrictions that would establish treatment standards for contaminated soil. In that proposal, the Agency is considering requesting comment in particular on whether soils with a particle size between 9.5 mm and 60 mm can be effectively treated under those proposed standards.

regulated as debris, they would be subject to the LDRs for the waste contaminating them and would remain subject to subtitle C regulation after treatment. Basing the size criterion on particle size rather than sieve size precludes the potential for such sham activities.

(4) Implementation of the Particle Size Criterion. To make today's rule workable, equipment operators need to be able to determine quickly whether material being remediated is debris or nondebris (e.g., soil, waste). In some cases, the determination will vary from one front end loader bucketfull of material to another. Accordingly, the Agency intends for the size criterion to be implemented by visual observation. Screening is not required. If screening is used, however, the screen may be either a square grid with openings 60 mm on a side or a circular grid with circles with a 60 mm diameter.

(d) Waste for Which a Specific Treatment Standard Has Been Established is not Debris. There is one further exception to this definition of debris. EPA is indicating that debris-like material for which the Agency has promulgated a specific treatment standard is not considered to be debris. The reason is that the Agency will have determined that specific treatment standards are appropriate for the material, rather than the assortment of technologies adopted for debris generally. See 57 FR 983 c.3 (Jan. 9, 1992).

The chief examples of a material subject to a specific treatment standard rather than the general debris standards are lead acid batteries and cadmium batteries. EPA has promulgated a treatment standard of metal recovery for each of these materials. See § 268.42. Thus, this more specific treatment standard takes precedence over the more general debris standard adopted today.[17]

d. Mixtures of Debris with Other Materials are Subject to Regulation as Debris if Debris is the Primary Material Present. A further issue needing to be addressed is the status of mixtures of debris and other materials such as soils or sludge. This situation arises often, particularly in remedial situations where debris is rarely present in a pristine state. Since the treatment standards for debris and other materials—sludge or contaminated soil—differ, the issue of classification is an important one. In developing a means of classification, the Agency on the one hand is seeking to prevent the debris classification from invariably overriding the treatment standards for other hazardous wastes. On the other hand, it is important to have a means of classification that is easy to apply by equipment operators in the field.

The Agency has therefore decided to classify [18] as debris any mixture where the debris portion comprises the largest amount of material present by volume, to be determined by visual inspection.[19] Thus, for example, if upon examination, a mixture of cobbles (i.e., with a particle size of 60 mm or more), soil, and sludge is comprised mostly of cobbles, the mixture is classified as debris. After being treated by one of the treatment methods for debris promulgated in today's rule, it could then be land disposed. (Residues from applying the treatment method could be land disposed after being treated to meet the treatment standards for the prohibited waste contaminating the debris.)

The definition of debris encompasses this classification principle by stating that "A mixture of debris and other material such as soil or sludge is also debris if the mixture is comprised primarily of debris by volume, based on visual inspection." It should be clear from this discussion that the rule does not require debris and nondebris materials to be separated prior to treatment (an unintended implication of the proposed rule). Rather, mixtures are either classified as debris or some other type of waste treatability group according to the classification test discussed above.

We note that the "primary material" test for classifying debris does not apply to intact, nonempty containers. Given that such containers are not debris (see discussion below in section V.B.1.f) and can be readily separated from debris (or mixtures of debris and other materials), they are not considered in applying the "primary material" test. Consequently, intact, nonempty containers must not be included in making the volume determinations to classify mixtures of debris.

There is one further point to be made. Although EPA is classifying mixtures that are predominantly debris as debris, this does not mean that debris can be deliberately mixed with other wastes in order to change their treatment classification. Such mixing is impermissible dilution under § 268.3 since it is a substitute for adequate treatment. See also 53 FR 31145 (Aug. 17, 1988); dilution to change treatability groups is ordinarily impermissible. In addition, such situations where debris is used merely to dilute another prohibited waste, the mixture would remain subject to the most stringent treatment standard of any waste that is part of the mixture. See § 268.41(b).

e. *Process Residuals Are Not Debris.* Today's definition of debris explicitly excludes process residuals by stating: "Process residuals such as smelter slag and residues from the treatment of waste (e.g., incinerator ash), wastewater, sludges, or air emissions residues (e.g., collected particulate matter) are not debris." The Agency believes that debris should be limited to manufactured objects (e.g., metal, glass) and naturally occurring objects (e.g., boulders, tree stumps). The Agency developed the treatment standards generally to ensure effective treatment of hazardous waste contaminating an object, rather than effective treatment of a large particle size hazardous waste such as slag.[20]

Several commenters requested clarification as to what the Agency meant in the proposed rule by excluding from the definition of debris "solids that are listed wastes or can be identified as being residues from treatment of wastes and/or wastewaters." The commenters felt that it was unclear whether this phrase exempts from the definition of debris only pollution control residues, or material such as metal filters, ceramic column packing, or discarded pollution control equipment. Commenters suggested that EPA clarify, through examples, that discarded industrial equipment (such as filters, pumps, etc.) would be included in the definition of

[17] A number of commenters questioned the jurisdictional basis for regulating battery plates and groups from lead acid batteries as "solid wastes" subject to subtitle C regulation. EPA adheres to the response set out at 57 FR 960–961 in the proposed rule.

[18] We note that although such mixtures are classified as debris and are subject to the debris treatment standards, if the nondebris materials are separated from the debris prior to treatment by a specified technology, the separated material is no longer classified as debris. If the separated material is a hazardous waste (or soil contaminated with a hazardous waste), it is subject to the waste-specific treatment standards. When treatment residue (i.e., soil, waste, or other nondebris material) is separated from treated debris as required by today's debris standards for extraction or destruction technologies, the residue is subject to the waste-specific standards for the waste contaminating the debris.

[19] Some materials (e.g., soil) mixed with debris may contain free liquids that may still be oozing from the material. The volume of such entrapped liquids need not be considered in determining whether the mixture is primarily debris because it is impracticable to determine the volume of such liquids by visual inspection.

[20] We note that previous debris definitions (see § 268.2(g)) considered "slag" as debris. The Agency has reconsidered this issue and has determined the slag is not debris because it is not the type of material for which today's debris treatment standards were developed—objects contaminated (generally surficially) with hazardous waste.

hazardous debris. The basis for these determinations is discussed below.

(1) Electropolishing Is Not BDAT. The Agency has determined that electropolishing is not BDAT for hazardous debris because of concerns that the technology is intended primarily for smoothing clean metal parts. Painted or contaminated metal parts might not be effectively treated by this method. A contaminating organic waste or paint could electrically insulate the surface from the solution and prevent surface removal of contaminants.

(2) Ultraviolet Radiation Is Not BDAT. The Agency deleted ultraviolet radiation treatment from the list of BDAT technologies for hazardous debris because of difficulties of specifying performance standards that would ensure effective treatment in all cases. This technology is primarily intended for liquid waste treatment where the fluid is passed by a ultraviolet radiation source in a thin stream. This approach is designed to ensure that the ultraviolet light reaches all of the toxic molecules and detoxifies them. If the technology were to be applied to hazardous debris, it would be virtually impossible to ensure that all toxic molecules contaminating the debris were adequately radiated. Sludge and soil caked onto debris would preclude radiation of both inner layers of caked material and the debris surface. Further, even for debris that is relatively free of caked-on materials, the debris would have to be systematically turned to expose all contaminated surfaces to the radiation. The use of sunlight to provide the ultraviolet radiation as proposed as an alternative to an artificial source poses even greater problems of ensuring exposure to ultraviolet radiation at levels that would ensure effective treatment. The Agency's effort to provide for innovative debris treatment at proposal simply went too far.

(3) High Temperature Metal Recovery Is BDAT. The Agency has added high temperature metal recovery (HTMR) to the list of acceptable debris treatment technologies. It is a very effective method for treatment of recoverable metal values in both metal debris and debris that is contaminated with metal-bearing hazardous waste. The Agency did not include HTMR as BDAT at proposal simply because of oversight. Several commenters suggested that we include this method, and the Agency agrees.

We note that HTMR can also effectively treat toxic organic contaminants. If the debris contains more than a total of 500 ppm of toxic organic compounds listed in appendix VIII, part 261, the HTMR facility is subject to the Boiler and Industrial Furnace (BIF) Rule. See § 266.100. The HTMR would be subject to the same controls on organic emissions [22] as other BIFs burning hazardous waste. When the total concentration of toxic organic compounds in the waste is less than 500 ppm, the Agency believes that any emissions of organic compounds attributable to those organic compounds will not pose a hazard to human health and the environment.

3. Contaminants Subject to Treatment

Today's rule requires hazardous debris to be treated by one of the specified technologies [23] for each "contaminant subject to treatment" defined as: (1) the BDAT constituents identified in §§ 268.41 and 268.43 for the listed waste contaminating the debris that are present at detectable levels; [24] (2) the constituents for which the debris exhibits Extraction Procedure toxicity; and (3) cyanide or sulfide if debris exhibits reactivity due to the presence of those constituents. As discussed in section V.C.5 below, although debris may contain several contaminants subject to treatment, the treatment standards generally do not require treatment by multiple technologies (i.e., a treatment train). This is because many of the specified technologies effectively treat various types of contaminants (e.g., metals, aromatic and aliphatic organic compounds, halogenated and nonhalogenated organic compounds).

In the proposed rule, the Agency proposed a broader definition of "contaminants subject to treatment" that would have included constituents on appendix VIII, part 261, that the generator could reasonably know may contaminate the debris at detectable levels. Further, the Agency requested comment on whether the rule should require that debris that is hazardous solely because it exhibits a characteristic (i.e., toxicity, ignitability, or reactivity) be treated for all constituents on appendix VIII, part 261, that the generator could reasonably know may contaminate the debris at detectable levels. The Agency addressed these provisions at proposal because of concern that all toxic constituents present be effectively treated given that debris treated by an extraction or destruction technology and that does not exhibit a characteristic is excluded from subtitle C regulation.

We have determined, however, that neither of these provisions is likely to be necessary to ensure effective treatment of hazardous debris for a number of reasons. Thus, these provisions are not included in today's rule. First, we believe that enough contaminants subject to treatment will be identified for most debris to ensure effective treatment of other toxic contaminants that may be present. Given that most debris is generated by remediation, the debris is often associated with a variety of wastes that will result in a number of contaminants being designated contaminants subject to treatment—either because listed wastes or known to be present, or more likely, because the debris fails the EP [25] for one or more constituents. For example, it is highly unlikely that debris will exhibit only ignitability or reactivity and not fail the TC or be contaminated with a listed waste (and thus, require only deactivation of the ignitability or reactivity characteristic under today's rule) if, in fact, toxic constituents are present at significant levels. Given that most of the debris treatment technologies specified in today's rule are not restricted to specific contaminants other than metal vs. nonmetal contaminants and that many technologies (e.g., surface removal, incineration) have no contaminant restrictions (see section V.C.5 below), the designation of a few contaminants subject to treatment should be sufficient to ensure effective treatment of other toxic contaminants that may be present.

Further, commenters argued, and the Agency agrees, that it would be difficult to implement and enforce a rule that required generators to treat toxic constituents that they have reason to know are present at detectable levels. First, whether the generator, in fact, could have reason to know that a toxic constituent is present is highly

[22] Emissions of metals, HCl, Cl_2, and particulate matter are also controlled by the BIF rule.

[23] Unless EPA determines the hazardous debris no longer contains hazardous waste (see discussion in section V.B.2 of the text) or unless the generator elects to comply with the waste-specific treatment standards for the waste contaminating the debris (see discussion in section V.C.4 of the text).

[24] We note that the generator may presume that the BDAT constituents for the listed waste are present at detectable levels and is not required to sample and analyze the debris to make that determination. If, however, the generator elects to sample and analyze the debris, the Agency acknowledges that this may be a difficult task for many types of debris and debris mixtures. In this situation, the generator must use best engineering judgement to obtain samples that are as representative as practicable.

[25] We note that the Agency is considering proposing treatment standards for TC wastes and debris contaminated with TC wastes. If that rule is promulgated, debris will be identified as hazardous debris if it exhibits the TC for an additional 26 organic compounds many of which are commonly found at remediation sites. Thus, over time, additional debris contaminants will become designated contaminants subject to treatment.

subjective and difficult to enforce. Second, the Agency upon additional consideration believes that, if treatment of such additional toxic constituents were to be required, treatment should only be required if the constituent is present at significant levels, not merely at detection levels. This raises the issue of what is a significant level. Possible criteria include a level of potential health significance or the F039 treatment levels. (We note that the Agency, in fact, requested comment on using these criteria to determine when these other (i.e., other than BDAT constituents for listed waste contaminating the debris and the constituents for which the debris fails the EP) toxic constituents known to be present would be contaminants subject to treatment. See 57 FR 984, n. 11.) Not only is the Agency unsure which approach would be more appropriate, but under either approach—i.e, health-based levels or F039 levels—sampling and analysis would be required if the generator did not want to presume that a toxic constituent known to be present was present at the trigger level. Since it is particularly difficult to take representative samples of untreated debris, EPA considers this approach to be inadvisable.

4. Debris May Be Treated to the Existing Waste-Specific LDRs in Lieu of Today's Debris Treatment Standards

Today's rule gives generators the option of treating hazardous debris to the existing waste-specific treatment standards for the waste contaminating the debris. The treated debris, however, must continue to be managed under subtitle C. If land disposed, the debris must be disposed in a subtitle C landfill. However, such debris would be excluded from subtitle C regulation if the Agency determined that it no longer contained hazardous waste (see discussion above in section V.B.2) or if the treater determined that the debris no longer contained hazardous constituents at levels that may be established under a final Hazardous Waste Identification Rule (see discussion above in section V.B.3).

The Agency is providing this option in today's rule based on the request of numerous commenters. For example, one commenter routinely adds the tyvek suits and rubber gloves worn by facility operators to the waste stream leaving his factory, and wishes to continue doing so. The proposed rule would have required the tyvek suits and rubber gloves (as debris) to be separated from the waste for treatment by the specified technology. The commenter preferred to treat the waste/debris mixture to the waste-specific standards and the Agency believes that this practice is appropriate to provide an additional means of treating debris that substantially reduces toxicant mobility or concentration.

The Agency developed special treatment standards for hazardous debris because of concern that, in most cases, the waste-specific standards would not be practicable for debris given the difficulty in obtaining representative samples of treated debris to document compliance with the concentration-based waste-specific standards. The Agency acknowledges, however, that some types of debris may be amenable to representative sampling and therefore compliance with the waste-specific standards may be workable.[26]

Debris that is treated to the waste-specific treatment standards rather than today's debris treatment standards remains subject to subtitle C regulation because toxic constituents may continue to be present at levels that could pose a hazard to human health and the environment. EPA believes that this position is appropriate for two reasons. First, there is no reason to exclude from subtitle C regulation hazardous debris treated to the waste-specific standards when the waste itself is not excluded when treated to those standards. Second, and moreover, the Agency believes that today's treatment standards will treat debris to levels resulting in minimum threat to human health and the environment. See discussion below. Although meeting the waste-specific standards may result in some cases in levels of toxic constituents in the treated debris that do not pose a hazard to human health and the environment, the Agency is not certain that this will be the case in all situations (and in any case, the issue is more appropriate for resolution in the context of the May 20, 1992, proposed rule, 57 FR 21450).

5. Treatment Standards

In this section, we provide the rationale for the treatment standards for each technology and explain how the standards work, and we explain how the final treatment standards differ from those proposed.

a. *Overview.* Today's rule establishes performance and/or design and operating requirements for 17 treatment technologies that the Agency has designated as BDAT for hazardous debris. See Table I of § 268.45. Although any technology may be used to treat any debris, the treatment standards vary for many technologies according to the type of debris treated.[27] In addition, the rule prohibits the use of some technologies to treat specific types of contaminants. For example, the physical extraction technologies (e.g., abrasive blasting) have no contaminant type restrictions, while thermal desorption may not be used to treat metals other than mercury. Generators (and owners and operators of treatment facilities) may select any treatment technology that is not restricted for the contaminant subject to treatment.

The Agency has attempted to establish performance or design and operating requirements for each of the extraction and destruction technologies that will optimize treatment effectiveness such that hazardous contaminants would not be present at residual levels in the debris that could pose a hazard to human health and the environment. Thus, the treated debris could be excluded from subtitle C regulation. Unfortunately, the Agency was not able to develop objective performance or design and operating standards for all extraction and destruction technologies that would ensure treatment to minimum threat levels (e.g., thermal desorption, biodegradation, and chemical destruction; see discussion below). For these technologies, the Agency is concerned that residual levels of hazardous contaminants may remain in the debris at levels that could pose a hazard to human health and the environment. Consequently, today's rule requires for these technologies that the owner or operator of the treatment unit must make an "Equivalency Demonstration" to the Agency under existing § 268.42(b) that documents that the technology treats contaminants subject to treatment to a level equivalent to that required by the performance and design and operating standards for the other technologies in

[26] We note that commenters may have requested this option out of frustration that the proposed rule did not effectively address the issue of debris mixtures. The proposed rule appeared to require either separation of debris types prior to treatment or the extensive use of treatment trains to treat different debris types. This problem has been remedied in today's final rule by acknowledging the ability of the treatment technologies to treat a greater variety of debris types than proposed. See discussion in section V.C.5 of the text.

[27] In addition, although the rule does not prohibit treatment of specific debris types by a technology, the treatment standards cannot be met as a practical matter for certain debris/technology combinations (e.g., high pressure steam and water sprays cannot remove 0.6 cm of the surface layer of brick, concrete, etc). In other situations, the definition of the technology as a practical matter precludes the use of some technologies for some debris types (e.g., the definition of spalling cannot be met when applied to treat cloth).

Table 1, § 268.45, such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent subtitle C control.

Today's treatment standards establish performance standards rather than design and operating standards where supporting data were available. The Agency believes that performance standards will better ensure effective treatment given the variability in contaminant and debris types and properties that affect treatability. Further, performance standards give the owner and operator of the treatment unit the flexibility to tailor the design and operation of the unit to the specific debris/contaminant(s) being treated. An example of a performance standard is the standard for physical extraction technologies (e.g., abrasive blasting) used to treat a metal object where the standard requires decontamination to a "clean metal finish" as defined in the regulation. An example of a design and operating standard is the standard for thermal desorption that limits the thickness of porous debris to 10 cm (4 inches).

EPA recommends that the generator or owner or operator of the treatment facility consider the thermal, chemical, and physical properties of the debris and the contaminants on the debris before selecting a treatment technology to ensure that the performance or design and operating requirements can by achieved. The Agency plans to develop a nonregulatory implementation assistance document to provide assistance on how to select the most appropriate technologies for a given debris/contaminant combination.

Although hazardous debris treatment operations are generally subject to regulation under the interim status or permit standards of parts 270 and 264, 265, or 266,[28] today's hazardous debris performance or design and operating standards are neither interim status nor permit standards. The hazardous debris treatment standards are adopted pursuant to section 3004(m) of RCRA to ensure that debris is treated to minimize the hazardous constituents' toxicity or mobility during future management, while the interim status and permit standards are designed to protect human health and the environment from the operation of the storage, treatment, or disposal facility itself. It is for this reason that today's treatment standards do not address control of emissions that can occur from debris treatment; the Agency is relying on the applicable interim status and permit standards to control treatment emissions. See discussion below in section V.F.

The Agency has grouped the various treatment technologies into categories of like treatment type. Each category is based on the same (or similar) performance or design and operating standards. See Table 1 of § 268.45. We discuss below for each group of treatment technologies the basis for the standards and how the standards will work. Note that the performance or design and operating standards must be met for all debris surfaces that are contaminated with hazardous waste. Thus, if a pipe or pump was used to manage hazardous waste, the performance standards must be met for the inside surfaces of the pipe or pump. Decontamination of the outer surfaces only does not constitute compliance with the debris treatment standards.

b. *Extraction Technologies.* The Agency has classified the extraction technologies as physical extraction, chemical extraction, and thermal extraction.

(1) Physical Extraction Technologies. The physical extraction technologies are: abrasive blasting; scarification, grinding, and planing; spalling; vibratory finishing; and high pressure steam and water sprays. For these technologies, the rule establishes performance standards based on removal of the contaminated layer of the debris. Any contaminant subject to treatment may be treated by these technologies,[29] because the contaminants are removed as residue [30] subject to the treatment standards for the waste contaminating the debris.

In addition, any debris type (e.g., metal, concrete, wood, paper, cloth) may be treated by these technologies. The Agency reasoned that any debris type would be effectively treated provided that the contaminated layer of the debris is removed. We note that, although the rule allows the use of physical extraction technologies on any debris type, it will be impracticable to use these technologies on some debris types and the performance standards cannot be met for some technology/debris combinations. For example, it is impracticable to spall paper or cloth. However, we realize that debris often is comprised of a mixture of debris types, and physical extraction may be the most reasonable technology for the predominate debris type while other types of debris present would be removed as residue. An example is large chunks of concrete that have paper labels adhered to them. Spalling or another physical extraction technology may be practicable for the concrete and the paper labels will be removed as residue. An example of where the performance standard cannot be met for a technology/debris combination is high pressure steam and water spray used to treat brick or concrete. As discussed below, because these debris types are porous and toxic contaminants may be adsorbed below the surface of the debris, the performance standard requires removal of at least the outer 0.6 centimeter surface layer. This technology cannot meet that performance standard for those types of debris. Rather than explicitly prohibiting such practices, however, such practices will be precluded because of the inability to comply with the standards.

To ensure that the contaminated layer of debris is removed and to account for the physical properties of different types of debris, the rule establishes different performance standards for different types of debris.

(a) Metal Objects. Metal objects must be treated to remove foreign matter adhering to the metal to produce a "clean debris surface". The rule defines a "clean debris surface" as a surface that, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste, except that residual staining caused by soil and waste consisting of light shadows, slight streaks, or minor discolorations, and soil and waste in cracks, crevices, and pits may be present provided that such staining and soil and waste in cracks, crevices, and

[28] Unless treatment occurs in an on-site container, tank, or containment building, the hazardous debris is treated within 90 days of generation, and the unit complies with the appropriate standards of part 265, or unless the treatment occurs within the Area of Containment (AOC) at a Superfund remediation site and the generator complying with today's treatment standards in order to remove the treated debris from the AOC and manage it as debris excluded from subtitle C. See discussion in section V.F. of the text.

[29] As discussed below in the text, today's rule establishes additional requirements for certain technologies in order to exclude the treated debris from subtitle C when the debris is contaminated with waste that is listed for dioxins (EPA Hazardous Waste Numbers F020, F021, F022, F023, F026, or F027). The Agency did establish such additional requirements for treatment of debris contaminated with dioxin-listed waste when treated by the physical extraction technologies, however, because the Agency believes that it is highly unlikely that compliance with the rigorous performance standards for these physical extraction technologies will allow significant residual levels of contaminants such that even highly toxic contaminants could pose a hazard to human health and the environment absent subtitle C control.

[30] Except that for spalling, the spalled material is considered untreated debris, not residue, and must be treated before land disposal. See additional discussion in the text.

pits shall be limited to no more than 5% of each square inch of surface area.

The rule allows minor residual staining caused by soil and waste and soil and waste to remain in cracks, crevices, and pits of up to 5% of each square inch of surface area [31] because of the impracticability of cleaning metal debris to a "white metal finish" as proposed. The Agency selected the 5% surface area criterion because: (1) it is within the range of reasonable levels—1% to 10%—that could have been selected; (2) it is generally equivalent to the Steel Structures Painting Council's specification for "Near-White Blast Cleaning" for cleaning steel surfaces by the use of abrasives; [32] and (3) it should not allow toxic contaminants to remain at levels that could pose a hazard to human health and the environment absent subtitle C regulation, and should remove contaminants so that threats posed by disposal of the debris are minimized.

(b) Brick, Cloth, Concrete, Paper, Rock, Pavement, and Wood. The performance standard for these types of debris requires: (1) Removal of at least 0.6 centimeters of the surface layer; and (2) treatment to a "clean debris surface." Removal of 0.6 centimeters of the surface layer is required for these types of debris because they may be porous and toxic contaminants may by absorbed within the debris. (The Agency recognizes that, as a practical matter, the 0.6 cm surface removal requirement precludes the use of this technology for most porous debris.) To ensure removal of contaminants that may be absorbed to depths beyond 0.6 centimeters, the rule requires removal of virtually all staining that could be indicative of the presence of toxic contaminants. The rule allows minor residual staining and foreign matter in cracks and crevices on up to 5% of the surface area (on a square inch basis) as a reasonable and practicable method to help ensure that the standards do not require treatment to a level beyond that necessary to ensure that the treated debris does not pose a hazard to human health and the environment absent subtitle C regulation. We note that staining that is not indicative of the potential presence of hazardous waste or contaminated soil (e.g., rust stains on concrete adjacent to steel reinforcing bars) need not be removed and is not considered in determining compliance with the maximum 5% surface area limit on residual staining. The basis for the 5% surface area limit (on a square inch basis) on residual staining and foreign matter in cracks and crevices is the same as the basis discussed above for the definition of clean metal finish.

(c) Glass, Rubber, Plastic. The physical extraction performance standards for these types of debris are the same as for brick, concrete, etc., except that removal of at least 0.6 centimeters of the surface layer is not required. Removal of the surface layer for glass, rubber, or plastic is not required because glass is nonporous and will not absorb contaminants below the surface, and rubber and plastic, although permeable, are not likely to leach absorbed contaminants at substantial rates.

(2) Chemical Extraction. The technologies classified as chemical extraction are water washing and spraying; liquid phase solvent extraction; and vapor phase solvent extraction. The performance standards for these technologies are based on dissolution of the contaminants into the cleaning solution. Removal of the outer debris layer is not intended.

(a) Water Washing and Spraying. Water sprays or water baths will effectively treat debris when sufficient temperature, pressure, residence time, agitation, surfactants, acids, bases, and/or detergents are used to meet the performance standards in accord with the contaminant restrictions. The rule requires that the debris must be treated to a "clean debris surface" (see discussion above) to ensure effective treatment to levels of hazardous contaminants that are not likely to pose a hazard to human health and the environment absent subtitle C control.

For porous debris—brick, cloth, concrete, paper, pavement, rock, and wood—the rule provides two other requirements. The thickness (i.e., one dimension) of each piece of porous debris may not be more than 1.2 cm (i.e., ½ inch), and the contaminants must be soluble to at least 5% by weight in the water solution or 5% by weight in the emulsion, as applicable. The Agency is applying these standards for porous debris to ensure effective extraction of toxic contaminants that may be absorbed below the surface layer of the debris.

If reducing the thickness of debris to 1.2 cm to meet the treatment standards results in debris that no longer meets the 60 mm minimum particle size limit for debris, such material is subject to the waste-specific treatment standards for the waste contaminating the material, unless the debris has been cleaned and separated from contaminated soil and hazardous waste before size reduction. This is consistent with the Agency's position that material with a particle size less than 60 mm is amenable to conventional treatment for process waste and small particle-sized material (i.e., as opposed to large debris objects) and that such material can be reasonably sampled for analysis to document compliance with the concentration-based treatment standards for the waste contaminating the material.

If the debris has been cleaned and separated from contaminated soil and hazardous waste before size reduction the material remains classified as debris subject to today's treatment standards even if it no longer has a 60 mm particle size. The Agency believes that cleaning and separation of contaminated soil and hazardous waste will substantially reduce the concentration of toxic constituents such that the debris should contain minimum threat levels subsequent to treatment by an extraction or destruction technology. The level of cleaning and separation that is required is the same as required for separation of treatment residue from treated debris. See Note 9 to Table 1, § 268.45. At a minimum, simple physical or mechanical methods must be used such as vibratory or trommel screening or water washing. The debris surface need not be cleaned to a "clean debris surface" as defined in Table 1; rather, the surface must be free of caked soil, waste, or other nondebris material. Nondebris materials so separated are subject to the waste-specific treatment standards for the waste contaminating the material.

Porous debris (i.e., brick, cloth, concrete, paper, pavement, rock, or wood) that is contaminated with a waste listed for dioxin—EPA Hazardous Waste Numbers F020, F021, F022, F023, F026, or F027—is subject to additional controls. Because of the potential toxicity of the constituents in these wastes, the Agency believes that it is prudent to require additional controls to ensure that the potentially highly toxic constituents in these wastes are extracted from below the debris surface and that the treated debris poses minimum threat to human health and the environment absent subtitle C control. Accordingly, the rule requires the treater to make an "Equivalency Demonstration" to the Agency under

[31] Note that the 5% surface area criterion is applied to each square inch of the debris surface that has been contaminated with hazardous waste. The area covered by large stains cannot be averaged against large unstained areas. Only 5% of the area within any square inch can contain a residual stain.

[32] See the May 18, 1992, memorandum from Peter Shields, Radian, to Mark Mercer, EPA, entitled "Industry Standards for Cleanliness of Metal Surfaces".

existing § 268.42(b) that documents that the technology treats contaminants subject to treatment in these dioxin-listed wastes to a level equivalent to that required for these contaminants by the performance and design and operating standards for other technologies in Table 1, § 268.45, such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent subtitle C control.

(b) Liquid Phase Solvent Extraction. This technology decontaminates debris surfaces by applying a nonaqueous liquid or liquid solution which causes the toxic contaminants to enter the liquid phase and be flushed away from the debris along with the liquid or liquid solution using agitation, temperature, and residence time sufficient to meet the performance standards. The treatment standards for this technology are the same as for water washing and spraying because the technologies use the same principles to extract toxic contaminants from debris.

(c) Vapor Phase Solvent Extraction. This technology decontaminates debris surfaces by applying an organic vapor which causes the toxic contaminants to enter the vapor phase using sufficient agitation, residence time, and temperature and to be flushed away with the organic vapor such that the performance standards are achieved. The treatment standards for this technology are the same as for water washing and spraying, except that porous debris surfaces must be in contact with the organic vapor for more than 60 minutes. This treatment time is consistent with state-of-the-art practices and is necessary to ensure effective extraction of contaminants.

(3) Thermal Extraction. The Agency has classified two technologies as thermal extraction: High temperature metals recovery and thermal desorption.

(a) High Temperature Metals Recovery (HTMR). HTMR furnaces are smelting, melting, or refining furnaces (including pyrometallurgical devices such as cupolas, reverberator furnaces, sintering machines, roasters, and foundry furnaces (see § 260.10 definition of "industrial furnace")) that use sufficient heat, residence time, mixing, fluxing agents, and/or carbon to extract metals from debris. HTMR furnaces are potentially subject to regulation under the Boiler and Industrial Furnace (BIF) Rule (subpart H, part 266) when they burn hazardous debris.[33]

Today's rule requires that, for nonslagging furnaces (e.g., refining furnaces), treatment residuals must be separated from the debris. In addition, such separated residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris prior to further treatment. Further, these residues must meet the waste-specific treatment standards for all BDAT constituents in the waste contaminating the debris prior to land disposal. Finally, if debris is contaminated with a dioxin-listed waste, HTMR is not BDAT and the treated debris is not excluded from subtitle C unless the treater makes an "Equivalent Technology" demonstration to the Agency under § 268.42(b) that documents that the technology treats contaminants subject to treatment to a level equivalent to that required by the performance and design and operating standards for other technologies in Table 1, § 268.45, such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent subtitle C control.

Today's rule does not establish performance or design and operating standards for slagging HTMR furnaces (other than the requirements inherent in the definition—a melting or smelting furnace must melt metals and extract the metals from debris) because a slagging furnace is likely to provide effective treatment for all contaminants, except perhaps for chlorinated dioxins as discussed below, and for all debris types.

For nonslagging (i.e., refining furnaces such as roasters) HTMR furnaces, the rule ensures treatment of both metal and organic contaminants. First, the definition of HTMR furnaces requires that metals must be separated from the debris. Thus, not only will metals be removed, but temperatures hot enough to separate metals from debris should also remove organic contaminants from the debris (with perhaps the exception of dioxins, as discussed below). Second, to help ensure that the HTMR unit has effectively removed organic contaminants in the debris the rule requires that the residue be separated from the treated debris and that the separated residue must meet the waste-specific treatment standards for the BDAT organic contaminants in the waste contaminating the debris prior to further treatment.

In addition, the Agency is concerned that potentially extremely toxic contaminants may not be destroyed (or removed with the residue) to levels that would not pose a hazard to human health and the environment absent subtitle C control. Consequently, if debris is contaminated with a dioxin-listed waste, HTMR is not BDAT for the debris and the debris is not excluded from subtitle C after treatment unless the treater obtains approval from the Director under an equivalent technology demonstration provided by § 268.42(b) for the design and operating conditions of the HTMR unit. The rule provides this restriction for dioxin-listed waste because of concern that if such contaminants remained undestroyed even at low concentrations in the residue and were not completely removed from the treated debris, that the debris could pose a health or environmental hazard absent subtitle C control.

(b) Thermal Desorption. Thermal desorption is heating in an enclosed chamber under either oxidizing or nonoxidizing atmospheres at sufficient operating temperature and residence time such that the contaminants subject to treatment are vaporized and removed from the heating chamber in a gaseous exhaust streams.[34] The rule establishes operating and performance standards and contaminant restrictions, and requires the treater to make a demonstration of "Equivalent Technology" under § 268.42(b) to document that the technology treats contaminants subject to treatment to a level equivalent to that required by the performance and design and operating standards for other technologies in Table 1, § 268.45, such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent subtitle C control.

The Agency attempted to develop objective treatment standards that would obviate the need for an equivalency demonstration (see discussion above). The Agency determined, however, that it was very difficult to establish universal operating

[33] See § 266.100(c) that states generally that a smelting, melting, or refining furnace that burns a hazardous waste with a heating value of 5,000 Btu/lb or more or that contains a total concentration of toxic organic compounds exceeding 500 ppm by weight is subject to the BIF Rule.

[34] We note that a thermal desorber is regulated either as an incinerator (if the device is direct-fired or if the off-gas is burned in an afterburner) under subpart O of part 264 or 265, or as a thermal treatment unit under subpart X, part 264 or subpart P, part 265. To distinguish between thermal desorption and thermal destruction (for which separate debris treatment standards are provided) for purposes of complying with this rule, the primary purpose of thermal desorption is to volatilize contaminants and to remove them from the treatment chamber for subsequent destruction or treatment. We note that the treatment standards in Table 1, § 268.45 for thermal destruction specifically excludes thermal desorbers.

limits for the key operating parameters that affect treatment efficiency—temperature, residence time, size of porous debris, bed depth, and volatility of the contaminant—that would strike a balance between ensuring treatment to minimum threat levels and establishing requirements that could grossly over-regulate in many situations. Rather, the Agency believes that operating requirements can best be determined on a case-by-case basis (i.e., under an equivalent technology demonstration under § 268.42(b)) considering the parameters listed above. In addition, the Agency believes that the performance standard used for physical and chemical extraction—treatment to a clean debris surface—is not practicable for thermal desorption because treated debris surfaces will continue to have a dusting of residue after separation of the debris from the residue by simple, physical or mechanical means (unless water washing is used). See discussion below regarding the requirement for separation of debris from residue.

The treatment standards for thermal desorption require, in addition to the case-by-case Agency approval of design and operating conditions, that hazardous contaminants be vaporized (by virtue of the definition of thermal desorption), and restricts the use of the technology for metal contaminants other than mercury (i.e., thermal desorption is not BDAT for metals other than mercury). In addition, to help ensure extraction of contaminants from below the surface of porous debris, the rule establishes a maximum thickness (in one dimension) for porous debris of 10 cm (4 inches).[35] The 4 inch maximum thickness limit is consistent with state-of-the-art practices. The restriction on metals other than mercury is provided because they are not likely to be extracted from below the debris surface at normal desorption temperatures and residence times.

We note that we considered restricting the use of thermal desorption for only porous debris that is contaminated with a metal other than mercury. We reasoned that metal contaminants in soil or waste on the surface of nonporous debris will be physically separated from the debris along with the soil or waste during or after desorption, and thus a restriction would not be necessary. However, we are also concerned about metal contaminants that may remain on the surface of nonporous (and porous) debris after desorption and after separation of the treated debris from the residue. An example is a piece of steel contaminated with a metal-bearing paint that causes the steel to fail the TC. The metal may not be desorbed and the paint would not be separated from the steel during the simple physical or mechanical separation of residue from debris. Although the steel would continue to fail the TC, it would have been treated to meet BDAT and could be land disposed in a subtitle C facility. This is inconsistent with the Agency's view that BDAT for a TC waste must cause the waste to no longer exhibit the TC.

The treatment standard for thermal desorption also requires separation of the treated debris from treatment residuals and soil, waste, or other nondebris material (collectively referred to as residuals) because residuals are subject to the treatment standards for the waste contaminating the debris. See discussion in Section V.E. Not only will these residuals contain unvolatilized metals that require further treatment, but the Agency is using the residue separated from debris as a surrogate means to ensure effective debris treatment. The rule achieves this objective by requiring that the residue separated from the treated debris must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris. If the residue (prior to further treatment) does not meet applicable treatment standards for organic compounds, it is an indication that the desorption process did not effectively extract the organic contaminants subject to treatment. Thus, the treatment is not BDAT, the treated debris is not excluded from subtitle C, and both the residues and the debris cannot be land disposed without further treatment.

Separation of the desorbed debris from treatment residuals (i.e., soil, waste, or other nondebris materials) must be accomplished using simple physical or mechanical means such as vibratory or trommel screens or water washing. The separation process need not produce a "clean debris surface" [36] as discussed above, however; rather the debris surface must be free of caked residuals or nondebris materials such as soil or waste. For example, debris need not be water washed after trommel screening to remove dust from residuals or nondebris material. (Note that the use of water washing to separate thermally desorbed debris from residuals and nondebris materials need not comply with the treatment standards for water washing (e.g., treatment to a "clean debris surface") because the debris has already been treated by an alternative technology.)

c. *Destruction Technologies.* The Agency has identified two classifications of destruction technologies: chemical destruction and thermal destruction. These technologies are designed and operated to destroy hazardous contaminants on debris surfaces and in surface pores.

(1) Biodegradation. Biodegradation is the removal of hazardous contaminants from debris surfaces and surface pores in an aqueous solution and biodegradation of organic or nonmetallic inorganic compounds (i.e., inorganics that contain phosphorus, nitrogen, or sulfur) in units operated under either aerobic or anaerobic conditions. The rule establishes operating and performance standards and contaminant restrictions, and requires the treater to make a demonstration of "Equivalent Technology" under § 268.42(b) to document that the technology treats contaminants subject to treatment to a level equivalent to that required by the performance and design and operating standards for other technologies in Table 1, § 268.45, such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent subtitle C control.

The Agency attempted to develop objective treatment standards that would obviate the need for an equivalency demonstration (see discussion above). The Agency determined, however, that it was very difficult to establish universal operating limits for the key operating parameters that affect treatment efficiency—type of matrix contaminating the debris, biological proprieties of the contaminant, temperature, pH, treatment time, biomass concentration, moisture level, and for aerobic biodegradation, oxygen concentration—that would strike a balance between ensuring treatment to minimum threat levels and establishing requirements that could

[35] See previous discussion in the text that, if size reduction of debris to meet the treatment standards reduces the particle size to below the minimum 60 mm size limit for the definition of debris, such nondebris material is subject to the waste-specific treatment standards for the waste contaminating the material, unless the debris has been cleaned and separated from contaminated soil and waste prior to size reduction.

[36] "Clean debris surface" means the surface, when viewed without magnification, shall be free of all visible soil, waste, paint, or other foreign (i.e., nondebris) matter, except that residual staining consisting of light shadows, slight streaks, or minor discolorations, and foreign matter in cracks and crevices may be present provided that such staining and foreign matter in cracks and crevices shall be limited to no more than 5% of each square inch of surface area.

grossly over-regulate in many situations. Rather, the Agency believes that operating requirements can best be determined on a case-by-case basis (i.e., under an equivalent technology demonstration under § 268.42(b)) considering the parameters listed above.

In addition, the Agency believes that the performance standard used for physical and chemical extraction—treatment to a clean debris surface—is not practicable for biodegradation because treated debris surfaces are likely to fail that standard even though organic contaminants may have been destroyed and metal contaminants may have been extracted. Further, the Agency could not identify a generic standard that would ensure effective treatment of organic contaminants that may be beneath the surface of porous debris.

In addition to the requirement to make an equivalency demonstration, the treatment standards establish a maximum thickness (in one dimension) for porous debris of 1.2 cm (½ inch.[37] These requirements will help ensure extraction of contaminants from below the surface of porous debris.

The rule also restricts the use of biodegradation for metal contaminants because metals are not destroyed by the biomass (i.e., biodegradation is not BDAT for metals). Further, the performance and design and operating standards would not ensure that undestroyed metal would partition to the biomass for treatment to the numeric standards for the waste contaminating the debris. This is because the performance standard does not require treatment to a "clean debris surface" as discussed above, so that neither the performance standard nor the requirement to separate treated debris from residuals (see discussion below) would ensure that metal contaminants would partition to the residue.

The treatment standard for biodegradation requires separation of the treated debris from treatment residuals (i.e., soil, waste, or other nondebris material) because residuals are subject to the numerical treatment standards for the waste contaminating the debris. See discussion in section V.E. Not only will these residuals contain metal contaminants that require further treatment, but the Agency is using the residue separated from debris as a surrogate means to ensure effective debris treatment. Accordingly, the debris treatment standard also requires that the residue separated from the treated debris must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris prior to further treatment. If the residue (prior to further treatment) does not meet applicable treatment standards for organic compounds, it is an indication that the biodegradation process did not effectively destroy the organic contaminants subject to treatment. Thus, the treatment is not BDAT, treated debris is not excluded from subtitle C, and both the residues and the debris cannot be land disposed without further treatment.

Separation of the biodegraded debris from treatment residuals, soil, waste, or other nondebris materials (collectively referred to as residuals and subject to the treatment standards for residuals) must be accomplished using simple physical or mechanical means such as vibratory or trommel screens or water washing. The separation process need not produce a "clean debris surface" as discussed above, however; rather the debris surface must be free of caked biomass or nondebris materials such as soil or waste. For example, the use of water to wash off the biomass or other foreign matter from the debris after removal from the treatment process does not subject the debris to the treatment standards for water washing (e.g., treatment to a "clean debris surface"). This is because the debris has already been treated by an alternative technology.

(2) Chemical Destruction. The rule establishes two chemical destruction technologies as BDAT: Chemical oxidation and chemical reduction.

(a) Chemical Oxidation. Chemical oxidation is chemical or electolytic oxidation utilizing the following oxidation reagents (or waste reagents) or combination of reagents: Hypochlorite (e.g., bleach); chlorine; chlorine dioxide; ozone or UV (ultraviolet light) assisted ozone; peroxides; persulfates; perchlorates; permanganates; and/or other oxidizing reagents of equivalent destruction efficiency. Chemical oxidation specifically includes what is referred to as alkaline chlorination.

The Agency was not able to develop objective performance or design and operation standards because of the variety of oxidation reagents that could be used and the variety of chemical and physical properties of debris and hazardous contaminants. In addition, the Agency believes that the performance standard used for physical and chemical extraction—treatment to a clean debris surface—is not practicable for chemical oxidation because treated debris surfaces are likely to fail that standard even though organic contaminants may have been destroyed and metal contaminants may have been extracted. Further, the Agency could not identify a generic standard that would ensure effective treatment of organic contaminants that may be beneath the surface of porous debris. Consequently, the primary treatment standard for chemical oxidation requires the treater to make a demonstration of "Equivalent Technology" under § 268.42(b) to document that the technology treats contaminants subject to treatment to a level equivalent to that required by the performance and design and operating standards for other technologies in Table 1, § 268.45, such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent subtitle C control. See discussion above.

The rule also restricts the use of chemical oxidation for metal contaminants because metals are not destroyed by the chemical reagents (i.e., chemical oxidation is not BDAT for metals). Further, the performance and design and operating standards would not ensure that undestroyed metal would partition to the residue for treatment to the numeric standards for the waste contaminating the debris. This is because the performance standard does not require treatment to a "clean debris surface" as discussed above, so that neither the performance standard nor the requirement to separate treated debris from residuals (see discussion below) would ensure that metal contaminants would partition to the residue.

In addition, to help ensure effective treatment, the treatment standard requires that porous debris—brick, cloth, concrete, paper, pavement, rock, and wood—cannot have a thickness exceeding 1.2 cm (½ inch) [38] prior to treatment to ensure effective treatment of contaminants absorbed beyond the debris surface.

Finally, the rule requires that the treated debris must be separated from

[37] See previous discussion in the text that, if size reduction of debris to meet the treatment standards reduces the particle size to below the minimum 60 mm size limit for the definition of debris, such nondebris material is subject to the waste-specific treatment standards for the waste contaminating the material, unless the debris has been cleaned and separated from contaminated soil and waste prior to size reduction.

[38] See previous discussion in the text that, if size reduction of debris to meet the treatment standards reduces the particle size to below the minimum 60 mm size limit for the definition of debris, such nondebris material is subject to the waste-specific treatment standards for the waste contaminating the material, unless the debris has been cleaned and separated from contaminated soil and waste prior to size reduction.

treatment residues, and that such separated residue must meet the waste-specific treatment standards for organic compounds for the waste contaminating the debris. See discussion above for rationale and information on how this provision works.

(b) Chemical Reduction. Chemical reduction is a chemical reaction utilizing the following reducing reagents (or waste reagents) or a combination of reagents: Sulfur dioxide; sodium, potassium, or alkali salts of sulfites, bisulfites, and metabisulfites, and polyethylene glycols (e.g., NaPEG and KPEG); sodium hydrosulfide; ferrous salts; and/or other reducing reagents of equivalent efficiency. The treatment standards for chemical reduction are identical to those for chemical oxidation because the technologies are based on similar chemical reactions.

(3) Thermal Destruction. Thermal destruction is treatment in an incinerator operating in accordance with subpart O of part 264 or 265, a boiler or industrial furnace operating in accordance with subpart H of part 266, or other thermal treatment unit operated in accordance with subpart X, part 264 (permit standards) or subpart P, part 265 (interim status standards).

As noted above in the discussion of treatment standards for thermal desorption, a thermal desorber is regulated either as an incinerator (if the device is direct-fired or if the off-gas is burned in an afterburner) under subpart O of part 264 or 265, or as a thermal treatment unit under subpart X, part 264 or subpart P, part 265. To distinguish between thermal desorption and thermal destruction (for which separate debris treatment standards are provided) for purposes of complying with this rule, the primary purpose of thermal desorption is to volatilize contaminants and to remove them from the treatment chamber for subsequent destruction or treatment. The definition of thermal destruction in Table 1, § 268.45, specifically excludes thermal desorbers.

Today's rule requires that treatment residuals be separated from the debris and restricts the use of thermal destruction (i.e., thermal treatment is not BDAT) for inorganic debris contaminated with a metal other than mercury. In addition, if debris is contaminated with a dioxin-listed waste, thermal destruction is not BDAT and the treated debris is not excluded from subtitle C unless the treater makes an "Equivalent Technology" demonstration to the Agency under § 268.42(b) that documents that the technology treats contaminants subject to treatment to a level equivalent to that required by the performance and design and operating standards for other technologies in Table 1, § 268.45, such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent subtitle C control. (Note as discussed below that these restrictions do not apply to vitrification.)

Given that thermal destruction uses substantially higher temperatures and often longer residence times than thermal desorption, the Agency believes that thermal destruction will destroy all but the most toxic hazardous nonmetal contaminants to minimum threat levels. Although metal contaminants will not be destroyed, metal contaminants in organic debris (e.g., wood, paper) will be removed from the treated debris. Metals in organic debris will partition to the residue (i.e., the material resulting from treatment that remains subject to numerical treatment standards) because the organic debris will be destroyed. Given that the treatment standards require separation of treated debris from the residue, the metals from the organic debris will partition to the residue for subsequent treatment to the waste-specific treatment standards for the waste contaminating the debris.[39] Thus, only metals contaminating inorganic debris (e.g., concrete, bricks) may remain untreated if they are not volatilized. To ensure treatment of such metals, the rule restricts the use of thermal destruction (i.e., thermal treatment is not BDAT) for inorganic debris contaminated with a metal other than the highly volatile mercury.

The treatment standards also require that the residue separated from the treated debris must meet the waste-specific treatment standards for the BDAT organic contaminants in the waste contaminating the debris prior to further treatment. This will help ensure that the thermal destruction unit has effectively destroyed organic contaminants in the debris.

In addition, the Agency is concerned that extremely toxic contaminants may not be destroyed (or removed with the residue) to levels that would not pose a hazard to human health and the environment absent subtitle C control. Consequently, if debris is contaminated with a dioxin-listed waste, incineration is not BDAT for the debris and the debris is not excluded from subtitle C after treatment unless the treater obtains approval from the Director of the design and operating conditions of the thermal destruction unit. We considered applying this restriction only to porous, inorganic debris under the reasoning that the contaminants in dioxin-listed waste would partition to the residue for nonporous debris (e.g., metal) and organic, porous debris (e.g., wood). We were concerned, however, that if such contaminants remained undestroyed even at low concentrations in the residue and were not completely removed from the treated debris, that the debris could pose a health or environmental hazard absent subtitle C control. Given that the requirements for separation of residue and treated debris do not require a "clean debris surface" but, rather allow a dusting of residue to remain on the debris, we believe that it is prudent to establish this restriction on dioxin-listed waste.

Finally, we note that vitrification is a type of thermal destruction and that the rule establishes special (i.e., reduced) requirements for vitrification. Although the Agency classified vitrification as both thermal destruction and an immobilization technology at proposal (57 FR 1036), the Agency believes that the regulation is more easily understood if vitrification is classified only as thermal destruction with appropriate consideration given to the fact that vitrification heats the debris to extremely high temperatures resulting in the formation of nonasbestiform glass. The fact that vitrification transforms debris into a glass-like residue is the basis for the special requirements established for vitrification: (1) The restriction on metal contaminants for porous, inorganic debris does not apply; and (2) the requirement for Agency approval of design and operating conditions to treat debris contaminated with dioxin-listed waste does not apply. Nonetheless, the vitrified residue, like all debris treatment residue, is subject to the waste-specific treatment standards for the waste contaminating the debris.

d. *Immobilization Technologies.* The Agency has identified three immobilization technologies as BDAT for hazardous debris: macroencapsulation, microencapsulation, and sealing. Immobilized debris must be land disposed in a subtitle C facility;[40] it is not excluded from subtitle C regulation because the contaminants have not been destroyed or removed but rather contained indefinitely. Today's rule

[39] Although metals in soil or waste contaminating the debris may be removed by separation of the treated debris from these materials as the rule requires, metals in metal-bearing, heat resistant coatings on inorganic debris may neither be volatilized nor separated from the treated debris.

[40] In the Phase II land disposal restrictions rule, the Agency will reopen and request comment on the issue of whether immobilized debris should be excluded from subtitle C regulation.

establishes only general, nonobjective performance standards for these technologies rather than the more prescriptive standards that were proposed (57 FR 1035–1036) because, based on public comment and the Agency's re-evaluation, the Agency is concerned that the proposed prescriptive standards may be overly restrictive (i.e., by requiring conditions that are more than necessary to ensure immobilization prior to subtitle C management) [41] in some cases and ineffective in others. Nonetheless, the Agency believes that the performance standards promulgated will substantially reduce the likelihood of migration of hazardous constituents from the debris as required by RCRA section 3004(m)(1).

(a) Macroencapsulation. Macroencapsulation is the application of surface coating materials such as polymeric organics (e.g., resins and plastics) or the use of a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media. The treatment standard requires that the encapsulating material must completely encapsulate the debris (i.e., the encapsulant must completely surround the debris and be unbroken). Further, the encapsulating material must be resistant to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other waste, microbes) to ensure that the likelihood of migration of toxic contaminants has been substantially reduced.

(b) Microencapsulation. Microencapsulation is stabilization of the debris with the following reagents (or waste reagents) such that the leachability of the hazardous contaminants is reduced: Portland cement; or lime/pozzolans (e.g., fly ash and cement kiln dust). Reagents (e.g., iron salts, silicates, and clays) may be added to enhance the set/cure time and/or compressive strength, or to reduce the leachability of the hazardous constituents. The performance standard for microencapsulation requires that the leachability of the hazardous contaminants must be reduced.

We note that the proposed rule would have prohibited the presence of free liquids in the microencapsulated debris. Today's rule does not provide this explicit prohibition because free liquids are prohibited from land disposal facilities under existing requirements—§ 264.314 or 265.314.

If the treater reduces the particle size of debris to make it amenable to microencapsulation so that the debris no longer meets the 60 mm minimum particle size limit for debris, such material is subject to the waste-specific treatment standards for the waste contaminating the material, unless the debris has been cleaned and separated from contaminated soil and waste before size reduction. This is consistent with the Agency's position that material with a particle size less than 60 mm is amenable to conventional treatment for process waste and small particle-sized material (i.e., as opposed to large debris objects) and that such material can be reasonably sampled for analysis to document compliance with the concentration-based treatment standards for the waste contaminating the material.

If the debris has been cleaned and separated from contaminated soil and hazardous waste [42] before size reduction, the material remains classified as debris subject to today's treatment standards even if it no longer has a 60 mm particle size. The Agency believes that cleaning and separation of contaminated soil and hazardous waste will substantially reduce the concentration of toxic constituents such that, upon microencapsulation and placement in a subtitle C unit, the toxic constituents should not pose a hazard to human health and the environment.

The level of cleaning and separation that is required is the same as required for separation of treatment residue from treated debris. See Note 9 to Table 1, § 268.45. At a minimum, simple physical or mechanical methods must be used such as vibratory or trommel screening or water washing. The debris surface need not be cleaned to a "clean debris surface" as defined in Table 1; rather, the surface must be free of caked soil, waste, or other nondebris material. Nondebris materials so separated are subject to the waste-specific treatment standards for the waste contaminating the material.

(c) Sealing. Sealing is the application of an appropriate material which adheres tightly to the debris surface to avoid exposure of the surface to potential leaching media. When necessary to effectively seal the surface, sealing entails pretreatment of the debris surface to remove foreign matter and to clean and roughen the surface. Sealing materials include epoxy, silicone, and urethane compounds; paint may not be used as a sealant.

The performance standard requires that the sealing must be performed to avoid exposure of the debris surface to potential leaching media—that is, the sealant must completely enclose the debris. Further, the sealant must be resistant to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other waste, microbes) to ensure that the likelihood of migration of toxic contaminants has been substantially reduced.

e. *Changes to the Proposed Rule.* In addition to the changes from proposal discussed above, today's final rule greatly simplifies presentation of the treatment standards. Proposed Table 1 (indicating by YES or NO which technologies would be BDAT for which debris types when specific contaminant categories were present) and Table 2 (classifying contaminants by category) are not promulgated. Nonetheless, the final rule will operate essentially as the Agency had intended for the proposal rule. Rather than explicitly identifying acceptable technology/debris/contaminant combinations in two tables and providing the performance or design and operating standards in a third table as proposed, the final rule establishes the treatment standards in a single table—Table 1 of § 268.45. Not only was the proposed approach confusing, but proposed Table 1 forced unintended consequences.

Proposed Table 1 would have prohibited the use of particular technologies to treat certain debris types contaminated with certain hazardous constituents. In most cases, the proposed prohibition was based on the impracticability of applying the technology to the debris type rather than a determination as to whether the technology would effectively treat the debris if it was (or could be) applied. An example is the proposed prohibition on using abrasive blasting for paper, cloth, rubber, and plastic. The Agency has determined that abrasive blasting should be allowed for these types of debris because they may be mixed with debris that is amenable to the technology and would be converted to a treatment residue. An example is a steel I-beam that has paper labels on it. If abrasive blasting was used to treat the I-beam, the performance standards would ensure that the paper labels became part of the treatment residual subject to the treatment standard for the waste contaminating the debris.

We note, however, that depending on the type of contaminants subject to

[41] For example, by requiring a minimum 7 day cure time for microencapsulation when some reagents can adequately stabilize some debris types in much less time.

[42] We note that mixtures of contaminated soil, waste, and debris are regulated as debris if the mixture is at least 50% debris by volume. Thus, materials regulated as debris may contain high concentrations of toxic constituents.

treatment and the technology selected to treat the debris, more than one treatment technology may be required to meet the standards. For example, if water washing was used as an extraction technology for a porous debris (e.g., concrete) with a contaminant subject to treatment that was not soluble to at least 5% by weight in the water solution, another technology (e.g., thermal desorption) must be used to treat that contaminant.

In summary, today's final rule uses the definition of the technology, the performance or design and operating standards, and the contaminant restrictions provided by Table 1 of § 268.45 to ensure effective treatment of hazardous debris.

6. Treatment of Characteristic Debris

EPA proposed that debris that exhibits a characteristic of ignitability or reactivity, or that is contaminated with wastes that are ignitable, reactive, or corrosive, be treated to deactivate the waste. See 57 FR 1021. The Agency solicited comment on the question of whether such debris should also be treated for all Appendix VIII constituents that could reasonably be expected to be contaminating the debris (see 57 FR 984–85), and whether simple dilution should be allowed as a means of achieving deactivation, *id.* at 990.

In the third third final rule, EPA established deactivation as a treatment standard for certain ignitable, corrosive, and reactive wastes, and allowed dilution as a means of achieving this standard. In large part, this was due to the enormous diversity of wastes exhibiting these characteristics and the difficulty of ascertaining the existence or extent of contamination not attributable to the characteristic property itself for this enormously disparate group of wastes. See 55 FR 22654. These concerns are less apparent for debris exhibiting ignitability or reactivity, or contaminated with ignitable, corrosive or reactive wastes, because there appears to be much less of it (almost no debris could be ignitable, given that most ignitable wastes must be liquids (see § 261.21(a)(1) and (2)), none is corrosive (only liquids can be corrosive wastes), and also because a large proportion of debris would likely be contaminated with hazardous constituents because most hazardous debris comes from remediation sites. *Id.* at 985.

Most commenters opposed requiring treatment for specific hazardous contaminants. They also urged that all dilution be allowed as a form of treatment. Some commenters argued that this result was compelled by the statute. (This issue is presently awaiting decision by a panel of the District of Columbia Circuit Court of Appeals.) Others expressed concern with the practical difficulties inherent in sampling for hazardous constituents, or otherwise ascertaining their presence.

After considering the record, the Agency has decided to adopt the same treatment standards for ignitable, corrosive, or reactive (ICR) debris as for other hazardous debris because ICR debris is just as likely to be contaminated with hazardous constituents. See 55 FR 22654. (EPA will subcategorize ICR wastes and develop specific treatment standards, rather than allowing all types of dilution as treatment when a specific toxicity threat is apparent.) We are adopting a treatment standard of deactivation for these wastes but are requiring that the standard be achieved by use of the treatment methods adopted for other debris, unless the generator or treater demonstrates to the Agency that the debris does not contain toxic constituents. See discussion on codification of the contained-in principle above in Section V.B.2.b. (If necessary, petitioners could also make an equivalency demonstration under § 268.42(b) if they wish to treat by some means other than one of the methods set out in the rule.) This will result in some treatment of hazardous constituents that are present, rather than allowing simple dilution to be used. (Many treatment methods for debris involve some type of dilution, and are permissible under today's rule. The effect of today's rule is to prohibit dilution other than that occurring as a result of a designated treatment method. An example of impermissible dilution could be packing ignitable, corrosive, or reactive debris in sand.) In addition, the types of concerns voiced by the Agency in the third third rule against adopting this type of standard for all ignitable, corrosive, and reactive wastes are not present for debris. The Agency is not requiring identification of hazardous contaminants that may be present, as proposed, in part due to the practical concerns voiced by commenters, in part because the Agency is not adopting this approach for other debris, and because most of the treatment methods will provide some treatment of most if not all hazardous contaminants.

EPA is not providing the option of treating by existing treatment standards for these wastes. This is because the existing treatment standard for most ignitable, corrosive, or reactive wastes can be achieved by deactivation involving any type of dilution. Since this is the very result that the Agency is seeking to avoid, EPA is indicating in the rule that this option is not available for this one class of debris.

EPA noted at proposal that special rules would be needed for debris that is reactive due to presence of cyanide in order that cyanide by treated adequately. See 57 FR 990. We are adopting this approach in the final rule. Any such debris must therefore be treated by one of the specified technologies for which the treatment standards can be achieved for cyanide. In addition, any residues of such treatment may not be disposed until cyanide is treated to levels established in existing Table CCW of § 268.43 (the treatment standard for waste that is reactive because of cyanide). This approach is consistent with that adopted for reactive cyanide wastes in the third third rule and should ensure that the cyanide known to be present is treated adequately before land disposal.

7. Special Requirements for Inherently Hazardous Debris

The proposed rule also considered the regulatory status of debris that is itself hazardous because it is fabricated with toxic constituents. Because such debris will continue to exhibit the toxicity characteristic after treatment by an extraction or destruction technology, today's rule requires treatment by an immobilization technology to reduce the likelihood of migration of hazardous contaminants. See § 268.45(b)(4). Examples are lead pipe, or refractory brick containing chromium. See 57 FR 990. (This debris is referred to in this preamble discussion as "inherently hazardous debris".) Such debris can also be contaminated with listed wastes. In the proposed rule, the Agency discussed how the land disposal restrictions would apply if such debris were disposed of, and also indicated that an alternative for much of this debris would be to recycle it as scrap metal, in which case an existing regulatory exemption could apply. *id.* EPA also solicited comment on what standards should apply to residues from treating inherently hazardous debris, and also requested comment on whether there were situations when immobilization would not be an appropriate treatment technology for such debris. *Id.* at n. 26 and 990–91.

The Agency is essentially adopting the proposed approach in the final rule. However, some of the issues raised in the proposal require additional clarification, which is provided below.

a. *Inherently Hazardous Debris that Is Disposed.* When recycling of inherently hazardous debris is not

practicable and it is to be disposed, today's rule requires treatment by an immobilization technology to reduce the likelihood of migration of hazardous contaminants, followed by disposal in a subtitle C facility. In response to commenters' concerns about the need for size reduction for immobilization, we note that the treatment standards for macroencapsulation and sealing may be achieved in some cases without size reductions.[43]

A number of commenters questioned whether any treatment was needed to be performed on inherently hazardous debris or whether it could simply be disposed directly. The statute forecloses that option. Section 3004(m)(1) indicates that the Agency is to establish "levels or methods of treatment, if any" which substantially reduce waste toxicity and mobility and minimize threats. If there are not such methods, the situation EPA believes contemplated by the clause "if any" in section 3004(m), the waste cannot be land disposed. See section 3004 (d), (e), and (g); see also *API* v. *EPA*, 906 F. 2d 729, 738 (D.C. Cir. 1990) (use of comparative risk assessment to compare safety of treatment methods versus land disposal of untreated wastes is unnecessary given that the statute forecloses land disposal as an option). Thus, some treatment of inherently hazardous debris is needed in order for it to be land disposed. As indicated above, the Agency believes that such methods exist (i.e., immobilization).

If inherently hazardous debris is also contaminated with listed wastes, then that waste also must be treated by one of the prescribed treatment methods, the same approach adopted for all other debris. Note that the contaminants in the waste contaminating the debris need not be treated prior to immobilization of the debris if the performance standards for the immobilization technology can be achieved without such prior treatment.

Residues from treating inherently hazardous debris would not require further treatment unless the residues also exhibited a prohibited hazardous waste characteristic. However, if the inherently hazardous debris is contaminated with a listed waste, residues from treating the debris would remain subject to the numerical standards applicable to that listed waste. Furthermore, if the debris were treated first to remove or destroy the listed waste (i.e., treated by an extraction or destruction technology prescribed in today's rule) and subsequently treated again by immobilization due to its inherent content, the Agency would not consider the debris to be contaminated any longer with a listed waste, since the initial treatment would have removed or destroyed it. Thus, any residues from subsequent immobilization would not be subject to treatment standards unless those residues exhibited a characteristic. For example, if lead pipe contaminated with listed solvents was first treated to remove the solvent and then treated to immobilize the lead, only residues from removing the solvent would have to meet the numerical solvent treatment standards. This approach mirrors that adopted for all other hazardous debris.

b. *Inherently Hazardous Debris that Is Scrap Metal and Is Recycled.* EPA's rules provide for an exemption from regulation for scrap metal that is recycled. See § 261.6(a)(3)(iv); scrap metal is defined at § 261.1(c)(6). EPA consequently indicated at proposal that the land disposal prohibitions would not apply to inherently hazardous debris that was also scrap metal being recycled. EPA adheres to that approach, which simply restates current rules (and was not reopened for reconsideration). The only obligation for generators handling such scrap metal is to keep a record of the scrap and its subsequent disposition or recycling by metal reclamation. See § 268.7(a)(6). If the scrap metal is also contaminated with listed waste, the exemption continues to apply since the material would still meet the regulatory definition of scrap metal. However, any residues from processing the waste would remain hazardous by the derived from rule, and would require treatment to meet the standard for that listed waste before it could be land disposed. Thus, persons treating such scrap metal would become hazardous waste generators, and would also incur responsibilities under the land disposal restriction rules (see § 268.7(a) (1) and (2)). As explained in the previous section, however, if the scrap metal were to be treated first by a prescribed removal or destruction technology, it would no longer be considered to be contaminated with a listed waste, and any residues generated subsequently would not be hazardous wastes unless they exhibited a hazardous waste characteristic. Thus, it may be advantageous to arrange for pretreatment of contaminants before this type of scrap metal is recycled.

c. *Status of Stainless Steel Debris.* The Agency provided an example in the proposed rule of demolition of a building containing stainless steel fixtures and indicated that if a representative sample of the demolition debris exhibited a characteristic debris would be hazardous waste. The Agency noted that stainless steel could also be removed before demolition and managed separately, perhaps by recycling it as scrap metal. See 57 FR 990.

In providing this example, the Agency was not stating that discarded stainless steel artifacts are hazardous wastes, and in fact has no information indicating that such materials, much less demolition debris containing small bits of stainless steel, would exhibit a characteristic. Although it may be worthwhile (for environmental and economic reasons) to remove metal artifacts for recycling rather than destroying them when demolition occurs, today's rule does not mandate any such conduct.

8. Relationship of the TSCA PCB Rules to Today's Rule

As proposed, the final rule requires that hazardous debris that is also a waste PCB under 40 CFR part 761 must comply with both the applicable PCB requirements and today's debris treatment standards, by satisfying the more stringent applicable requirements.

The treatment standards for hazardous debris also apply to debris contaminated with both PCBs and RCRA hazardous wastes. See § 268.45(a)(5). This is consistent with the approach taken in the third third final rule. See 55 FR 22678 (June 1, 1990). Debris treated to today's performance standards by an extraction or destruction technology (and that does not exhibit a hazardous characteristic) remains subject only to TSCA rules because it is excluded from subtitle C regulation, whereas debris treated by an immobilization technology remains subject to applicable requirements under both statutes.

Under the Toxic Substances Control Act (TSCA), disposal of debris contaminated with PCBs is regulated under 40 CFR 761.60. In addition, disposal of debris and materials resulting from the cleanup of certain PCB spills is subject to the PCB Spill Cleanup Policy, as provided under 40 CFR 761.125.

9. Relationship of Existing Agency Standards for Asbestos to Today's Rule

As proposed, the Agency is today requiring that the treatment standards for hazardous debris also apply to debris subject to standards for asbestos

[43] Certainly, size reduction to that normally achieved prior to microencapsulation is not necessary.

under OSHA, TSCA, and NESHAPs.[44] EPA acknowledges that many of the treatment technologies specified in today's rule for hazardous debris would not be practicable for asbestos debris because of the potential for occupational exposure or environmental release of asbestos. However, the Agency believes that several technologies could be used to treat hazardous debris in compliance with the applicable OSHA, NESHAPs, and TSCA by using filtration devices on air and water emissions to control asbestos—water washing and spraying; liquid phase solvent extraction; vapor phase solvent extraction; biodegradation; chemical oxidation; chemical reduction; and macroencapsulation.

The Agency considered the argument made by several commenters that asbestos-contaminated hazardous debris and hazardous debris contaminated with asbestos should be managed according to existing EPA and OSHA regulations (i.e., bagging) and placing the bagged material in a subtitle C facility. The Agency agrees with the commenters that, if bagging meets the performance standard for macroencapsulation, such debris may then be disposed of in a subtitle C facility.

10. Special Requirements for Radioactive Debris

The Agency is today requiring that hazardous debris that is subject to regulations under the Atomic Energy Act (AEA) because of its radioactivity (i.e., mixed waste) is also subject to today's debris treatment standards.[45] This is consistent with the Agency's regulation of the waste that is contaminating the debris—if a prohibited waste is also a mixed waste, it is nonetheless subject to the treatment standards for the waste.

Commenters expressed concern that the treatment of certain radioactive mixed waste debris may pose an unreasonable risk to human health and the environment due to the radiological nature of the waste. The Agency understands commenters' concerns but believes that there is sufficient flexibility in the debris treatment standards to enable generators or treaters to select a technology that will effectively treat the hazardous contaminants without posing an unreasonable risk to human health and the environment because of the radiological nature of the waste.

11. Documentation of Compliance With the Treatment Standards

When hazardous debris is treated to today's treatment standards, treaters must comply with the applicable residue analysis, notification, certification, and recordkeeping and requirements of revised § 268.7. In today's rule, the Agency has revised several paragraphs in § 268.7 and added one paragraph to accommodate hazardous debris.

Paragraph (a)(1) is revised to require generators who ship their hazardous debris to a storage or treatment facility to provide a notice that includes the information already required for restricted wastes as well as a listing of the contaminants subject to treatment. This will assist the treater in determining which treatment technology is appropriate for the debris. In addition, the notice must inform the treater that the debris is subject to (i.e., eligible for) the alternative treatment standards of Table 1; § 268.45.

Paragraph (a)(2) is revised to exempt generators of hazardous debris who obtain a determination from the Agency that the debris does not contain hazardous waste (see § 261.3(e)(2)) from the notification requirements of that paragraph for facilities receiving the shipment. Given that such debris is no longer hazardous waste, the notification requirement is not necessary.

Paragraph (a)(3) is revised to require generators whose restricted hazardous debris is not yet prohibited debris (because of, for example, the capacity variance discussed in section V.G below) to provide a notice that includes the information already required for restricted wastes as well as a listing of the contaminants subject to treatment and a statement that the debris is subject to (i.e., eligible for) the alternative treatment standards of Table 1, § 268.45. See discussion above for the rationale for requiring that this additional information be submitted to the receiving facility.

Paragraph (a)(4) is revised to exempt generators who treat their debris by one of the technologies specified in Table 1, § 268.45, from the waste analysis requirements of that paragraph. As discussed elsewhere in today's notice, the debris treatment standards are technology-specified standards rather than numerical concentration standards. Thus, analysis of the debris is generally not necessary (except to determine where knowledge about the debris is not available whether the debris exhibits a characteristic of hazardous waste).

Paragraph (b)(4) is revised to exempt facilities that treat hazardous debris so that it is excluded from the definition of hazardous waste under § 261.3(e) (i.e., debris treated by an extraction or destruction technology provided by Table 1, § 268.45, and debris that the Agency has determined does not contain hazardous waste) from the notification requirements of that paragraph. Paragraph (b)(4) requires treaters of prohibited waste to notify the land disposal facility receiving each shipment of waste of information including the treatment standards applicable to the waste. We revised this requirement because notification of receiving facilities is not necessary for debris that is excluded from subtitle C regulation. We note, however, that treaters of excluded debris are subject to the new notification (to EPA) and certification requirements provided by paragraph (d), as discussed below.

Paragraph (b)(5) is revised to exempt facilities that treat hazardous debris so that it is excluded from the definition of hazardous waste under § 261.3(e) from the certification requirements of that paragraph. Such facilities are subject to the new certification requirements, however, provided by paragraph (d), as discussed below.

Finally, paragraph (d) is added to subject generators and treaters who first claim that their debris is excluded from the definition of hazardous waste under § 261.3(e) to notification and certification requirements. Such generators and treaters are required to submit to EPA a one-time notice identifying the name and address of the subtitle D facility receiving the excluded debris, a description of the debris before treatment (i.e., as-generated), and, if the debris is excluded because it was treated by an extraction or destruction technology specified in Table 1, § 268.45 (i.e., it is not excluded as a result of a contained-in determination), the treatment technology used. The Agency will use this information for enforcement purposes. Not only will the notification identify those facilities that claim that hazardous debris is excluded from regulation, but the information on the type of debris treated and the technology used will enable the Agency to establish a priority for inspections taking into account how difficult it may be to treat the debris to the performance and design and operating standards with the selected technology.

In addition, for debris treated by a technology specified in Table 1, § 268.45

[44] For a summary of OSHA, TSCA, and NESHAP controls on asbestos, see the proposed rule at 57 FR 993–994.

[45] We note that the Agency has established treatment standards in § 268.42 for several types of radioactive wastes (e.g., D008: Radioactive lead solids subcategory) that may be generated in particle sizes greater than 60 mm, the minimum size limit for debris. Nonetheless, such wastes are excluded from the definition of debris (see § 268.2(g)) and are subject to the waste-specific treatment standards.

(i.e., debris not excluded as a result of a contained-in determination), the treater must document and certify compliance with the treatment standards specified in Table 1. The rule requires the treater to record in the facility's files all inspections, evaluations, and analyses (e.g., determinations that a physical extraction technology has removed at least 0.6 cm of the debris surface and that the debris is treated to a "clean debris surface") of the treated debris that the treater made to determine compliance with the standards, as well as any data or information pertaining to key operating parameters the treater may have generated during treatment of the debris (e.g., exit gas temperature and feed rate, of a thermal desorber). The rule also requires the treater to place a certification in the facility's files for each shipment of excluded debris that the debris has been treated in accordance with the standards specified in Table 1. These requirements will enable the Agency to enforce the debris treatment standards.

D. Exclusion of Hazardous Debris From Subtitle C Regulation

Under today's rule, hazardous debris may be excluded from subtitle C regulation either by: (1) the Agency's determination that the debris no longer contains hazardous waste (i.e., the contained-in policy discussed in section V.B.2) as provided by new § 261.3(e) (2); or (2) by compliance with the debris treatment standards for extraction or destruction technologies for exclusion from subtitle C provided in Table 1 of § 268.45 (and provided the debris does not exhibit a hazardous characteristic after treatment). The basis for excluding debris determined to no longer contain hazardous waste is discussed above in section V.B.2. We discuss here the basis for excluding from subtitle C regulation debris that is treated to meet today's performance standards requisite to such exclusion.

1. Basis for Excluding Debris Treated by Extraction or Destruction Technologies and That Is Not Characteristic

Debris treated by a prescribed extraction or destruction technology and that does not exhibit a hazardous characteristic is excluded from subtitle C regulation. As discussed in section V.C.5 above, the Agency has given careful consideration as to whether each debris/contaminant type would be effectively treated by each BDAT technology to levels that present minimum risk (i.e., would no longer pose a hazard to human health or the environment). The Agency believes that debris treated to those standards would pose minimum risk for a number of reasons. First, the Agency has deleted two technologies (i.e., electropolishing and ultraviolet radiation) from the proposed list of BDAT technologies because they are not likely to provide effective treatment. Second, the final rule requires separation of nonempty intact containers of hazardous waste from debris for treatment to the waste-specific treatment standards. Thus, containerized waste that is readily amenable to separation from debris by equipment operators in the field and that may have high concentrations of toxic constituents will be subject to concentration-based, waste-specific treatment standards rather than to the debris standards. Third, the final rule raises the particle size used to define debris from 9.5 mm to 60 mm and applies the size limit to all debris, not just geologic matter. Thus, materials that should be amenable to treatment methods for process waste are subject to the waste-specific treatment standards rather than to the debris standards. Fourth, the final rule specifically excludes process waste of any particle size (e.g., slag) from the definition of debris. Thus, process wastes with potentially high concentrations of hazardous constituents will be subject to the waste-specific treatment standards rather than to the debris standards.

Most important, the performance and design and operating standards that the rule establishes for exclusion of treated debris from subtitle C are rigorous standards. Examples are the requirements that physical extraction technologies treat metal to a "clean metal finish" and other debris surfaces to a "clean debris surface". A minimum of 0.6 cm of the surface layer of porous debris must be removed as well. Another example is the maximum thickness standard for porous debris that is to be treated by chemical extraction.

For several technologies, the Agency was concerned that the performance and design and operating standards may not ensure treatment to minimum risk levels. Consequently for these technologies—thermal desorption, biodegradation, chemical oxidation and reduction and thermal destruction of debris contaminated with dioxin-listed wasted [46]—treated debris would be excluded only after the treater successfully makes an equivalent technology demonstration to the Agency under § 268.42(b) documenting that the technology treats a particular type of debris/contaminant combination as effectively as the other BDAT technologies to residual levels of hazardous contaminants that would not pose a hazard to human health and the environment absent management controls.

Finally, the rule requires separation of the treated debris from all treatment residues, including soil, waste, or other nondebris material that could remain adhered to the debris surface. This will ensure that metal contaminants in the residue will not continue to contaminate the treated debris and that any waste or contaminated soil in a primarily debris mixture as it was generated is separated from the treated debris prior to exclusion from subtitle C.

The philosophy underlying this approach is similar to that contained in principle: It is not normally the debris itself that is hazardous, but rather hazardous waste that is contaminating the debris. Thus, the goal of treatment should be to destroy or remove the contamination (if possible) and if this is achieved, to dispose of the cleaned debris as a nonhazardous waste. The removed residues from this treatment contain the contamination, and must meet numerical concentration levels before they can be land disposed.

Not only are the treatment methods developed to achieve this objective, but the various separation requirements (both before and after treatment) forcing removal of all nondebris materials such as soil and other wastes, and the definition of debris itself (which limits the debris classification to materials most amenable to the treatment methods, and classifies materials most amenable to meaningful sampling as nondebris subject to numerical treatment standards) are intended to achieve the same goal. As discussed above, the debris treatment standards are written wherever possible as performance standards to ensure that contamination is in fact removed from the debris. In addition, the rule specifies which contaminants are unsuitable for certain of the treatment methods. In short, the Agency believes that treatment of contaminated debris by the methods established here will result in clean debris which may then be land disposed, and should also no longer be regulated as a hazardous waste.

EPA notes, however, that the notion of excluding wastes from subtitle C regulation without sampling for hazardous constituent concentration levels is potentially at odds with many of the approaches recently proposed for public comment in the Hazardous Waste

[46] Note that the standards provide other restrictions for debris contaminated with dioxin-listed waste.

Identification Rule (HWIR). See 57 FR (May 20, 1992). In that rule, the Agency asked for comment on means of identifying and excluding hazardous wastes from subtitle C regulation that potentially take into account presence of a majority of the hazardous constituents listed in appendix VIII of part 261. If these approaches are adopted, they could provide a principled means of evaluating wastes heretofore excluded from subtitle C regulation without requiring analysis of hazardous constituent concentrations, such as the debris being excluded in today's rule, or residues from "empty containers" discussed above in Section V.B.2. EPA expects that hazardous constituent levels in debris treated by the methods adopted today will be consistent with levels resulting from the May 20 proposal, and in addition, for many types of treated debris there remain difficulties in obtaining representative samples necessary to make hazardous waste identification and listing determinations, and for this reason is finalizing the rule today rather than delaying action pending the results of the May 20 rulemaking. Nevertheless, the Agency believes it an appropriate issue for comment in the HWIR rulemaking the extent to which those standards should be used to replace exclusions from the definition of hazardous waste that are established without requiring analysis of hazardous constituent levels in the excluded waste.

2. Rationale for Continued Subtitle C Regulation of Debris Treated by Immobilization

Debris treated by an immobilization technology would remain subject to subtitle C regulation. EPA currently has insufficient data to demonstrate generically that debris which can be contaminated with both organic and inorganic constituents would be nonhazardous when treated by any of the immobilization technologies. Until the Agency gathers further data, EPA is concerned that, absent subsequent subtitle C management, hazardous contaminants may migrate from certain immobilized debris at levels that could pose a hazard to human health and the environment. Thus, EPA believes it inappropriate to promulgate a self-implementing exclusion at this time. Nonetheless, in the Phase II land disposal restrictions rule, the Agency will reopen and request comment on the issue of whether immobilized debris should be excluded from subtitle C regulation. The Agency plans to investigate this issue further and will publish in the Phase II proposed rule any information or data that are available. In addition, the Agency will specifically explore the potential of using the TCLP, and if so, under what circumstances, in determining whether immobilized hazardous debris should be excluded from subtitle C control. To assist the Agency in this effort, we ask for data on the performance of specific immobilization technologies and short- or long-term leachibility studies. Based on past experiences, the Agency has found that uncertainty over the technical performance of immobilization precludes a general exemption from subtitle C for all types of immobilized hazardous debris. However, the Agency will continue to evaluate all available and new information about the performance of immobilization technologies which could limit the technical uncertainty. To the extent that sufficient information that meets proper quality assurance/quality control procedures is available, the Agency plans to propose in the Phase II LDR rule an exclusion from subtitle C for those immobilized hazardous debris.

E. Regulation of Treatment Residuals

1. Overview

In this section, we discuss: (1) The rationale for subjecting treatment residues to the waste-specific treatment standards for the waste contaminating the debris; (2) separation of treated debris from treatment residue; (3) special requirements for debris treated by spalling; (4) special requirements for residue from the treatment of debris contaminated with cyanide reactive waste; and (5) special requirements for ignitable wastewater residue.

2. Treatment Residues Are Subject to the Waste-Specific Treatment Standards for the Waste Contaminating the Debris

Residuals from the treatment of hazardous debris are subject to the waste-specific treatment standards for the waste contaminating the debris. The residual must be treated to those standards for all BDAT constituents specified in §§ 268.41, 268.42 and 268.43 for the waste.

The Agency had proposed to require treatment of nonsoil residuals to the multi-source leachate F039 levels and soil residuals to the waste-specific treatment standards for the waste contaminating the debris. Based on public comment and the Agency's re-evaluation of this issue, the Agency had determined that it is more appropriate to subject all treatment residues—soil, wastewater, and nonwastewater—to the waste-specific treatment standards for the waste contaminating the debris for a number of reasons. First, the waste-specific treatment standards currently apply to treatment residuals, and the Agency does not know of a compelling reason to change that position. Second, requiring compliance with the waste-specific treatment standards rather than the F039 standards may be somewhat easier to understand and implement because the treatment standards for the BDAT constituents in the residue can be determined at the same time that the BDAT constituents are identified as contaminants subject to treatment (i.e., the contaminants subject to treatment in the contaminated debris are the same contaminants that must be treated in treatment residuals). Third, the Agency is considering simplifying and revising the treatment standards for all prohibited waste to "universal standards" in the Phase II proposed land disposal restrictions rule.

Several commenters suggested that the thermal destruction process of vitrification should be considered immobilization of debris. Thus, commenters argued that such vitrified debris could be land disposed under subtitle C without being subject to the waste-specific treatment standards for the waste contaminating the debris. The Agency disagrees with this view. Vitrification is a type of thermal destruction that produces a residue that is vitrified. Thus, the vitrified residue is subject to the same treatment standards as any debris treatment residue—the waste-specific standards for the waste contaminating the debris. This is consistent with the Agency's position that slag from high temperature metals recovery is residue, not debris, subject to the waste-specific treatment standards.

3. Treated Debris Mixed With Treatment Residue Is Subject to Regulation as Residue

As discussed above in section V.C.5, treatment residues generally contain high levels of toxic contaminants removed from the debris. Examples are residue from thermal desorption or incineration of debris contaminated with metal-bearing waste, and residue from water washing of debris. As discussed below, treatment residuals are subject to the waste-specific treatment standards for the waste contaminating the debris. Thus, to ensure that treatment residuals are treated effectively before land disposal, and to ensure that treated debris is not contaminated with the treatment residue, the treatment standards require that the treated debris must be separated from the treatment residue. If the debris is not separated from the

treatment residue, it remains a prohibited waste and may not be land disposed. It also remains subject to all other subtitle C standards.

The Agency defines treatment residuals as residuals such as biomass from biodegradation and ash from incineration as well as soil, waste, or other nondebris material that may remain adhered to the treated debris. We note further that slag from a high temperature metals recovery furnace and vitrified residue from a thermal destruction unit are treatment residues rather than debris. In both cases, the original debris no longer exists and the residuals from soil or waste contaminating the debris are integral components of the slag and vitrified residue.

Separation of the treated debris from treatment residuals must be accomplished using simple physical or mechanical means such as vibratory or trommel screens or water washing. The separation process need not produce a "clean debris surface" [47] as discussed above, however; rather the debris surface must be free of caked residuals or nondebris materials such as soil or waste. For example, thermal desorption debris need not be water washed after trommel screening to remove dust from residuals or nondebris material. (Note that the use of water washing to separate thermally desorbed debris from residuals and nondebris materials need not comply with the treatment standards for water washing (e.g., treatment to a "clean debris surface") because the debris has already been treated by an alternative technology.)

4. Special Requirements for Debris Treated by Spalling

As proposed and as discussed in Section V.C.5, debris removed by spalling remains debris subject to the debris treatment standards. Debris surfaces removed by spalling are, by definition of the technology, large pieces of debris. The Agency believes that such pieces of spalled debris are more debris-like than waste or residual-like and are more amenable to treatment by the debris treatment standards than the waste-specific treatment standards.

[47] "Clean debris surface" means the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste, except that residual staining consisting of light shadows, slight streaks, or minor discolorations, and soil and waste in cracks, crevices, and pits may be present provided that such staining and soil and waste in cracks, crevices, and pits shall be limited to no more than 5% of each square inch of surface area.

5. Special Requirements for Residue From the Treatment of Debris That Is Cyanide-Reactive

As proposed, the final rule requires that residues from the treatment of debris that is reactive because of cyanide is subject to the waste-specific treatment standards for cyanide under § 268.43. As with cyanide-reactive waste, EPA believes that BDAT for cyanide-reactive debris requires treatment of cyanide because of its toxicity.

6. Special Requirements for Ignitable Nonwastewater Residue

As proposed, the final rule requires that ignitable nonwastewater residue containing greater than or equal to 10% total organic carbon be subject to the technology-based standards for D001: "Ignitable Liquids based on 261.21(a)(1)" under § 268.42. This residue must be treated by fuel substitution (i.e., burning as fuel in a boiler or industrial furnace), recovery of organic constituents (e.g., distillation, carbon adsorption), or incineration. EPA has established these technologies as BDAT for high total organic carbon ignitable liquids because they will effectively remove or destroy the toxic organic constituents.

F. Permit Requirements for Treatment Facilities

Treatment of hazardous debris (except as discussed below for 90-day on-site treatment in a container, tank, or containment building) is currently subject to the applicable interim status and permit standards of parts 264, 265, 266, and 270 that ensure protection of human health and the environment from the operation of the treatment unit. (We note that, for containment buildings, interim status and permit standards and requirements for 90-day on-site treatment are promulgated in today's rule as discussed elsewhere in this notice.) Today's debris treatment standards to implement the land disposal restrictions of section 3004(m) of the statute do not affect those existing facility standards. For example, today's treatment standards do not reopen interim status eligibility for debris treatment facilities. (We note, however, that today's rule does establish the interim status eligibility date for containment buildings given that these units are newly regulated by this rule, assuming that such buildings are located at facilities containing no other regulated units.) Rather, today's debris treatment standards subject generators and treaters to additional requirements to ensure effective treatment of hazardous debris prior to exclusion from subtitle C (for debris treated by an extraction or destruction technology and that does not exhibit a hazardous characteristic) or land disposal in a subtitle C facility (for debris treated by an immobilization technology).

As information for the reader, we note that the existing facility standards for the following common debris treatment operations (other than for 90-day on-site treatment in a container, tank, or containment building) are:

- Debris treatment technologies conducted in tanks such as high pressure steam and water spraying, chemical extraction, and biodegradation are subject to the standards for tank facilities in subpart J of part 264 (permit standards) and part 265 (interim status standards).
- Storage or treatment in containment buildings is subject to the subpart DD, parts 264 and 265, standards also promulgated today (see discussion elsewhere in today's notice).
- Physical extraction technologies such as abrasive blasting or spalling used to treat debris in place but that is intended for discard (e.g., treatment of a contaminated building prior to demolition) are subject to the permit standards of subpart X, part 264 for miscellaneous units or the interim status standards for chemical, physical, or biological treatment in subpart Q, part 265.
- Incinerators are subject to subpart O, part 264 (permit standards) and part 265 (interim status standards).
- High temperature metal recovery furnaces are conditionally exempt from the rules for boilers and industrial furnaces burning hazardous waste in subpart H, part 266.
- Thermal desorbers are subject either to the incinerator or thermal treatment standards, depending on whether the unit meets the incinerator definition. Thermal treatment units are subject to subpart X, part 264 (permit standards for miscellaneous units) and subpart P, part 265 (interim status standards).

1. Adding Capacity for Debris Treatment to Existing Facilities

Today's rule amends the permit and interim status standards of part 270, as proposed, to facilitate the expansion of existing debris treatment capacity and the addition of new debris treatment capacity at existing facilities currently subject either to permit or interim status standards for managing hazardous waste. However, if an owner or operator of a facility that is not currently managing hazardous waste under the permit or interim status standards wants

to construct a debris treatment facility, he must first obtain a RCRA permit.

a. *Facilities With a RCA Permit.* Facilities with a RCRA permit may add new treatment processes and additional capacity by applying for a permit modification under § 270.42. See 53 FR 37912 (Sept. 28, 1988). Although regulations at § 270.42 were promulgated under pre-HSWA authority, EPA may use these regulations in authorized States when necessary to implement HSWA provisions such as the land disposal restrictions. See 53 FR 37933.

The types of modifications needed to add new capacity or processes would likely require submittal of a Class 2 or 3 modification. The Class 2 modification process requires Agency action on the request within 120 days. This action would consist of approval or denial, reclassification as a Class 3 modification, or authorization to conduct activities (in containers, tanks, and containment buildings, as discussed below) for up to 180 days pending Agency action. Further, for Class 2 modifications, construction to implement the requested facility change may commence 60 days after submission of the request. There is no deadline for Agency action for Class 3 modifications, which apply to more substantial changes.

Permitted facilities may apply under existing § 270.42(e)(3)(ii)(B) for a temporary authorization to initiate necessary activities to treat or store restricted wastes (e.g., hazardous debris) in tanks or containers while a Class 2 or 3 permit modification is undergoing review, or to undertake a treatment or storage activity which will be of short duration (e.g., decontamination of a building intended for demolition). Today's rule revises that section to enable the Agency also to grant a temporary authorization for containment buildings meeting the requirements promulgated today in subpart DD of parts 264 and 265.

Any request for a temporary authorization must demonstrate compliance with the part 264 standards and also meet the criteria of § 270.42(e) for approval. Interested members of the public (i.e., those that have previously expressed interest in any permitting action for the facility) will receive notice by mail of a facility's request for a temporary authorization. The temporary authorization may be renewed once if the additional procedures of § 270.42(e) are followed, including submission of appropriate permit modification information and the initiation of public meetings and public comment period. See 53 FR 37919.

b. *Facilities Operating Under Interim Status.* Facilities managing hazardous waste under interim status may add new treatment processes or additional treatment or storage capacity by using the existing procedures for changes during interim status in § 270.72. Under these procedures, a facility must submit to EPA a revised Part A permit application and justification explaining the need for the change. The change must then be approved by EPA.

Such changes must meet one of several criteria specified in § 270.72, such as being necessary to comply with a Federal, State, or local requirement. However, changes generally may not be made if they amount to reconstruction of the facility. The Agency considers the facility to be "reconstructed" if the capital investment for the changes to the facility exceed 50% of the capital cost of a comparable entirely new facility.

Existing § 270.72(b)(6) lifted the reconstruction limit for changes to treat or store in tanks and containers hazardous waste subject to land disposal restrictions imposed by part 268, provided that such changes are made solely for the purpose of complying with part 268 land disposal restrictions. Today's rule revises that paragraph to lift the reconstruction limit for containment buildings as well. See the the new subpart DD, part 264 and 265, standards for containment buildings that are also promulgated today.

2. On-Site Treatment of Debris in Containers, Tanks, and Containment Buildings

Existing § 262.34 exempts from permit requirements generators who store or treat hazardous debris on-site in tanks or containers for a period not exceeding 90 days provided that the tank or container is designed and operated in compliance with subpart I (for containers) and subpart J (for tanks) of part 265. Today's rule revises § 262.34, as proposed, to also provide this exemption to containment buildings designed and operated in compliance with the subpart DD, part 265, standards also promulgated today.

G. Capacity Variance for Hazardous Debris

In the May 15, 1992, Notice to Approve Hazardous Debris Case-By-Case Capacity Variance, the Agency approved a generic, one year extension of the LDR effective date applicable to all persons managing hazardous debris (57 FR 20766). For the purpose of the extension, the term "debris" was defined as set out in the preamble to the June 1, 1990 Third Third final rule. See 55 FR 22650 and § 268.2(g). Furthermore, the Agency indicated that it will explain in the debris rule how a change in definition will affect the case-by-case extensions.

Although in general, both definitions will identify the same materials as debris, there are differences that may result in situations where either definition could include debris not included by the other. Of concern is the situation where someone has entered into contracts for, or actually initiated the process of, removing for disposal debris which met the old definition but does not meet the current definition. To avoid possible disruption of on-going activities, which have relied on the previous definition of debris, the Agency will allow the extension to apply to materials meeting either definition through May 8, 1993.

H. Other Issues

1. Applicability of Standards to Contaminated Structures and Equipment

a. *Structures and Equipment Contaminated With Hazardous Waste and Intended for Discard Are Regulated Debris.* As discussed above in section V.B.1.a of the preamble, structures and equipment contaminated with hazardous waste and that are intended for discard are hazardous debris subject to today's treatment standards. Thus, if a contaminated tank or building is decontaminated before demolition, the debris may not be land disposed unless the tank or building was decontaminated in compliance with today's treatment standards. (We note that, as discussed above in section F.2, such treatment is subject to the permit standards unless conducted in a tank, container, or containment building.)

If the contaminated structure or equipment is being decontaminated for subsequent use, however, the structure or equipment is not debris and the decontamination is neither subject to today's debris treatment standards nor the permit standards for hazardous waste management facilities. Thus, cleaning a building that is in use is not treatment of debris.

b. *Treatment Standards for Concrete Pads and Walls Intended for Discard.* The Agency believes that concrete pads and walls are typically decontaminated using "water washing" techniques. These techniques include the following technologies specified in today's rule: Abrasive blasting using water to propel abrasive media, high pressure steam or water sprays, and water washing and spraying.

We note that the performance standards for abrasive blasting and high

pressure water sprays require removal of 0.6 cm of the surface because these are physical extraction technologies designed to remove the surface layer of the debris. The performance standards for water washing and spraying limits the thickness of the concrete to 3/8 inch because this technology relies on chemical extraction (i.e., dissolving or removing with surfactants) of contaminants below the concrete surface. If the treater believes that treatment to these performance standards is not necessary to ensure effective treatment to residual levels of hazardous constituents that will not pose a hazard to human health and the environment absent management controls, the treater may: (1) Obtain a waiver of the standards (e.g., the thickness limit for water washing) under an equivalent technology demonstration under § 268.42(b); or (2) demonstrate to the Agency that the debris upon alternative treatment does not contain toxic constituents under the contained-in principle codified in today's rule. See discussion in section V.B.2.b above.

c. *Relation of Debris Standards to Closure Rules.* Existing closure standards for hazardous waste management facilities require "decontamination" of contaminated structures and equipment. See, e.g., §§ 264.114 and 265.114. The precise meaning of decontamination presently is determined on a case-by-case basis through review of the facility's closure plan. However, if such structures or equipment is also debris which is going to be land disposed, which could often be the case, an issue arises regarding the relationship of the "decontamination" standard in the closure rule and the treatment methods adopted in today's rule.

The Agency believes that the treatment methods in today's rule would always satisfy the decontamination standard in the closure provisions. After all, the purpose of these treatment methods is to decontaminate. EPA also interprets the land disposal and closure rules to require that all hazardous debris be treated to meet the debris treatment standards, even if the debris is generated during closure. (Put another way, the debris standards normally would be appropriate for any debris generated as a result of closure.)

If the debris treatment standards appear to be inappropriate for debris (such as contaminated structures or equipment) generated during closure, a site-specific treatability variance pursuant to § 268.44(h) may be available. The Agency believes that such a variance could be processed administratively as part of the closure procedures.

2. Mixing of Hazardous Waste or Contaminated Soil With Debris To Avoid the Waste-Specific Treatment Standards Is Prohibited

Today's rule prohibits the intentional mixing of hazardous waste or contaminated soil with debris to avoid the concentration-based treatment standards for the waste or soil. The Agency is prohibiting such sham mixing to ensure that hazardous waste and contaminated soil are treated to the existing treatment standards given that the waste [48] is amenable to treatment to those levels and that the waste and soil are likely to be much more heavily contaminated with hazardous constituents than debris and, thus, should be subject to such concentration-based treatment levels.

The prohibition on mixing applies to debris treated by any technology: Immobilization as well as extraction or destruction. Although the debris treatment standards require separation of the waste or contaminated soil from debris treated by an extraction or destruction technology and that the residue must meet the waste-specific treatment standards for the waste contaminating the debris, the treatment process itself could enable the residue to meet the concentration-based waste treatment standards by virtue of dilution during treatment. An example is water washing of debris intentionally mixed with a prohibited listed waste. The water residue may easily meet the waste-specific treatment standard by virtue of dilution rather than treatment.

We note that this prohibition on sham mixing does not affect implementation of the principle discussed above in section V.B.1 to classifying mixtures of debris with contaminated soil or waste as debris. That principle says that if debris is the primary material in a mixture by volume based on visual observation, the mixture is subject to regulation as debris. Thus, for example, when debris is initially excavated in a mixture of debris and nondebris materials, and debris is the primary material present, the mixture is appropriately regulated as debris and sham mixing has not occurred. However, if debris is intentionally mixed with contaminated soil or hazardous waste (e.g., after excavation), and the mixture is regulated as debris by the application of the mixture principle and subsequently immobilized, prohibited sham mixing has occurred.

3. Procedures for Demonstrating Equivalency of Alternative Technologies

As discussed at proposal, existing § 268.43(b) provides the generator or treater an opportunity to demonstrate to the Agency than an alternative technology can achieve the equivalent level of performance as that of the specified treatment method. We note that this variance procedure can also be used to demonstrate that one of the technologies specified in today's rule can be designed or operated under conditions other than those established in Table 1, § 268.45, to provide equivalent treatment (i.e., meet the performance standard for the technology) or that a specified technology can treat hazardous contaminants to levels that do not pose a hazard to human health and the environment absent subtitle C control without achieving the performance and design and operating standards established in Table 1.

In addition, the Agency is requiring in the treatment standards of Table 1, § 268.45, that treaters must make an Equivalency Demonstration under § 268.43(b) in order for certain technologies to be considered BDAT. See discussion above for thermal desorption, biodegradation, and chemical destruction.

VI. Capacity Determinations

This section presents the data sources, methodology, and results of EPA's capacity analysis for today's newly listed wastes. Specifically, section VI summarizes the results of the capacity analysis for petroleum refining wastes and other organic wastes; wastes mixed with radioactive contaminants; and debris contaminated with the newly listed wastes. Soil and debris contaminated with newly listed wastes for which standards are finalized today will be addressed in future proposals.

The capacity analysis for the newly listed wastes for which the Agency is today promulgating treatment standards relied on information obtained from several sources. Primary data sources include the National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities (the TSDR Survey), the National Survey of Hazardous Waste Generators (the Generator Survey), data received in response to the proposed rule (57 FR 957), data received in response to the ANPRM for the Newly Identified and

[48] We note that the Agency is concerned that the waste treatment standards may not be appropriate for soil contaminated with the waste and, consequently is considering proposing in summer 1992 treatment standards for contaminated soil.

268.43.—TABLE CCW.—CONSTITUENT CONCENTRATIONS IN WASTES—Continued

Waste code	Commercial chemical name	See also	Regulated hazardous constituent	CAS number for regulated hazardous constituent	Wastewaters		Nonwastewaters	
					Concentration (mg/l)	Notes	Concentration (mg/l)	Notes
K052	NA	Table CCWE in 268.41.	o-Cresol	95-48-7	0.11	(2)	6.2	(1)
			p-Cresol	106-44-5	0.77	(2)	6.2	(1)
			2,4-Dimethylphenol	105-67-9	0.036	(2)	NA	
			Ethylbenzene	100-41-4	0.057	(2)	14	(1)
			Naphthalene	91-20-3	0.059	(2)	42	(1)
			Phenanthrene	85-01-8	0.059	(2)	34	(1)
			Phenol	108-95-2	0.039	(2)	3.6	(1)
			Toluene	108-88-3	0.08	(2)	14	(1)
			Xylenes		0.32	(2)	22	(1)
			Cyanides (Total)	56-12-5	0.028	(1)	1.8	(1)
			Chromium (Total)	7440-47-32	0.2		NA	
			Lead	7439-92-1	0.037		NA	
*	*	*	*	*	*		*	
K087	NA	Table CCWE in 268.41.	Acenaphthalene	208-96-8	0.059	(2)	3.4	
			Benzene	71-43-2	0.14	(2)	0.071	(1)
			Chrysene	218-01-9	0.059	(2)	3.4	(1)
			Fluoranthene	206-44-0	0.068	(2)	3.4	(1)
			Indeno (1,2,3-cd) pyrene	193-39-5	0.0055	(2)	3.4	(1)
			Naphthalene	91-20-3	0.059	(2)	3.4	(1)
			Phenanthrene	85-01-8	0.059	(2)	3.4	(1)
			Toluene	108-88-3	0.08	(2)	0.65	(1)
			Xylenes		0.32	(2)	0.07	(1)
			Lead	7439-92-1	0.037		NA	
K093	NA		Phthalic anhydride (measured as Phthalic acid).	85-44-9	0.069		28	(1)
K094	NA		Phthalic anhydride (measured as Phthalic acid).	85-44-9	0.069		28	(1)
*	*	*	*	*	*		*	
K111	NA		2,4-Dinitrotoluene	121-14-2	0.32		140	(1)
			2,6-Dinitrotoluene	606-20-2	0.55		28	(1)
*	*	*	*	*	*		*	
K117	NA		Ethylene dibromide	106-93-4	0.028		15	(1)
			Methyl bromide	74-83-9	0.11		15	(1)
			Chloroform	67-66-3	0.046		5.6	(1)
K118	NA		Ethylene dibromide	106-93-4	0.028		15	(1)
			Methyl bromide	74-83-9	0.11		15	(1)
			Chloroform	67-66-3	0.046		5.6	(1)
K131	NA		Methyl bromide	74-83-9	0.11		15	(1)
K132	NA		Methyl bromide	74-83-9	0.11		15	(1)
K136	NA		Ethylene dibromide	106-93-4	0.028		15	(1)
			Methyl bromide	74-83-9	0.11		15	(1)
			Chloroform	67-66-3	0.046		5.6	(1)
*	*	*	*	*	*		*	
U028	Bis(2-ethylhexyl) phthalate.		Bis(2-ethylhexyl) phthalate	117-81-7	0.28		28	(1)
*	*	*	*	*	*		*	
U069	Di-n-butyl phthalate.		Di-n-butyl phthalate	84-74-2	0.057		28	(1)
*	*	*	*	*	*		*	
U088	Diethyl phthalate		Diethyl phthalate	84-66-2	0.2		28	(1)
*	*	*	*	*	*		*	
U102	Dimethyl phthalate		Dimethyl phthalate	131-11-3	0.047		28	(1)
*	*	*	*	*	*		*	
U107	Di-n-octyl phthalate.		Di-n-octyl phthalate	117-84-0	0.017		28	(1)
*	*	*	*	*	*		*	
U190	Phthalic anhydride (measured as Phthalic acid).		Phthalic anhydride (measured as Phthalic acid).	85-44-9	0.069		28	(1)
*	*	*	*	*	*		*	

[1] Treatment standards for this organic constituent were established based upon incineration in units operated in accordance with the technical requirements of 40 CFR 264 Subpart O or Part 265 Subpart O, or based upon combustion in fuel substitution units operating in accordance with applicable technical requirements. A facility may certify compliance with these treatment standards according to provisions in 40 CFR Section 268.7.

[2] Based on analysis of composite samples.

* * * * * * *

NOTE: NA means Not Applicable.

38. In subpart D, § 268.45 with Table 1 is added to read as follows:

§268.45 Treatment standards for hazardous debris.

(a) *Treatment standards.* Hazardous debris must be treated prior to land disposal as follows unless EPA determines under § 261.3(e)(2) of this chapter that the debris is no longer contaminated with hazardous waste or

the debris is treated to the waste-specific treatment standard provided in this subpart for the waste contaminating the debris:

(1) *General.* Hazardous debris must be treated for each "contaminant subject to treatment" defined by paragraph (b) of this section using the technology or technologies identified in Table 1 of this section.

(2) *Characteristic debris.* Hazardous debris that exhibits the characteristic of ignitability, corrosivity, or reactivity identified under §§ 261.21, 261.22, and 261.23 of this chapter, respectively, must be deactivated by treatment using one of the technologies identified in Table 1 of this section.

(3) *Mixtures of debris types.* The treatment standards of Table 1 in this section must be achieved for each type of debris contained in a mixture of debris types. If an immobilization technology is used in a treatment train, it must be the last treatment technology used.

(4) *Mixtures of contaminant types.* Debris that is contaminated with two or more contaminants subject to treatment identified under paragraph (b) of this section must be treated for each contaminant using one or more treatment technologies identified in Table 1 of this section. If an immobilization technology is used in a treatment train, it must be the last treatment technology used.

(5) *Waste PCBs.* Hazardous debris that is also a waste PCB under 40 CFR part 761 is subject to the requirements of either 40 CFR part 761 or the requirements of this section, whichever are more stringent.

(b) *Contaminants subject to treatment.* Hazardous debris must be treated for each "contaminant subject to treatment." The contaminants subject to treatment must be determined as follows:

(1) *Toxicity characteristic debris.* The contaminants subject to treatment for debris that exhibits the Toxicity Characteristic (TC) by § 261.24 of this chapter are those EP constituents for which the debris exhibits the TC toxicity characteristic.

(2) *Debris contaminated with listed waste.* The contaminants subject to treatment for debris that is contaminated with a prohibited listed hazardous waste are those constituents for which BDAT standards are established for the waste under §§ 268.41 and 268.43.

(3) *Cyanide reactive debris.* Hazardous debris that is reactive because of cyanide must be treated for cyanide.

(c) *Conditioned exclusion of treated debris.* Hazardous debris that has been treated using one of the specified extraction or destruction technologies in Table 1 of this section and that does not exhibit a characteristic of hazardous waste identified under subpart C, part 261, of this chapter after treatment is not a hazardous waste and need not be managed in a subtitle C facility. Hazardous debris contaminated with a listed waste that is treated by an immobilization technology specified in Table 1 is a hazardous waste and must be managed in a subtitle C facility.

(d) *Treatment residuals*—(1) *General requirements.* Except as provided by paragraphs (d)(2) and (d)(4) of this section:

(i) Residue from the treatment of hazardous debris must be separated from the treated debris using simple physical or mechanical means; and

(ii) Residue from the treatment of hazardous debris is subject to the waste-specific treatment standards provided by subpart D of this part for the waste contaminating the debris.

(2) *Nontoxic debris.* Residue from the deactivation of ignitable, corrosive, or reactive characteristic hazardous debris (other than cyanide-reactive) that is not contaminated with a contaminant subject to treatment defined by paragraph (b) of this section, must be deactivated prior to land disposal and is not subject to the waste-specific treatment standards of subpart D of this part.

(3) *Cyanide-reactive debris.* Residue from the treatment of debris that is reactive because of cyanide must meet the standards for D003 under § 268.43.

(4) *Ignitable nonwastewater residue.* Ignitable nonwastewater residue containing equal to or greater than 10% total organic carbon is subject to the technology-based standards for D001: "Ignitable Liquids based on § 261.21(a)(1)" under § 268.42.

(5) *Residue from spalling.* Layers of debris removed by spalling are hazardous debris that remain subject to the treatment standards of this section.

TABLE 1.—ALTERNATIVE TREATMENT STANDARDS FOR HAZARDOUS DEBRIS [1]

Technology description	Performance and/or design and operating standard	Contaminant restrictions [2]
A. Extraction Technologies:		
1. Physical Extraction		
a. *Abrasive Blasting:* Removal of contaminated debris surface layers using water and/or air pressure to propel a solid media (e.g., steel shot, aluminum oxide grit, plastic beads).	*Glass, Metal, Plastic, Rubber:* Treatment to a clean debris surface.[3] *Brick, Cloth, Concrete, Paper, Pavement, Rock, Wood:* Removal of at least 0.6 cm of the surface layer; treatment to a clean debris surface.[3]	*All Debris:* None.
b. *Scarification, Grinding, and Planing:* Process utilizing striking piston heads, saws, or rotating grinding wheels such that contaminated debris surface layers are removed.	Same as above	Same as above
c. *Spalling:* Drilling or chipping holes at appropriate locations and depth in the contaminated debris surface and applying a tool which exerts a force on the sides of those holes such that the surface layer is removed. The surface layer removed remains hazardous debris subject to the debris treatment standards.	Same as above	Same as above.
d. *Vibratory Finishing:* Process utilizing scrubbing media, flushing fluid, and oscillating energy such that hazardous contaminants or contaminated debris surface layers are removed.[4]	Same as above	Same as above.

TABLE 1.—ALTERNATIVE TREATMENT STANDARDS FOR HAZARDOUS DEBRIS [1]—Continued

Technology description	Performance and/or design and operating standard	Contaminant restrictions [2]
e. *High Pressure Steam and Water Sprays:* Application of water or steam sprays of sufficient temperature, pressure, residence time, agitation, surfactants, and detergents to remove hazardous contaminants from debris surfaces or to remove contaminated debris surface layers.	Same as above	Same as above.
2. Chemical Extraction		
a. *Water Washing and Spraying:* Application of water sprays or water baths of sufficient temperature, pressure, residence time, agitation, surfactants, acids, bases, and detergents to remove hazardous contaminants from debris surfaces and surface pores or to remove contaminated debris surface layers.	*All Debris:* Treatment to a clean debris surface; [3] *Brick, Cloth, Concrete, Paper, Pavement, Rock, Wood:* Debris must be no more than 1.2 cm (½ inch) in one dimension (i.e., thickness limit,[5] except that this thickness limit may be waived under an "Equivalent Technology" approval under § 268.42(b);[6] debris surfaces must be in contact with water solution for at least 15 minutes	*Brick, Cloth, Concrete, Paper, Pavement, Rock, Wood:* Contaminant must be soluble to at least 5% by weight in water solution or 5% by weight in emulsion; if debris is contaminated with a dioxin-listed waste,[6] an "Equivalent Technology" approval under § 268.42(b) must be obtained.[6]
b. *Liquid Phase Solvent Extraction:* Removal of hazardous contaminants from debris surfaces and surface pores by applying a nonaqueous liquid or liquid solution which causes the hazardous contaminants to enter the liquid phase and be flushed away from the debris along with the liquid or liquid solution while using appropriate agitation, temperature, and residence time.[4]	Same as above	*Brick, Cloth, Concrete, Paper, Pavement, Rock, Wood:* Same as above, except that contaminant must be soluble to at least 5% by weight in the solvent.
c. *Vapor Phase Solvent Extraction:* Application of an organic vapor using sufficient agitation, residence time, and temperature to cause hazardous contaminants on contaminated debris surfaces and surface pores to enter the vapor phase and be flushed away with the organic vapor.[4]	Same as above, except that brick, cloth, concrete, paper, pavement, rock and wood surfaces must be in contact with the organic vapor for at least 60 minutes.	Same as above.
3. Thermal Extraction		
a. *High Temperature Metals Recovery:* Application of sufficient heat, residence time, mixing, fluxing agents, and/or carbon in a smelting, melting, or refining furnace to separate metals from debris.	For refining furnaces, treated debris must be separated from treatment residuals using simple physical or mechanical means,[9] and, prior to further treatment, such residuals must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris.	*Debris contaminated with a dioxin-listed waste:*[5] Obtain an "Equivalent Technology" approval under § 268.42(b).[6]
b. *Thermal Desorption:* Heating in an enclosed chamber under either oxidizing or nonoxidizing atmospheres at sufficient temperature and residence time to vaporize hazardous contaminants from contaminated surfaces and surface pores and to remove the contaminants from the heating chamber in a gaseous exhaust gas.[7]	*All Debris:* Obtain an "Equivalent Technology" approval under § 268.42(b);[6] treated debris must be separated from treatment residuals using simple physical or mechanical means,[9] and, prior to further treatment, such residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris. *Brick, Cloth, Concrete, Paper, Pavement, Rock, Wood:* Debris must be no more than 10 cm (4 inches) in one dimension (i.e., thickness limit),[5] except that this thickness limit may be waived under the "Equivalent Technology" approval	*All Debris:* Metals other than mercury.
B. Destruction Technologies:		
1. *Biological Destruction (Biodegradation):* Removal of hazardous contaminants from debris surfaces and surface pores in an aqueous solution and biodegration of organic or nonmetallic inorganic compounds (i.e., inorganics that contain phosphorus, nitrogen, or sulfur) in units operated under either aerobic or anaerobic conditions.	*All Debris:* Obtain an "Equivalent Technology" approval under § 268.42(b);[6] treated debris must be separated from treatment residuals using simple physical or mechanical means,[9] and, prior to further treatment, such residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris. *Brick, Cloth, Concrete, Paper, Pavement, Rock, Wood:* Debris must be no more than 1.2 cm (½ inch) in one dimension (i.e., thickness limit),[5] except that this thickness limit may be waived under the "Equivalent Technology" approval	*All Debris:* Metal contaminants.
2. Chemical Destruction		
a. *Chemical Oxidation:* Chemical or electolytic oxidation utilizing the following oxidation reagents (or waste reagents) or combination of reagents—(1) hypochlorite (e.g., bleach); (2) chlorine; (3) chlorine dioxide; (4) ozone or UV (ultraviolet light) assisted ozone; (5) peroxides; (6) persulfates; (7) perchlorates; (8) permanganates; and/or (9) other oxidizing reagents of equivalent destruction efficiency.[4] Chemical oxidation specifically includes what is referred to as alkaline chlorination.	*All Debris:* Obtain an "Equivalent Technology" approval under § 268.42(b);[6] treated debris must be separated from treatment residuals using simple physical or mechanical means,[9] and, prior to further treatment, such residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris. *Brick, Cloth, Concrete, Paper, Pavement, Rock, Wood:* Debris must be no more than 1.2 cm (½ inch) in one dimension (i.e., thickness limit),[5] except that this thickness limit may be waived under the "Equivalent Technology" approval	*All Debris:* Metal contaminants.

TABLE 1.—ALTERNATIVE TREATMENT STANDARDS FOR HAZARDOUS DEBRIS [1]—Continued

Technology description	Performance and/or design and operating standard	Contaminant restrictions [2]
b. *Chemical Reduction:* Chemical reaction utilizing the following reducing reagents (or waste reagents) or combination of reagents: (1) sulfur dioxide; (2) sodium, potassium, or alkali salts of sulfites, bisulfites, and metabisulfites, and polyethylene glycols (e.g., NaPEG and KPEG); (3) sodium hydrosulfide; (4) ferrous salts; and/or (5) other reducing reagents of equivalent efficiency.[4]	Same as above	Same as above.
3. *Thermal Destruction:* Treatment in an incinerator operating in accordance with Subpart O of Parts 264 or 265 of this chapter; a boiler or industrial furnace operating in accordance with Subpart H of Part 266 of this chapter, or other thermal treatment unit operated in accordance with Subpart X, Part 264 of this chapter, or Subpart P, Part 265 of this chapter, but excluding for purposes of these debris treatment standards Thermal Desorption units.	Treated debris must be separated from treatment residuals using simple physical or mechanical means,[9] and, prior to further treatment, such residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating the debris.	*Brick, Concrete, Glass, Metal, Pavement, Rock, Metal:* Metals other than mercury, except that there are no metal restrictions for vitrification. *Debris contaminated with a dioxin-listed waste.*[6] Obtain an "Equivalent Technology" approval under § 268.42(b),[8] except that this requirement does not apply to vitrification.
C. Immobilization Technologies:		
1. *Macroencapsulation:* Application of surface coating materials such as polymeric organics (e.g., resins and plastics) or use of a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media.	Encapsulating material must completely encapsulate debris and be resistant to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other waste, microbes).	None.
2. *Microencapsulation:* Stabilization of the debris with the following reagents (or waste reagents) such that the leachability of the hazardous contaminants is reduced: (1) Portland cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust). Reagents (e.g., iron salts, silicates, and clays) may be added to enhance the set/cure time and/or compressive strength, or to reduce the leachability of the hazardous constituents.[5]	Leachability of the hazardous contaminants must be reduced.	None.
3. *Sealing:* Application of an appropriate material which adheres tightly to the debris surface to avoid exposure of the surface to potential leaching media. When necessary to effectively seal the surface, sealing entails pretreatment of the debris surface to remove foreign matter and to clean and roughen the surface. Sealing materials include epoxy, silicone, and urethane compounds, but paint may not be used as a sealant.	Sealing must avoid exposure of the debris surface to potential leaching media and sealant must be resistent to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other waste, microbes).	None.

[1] Hazardous debris must be treated by either these standards or the waste-specific treatment standards for the waste contaminating the debris. The treatment standards must be met for each type of debris contained in a mixture of debris types, unless the debris is converted into treatment residue as a result of the treatment process. Debris treatment residuals are subject to the waste-specific treatment standards for the waste contaminating the debris.

[2] Contaminant restriction means that the technology is not BDAT for that contaminant. If debris containing a restricted contaminant is treated by the technology, the contaminant must be subsequently treated by a technology for which it is not restricted in order to be land disposed (and excluded from Subtitle C regulation).

[3] "Clean debris surface" means the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste except that residual staining from soil and waste consisting of light shadows, slight streaks, or minor discolorations, and soil and waste in cracks, crevices, and pits may be present provided that such staining and waste and soil in cracks, crevices, and pits shall be limited to no more than 5% of each square inch of surface area.

[4] Acids, solvents, and chemical reagents may react with some debris and contaminants to form hazardous compounds. For example, acid washing of cyanide-contaminated debris could result in the formation of hydrogen cyanide. Some acids may also react violently with some debris and contaminants, depending on the concentration of the acid and the type of debris and contaminants. Debris treaters should refer to the safety precautions specified in Material Safety Data Sheets for various acids to avoid applying an incompatible acid to a particular debris/contaminant combination. For example, concentrated sulfuric acid may react violently with certain organic compounds, such as acrylonitrile.

[5] If reducing the particle size of debris to meet the treatment standards results in material that no longer meets the 60 mm minimum particle size limit for debris, such material is subject to the waste-specific treatment standards for the waste contaminating the material, unless the debris has been cleaned and separated from contaminated soil and waste prior to size reduction. At a minimum, simple physical or mechanical means must be used to provide such cleaning and separation of nondebris materials to ensure that the debris surface is free of caked soil, waste, or other nondebris material.

[6] Dioxin-listed wastes are EPA Hazardous Waste numbers FO20, FO21, FO22, FO23, FO26, and FO27.

[7] Thermal desorption is distinguished from Thermal Destruction in that the primary purpose of Thermal Desorption is to volatilize contaminants and to remove them from the treatment chamber for subsequent destruction or other treatment.

[8] The demonstration "Equivalent Technology" under § 268.42(b) must document that the technology treats contaminants subject to treatment to a level equivalent to that required by the performance and design and operating standards for other technologies in this table such that residual levels of hazardous contaminants will not pose a hazard to human health and the environment absent management controls.

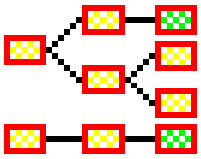
[9] Any soil, waste, and other nondebris material that remains on the debris surface (or remains mixed with the debris) after treatment is considered a treatment residual that must be separated from the debris using, at a minimum, simple physical or mechanical means. Examples of simple physical or mechanical means are vibratory or trommel screening or water washing. The debris surface need not be cleaned to a "clean debris surface" as defined in note 3 when separating treated debris from residue; rather, the surface must be free of caked soil, waste, or other nondebris material. Treatment residuals are subject to the waste-specific treatment standards for the waste contaminating the debris.

39. In subpart D, § 268.46 is added to read as follows:

§ 268.46 Alternative treatment standards based on HTMR.

Table 1 identifies alternative treatment standards for F006 and K062 nonwastewaters.

Site Conceptual Exposure Model Builder



User Manual

July 1997

U.S. Department of Energy
Office of Environmental Policy and Assistance
RCRA/CERCLA Division, EH-413
Washington, DC

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Introduction

The Department of Energy's (DOE's) Office of Environmental Policy and Assistance (EH-41) provides policy guidance and technical assistance on hazardous and mixed waste issues and environmental restoration at DOE facilities. CERCLA and RCRA programs require risk assessments to be conducted at many DOE sites to determine potential impacts of contamination on public health and the environment. In order to develop risk assessment data quality objectives (DQOs), observational approach decisions, and contaminant sampling design specifications, the environmental restoration project team frequently uses a Site Conceptual Exposure Model (SCEM).

The purpose of a SCEM is to provide a conceptual understanding of the potential for exposure to hazardous and/or radiological contaminants at a site based on the source of contamination, the release mechanism, the exposure pathway, and the receptor. A SCEM includes a graphical presentation that relates the source of contamination to human and ecological receptors. Based on a SCEM, a data collection strategy can be developed to prioritize field sampling activities and reduce uncertainty in risk characterization (e.g., contaminant release/transport mechanisms, receptor profiles, etc.). A SCEM may also provide sufficient information to allow for development of a strategy for early response actions to address exposure pathways that are considered complete and pose an imminent risk to public health.

DOE environmental restoration program managers (ERPMs) need the ability to develop SCEMs that promptly generate a range of "what-if" scenarios to respond to questions regarding site exposure conditions and data collection programs. The SCEM Builder is a user friendly computer tool that considerably shortens the time required to generate SCEM diagrams and associated documentation.

The SCEM Builder conceptually connects the source of contamination to human and ecological receptors by means of graphical boxes and lines. Sources of contamination and receptors are represented by boxes; release and exposure mechanisms are represented by lines. Note that fate and transport are implicitly treated by the SCEM Builder by means of a release mechanism from a source to another source; and by means of a exposure mechanism from a source to a receptor. Figure 1.1 shows the SCEM Builder main window with an example of a SCEM diagram.

Menu Bar
Toolbar 1
Toolbar 2

D i a g r a m
Screen

Status Bar

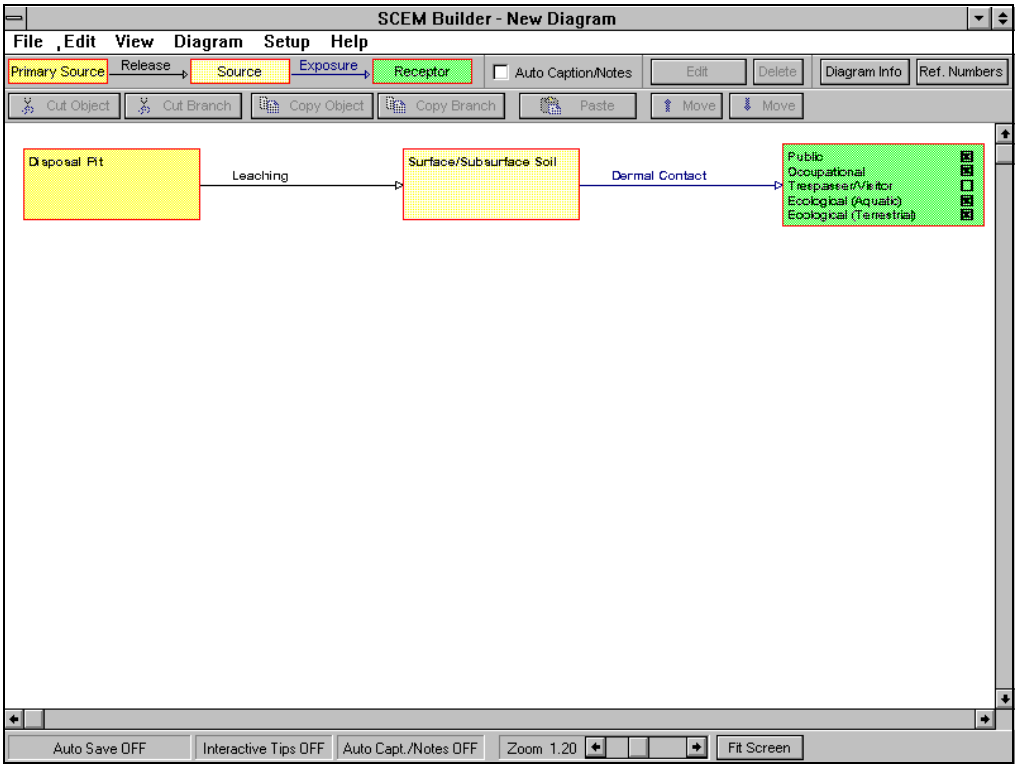

Figure 1.1 - SCEM Builder Main Window

1

Getting Started

The SCEM Builder is distributed on three high density IBM formatted diskettes. The application is written in Microsoft's Visual Basic and runs identically under Windows 3.1 or Windows 95. The illustrations in this manual show the SCEM Builder running under Windows 3.1.

The user should have a basic understanding of the Windows operating system to use the SCEM Builder properly. The layouts of the basic functions of the SCEM Builder are designed to follow Microsoft Windows guidelines.

System Requirements

The SCEM Builder was designed to run efficiently on a IBM compatible computer system with a 486 processor running at the clock speed of 25 MHz, and with 4 megabytes of random access memory (RAM). The computer should have Microsoft Windows 3.1 or higher operating system installed. The SCEM Builder uses approximately 3 megabytes of disk space for its storage. A "mouse" input device is useful, but not necessary to operate the program.

Installation

The SCEM Builder includes an installation routine that prompts the user for minimal information, such as location of where the program is stored in the computer system's hard drive. To initiate the installation, the user inserts the SCEM Builder installation diskette (diskette 1) in the computer disk drive. High density disk drives are usually designated as the *a:* drive.

To install the SCEM Builder, the user clicks on the File menu of the Windows Program Manager (the screen that opens when Windows is started). In the File menu, the user chooses the option *Run*. The computer system opens up a window where the user types the name of the drive (e.g., *a:*) and *setup*. The SCEM Builder starts the automatic installation routine and the necessary files are decompressed and copied onto the user's computer system in a designated location. The SCEM Builder creates the default directory *scem* on the operating system's drive (*e.g., c:/scem*).

Support

EH-413 developed the SCEM Builder to facilitate generation of the SCEM diagrams requested by EPA as part of CERCLA documentation. The SCEM Builder is distributed free of charge primarily to DOE personnel involved in CERCLA and RCRA actions. EH-413 can conduct demonstrations and/or training workshops if requested by DOE offices.

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Program Overview

The SCEM Builder is a computer tool used to design SCEM diagrams. The program has some limited "intelligence," in the form of a help system on building SCEM diagrams, as well as interactive messages and tips that the program will display to help the user in building the SCEM diagram.

The SCEM Builder includes the following components:

- Diagram Builder
- Diagram Information Screen
- Notes
- Help System

Diagram Builder

The Diagram Builder is the component of the SCEM Builder where the diagrams are constructed. A SCEM Builder diagram consists of the following objects (in this context, an object refers to a box or a line in the SCEM Builder diagram) :

Boxes
- Primary Source - the source of the contamination.
- Source - the secondary, tertiary, etc., source of contamination, if any.
- Receptor - the flora, fauna, or humans that may be exposed to a contaminated medium.

Lines
- Release Mechanism - how the contamination is released from the source.
- Exposure Mechanism - how the receptor is exposed to the contamination.

SCEM diagrams can range from simple to quite complex, as depicted in Figures 3.1 through Figure 3.3.

Figure 3.1 - Simplest SCEM Diagram

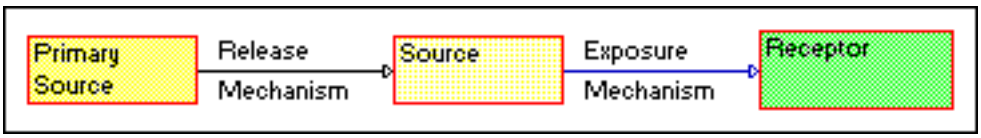

Figure 3.2 - Simple SCEM Diagram

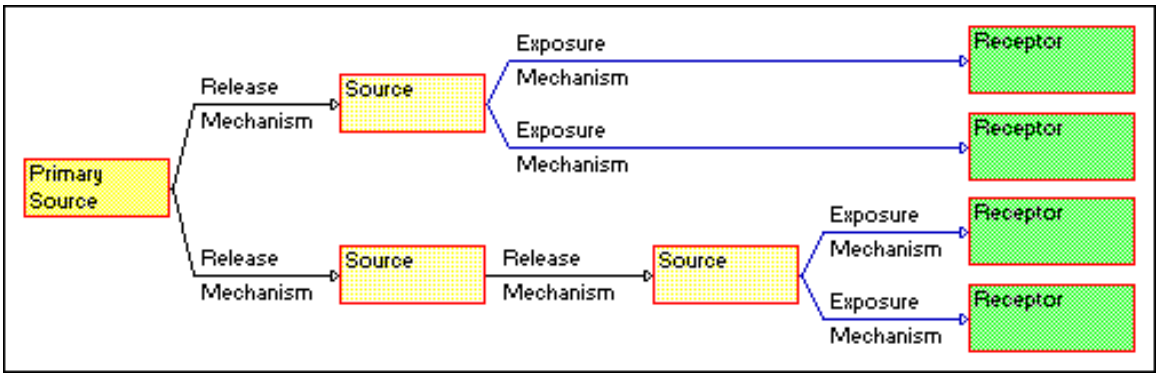

Figure 3.3 - Complex SCEM Diagram

Diagram Building Rules

The following rules must be observed when building a SCEM diagram:

- Diagrams can have one or more Primary Sources.
- A Primary Source can have one or more Release Mechanisms, and/or one or more Exposure Mechanisms.
- A Source can have one or more Release Mechanisms, and/or one or more Exposure Mechanisms.
- A Release Mechanism links one Primary Source to the next Source, or one Source to the next Source.
- An Exposure Mechanism links one Source to one Receptor.

The SCEM Builder includes an example of a diagram. Open the diagram *example.scm* and examine it to become more familiar with the concept.

Diagram Information Window

Each diagram contains a Diagram Information window that includes global information such as diagram title, diagram description, creation date, etc. This information can be edited by the user. Figure 3.4 is an example of a Diagram Information window.

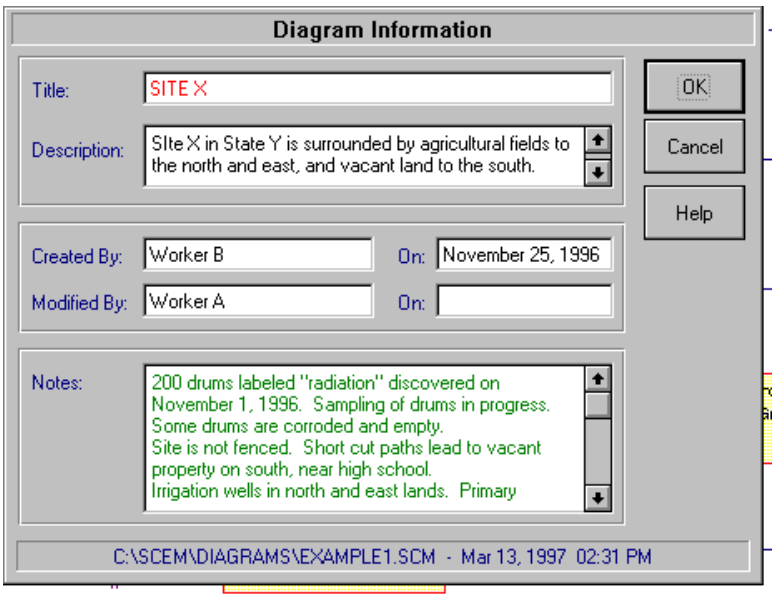

Figure 3.4 - Diagram Information Window

Notes

Each object on the diagram can have an associated note. For example, a note can describe the findings on the site, any assumptions, and description of the sources and pathways, etc.

Help System

The program includes two distinct help systems: Program Help and SCEM Help.

Program Help

This function provides information and guidance on the operation of the program. It explains, for example, how to cut and paste an object, how to print, and how to save or load a diagram. This help system is activated via the Help menu, or by pressing the **F1** key.

SCEM Help

SCEM Help provides information on default environmental factors built into the program, such as descriptions of contaminant sources commonly found at CERCLA sites. SCEM Help will present the user with a table of contents to select the topic of interest. This help system is activated via the Help menu.

Interactive Tips

This system will monitor the activity of the user and display pop-up windows with tips on building the SCEM diagram. The user will have the ability to turn these help tips on or off.

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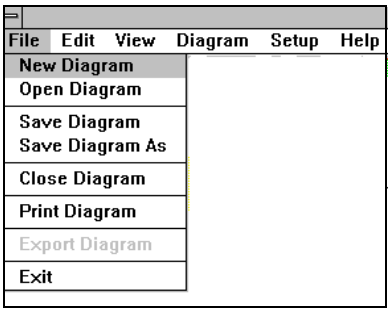
3

Menus

File



New Diagram

Opens a new blank diagram. To access this menu option, click on File, then select New Diagram.

Open Diagram

Opens a previously saved diagram. The user is prompted to select a file from a drive. To access this menu option, click on File, then select Open Diagram.

Save Diagram

Saves the diagram. In the case of a new diagram, the program will prompt the user for a file name. If no new filename is provided, the existing file is overwritten. To avoid overwriting the existing file, use the Save Diagram As menu option (see below). To access this menu option, click on File, then select Save Diagram.

Save Diagram As

Prompts the user for a file name and then saves the diagram. The SCEM Builder includes a diagrams directory as the default path for saving files. Diagrams are saved with a *.scm extension. To access this menu option, click on File, then select Save Diagram As.

Close Diagram

Closes the diagram. If changes have been made, the program will prompt the user to save the file before closing the diagram. To access this menu option, click on File, then select Close Diagram.

Print Diagram

Brings up the Print Diagram window. To access this menu option, click on File, then select Print Diagram.

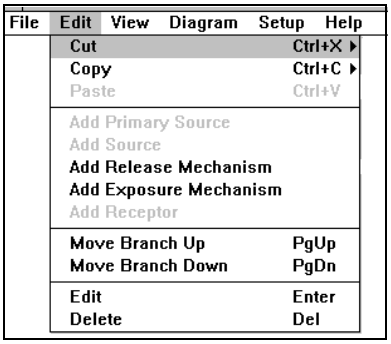
Export Diagram

Feature to be implemented in next version of the SCEM Builder.

Exit

Shuts down the SCEM Builder. If a diagram is open and changes have been made, the program will prompt the user to save the file before shutting down. To access this menu option, click on File, then select Exit.

Edit



Cut

This menu selection has two options:

- Object - Cuts the selected object. The object is removed from the diagram and placed in the Windows clipboard. From there, it can be pasted elsewhere on the diagram. This command can also be accessed by clicking the Cut Object button on Toolbar 2.

- Branch - Cuts the selected branch. A branch consists of all objects from the selected object to the right. By using the Cut Branch option, a branch is removed from the diagram and placed in the Windows clipboard. From there, it can be pasted elsewhere on the diagram. This command is also accessed by clicking the Cut Branch button on Toolbar 2.

If no object is selected, this menu option is not accessible and appears grey on the screen. See also Copy and Paste. To access this menu option, click on Edit, then select Cut.

Copy

This menu selection has two options:

- Object - Copies the selected object. The object is copied into the Windows clipboard. From there, it can be pasted elsewhere on the diagram. This command can also be accessed by clicking the Copy Object button on Toolbar 2.

- Branch - Copies the selected branch. A branch consists of all objects from the selected object to the right. The branch is copied into the clipboard. From there, it can be pasted elsewhere on the diagram. This command can also be accessed by clicking the Copy Branch button on Toolbar 2.

This menu option is not accessible and appears grey on the screen if no object is selected. See also Cut and Paste. To access this menu option, click on Edit, then select Copy.

Paste

Adds the object or branch in the Windows clipboard to the diagram. Note, however, that it is not possible to paste an object to a Receptor because the Receptor is always the last object in the branch. If the clipboard is empty, this menu option is not accessible and appears grey on the screen. To access this menu option, click on Edit, then select Paste. This command can also be accessed by clicking the Paste button on Toolbar 2.

Add Primary Source

Adds a Primary Source to the diagram. See Introduction for more information about SCEM diagrams and the definition of Primary Source. To access this menu option, click on Edit, then select Add Primary Source. This command can also be accessed by clicking and dragging the Primary Source box on Toolbar 1.

Add Source

Adds a Source to the diagram. A Source can be added only to a Release. For this menu option to be enabled, a Release has to be selected first. See Chapter 3 for more information about SCEM diagrams and the definition of Source. To access this menu option, click on Edit, then select Add Source. This command can also be accessed by clicking and dragging the Source box on Toolbar 1.

Add Release Mechanism

Adds a Release Mechanism to the diagram. A Release Mechanism can be added only to a Primary Source or a Source. Therefore, a Primary Source or a Source has to be selected first for this menu option to be enabled. To access this menu option, click on Edit, then select Add Release Mechanism. This command can also be accessed by clicking and dragging the Release arrow on Toolbar

1.

Add Exposure Mechanism

Adds an Exposure Mechanism to the diagram. An Exposure Mechanism can be added only to a Primary Source or a Source. Therefore, a Primary Source or a Source has to be selected first for this menu option to be enabled. See Chapter 3 for more information about SCEM diagrams and the definition of Exposure Mechanism. To access this menu option, click on Edit, then select Add Exposure Mechanism. This command can also be accessed by clicking and dragging the Exposure arrow on Toolbar 1.

Add Receptor

Adds a Receptor to the diagram. A Receptor can be added only to an Exposure Mechanism. For this menu option to be enabled, an Exposure Mechanism has to be selected first. To access this menu option, click on Edit, then select Add Receptor. This command can also be accessed by clicking and dragging the Receptor box on Toolbar 1.

Move Branch Up

Rearranges the appearance of the diagram by moving a branch up. See Move Branch Down menu for more information. To access this menu option, click on Edit, then select Move Branch Up. This command can also be accessed by clicking the Move button with the arrow pointing up on Toolbar 2.

Move Branch Down

Rearranges the appearance of the diagram by moving a branch down. For this option to be enabled, an object in the branch has to be selected (e.g., Release Mechanism, Exposure Mechanism). To access this menu option, click on Edit, then select Move Branch Down. This command can also be accessed by clicking the Move button with the arrow pointing down on Toolbar 2. The following examples show this menu option. Figure 4.1 shows a diagram before the Move Branch Down operation. Figure 4.2 shows the same diagram after the Move Branch Down operation.

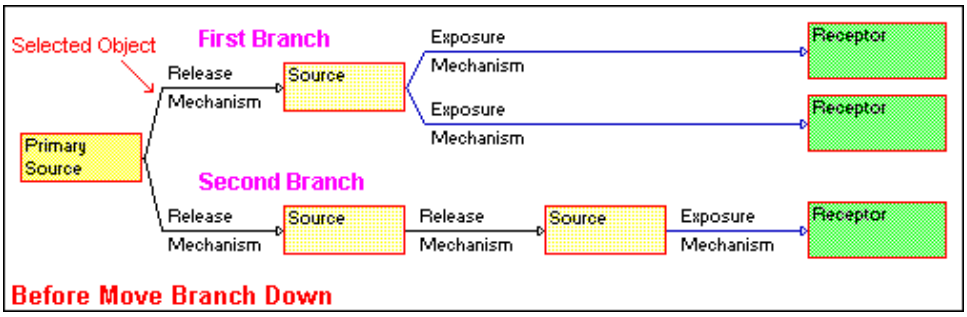


Figure 4.1 - Example of SCEM Diagram before Move Branch Down Operation

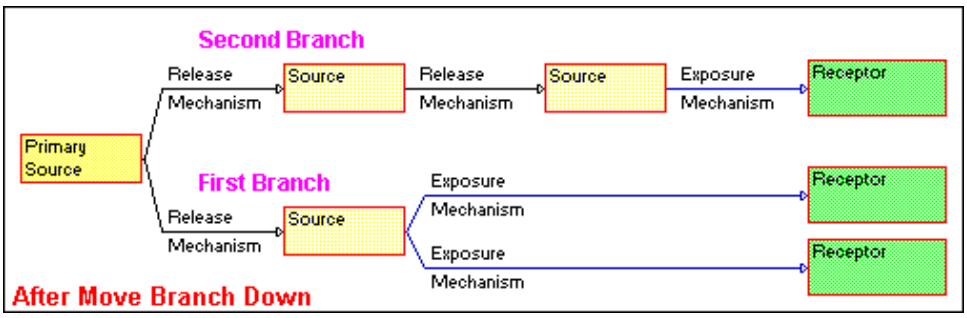


Figure 4.2 - Example of SCEM Diagram after Move Branch Down Operation

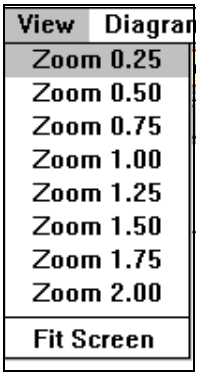
Edit

An object has to be selected first for this menu option to be enabled. Choosing Edit under the Edit Menu brings up the edit window for the currently selected object (e.g., Primary Source, Source, Release Mechanism, Exposure Mechanism, or Receptor). To access this menu option, click on Edit, then select Edit. The SCEM Builder will display a dialog window pertinent to the selected object. This command can also be accessed by clicking the Edit button on Toolbar 1.

Delete

An object has to be selected first for this menu option to be enabled. To access this menu option, click on Edit, then select Delete. Deletes the currently selected object (e.g., Primary Source, Source, Release Mechanism, Exposure Mechanism, or Receptor). If the object is in the middle of the branch and there are objects to the right, the program will ask the user for confirmation of the delete function. If the user confirms deletion, all the objects to the right of the selected object will also be deleted. This command can also be accessed by clicking the Delete button on Toolbar 1.

View



Zoom

Allows the user to select a zoom factor of 0.25, 0.50, 1.00, 1.25, 1.50, 1.75, and 2.00. Note that the scroll bar on the Status Bar allows selection of the zoom factor from 0.10 to 3.00 in increments of 0.05. See also the Status Bar and Fit Screen menu. To access this menu option, click on View, then

select the desired Zoom factor. This command can also be accessed by clicking on the Zoom arrows on the Status Bar.

Fit Screen

Adjusts the zoom factor so that the entire diagram is visible on the screen. See also the Status Bar and Zoom menu. To access this menu option, click on View, then select Fit Screen. This command can also be accessed by clicking the Fit Screen button on the Status Bar.

Diagram

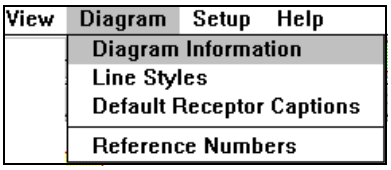


Diagram Information

Brings up the Diagram Information Window. This window allows the user to enter information about the diagram, such as a title for the diagram, the author of the diagram, and the date the diagram was created. Please refer to Diagram Information Window in Chapter 5 for a complete description of its useability. To access this menu option, click on Diagram, then select Diagram Information. This command can also be accessed by clicking the Diagram Information button on Toolbar 1.

Line Styles

Brings up the Line Styles window. This window allows the user to name each of the three line styles that can be used in the program for the Release and Exposure Mechanisms. Please refer to Line Styles Window in Chapter 5 for a complete description of its useability. To access this menu option, click on Diagram, then select Line Styles.

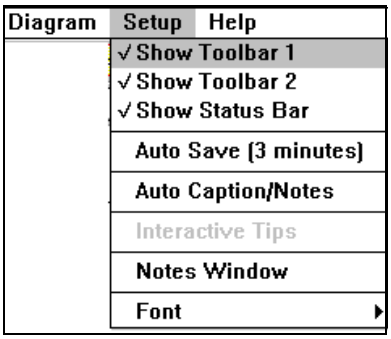
Default Receptor Captions

Brings up the Default Receptor Captions window. This window allows the user to name the default receptor captions for the Receptor object. Please refer to Default Receptor Window in Chapter 5 for a complete description of its useability. To access this menu option, click on Diagram, then select Default Receptor Captions.

Reference Numbers

Brings up the Reference Numbers Setup window. This window allows the user to include a reference number with each object in the diagram. Please refer to Reference Setup Window in Chapter 5 for a complete description of its useability. To access this menu option, click on Diagram, then select Reference Numbers. This command can also be accessed by clicking the Reference Numbers button on Toolbar 1.

Setup



Show Toolbar 1

Turns the Toolbar 1 on and off. Toolbar 1 has a number of buttons that access frequently used operations quickly. Please refer to Toolbar 1 in Chapter 6 for a complete description of its useability. The program starts with this option on (i.e., Toolbar 1 is visible). To access this menu option, click on Setup, then select Show Toolbar 1.

Show Toolbar 2

Turns the Toolbar 2 on and off. Toolbar 2 has additional buttons that access frequently used operations quickly. Please refer to Toolbar 2 in Chapter 6 for a complete description of its useability. The program starts with this option on (i.e., Toolbar 2 is visible). To access this menu option, click on Setup, then select Show Toolbar 2.

Show Status Bar

Turns the Status Bar on and off. The Status Bar shows useful information about various options in the program and includes a Zoom scroll bar and a Fit Screen button. Please refer to Status Bar in Chapter 6 for a complete description of its useability. The program starts with this option on (i.e., the Status Bar is visible). To access this menu option, click on Setup, then select Show Status Bar.

Auto Save

Turns the auto save feature on or off. If on, the program automatically saves the diagram every 3 minutes. The program starts with this option off (i.e., the program will not automatically save the diagram). To access this menu option, click on Setup, then select Auto Save.

Auto Caption/Notes

Turns the auto caption feature on or off. If Auto Caption/Notes is on, the program prompts the user for a caption and notes when a new object is added to the diagram. If Auto Caption/Notes is off, the user has to click on Edit to enter a caption and notes for an object. The program starts with this option off (i.e., the program will not automatically prompt the user for a caption and notes). To access this

menu option, click on Setup, then select Auto Caption/Notes. This command can also be accessed by clicking the Auto Caption/Notes button on Toolbar 1.

Interactive Tips

Feature may be implemented in next version of the program.

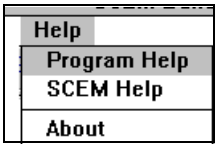
Notes Window

Allows the user to turn the Notes window on or off. The SCEM Builder allows for one Notes window to be continuously open on the Main window. The open Notes window refers to the selected object. If another object is selected, the Notes window will display the respective notes for that newly selected object. Please refer to Notes Window in Chapter 5 for a complete description of its useability. To access this menu option, click on Setup, then select Notes Window. This command can also be accessed by clicking the Auto Caption/Notes button on Toolbar 1.

Font

Allows the user to select a font for the diagram. Two fonts are available: Arial and Lucida Sans. A font can be selected if it is installed in the computer. To access this menu option, click on Setup, then select Font.

Help



Program Help

Displays help with the operation of the program. To access this menu option, click on Help, then select Program Help.

SCEM Help

Displays help with basic environmental concepts designed into the SCEM Builder. To access this menu option, click on Help, then select SCEM Help.

About

Brings up the "About" window. This window displays basic information about the program, including version number and copyright notice. To access this menu option, click on Help, then select About.

4

Windows

The SCEM Builder was developed with a user friendly interface that makes use of various windows. These windows are screens that allow the user to input information and/or select from a list of default factors. This chapter provides information on all the windows that are included in the SCEM Builder.

Main Window

SCEM diagrams are built and displayed in this window. The Main window is also referred to as the Diagram Builder window because that is where the diagrams are manipulated and displayed. A number of menus at the top of the window allow the user to perform various operations on a diagram. Information on these menus was presented in the previous chapter.

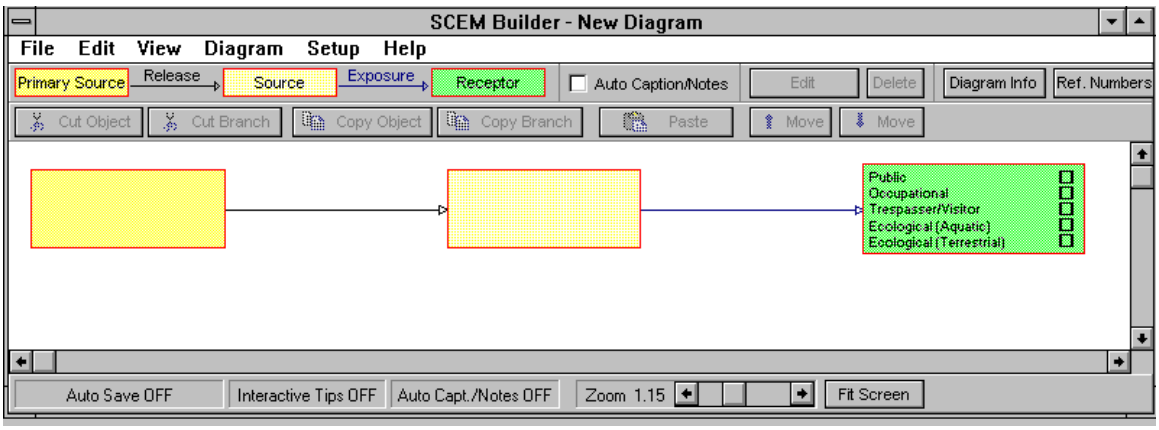


Figure 5.1 - SCEM Builder Main Window

Beneath the menu bar, the SCEM Builder includes two toolbars that allow for quick access to the most common functions. At the bottom of the screen, the SCEM Builder includes a status bar that displays various program information, a scroll bar to adjust the zoom factor, and a button that, when clicked on, fits the diagram to the screen. When the SCEM Builder starts, both toolbars and the status bar are visible on the screen. Note that the toolbars and the status bar can be made visible or removed from the screen by using the Setup menu, Show Toolbar 1 Menu, Show Toolbar 2 Menu, and Show Status Bar Menu.

New / Edit Primary Source Window

A Primary Source on the diagram has to be selected for this menu option to be enabled. Allows the user to enter information about the selected Primary Source. This window is accessed through the Edit menu; then select Edit (see Edit under Edit Menu in previous chapter).

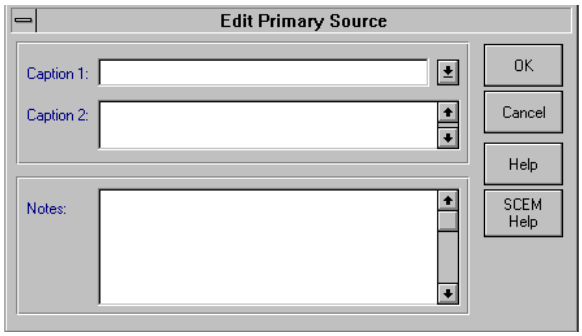


Figure 5.2 - Edit Primary Source Window

- Caption 1 - This text box is used for the main caption. On the diagram in the Main Window, this will be displayed as a bold line of text. Text is entered either by typing a caption, or by selecting from a list of captions included in the program (i.e., click on the small down arrow to the right of Caption 1 box).

- Caption 2 - This text box is used for an additional sub-caption. On the diagram in the Main Window, up to three lines of text can be displayed.

- Notes - This text box can be used to enter additional information (up to 4,096 characters). Notes are not automatically displayed on the diagram screen (because of space constraints); however, the user can direct that notes be displayed on the diagram screen in a separate window (see Chapter 4). Notes can also be printed. See the Print Diagram and Notes windows.

New / Edit Source Window

A Source on the diagram must be selected for this menu option to be enabled. This window allows the user to enter information about the selected Source. This window is accessed through the Edit menu; then select Edit (see Edit under Edit Menu in previous chapter).

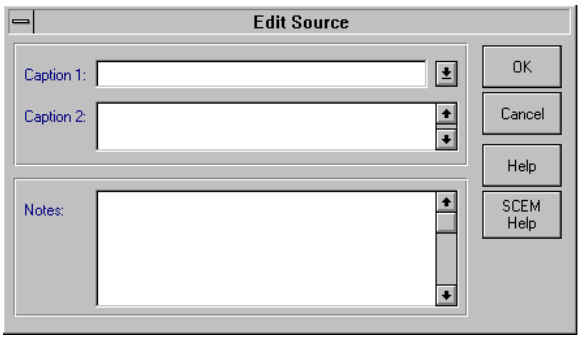


Figure 5.3 - Edit Source Window

- Caption 1 - This text box is used for the main caption. On the diagram, this will be displayed

as a bold line of text. Text is entered by typing a caption, or by selecting from a list of captions included in the program (i.e., click on the small down arrow to the right of Caption 1 box).

- Caption 2 - This text box is used for an additional caption. On the diagram in the Main Window, up to three lines of text can be displayed.

- Notes - This text box can be used to enter additional information (up to 4,096 characters). Notes are not automatically displayed on the diagram screen (because of space constraints); however, the user can direct that notes be displayed on the diagram screen in a separate window (see Chapter 4). Notes can also be printed. See the Print Diagram and Notes windows.

New / Edit Release Mechanism Window

A Release Mechanism on the diagram must be selected for this menu option to be enabled. Allows the user to enter information about the selected Release Mechanism. This window is accessed through the Edit menu; then select Edit.

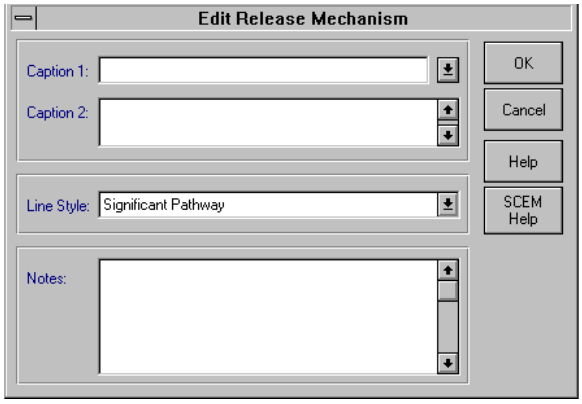


Figure 5.4 - Edit Release Mechanism Window

- Caption 1 - This text box is used for the main caption. On the diagram in the Main Window, this will be displayed as a bold line of text. Text is entered by typing a caption, or by selecting from a list of captions included in the program (i.e., click on the small down arrow to the right of Caption 1 box).

- Caption 2 - This text box is used for an additional sub-caption. On the diagram in the Main Window, up to three lines of text can be displayed.

- Line Style - This is used to select the line style for the release mechanism from one of three pre-defined styles. See Line Styles window.

- Notes - This text box can be used to enter additional information (up to 4,096 characters). Notes are not automatically displayed on the diagram screen (because of space constraints); however, the user can direct that notes be displayed on the diagram screen in a separate window (see Chapter 4). Notes can also be printed. See the Print Diagram and Notes

windows.

New / Edit Exposure Mechanism Window

An Exposure Mechanism on the diagram must be selected for this menu option to be enabled. Allows the user to enter information about the selected Exposure Mechanism. This window is accessed through the Edit menu; then select Edit (see Edit under Edit Menu in previous chapter).

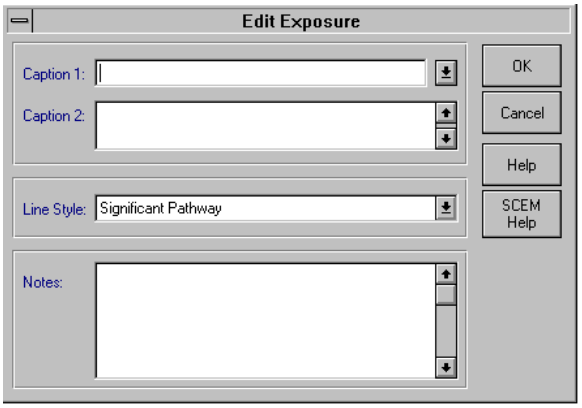


Figure 5.5 - Edit Exposure Mechanism Window

- Caption 1 - This text box is used for the main caption. On the diagram in the Main Window, this will be displayed as a bold line of text. Text is entered by typing a caption, or by selecting from a list of captions included in the program (i.e., click on the little down arrow to the right of Caption 1 box).

- Caption 2 - This text box is used for an additional sub-caption. On the diagram in the Main Window, up to three lines of text can be displayed.

- Line Style - This is used to select the line style from one of three pre-defined styles. See the Line Styles window.

- Notes -This text box can be used to enter additional information (up to 4,096 characters). Notes are not automatically displayed on the diagram screen (because of space constraints); however, the user can direct that notes be displayed on the diagram screen in a separate window (see Chapter 4). Notes can also be printed. See the Print Diagram and Notes windows.

New / Edit Receptor Window

A Receptor on the diagram must be selected for this menu option to be enabled. Allows the user to enter information about the selected Receptor. This window is accessed through the Edit menu; then select Edit (see Edit under Edit Menu in previous chapter).

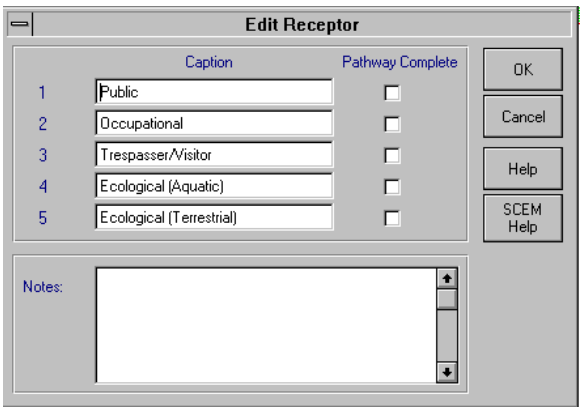


Figure 5.6 - Edit Receptor Window

- Captions - The Receptor object can have a maximum of five captions. Each caption can describe a potential receptor for the same contaminant release.

- Pathway Complete - Five check boxes are associated with the five potential receptor types (described in the five captions). For each potential receptor type, the user can check a box to mark a complete exposure pathway.

- Notes - This text box can be used to enter additional information (up to 4,096 characters). Notes are not automatically displayed on the diagram screen (because of space constraints); however, the user can direct that notes be displayed on the diagram screen in a separate window (see Chapter 4). Notes can also be printed. See the Print Diagram and Notes windows..

Line Styles Window

Allows the user to name each of the three line styles that can be used in the program for the Release and Exposure Mechanisms. The names of the line styles can be printed together with the diagram. This window is accessed through the Diagram menu; then select Line Styles.

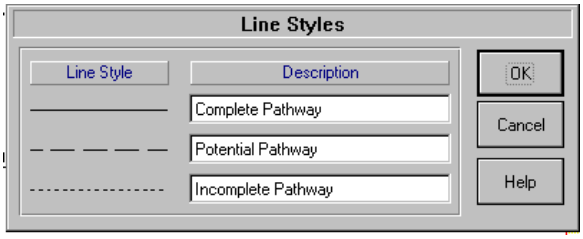


Figure 5.7 - Line Styles Window

Notes Window

Displays the notes for a selected object to allow the user to review the information entered for that object. The Notes Window does not support text editing. To enter or change notes for an object, first select an object, then use the Edit command under the Edit menu. A click of the mouse on the Notes Window will have the same effect and will bring up the edit window for the selected object. The Notes

Window can be made visible or removed from the screen by using the Setup menu, Notes Window Menu option.

Default Receptor Captions Window

Allows the user to name the default receptor captions for the Receptor object. These captions will be used each time a new receptor object is created. To create a new receptor object click and drag a receptor box from Toolbar 1 or choose the Add Receptor command under the Edit Menu) . See also the Edit Receptor window.

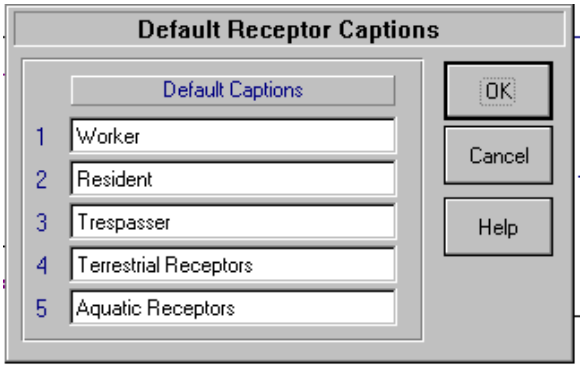


Figure 5.8 - Default Receptor Captions Window

Diagram Information Window

This window is accessed through the Diagram menu; then select Diagram Information.

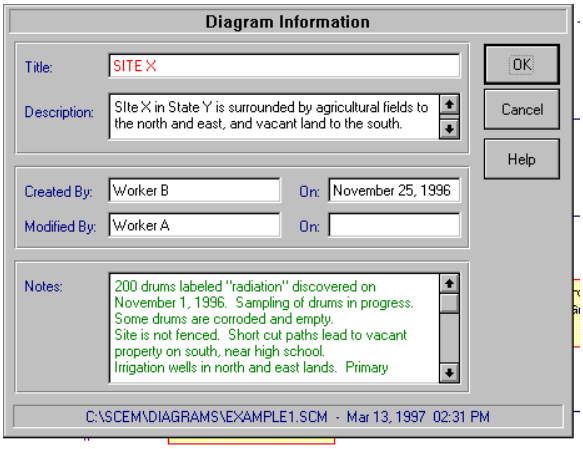


Figure 5.9 - Diagram Information Window

This window allows the user to enter the following information about the diagram:

- Title, Description - These text boxes allow the user to enter the title of the diagram and a description.

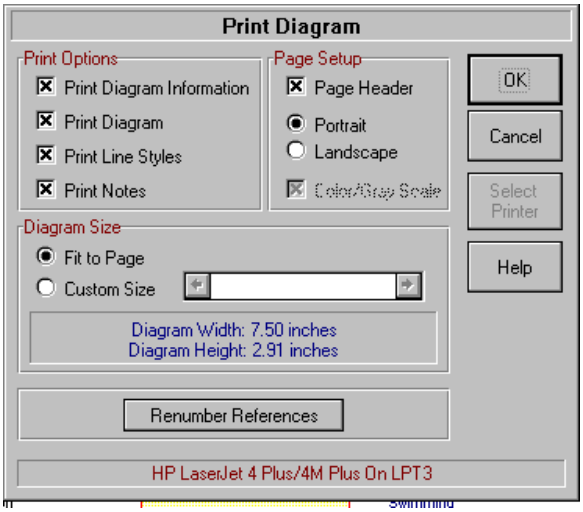
- Created By, On - Use these text boxes for the name of the person who created the diagram, and to enter the date the diagram was created.

- Modified By, On - Use these text boxes for the name of the last person who modified the diagram, and the respective date.

- Notes - Use this text box to type additional information about the diagram.

Print Diagram Window

Allows the user to print the diagram. This window is accessed through the File menu; then select Print Diagram. The Print Options, Page Setup, and Diagram Size options allow the user control over printing. The OK button prints the diagram. Please note that the program does not include printer selection. The printer is selected from the Microsoft Windows Operating System Control Panel, under Printers.



Gigure 5.10 - Print Diagram Window

The SCEM Builder includes the following printing option:

- Print Diagram Information - Click on this check box to print diagram information. This includes the title of the diagram, the description, etc. See also Diagram Information Window.

- Print Diagram - Click on this check box to print the diagram itself.

- Print Line Styles - Click on this check box to print line style descriptions. See also Line Style Window.

- Print Notes - Click on this check box to print the notes associated with each object.

For notes to be referenced to the respective object on the diagram, Sequential or Scientific reference numbers have to be enabled. See Reference Setup Window.

- Page Header - Click on this check box to have the header printed on every page. The header

includes the diagram title, current date, and page number.

- Portrait - Click on this option box to print in portrait mode.
- Landscape - Click on this option box to print in landscape mode.
- Color/Gray Scale - Feature to be implemented in the next version of the program.
- Fit to Page - Click on this option box to have the diagram automatically sized to fit on one printed page.
- Custom Size - Click on this option box and then use the scroll bar to manually set the size of the diagram.
- Renumber References Button - Click on this button to renumber reference numbers before printing the diagram. This button is enabled only if Sequential Reference Numbers are enabled. See Reference Setup Window.
- OK Button - Prints the diagram.
- Select Printer Button - Feature to be implemented in the next version of the program.

Reference Setup Window

Allows the user to include a reference number with each object in the diagram. This window is accessed through the Diagram menu; then select Reference Numbers.

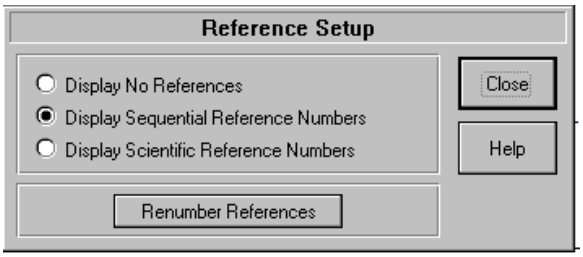


Figure 5.11 - Reference Setup Window

The SCEM Builder includes the following Reference Setup options:

- Display No References - Displays no reference numbers.
- Display Sequential Reference Numbers - Displays sequential reference numbers. (e.g., 1, 2, 3). By inserting or deleting objects, these numbers can get out of sequence. Use the Renumber References button to correct that.
- Display Scientific Reference Numbers - Displays scientific reference numbers. (e.g., 1.1, 1.1.1, 1.1.2). Scientific reference numbers are always renumbered when inserting or deleting objects.

- Renumber References Button - This button is enabled only if Sequential Reference Numbers are selected. Numbers can get out of sequence when inserting or deleting objects. This button fixes that.

Export Diagram Window

Feature may be implemented in the next version of the program.

Select Printer Window

Feature may be implemented in the next version of the program.

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5

Toolbars

Toolbars are time-saving features that give the user the ability to point-and-click on a graphical representation of a program function and have that function respond immediately. The SCEM Builder has two toolbars above the Diagram Builder window and one toolbar below the Diagram Builder window.

Toolbar 1

Toolbar 1 has a number of buttons that access frequently used operations quickly. All of the features accessible from the toolbar are also accessible through the program menus. Toolbar 1 can be made visible or removed from the screen by using the Setup menu and selecting the Show Toolbar 1 option.

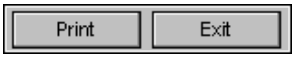
The five objects on the left represent Primary Sources, Release Mechanisms, Sources, Exposure Mechanisms, and Receptors. These objects can be selected, dragged, and dropped onto the Diagram Builder window - faster than using the Add option under the Edit menu. For more information, see these menu options:

- Add Primary Source
- Add Release Mechanism
- Add Source
- Add Exposure Mechanism
- Add Receptor
- Auto Caption/Notes
- Edit
- Delete

Two other buttons are also visible on the screen if the user's computer monitor supports a resolution of 800 pixels by 600 pixels.

For more information on these buttons, see Diagram Information and Reference Numbers in Chapter 4, Menus.

Two more buttons are visible on the screen if the user's computer monitor supports a resolution of 1,024 by 768 pixels.



For more information on these buttons, see Print Diagram and Exit in Chapter 4, Menus.

Toolbar 2

Toolbar 2 has additional buttons that access frequently used operations quickly.

All of the features in Toolbar 2 are also accessible through the following Edit Menu options:

- Cut
- Copy
- Paste
- Move Branch Up
- Move Branch Down

Toolbar 2 can be made visible or removed from the screen by using the Setup menu and selecting the Show Toolbar 2 option. For more information on these buttons, see information on these options in Chapter 4, Menus.

Status Bar

The bar below the Diagram Builder window is named Status Bar because it offers useful information about various options in the program. The Status Bar also includes a Zoom scroll bar and a Fit Screen button. The Status Bar can also be made visible or removed from the screen by using the Setup menu and selecting the Show Status Bar option.

Auto Save and Auto Caption/Notes are options accessible to the user under the Setup menu. The Interactive Tips function may be implemented in the next version of the SCEM Builder. The Zoom and Fit Screen functions can also be accessed under the View menu.

6

Environmental Components

The SCEM Builder includes the following objects:

- Contaminant Sources
- Release Mechanisms
- Exposure Mechanisms
- Receptors

Each of these objects has a distinct interface window where the user inputs information related to a specific object. The SCEM Builder was designed to allow flexible input by the user, while also providing time-saving default configurations. *The user input window for Contaminant Sources includes a caption area where the user can type the name of the contaminant source or choose from a default list of contaminant sources.* This chapter provides information on the list of default factors incorporated into the user input windows of the SCEM Builder (i.e., Contaminant Sources, Release Mechanisms, Exposure Mechanisms, Receptors).

Contaminant Sources

A contaminant source is an area where hazardous substances (including waste and waste constituents and/or radionuclides) are located. A contaminant source may include contaminated media. Contaminant sources may be grouped as primary, secondary, or tertiary. Contamination of secondary and/or tertiary sources results from releases from the primary source. For example, contaminated biota could be a secondary or tertiary source derived from a primary source that released a hazardous substance that is bioaccumulative and amenable to uptake by terrestrial or aquatic species.

Contaminated Ground Water or Plume

This contaminant source represents an aquifer or saturated zone in subsurface soils containing contaminants that may be dissolved or exist as separate phase products (i.e., Light Non-Aqueous Phase Liquids [LNAPL] or Dense Non-Aqueous Phase Liquids [DNAPL]). Contaminants in ground water may be released and contaminate other sources such as:

- Lake, river, stream, bay, harbor, or coastal waters that receive the ground water plume discharges

- Conduits (e.g., utility lines or underground piping/sewers) that have trapped LNAPL

- Lake, river, stream, and marine sediments located at the embankment soil/surface water

interface that receives the ground water plume discharges

Cooling Tower and Its Discharge

This contaminant source includes building structures, debris, and associated swales and drainage ditches that are currently receiving or have received cooling tower discharges. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils within the contaminant source area
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas
- Air containing airborne particulates or dust originating from the source area

Drip Pad or Sludge Drying Bed

This contaminant source typically includes an above ground area, including enclosures or berms, sumps, or overflow channels, used to drain liquids off wastewater treatment plant sludges, laboratory tank bottoms, or semi-solids. The pad or bed may be constructed of concrete, asphalt, gravel, or soil. Drip pads or sludge drying beds may release contaminants creating secondary sources, including:

- Surface and subsurface soils within the contaminant source area
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, and/or drainage ditches
- Air containing airborne particulates/dust or gaseous materials originating from the source area

Fire Training Area

This contaminant typically includes an above ground area used to train fire fighting personnel on fire control techniques. A fire training area is typically an outdoor facility that may not be readily identifiable if the area has no engineering structures (e.g., concrete or gravel pads) and has not been used for a long time. Releases from fire training areas may create additional secondary sources of contaminants, including:

- Surface and subsurface soils within the contaminant source area
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any
- Air containing airborne particulates/dust originating from the source area

Firing Range

This contaminant source typically includes an above ground area that encompasses razed or existing buildings (indoor pistol ranges) and/or open area areas used by security personnel for target practice. Unexploded or spent ammunition containing lead and copper are typical wastes associated with firing ranges. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils (for a demolished indoor range) within the contaminant source area (the entire range area)
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any

French Drain or Disposal Pit

This contaminant source typically includes a below ground structure or excavation that may or may not contain engineered piping sections/extensions. It may contain gravel, stones, or other aggregates to allow seepage of liquid waste or the disposal of semi-liquids. This source area may have been filled in with soil and may not be visually identifiable on the ground surface. Historical aerial photos may show these areas barren or devoid of vegetation or ground cover. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils within the contaminant area, including those of the lateral sections or extensions
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any
- Air containing airborne particulates/dust or gaseous materials originating from a source
- Infiltration seeps at downgradient locations that may or may not be mixed with surface water or shallow ground water

Laboratory/Sanitary Sewers and Wastewater Treatment Plants

This contaminant source typically includes an area that includes existing or razed structures associated with treatment of laboratory and/or sanitary wastewaters. Many of these structures may be buried or abandoned in place, broken, and contain sludges that are radioactive or that could be classified as hazardous or mixed wastes. Releases from this source may contaminate other sources, including:

- Subsurface soils within the contaminant source area
- Conduits (i.e., including the abandoned in place underground treatment plant components, sewer main, manholes, and lateral sections or extensions) that were part of the sewer systems
- Surface soil (at razed structures or subsurface soil that has been turned over due to demolition

and excavation) and surface soil located immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any

- Ground water in the vadose and saturated zones
- Surface water
- Air containing airborne particulates/dust originating from the source area

Lagoon/Pond/Surface Impoundment

This contaminant source typically includes a below ground or partially above ground structure or excavation area containing contaminated solids and/or liquids (e.g., mixture of waste and runoff/precipitation). It may include natural or engineered physical structures such as pipes, swales, and embankments. Equalization ponds for receiving process water and process water/stormwater combined flow are in this category. Releases from this source may contaminate other sources, including:

- Subsurface soils that are commingled or in contact with waste within the lagoon/surface impoundment
- Surface soil or exposed subsurface soil that is commingled or in contact with the waste within the surface impoundment and surface soil located immediately downgradient from the impoundment area, including soil and sediment in swales, drainage ditches, and runoff areas, if any
- Air containing airborne particulates/dust or gaseous materials originating from the impoundment or its contaminated dikes or embankments
- Ground water in the vadose and saturated zones
- Surface water

Landfarm

This contaminant source typically includes an above ground area or open space on the ground surface where solid waste such as sludges or contaminated soil or sediment are placed, dumped, or discharged, and commingled with soil by mechanical means (e.g., bulldozer or tractor equipped for soil mixing). Abandoned landfarms or landfarms that have not been used for a long time may not be visually identifiable. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils within the contaminant source area, and surface soil immediately downgradient from the source area
- Air containing airborne particulates/dust originating from the source area

Landfill

This contaminant source typically includes a below ground area filled with waste materials, debris, sludges, or contaminated soils. This source is typically abandoned or non-operational, uncontrolled, or out of compliance with EPA's minimum technology requirements for a land-based disposal unit, and may include the entire physical boundary of the landfill or a portion thereof (e.g., old cells). This source may be covered by soil or an artificial barrier, or may contain exposed contaminated structures, drums, or contaminated surface soil. Releases from this source may contaminate other sources, including:

- Subsurface soils that are commingled or in contact with the waste within the landfill
- Surface soil or exposed subsurface soil that is commingled or in contact with the waste within the landfill and surface soil located immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any
- Air containing airborne particulates/dust or gaseous materials vented from the landfill or originating through the landfill cover
- Ground water in the vadose and saturated zones

Map Tube Vault and Footing Drain

This contaminant source typically includes a below ground vault with drainage footing tile systems to divert subsurface water. The vault has multiple compartments (tubes) that can be used to store high level or transuranic wastes that may also contain hazardous substances. Due to maintenance or construction problems, it is not uncommon to find that the vault's structures have been degraded. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils within the contaminant source area, including the subsurface soil at the footing drain
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any
- Air containing airborne particulates/dust originating from the source area

Oil/Water Separator

This contaminant source consists of a below ground-surface concrete structure or tank-like device used to trap or separate oil from process water or fluids containing oil as a free-phase product. It may also contain sludges or residues. Many oil/water separators have been abandoned in place, cracked, or had their above ground structures partially demolished. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils within the contaminant source area, including the subsurface soil surrounding the inlet and discharge pipes
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any

- Air containing airborne particulates/dust and gaseous materials originating from the source area

Residual Soils and Sediments After Physical Removal

This contaminant source typically consists of residual surface soil, subsurface soil, or sediments remaining in an area where removal actions have been conducted. A removal action addresses physical structures, such as tanks, buildings, contaminated soils, sediments, or aggregates; however, the residual media may still be contaminated and could be a source for potential exposure pathways. Releases from contaminated soils and sediments may contaminate other sources, including:

- Ground water in the vadose and saturated zones
- Surface water

Storage Pad for Waste Drums or Containers

This contaminant typically includes a concrete, asphalt, or graveled pad, or a clear open area on the ground. Typically, debris, abandoned equipment, and waste containers of different sizes and shapes are stored on these pads. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils (if the pad has poor integrity) within the contaminant source area
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas, if any
- Surface water

Waste Pile/Open Disposal Area

This contaminant source typically includes an above ground area or a depression on the ground surface where scrap metal, solid waste, drums (with or without their contents), and other contaminated aggregates or media are placed, discharged, or abandoned. The waste pile may or may not have an engineered barrier such as concrete or asphalt pads between the waste materials and the soil. Typically, the waste pile is not covered by a roof, although sometimes canvas or plastic tarp may be used to cover the waste materials either partially or entirely. Releases from this source may contaminate other sources, including:

- Surface and subsurface soils (if the pile has no engineering barrier or if the barrier has poor integrity) within the contaminant source area
- Surface water
- Surface soil immediately downgradient from the source area, including soil and sediment in swales, drainage ditches, and runoff areas

- Air containing airborne particulates/dust originating from the source area

Release Mechanisms

A release mechanism is the manner by which hazardous substances and their constituents (chemicals or radionuclides) are released or made to leave their sources or matrices of sources. A release mechanism can be physical, chemical, or thermal. The physical and chemical nature of the hazardous substances or radionuclides in the contaminated source and its immediate environment (e.g., acidity, alkalinity, and sorptive properties of the receiving media) may influence the release mechanism. Several release mechanisms can occur simultaneously at a contaminated source.

Chemical Transformation

Chemical transformation is due to a variety of chemical reactions, such as oxidation. During chemical transformation, a hazardous substance (chemical or radionuclide) changes chemical characteristics (e.g., the conversion of lead to lead chloride or lead sulfate in acidic soil) and physical characteristics (e.g., solubility, vapor pressure). Other examples include the hydrolysis of many chemicals with water, the methylation of mercury, radiological decay, and photolysis. This release mechanism modifies the effectiveness of other release mechanisms.

Digging and Burrowing

This release mechanism refers to human or animal activities that cause the hazardous substances and/or their constituents to be released from a contaminant source. Construction activities that entail soil or sediment excavation, and burrowing actions by small mammals are examples of this release mechanism.

Dredging and Tracking

This release mechanism is caused by the physical force posed by act of dredging or tracking (vehicular or foot traffic). Under this release mechanism, the hazardous substances and/or their constituents are released from the matrix surfaces (solid, semi-solid, or liquid) into air in the form of particulates or fugitive air emissions, or into water in the form of solubilized chemicals or suspended solids. Dredging or tracking actions also serve as migration pathways that transport the released hazardous substances and their constituents to other media or locations.

Force of Gravity

This release mechanism is most applicable to sources that have inadequate containment systems or poor integrity. Hazardous substances and their constituents may leak from a unit (e.g., tank, container, surface impoundment, waste pile) to adjacent soils. Under this release mechanism, the hazardous substances are pulled by gravity toward lower subsurface strata through the path of least resistance.

Hydraulic Gradient

This release mechanism refers to the pressure caused by differences in ground water depths that results in the hazardous substances and their constituents being released from the source or structures/barriers. A typical example is the leaching of hazardous waste or hazardous constituents

through the liner of a surface impoundment or landfill.

Leaching

This release mechanism refers to the movement of soluble chemicals via infiltration into surface soils. Leaching could be viewed as the combined mechanisms of gravitational force, hydraulic gradient, and solubility. As a result of atmospheric precipitation, and runoff from storm and/or ground water recharge, infiltration leaching action removes the hazardous substances and their constituents from a source (e.g., soils) to other media (e.g., perched aquifer).

Runoff

This release mechanism refers to the physical force, posed by surface water moving in a downstream direction, that removes the hazardous substances and their constituents from the source and transports them to other media. Runoff also serves as a migration pathway that transports released hazardous substances and their constituents to other media or locations. The effectiveness of this release mechanism is typically related to other mechanisms, such as solubility. Runoff action is a predominant cause of release of hazardous substances in contaminated soils along swales channels, river banks, or ground water recharge areas. Flooding overland flow may be considered a runoff mechanism on a larger scale.

Solubility

This release mechanism refers to the forming of chemical bonds within the solvent or water matrices. Polar compounds form ionic bonds with the water molecules, acids, or bases. Non-polar compounds form weak intermolecular bonds with van der Waals forces in common solvents like kerosene, jet fuels, hexane, or isopropyl alcohol. Release stops when the solubility or saturation limit is reached within the solubilizing agent.

Tidal Action

Like runoff, this release mechanism refers to the physical force posed by the movement of surface water caused by gravitational force from the moon (diurnal) or storms (episodic). Tidal action can act as a release and a transport mechanism, removing the hazardous substances and their constituents from one medium to another, as well as from one location to another. Tidal action is applicable to large inland lakes, and marine and coastal areas.

Uptake

This release mechanism refers to physical and/or chemical means occurring at the barrier between an organism and the contaminated media. Under this release mechanism, the hazardous substances and/or their constituents are released from the matrix (food, soil, sediment, and surface water) by physical means (e.g., molecular diffusion), biochemical means (e.g., active transport), or chemical means (stomach acids), or a combination of the above. The biochemical processes following ingestion and plant translocation mechanism at the root zone are examples of uptake release mechanism.

Volatilization

This release mechanism is dependent on the chemical characteristics of the hazardous substance (i.e., molecular weight, vapor pressure, Henry's Law constant, boiling point, etc.), ambient temperature, and wind velocity or air movement. Under this release mechanism, the hazardous substances and/or their constituents are released from the matrix surfaces (solid or liquid) into air (pores in soil or the ambient air). This release mechanism is most applicable to volatile organic chemicals and, to a lesser extent, semi-volatile organic chemicals.

Wind Erosion

This release mechanism refers to the frictional force, posed by air movement near the earth surface, that removes the hazardous substances and their constituents from the source to air. Under this release mechanism, the hazardous substances and/or their constituents are released from the matrix surface into air. This release mechanism is most applicable to metals and semi-volatile organic chemicals.

Exposure Mechanisms

This is a term used to describe the manner by which hazardous substances or radionuclides released from the source and transported to the exposure media (e.g., soil, sediment, ground water, indoor air, ambient air, surface water, and food/biota) are available to an organism (humans or ecological receptors) for absorption at the barrier surfaces. Point of exposure is the location where exposure media (e.g., soil, sediment surface water, ground water, or biota) are present.

Dermal Contact

This exposure mechanism refers to the exposure to released hazardous substances and their constituents via the dermal route.

Ingestion

This exposure mechanism refers to the exposure to released hazardous substances and their constituents via the ingestion route. Hazardous substances and theis constituents present in ground water or surface water may be ingested if water is potable, and the exposure point is located downgradient from the contaminated source and is hydraulically connected. Contaminants may be present in biota if the contaminant is bioaccumulative (e.g., PCBs, dioxins/furans, PAHs, and certain metals [e.g., antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, mercury, selenium, silver, and thallium]) and is attractive to ecological species due to availability of food, and harborage/shelter.

Inhalation

This exposure mechanism refers to the exposure to released hazardous substances and their constituents via the inhalation route. The released substances and constituents present in air may be inhaled if the receptor is located downwind from the source.

Receptors

Receptors are human or ecological species that are potentially exposed to contaminants at the source area or other locations where contaminants were transported because of release mechanisms. A receptor may be exposed to hazardous substances via several exposure pathways. Receptor characterization includes determining locations of potential receptors, activity patterns, and the presence of subpopulations.

Many receptor types or species could be exposed to the hazardous substances or radionuclides released and transported from the source to the exposure media. According to Risk Assessment Guidance for Superfund (RAGS), only significant receptors are to be evaluated for exposure pathway completeness. These receptors should be those who have the highest degree of exposure (high-end exposure), based on consideration of the exposure patterns (frequency, duration, and contact rate). In the case of ecological receptors, any identified threatened or endangered species should also be considered.

Aquatic

These receptors include free-swimming and benthic organisms, and aquatic vegetation. These species could be exposed to contaminated surface water, sediment, ground water infiltration (intersecting surface water), and/or runoff carrying contaminated soil or sediment. Bottom feeders or prey fish may ingest contaminated benthic invertebrates or other aquatic species if the site contaminants are bioaccumulative and have been transported from the site to surface water bodies, resulting in biomagnification of hazardous substances.

Occupational

Occupational receptors include persons who work or live on site (e.g., construction workers, industrial workers, office workers, groundskeepers, visitors). Depending on their activities and where they are located relative to the source area, these humans may be exposed via airborne contaminants (gaseous [including indoor air] or fugitive dust emissions/particulates), incidental soil and sediment ingestion, and dermal contact. If they use on-site wells or surface water, they may be exposed to the contaminants if such media have been contaminated. If food chain species have been impacted, these persons may be impacted if such food or species are collected or hunted and ingested, although this is highly unlikely in most occupational settings.

Public

Public receptors include humans who live or work near the site (off-site residents and workers). Public receptors may be exposed to airborne contaminants (gaseous or fugitive dust emissions/particulates) if they are located downwind from the site, or to contaminants in surface water or ground water, if these waters are used and if contamination is feasible or has occurred, and if the flow directions are toward these receptors. Public receptors may also be exposed to contaminants via ingestion of contaminated food/species collected or hunted.

Terrestrial

These receptors include wild, domestic, farm, and game animals and plants. These animals and may

be subject to exposure from airborne contaminants (gaseous or fugitive dust emissions/ particulates) if the ambient air is contaminated. If these receptors use contaminated surface or ground water or are provided with such water for consumption, they may be exposed. If these species ingest food crops or other species that bioaccumulate site contaminants, these terrestrial species may also be impacted. On-site burrowing animals may be impacted or exposed via incidental soil ingestion, inhalation, and dermal contact routes of exposure.

Trespasser/Non-Residential Visitors

These receptors include humans who live off site and come in contact with the site at a frequency less than on-site workers or residents. They include visitors, contract personnel, and delivery personnel. The relevancy of these receptor categories will depend on the exposure area and the anticipated activities of the receptor groups. Depending on their activities and where they trespass or visit the site and the source area, these receptors could be exposed via airborne contaminants (gaseous emissions or fugitive dust emissions/particulates), incidental soil and sediment ingestion, or dermal contact. If they wade or swim, they may be exposed to the contaminants in on-site sediment or surface water. If food chain species have been impacted, these receptors may be impacted if such food/species are collected or hunted and ingested.

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Support

EH-413 developed the SCEM Builder to facilitate generation of the SCEM diagrams requested by EPA as part of CERCLA documentation. The SCEM Builder is distributed free of charge primarily to DOE personnel involved in CERCLA and RCRA actions. EH-413 can conduct demonstrations and/or training workshops if requested by DOE offices.

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USER'S GUIDE
SUBSURFACE FUGACITY SPREADSHEET TOOL
FOR RESULTS BASED PROJECT MANAGEMENT

The purpose of this User's Guide is to provide instructions regarding downloading and using a fugacity spreadsheet to determine the distribution of an organic chemical among air, water (aqueous), soil solids, and non-aqueous phase liquid (NAPL) in a subsurface environment.

1. access web address:
   http://www.engineering.usu.edu/uwrl/www/faculty/fugacity/fugacity.html

2. On page one, select Level 1 Fugacity Model

3. Information is provided in the tab labeled "Fugacity Level 1" for the chemical benzene.
   The information displayed addresses:
   (a) chemical characteristics of benzene,
   (b) default site characteristics, and
   (c) three formats [pie chart, bar chart, and table] for presenting information on the distribution of benzene among subsurface phases including air, water, soil solids, and NAPL. In addition, the table provides values for the concentration of benzene (mg/L) in each phase, based on a total amount of 1 gm of benzene and a total volume of all phases of 100 m^3.

4. Chemical characteristics are obtained from the tab labeled "chemical data." Chemical characteristics for the chemical of interest are obtained as follows:
   (1) access the "chemical data" tab, then
   (2) locate the chemical (listed in alphabetical order)
   (3) copy the list of chemical characteristics
   (4) paste the list of chemical characteristics under "Level 1 Fugacity."

5. Site characteristics are listed under the "Level 1 Fugacity." tab for a typical "evaluative site" and typical values are provided as default values. Site specific data is entered manually.
   (1) The volume of each phase can be provided as input, but the total volume of the "evaluative site" must be 100 (m^3). Therefore the values for each phase represent the "percent" of that phase within the "evaluative site." Ranges of values include:

Soil Phase	Range(% volume)	Typical Values (% volume)	
		Unsaturated Soil	Aquifer
Water	5 - 50	25	40
Air	0 - 40	25	0
Soil Solid	40-60	50	60
NAPL	0 - 50	0	0

   (2) Values for % organic carbon in the soil phase and soil bulk density can be provided as input based on measured values for a particular site. Standard procedures are available for measuring these properties (Methods of Soil Analysis, Parts 1& 2, American Society of Agronomy, Inc., 1982 (Part 1), 1986 (Part 2)). Values for % organic carbon and soil bulk density in soil include:

Property	Range	Typical Values	
		Unsaturated Soil	Aquifer
% Organic carbon	0.2 - 5.0	0.5	0.2
Bulk Density (Kg/m^3)	1.2 - 1.7	1.3	1.6

   (3) The default value for the mass of the compound in the system (air, water, soil solid, and NAPL) is one gram, but site-specific values can be provided as input. Calculation of chemical concentrations in each phase at equilibrium is provided.