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Ms. Barbara Driscoll
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US Environmental Protection Agency, Region 6
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Dear Barbara:

SUBJECT: GUIDANCE FOR SCREENING ASSESSMENT METHODOLOGY

Enclosed for your review is the Los Alamos National Laboratory (Laboratory) Environmental Restoration (ER) Assessment Council's position paper entitled, "Screening Assessment Methodology at Los Alamos National Laboratory," dated January 18, 1995. The Department of Energy and other Laboratory personnel are simultaneously reviewing this paper. Those comments are due back **March 3, 1995**. If at all possible, we would appreciate your comments by then as well. When all comments are resolved, we will distribute the paper to ER personnel for use in preparing Resource Conservation and Recovery Act Facility Investigation reports. The position paper will then be part of approved ER methodology and will be cited as such.

The Strenge, D.L. and S.R. Peterson, 1989, reference is not included because it is a computer data base. Environmental Protection Agency references are also not included. Other references, as cited, are included.

If you have any questions regarding this document, please call Alison Dorries at (505) 665-4791. Thank you.

Sincerely,

Tracy Glatzmaier
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Sincerely,

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An Equal Opportunity

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Enc.: Position Paper
Cited References

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SCREENING ASSESSMENT METHODOLOGY AT LOS ALAMOS NATIONAL LABORATORY

The Environmental Restoration Project

Draft

January, 1995

1.0 Introduction

Screening assessments are performed at Los Alamos National Laboratory (the Laboratory) to identify whether or not potential releases have occurred. Figure 1 presents the decision logic for screening assessments.

The screening assessment begins with the identification of potential constituents and environmental media of concern based on knowledge of the history and processes that occurred at a potential release site (PRS). Existing or new environmental data collected during the Resource Conservation and Recovery Act (RCRA) field investigation are then compared with screening action levels (SALs) for the constituents identified. Usually, the maximum observed concentration of each constituent, rather than averages of several observations, is compared with SALs. In some cases, observations made on composite samples, or averages of closely related samples such as field duplicates, may be used. If SALs are not exceeded, the PRS may be recommended for no further action (NFA). However, further examination may be necessary if two or more constituents are present, even if they are below their associated SALs, to determine the potential for combined effects. Constituents whose concentrations exceed both SALs and background levels or that are identified as contaminants of concern because they may present a risk in combination with other constituents present require further evaluation (e.g., site-specific risk assessment, additional sampling). Table 1* presents a summary of SALs for nonradiological constituents. The SALs for radionuclides are presented in Table 2. These tables are maintained in the FIMAD database and may have been revised.

SALs are derived using conservative exposure assumptions that are not site-specific; therefore, SALs are only used as a screening tool and not as cleanup levels. If the results of the screening assessment show that chemical-specific levels are exceeded, more site-specific data and analysis may be needed. Under no circumstance should the waste generated during investigation or remediation be characterized based on SALs. This paper presents the equations and assumptions used to derive screening action levels for both nonradiological and radiological constituents and puts SALs in context of the Environmental Restoration decision process.

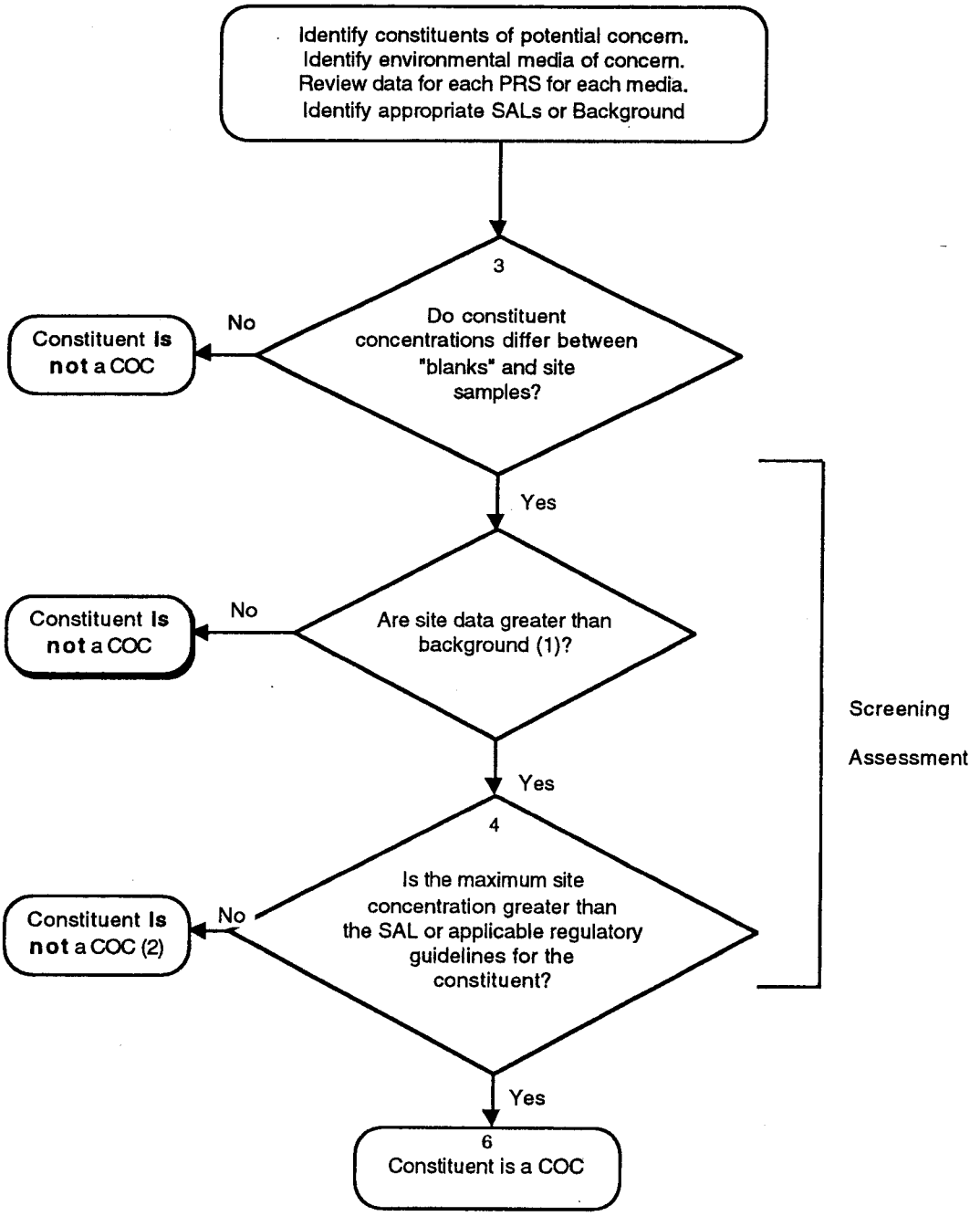
2.0 Screening Action Levels for Nonradiological Constituents

Methodology for calculating action levels to determine the need for further evaluation of contamination in various environmental media (i.e., ground water, surface water, air, and soil) is presented in "Corrective Action for Solid Waste Management Units," Subpart S (EPA 1990, 0432), a proposed regulation under RCRA. The action levels are calculated using chemical-specific toxicity values and default exposure parameters. In order to comply with the Hazardous and Solid Waste Amendments Module for the Laboratory, SALs have been developed that follow the Subpart S methodology for exposure parameter defaults but that incorporate more recent toxicity values available from the Environmental Protection Agency's (EPA's) Integrated Risk Information System (IRIS) data base (EPA 1994, 1167) and Health Effects Assessment Summary Tables (HEAST) (EPA 1994, 1169), which are updated periodically. Therefore, screening action levels will be revised when new toxicity information and/or applicable or relevant and appropriate requirements, sometimes called ARARs, become available.

2.1 Assumptions

A summary of the nonradiological SAL values is presented in Table 1. Table 3 contains the toxicological information (i.e., reference doses [RfDs] and carcinogenic slope factors) used for establishing nonradiological SALs. The constituents included in Tables 1 and 3 are common inorganic compounds, volatile and semivolatile organic compounds, and high-explosive compounds used at the Laboratory. Other constituents may need to be added as the results of site characterizations become available. Tables 1 and 3 are updated bi-annually to reflect any modified toxicity values and are available on the FIMAD database.

*In this document, tables are located after the text.



(1) Inorganics are compared to LANL background concentrations and organics are compared with literature values (see ER Policy Papers: *Making Comparisons with Natural Background Concentrations of Metals for the Los Alamos National Laboratory Environmental Restoration Project* and *Evaluating the Human Health Significance of Polynuclear Aromatic Hydrocarbons at the Los Alamos National Laboratory*).

(2) Site data will be reviewed for multiple constituents that are less than the SAL and are above background.

Figure 1. Decision logic for screening assessments.

SAL derivations are based on the following assumptions and equations contained in proposed Subpart S:

1. When deriving soil SALs for systemic (i.e., noncarcinogenic) effects, the model assumes that a 16-kg child ingests soil at a rate of 200 mg/day. For carcinogenic constituents in soil, the long-term exposure of an adult is modeled. For this calculation, it is assumed that a 70-kg adult ingests soil at a rate of 100 mg/day over a 70-yr exposure duration.

2. A modification of the Subpart S methodology has been introduced to account for exposure to organic compounds volatilizing from soil. The modification is applied to account for potential inhalation exposure, as presented in more recent EPA guidance for calculating preliminary remediation goals (EPA 1991, 0302). The Laboratory's ER Program has selected this approach because SALs for volatile substances calculated using this modified approach are lower (i.e., more conservative) than those calculated using the unmodified Subpart S method. For the purpose of calculating SALs, volatile constituents are defined as those with a molecular weight less than 200 and a Henry's Law Constant greater than 1×10^{-5} atm/m^3-mole (EPA 1991, 0302).

   The equation for calculating SALs for volatile constituents has been expanded to account for potential inhalation exposure (equations are given in Section 2.2, below). The soil-to-air volatilization factor was calculated based on an equation given by EPA (1991, 0302) and chemical-specific parameters (Strenge and Peterson 1989, 0837; EPA 1988, 0747). The default particulate emission factor was used in SAL calculations for volatile constituents to maintain consistency with the equation given in EPA guidance (EPA 1991, 0302), although this factor is so low that it does not affect the calculated SALs. To calculate SALs for volatile constituents that have systemic effects, a 16-kg child is assumed to ingest soil at a rate of 200 mg/day and inhale 20 m^3/day of air. The SAL calculation for carcinogenic volatile constituents models exposure of a 70-kg adult over a 70-yr exposure duration, with a soil ingestion rate of 100 mg/day and an inhalation rate of 20 m^3/day.

3. In deriving SALs for constituents in water, it is assumed that a 70-kg adult ingests water at a rate of 2 L/day over a 70-yr exposure duration. These SALs apply to constituents in both ground water and surface water.

4. In deriving SALs for constituents in air, it is assumed that a 70-kg adult inhales air at the rate of 20 m^3/day over a 70-yr exposure duration.

5. Proposed Subpart S specifies the use of maximum contaminant levels (MCLs) promulgated under the Safe Drinking Water Act as action levels for ground water constituents. Subpart S also indicates that state water quality standards established pursuant to the Clean Water Act, Section 303c, will be used as action levels for surface water constituents when these standards have been established for the surface water body in question. When numeric water quality standards have not been established by the state, Subpart S specifies that MCLs will be used as action levels if the state designates the surface water as a drinking water source.

   In keeping with Subpart S, when the MCL value or state ground water standard is not available, the value calculated using the specified exposure assumptions for water (No. 3 above) will be used as the SAL. Although not specifically stated, it is consistent with Subpart S to use the same SAL criteria

for both ground water and surface water constituents. For surface water constituents, these criteria may be more stringent than required because New Mexico has not designated surface waters to be evaluated as drinking water sources.

6. For arsenic and beryllium, the SALs derived using the Subpart S methodology are orders of magnitude lower than naturally occurring levels in tuff, soils, and sediments located in Los Alamos. Therefore, arsenic and beryllium concentrations should be compared to background distributions. If site concentrations are indistinguishable from background concentrations, the constituent can be eliminated from the list of contaminants of potential concern. Constituents whose concentrations exceed background levels require further evaluation.

2.2 Equations

2.2.1 General Equations for Calculating SALs

2.2.1.1 Systemic Toxicants

$$SAL = \frac{THI \times RfD \times BW \times CF}{I \times A}, \quad (1)$$

where

SAL	=	mg/kg for soil, µg/L for water, µg/m^3 for air;
THI	=	target hazard index: 1;
RfD	=	chronic reference dose: mg/kg/day (oral RfD used for soil and water SALs, inhalation RfD used for air SALs);
BW	=	body weight: 16 kg for child (for soil SALs), 70 kg for adult (for water and air SALs);
CF	=	conversion factor: 10^6 mg/kg for soil SALs, 10^3 µg/mg for water and air SALs;
I	=	intake rate: 200 mg/day for soil SALs, 2 L/day for water SALs, 20 m^3/day for air SALs;
A	=	absorption factor: 1.

2.2.1.2 Carcinogenic Constituents

$$SAL = \frac{R \times BW \times LT \times CF}{SF \times I \times A \times ED}, \quad (2)$$

where

SAL	=	mg/kg for soil, µg/L for water, µg/m^3 for air;
R	=	target risk: 10^{-6} for Class A and B carcinogens, 10^{-5} for Class C carcinogens;
BW	=	body weight: 70 kg;
LT	=	assumed lifetime: 70 yr;
CF	=	conversion factor: 10^6 mg/kg for soil SALs, 10^3 µg/mg for water and air SALs;

SF = slope factor: $(mg/kg/day)^{-1}$ (oral SF used for soil and water SALs, inhalation SF used for air SAL);

I = intake rate: 100 mg/day for soil SALs, 2 L/day for water SALs, 20 m^3/day for air SALs;

A = absorption factor: 1;

ED = exposure duration: 70 yr.

2.2.2 Equations for Calculating Soil SALs for Volatile Constituents

2.2.2.1 Systemic Toxicants

$$SAL = \frac{THI \times BW}{\{[1/RfD_o \times CF\ ING] + [1/RfD_i \times INH \times (1/VF + 1/PEF)]\}}, \quad (3)$$

where

SAL = mg/kg for soil, µg/L for water, µg/m^3 for air ;

THI = target hazard Index: 1;

BW = body weight: 16 kg;

RfD_o = chronic oral reference dose: mg/kg/day;

CF = conversion factor: 10^{-6} kg/mg;

ING = soil ingestion rate: 200 mg/day;

RfD_i = chronic inhalation reference dose: mg/kg/day;

INH = inhalation rate: 20 m^3/day;

VF = soil-to-air volatilization factor (chemical-specific): m^3/kg, calculated using equation given by EPA (1991, 0302) and chemical-specific parameters (Strenge and Peterson 1989, 0837; EPA 1988, 0747);

PEF = particulate emission factor: 4.63×10^9 m^3/kg (EPA 1991, 0302).

2.2.2.2 Carcinogenic Constituents

$$SAL = \frac{R \times BW \times LT}{ED \times \{[SF_o \times CF \times ING] + [SF_i \times INH \times (1/VF + 1/PEF)]\}}, \quad (4)$$

where

SAL = mg/kg for soil, µg/L for water, µg/m^3 for air;

R = target risk: 10^{-6} for Class A and B carcinogens, 10^{-5} for Class C carcinogens;

BW = body weight: 70 kg;

LT = assumed lifetime: 70 yr;

ED = exposure duration: 70 yr;

SF_O = oral slope factor $(mg/kg/day)^{-1}$;

CF = conversion factor: 10^{-6} kg/mg;

ING = soil ingestion rate: 100 mg/day;

SF_i = inhalation slope factor $(mg/kg/day)^{-1}$;

INH = inhalation rate: 20 m^3/day;

VF and PEF as defined above.

2.3 Derivation of SALs When Noncarcinogenic Toxicological Data Are Lacking

When adequate chronic toxicological information for a compound of interest does not exist for input to the SAL calculation, an interim conservative estimated value is derived by extrapolating from acute toxicological data.

2.4 Derivation of SALs for Other Media and Substances

2.4.1 Structural Surfaces and Debris

Proposed Subpart S does not provide guidance on the derivation of SALs for potentially contaminated structural surfaces or debris (e.g., concrete, wood). These values may be needed for evaluating currently unused buildings. The structural surfaces of unused buildings may contain removable nonradiological constituents because these surfaces have not been subjected to weathering. SALs for these structural surfaces may be derived using wipe test data and appropriate assumptions on dust resuspension rates, inhalation and ingestion rates, and exposure period. These SALs for structural surfaces will be derived on an as-needed basis when characterization data become available.

Plausible exposure routes for structural materials (i.e., demolition debris), either buried or at the land surface, are through human contact with the surrounding media (soil, water, air) because some constituents may already have been released into the surrounding media as the result of weathering. Therefore, nonradiological contamination from exposed and buried structural debris can be evaluated by comparing SALs with constituent levels in surrounding media.

2.4.2 Shrapnel and Unexploded High Explosives

Shrapnel and unexploded high explosives need special consideration. The primary health hazard associated with these materials is injury by explosion. The toxicity of chemicals that might be released from these materials will be evaluated for individual constituents using appropriate SALs for soil, water, air, and structural surfaces. SALs for some high explosives and constituents of high explosives known to have been used at the Laboratory and for which toxicity data exist are presented in Tables 1 and 3. The SALs for high explosives were developed using Subpart S methodology. Work plans for individual sites will address characterization of potential exposure to shrapnel and high explosives, as needed.

2.4.3 Asbestos

Another special substance that needs criteria for screening decisions is asbestos. The SAL approach developed for evaluating most other constituents is not appropriate for asbestos. Currently there is no generally accepted method for the analysis of asbestos in soil (Stenner et al. 1990, 1170). The likelihood of adverse health effects resulting from exposure to asbestos-contaminated soil is dependent on the presence of friable asbestos and the potential for human exposure via inhalation. Given these two considerations, the following guidelines to be followed during sampling are recommended to ensure protection to human health while minimizing

unnecessary expenses of sampling, analysis, and possible remedial action.

1. If there are no visible signs of asbestos-containing material and historical evidence indicates that asbestos-containing material was not at the site, NFA is suggested.

2. If there are no visible signs of asbestos-containing material but historical evidence indicates that asbestos-containing material might have been at the site and removal procedures are uncertain or may not have adequately contained the asbestos, ambient air monitoring will be initiated to better define the presence of asbestos contamination in the soil. Since current exposure at the sites is typically occupational exposure, it would be appropriate to compare asbestos levels in the air with the Occupational Safety and Health Administration (OSHA) standard of 0.2 fibers/cc of air (ACGIH 1993, 1102). If this value is exceeded, remedial actions may be necessary.

3. If there are visible signs of asbestos-containing material, it is recommended that the visible asbestos-containing material be removed by expedited cleanup and ambient air monitoring be initiated. Air monitoring should be performed during high winds and/or during activities that disturb the soil. Again, it is often appropriate to compare asbestos levels in the air with the OSHA standard of 0.2 fibers/cc of air (ACGIH 1993, 1102). If this value is exceeded, remedial actions may be necessary.

3.0 Screening Action Levels for Radioactive Constituents

As described above, SALs for many RCRA-regulated nonradioactive constituents have been recommended in, or derived, using proposed Subpart S regulations. However, radioactive compounds are not regulated under RCRA, and Subpart S regulations do not address radioactive constituents. To ensure that radioactive and nonradioactive compounds are addressed similarly and to simplify integrating RCRA, DOE, and CERCLA requirements for radioactive compounds, SALs for radioactive compounds have been derived in a manner similar to that used for deriving action levels in proposed Subpart S.

3.1 Rationale for Deriving SALs for Radioactive Constituents in Soils

In developing SALs for radioactive constituents, it is necessary to consider all relevant and applicable standards for protecting human health. For radionuclides in the environment, guidance assumes that the protection standards that govern human health generally protect other biotic species (NCRP 1991, 0986; International Atomic Energy Agency 1992, 0983). The limits of radiation exposure to humans are governed by listing an upper bound of a radiation dose established in the radiation protection standards that corresponds to an acceptable health risk. The upper-bounded radiation dose limit may not be exceeded but may be reduced by using health physics principles and DOE's as low as reasonably achievable (ALARA) guidance (DOE 1991, 0779).

Because current radiation protection standards [e.g., NESHAPS (EPA 1992, 1061) and MCLs (EPA 1993, 1071)] are based on radiation dose limits rather than on corresponding cancer slope factors or risk levels, as are nonradioactive compounds enumerated in Subpart S, SALs for radioactive compounds are based on radiation dose levels considered to be "acceptable" to individuals in the general public. The national and international radiological communities and DOE (NCRP 1988, 0778; DOE 1990, 0080) have set a limit of 100 mrem/yr as a maximum acceptable radiation dose to individuals in the general public from all contaminant pathways, radionuclides, and exposure sources. Radiation dose to the public is further limited to 25 mrem/yr from individual sources (e.g., DOE 1988, 0266; EPA 1977, 1064). The radiation dose limits to the general public apply to cumulative exposure from multiple radioactive constituents through multiple pathways, whereas action levels for nonradioactive compounds in Subpart S have been derived for a single contaminant via a single exposure pathway.

The Laboratory calculates SALs for radionuclides in soils at an annual dose limit of 10 mrem/yr above background levels. SALs are calculated for a single radioactive constituent via all pathways for radionuclides for which media-specific concentration limits are not specified in other regulations (e.g., MCLs). The proposed conservative dose limit of 10 mrem/yr was chosen on the basis of the following criteria:

- fraction of 100 mrem/yr and 25 mrem/yr regulatory standards,
- specified in DOE Order 5400.5 (DOE 1990, 0080) as a reporting level,
- generally within detection limits for current field instruments, and
- discernible from background radiation levels in the US (Table 4).

Even if radionuclide levels do not exceed a SAL, consideration of ALARA may lead to further investigation or cleanup.

3.2 SALs for Radioactive Constituents in Soil

Preliminary SALs have been derived for several radionuclides that may be encountered in contaminated soils at the Laboratory (Table 2) and available on FIMAD. The following methodology and assumptions were used in deriving these SALs:

- The RESRAD computer code (Yu et al. 1993, 1177), Version 5.18, was used to derive the SALs. This code is required by DOE Order 5400.5 to be used in the derivation of cleanup criteria for radionuclides in soils at DOE sites.

- A residential scenario, which included exposure to the following sources through the following pathways, was used to derive a SAL for each radionuclide: (1) external exposure from gamma emitters in soil, (2) inhalation of contaminated dust and radon gas, and (3) ingestion of contaminated soil and plants grown on the site.

- The input data used in the RESRAD calculations typify the range of soil properties encountered on Laboratory mesa tops (Dorries 1992, 1066; 1992, 1067; 1992, 1068;. 1993, 1069). The volume of contaminated soil is assumed to extend down 3 m from the surface and cover an area of 500 m^2. When LANL site-specific data were not available, default values in the model were used. These default values were derived from averaged soil data obtained from the general literature (Yu et al. 1993, 1177).

3.3 SALs for Radioactive Constituents in Water

SALs for radionuclides in water are based on regulations contained in 40 CFR 141.16 (EPA 1992, 1072) and the proposed national primary drinking water regulations for radionuclides (EPA 1991, 0887), which govern MCLs in community drinking water supplies. SALs for radionuclide constituents are presented in Table 2 and are available in the FIMAD database.

For alpha-emitting radionuclides, the proposed standards state that

- the maximum contaminant level for ^{226}Ra is 20 pCi/L, and the maximum contaminant level for ^{228}Ra is also 20 pCi/L;

- the maximum contaminant level for gross alpha activity (excluding ^{226}Ra, radon, and uranium) is 15 pCi/L;

- the maximum contaminant level for total uranium is 20 µg/L or 30 pCi/L (EPA 1993, 1071);

- if more than one alpha-emitting radionuclide is present, the appropriate standard is calculated by means of the equation described in Section 4.0.

For beta- and gamma-emitting radionuclides, the proposed standards state the following:

- The maximum contaminant level for ^{228}Ra is 20 pCi/L.

- Average annual concentrations of beta particle and gamma radioactivity (excluding ^{228}Ra) in drinking water shall not produce an effective dose equivalent greater than 4 mrem/yr . The proposed regulations also apply the 4-mrem/yr effective dose equivalent limit to tritium and ^{90}Sr. However 40 CFR 141.16 lists specific MCLs for these beta emitters. The MCLs are 20,000 pCi/L for tritium and 8 pCi/L for ^{90}Sr.

- If more than one alpha-emitting radionuclide is present, the appropriate standard is calculated by means of the equation described in Section 4.0.

Dose conversion factors are used to derive concentration limits of radionuclides that may be present in water at the Laboratory. The effective dose equivalent factors contained in EPA's Federal Guidance Report No. 11 (EPA 1988, 0982), consistent with those published by DOE (DOE 1988, 0266), are used to derive the SALs at the Laboratory. The methodology is discussed below.

For beta- and gamma-emitting radionuclides, the yearly dose limit of 4 mrem/yr is converted to a SAL by dividing the annual dose limit by the water intake rate and effective dose equivalent factor, as shown below:

$$SAL = \frac{DL \times CF}{IR \times DCF_{\beta-\gamma}} \quad , \tag{5}$$

where

SAL	=	screening action level for beta-gamma emitters in pCi/L;
DL	=	annual dose limit: 4 mrem/yr;
CF	=	conversion factor: 10^6 pCi/µCi;
IR	=	water intake rate: 2 L/day or 730 L/yr;
$DCF_{\beta-\gamma}$	=	ingestion effective dose equivalent factor for beta-gamma emitters: mrem/µCi (dose conversion factors for ingestion are listed in Table 2.2 of Federal Guidance Report 11, in units of Sv/Bq; to convert to mrem/µCi, these values were divided by 3.7×10^9).

4.0 Addressing Multiple Constituents

Proposed Subpart S does not address how to evaluate several constituents with concentrations close to but below SALs in a single environmental medium. If multiple constituents do not exceed but are near their SALs, it is possible that in combination they could prove deleterious to human health. For example, a mixture of chemicals may produce an additive response that is simply the sum of their individual responses. However, more complicated interactions can include synergism (combination has greater toxicity than the sum of individual chemicals), potentiation (individual chemical is generally nontoxic but becomes much more toxic in the presence of other specific chemicals), and antagonism (combination has less toxicity than sum of individual chemicals). Without research on a given combination of chemicals, predicting a possible toxic response from a mixture is highly uncertain.

As the first step in determining multiple effects, a simple additive equation based on concentration data normalized by SALs will be used. This approach assumes that there are no chemical interactions. Constituents are first grouped according to the environmental medium (soil, water, air) and toxicological effects (systemic toxicants, carcinogens, radionuclides). Then, SALs for all constituents are normalized to 1 so that concentration data can be treated as proportions of the respective SALs. If the sum of proportions for the different constituents is greater than 1, the effect of the multiple constituents is considered adverse and further action may be taken (e.g., baseline risk assessment); otherwise, NFA is proposed. Therefore, the decision rule is restated in terms of a comparison of the maximum normalized sum of concentrations (M) with one. The equation for calculating the appropriate normalized sum is

$$M = \max_{\text{samples}} \left\{ \sum_{\text{PCOCs}} C_i / SAL_i \right\} \tag{6}$$

where

M = maximum for all samples of the sum of normalized SALs;

C_i = concentration of the ith chemical or radionuclide in a given sample;

SAL_i = SAL for the ith chemical or radionuclide.

The choice of constituents to include in the calculation also needs to be addressed. If all constituents are included, exceedance is very likely. Therefore, constituents for which observed concentrations are within background levels will not be included when making this calculation.

For alpha, beta, and photon emitters present in either surface water or ground water, multiple constituents below SALs will be evaluated according the proposed EPA guidance (EPA 1991, 0887). The proposed guidance states that

- the total for all alpha emitters, other than ^{226}Ra , ^{222}Rn, and uranium, will not exceed 15 pCi/L, and
- the total of all beta and photon emitters, other than ^{228}Ra, will not exceed 4 mrem/yr.

REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists) 1993. "1993-1994 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices," ISBN: 1-882417-03-8, Cincinnati, Ohio. (ACGIH 1993, 1102)

DOE (US Department of Energy), July 1988. "Internal Dose Conversion Factors for Calculation of Dose to the Public," DOE/EH-0071, Washington, DC. (DOE 1988, 0266)

DOE (US Department of Energy), June 5, 1990. "Radiation Protection of the Public and the Environment," DOE Order 5400.5 (Change 1), Washington, DC. (DOE 1990, 0080)

DOE (US Department of Energy), March 8, 1991. "DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with DOE 5400.5, Interim Guidance," Office of Environmental Guidance, Washington, DC. (DOE 1991, 0779)

Dorries, A., October 16, 1992. Personal communication (FAX transmittal) with S. Y. Chen, Argonne National Laboratory, pertaining to LANL-specific RESRAD parameters, Los Alamos National Laboratory, Los Alamos New Mexico. (Dorries 1992, 1066)

Dorries, A., November 17, 1992. Personal communication (FAX transmittal) with S. Y. Chen, Argonne National Laboratory, pertaining to canyon bottom parameters for RESRAD, Los Alamos National Laboratory, Los Alamos New Mexico. (Dorries 1992, 1067)

Dorries, A., December 1, 1992. Personal communication (FAX transmittal) with S. Y. Chen, Argonne National Laboratory, pertaining to data provided by Larry Dziuk and example SWMUs, Los Alamos National Laboratory, Los Alamos New Mexico. (Dorries 1992, 1068)

Dorries, A., March 26, 1993. Personal communication (FAX transmittal) with S. Y. Chen, Argonne National Laboratory, pertaining to radiation SALs table, National Laboratory, Los Alamos New Mexico. (Dorries 1993, 1069)

EPA (US Environmental Protection Agency), January 1977. "Environmental Radiation Protection Standards for Nuclear Power Operations," Title 40, Part 190, Federal Register, Volume 42, p. 2860, Washington, DC. (EPA 1977, 1064)

EPA (US Environmental Protection Agency), April 1988. "Superfund Exposure Assessment Manual," EPA 1540/1-88/001, Office of Remedial Response, Washington DC (EPA 1988, 0747)

EPA (US Environmental Protection Agency),September 1988. "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Federal Guidance Report No. 11, EPA-520/1-88-020, Washington, DC. (EPA 1988, 0982)

EPA (US Environmental Protection Agency), July 27, 1990. "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," proposed rule, Title 40 Parts 264, 265, 270, and 271, Federal Register, Vol. 55., pp. 30798-30884 (EPA 1990, 0432)

EPA (US Environmental Protection Agency), July 18, 1991. "National Primary Drinking Water Regulations; Radionuclides; Proposed Rule," 40 CFR Parts 141 and 142, Federal Register, p. 33050. (EPA 1991, 0887)

EPA (US Environmental Protection Agency), December 1991. "Risk Assessment Guidance for Superfund, Volume I—Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)," Interim, EPA/540/R-92/003, Publication 9285.7-01B, Office of Research and Development, Washington, DC. (EPA 1991, 0302)

EPA (US Environmental Protection Agency), July 1992. "National Emission Standards for Hazardous Air Pollutants," Code of Federal Regulations, Title 40, Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," Washington, DC. (EPA 1992, 1061)

EPA (US Environmental Protection Agency), July 1, 1992. "Maximum Contaminant Levels for Beta Particle and Photon Radioactivity from Man-Made Radionuclides in Community Water Systems," Final Rule, Title 40, Part 141.16, Code of Federal Regulations, Washington, DC. (EPA 1992, 1072)

EPA (US Environmental Protection Agency), May 1993. "Drinking Water Regulations and Health Advisories," Office of Water, Washington, DC. (EPA 1993, 1071)

EPA (US Environmental Protection Agency), May 1994. "Integrated Risk Information System (IRIS)," Office of Science and Technology; database available from National Technical Information Service, Springfield, Virginia. (EPA 1994, 1167)

EPA (US Environmental Protection Agency), March 1994. "Health Effects Assessment Summary Tables Annual Update, FY-1994," 9200.6-303(94-1), EPA 540-R-94-020, Office of Research and Development, Office of Emergency and Remedial Response, Washington, DC. (EPA 1994, 1169)

International Atomic Energy Agency 1992. "Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards." Technical Report #332. Vienna, Austria. (International Atomic Energy Agency 1992, 0983)

NCRP (National Council on Radiation Protection and Measurements) 1988. "Recommendation on Limits for Exposure to Ionizing Radiation," NCRP Report No. 91, Bethesda, Maryland. (NCRP 1988, 0778)

NCRP (National Council on Radiation Protection and Measurements 1991. "Effects of Ionizing Radiation on Aquatic Organisms," NCRP Report No. 109, Bethesda, Maryland. (NCRP 1991, 0986)

Stenner, R. D., J. G. Droppo, R. A. Peloquin, R. W. Bienert, and N. C. VanHouten, April 1990. "Guidance Manual on the Estimation of Airborne Asbestos Concentrations as a Function of Distance from a Contaminated Surface Area for Area Suspension Evaluations," PNL-7311/UC-630, Pacific Northwest Laboratory, Richland, Washington. (Stenner et al. 1990, 1170)

Strenge, D. L. and S. R. Peterson, 1989. "Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS): Version 1," PNL-7145/UC-602,630, Pacific Northwest Laboratory, Richland, Washington. (Strenge and Peterson 1989, 0837)

Yu, C., A. J. Zielen, J.J. Cheng, Y. C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loueiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, September 1993. "A Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0," ANL/EAD/LD-2, Environmental Assesment Division, Argonne National Laboratory, Argonne, Illinois. (Yu et al. 1993, 1177)

TABLE 1

SUMMARY OF SCREENING ACTION LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN SOIL, WATER, AND AIR FOR CHARACTERIZATION AT LOS ALAMOS NATIONAL LABORATORYa

Chemical b	FN	CAS Number b	Soil Screening Action Level mg/kg	FN	Water Screening Action Level µg/L	FN	Air Screening Action Level µg/m3	CRQL mg/kg and µg/L c	FN
Inorganics									
Aluminum	d	7429-90-5		e				40, 200	
Antimony		7440-36-0	32		6	f		12, 60	g
Arsenic		7440-38-2		e	50	h	0.00023	2, 10	g
Barium		7440-39-3	5,600		2,000	f	0.49	40, 200	
Beryllium		7440-41-7		e	4	f	0.00042	1, 5	g
Cadmium		7440-43-9	80		5	f	0.00056	1, 5	
Calcium	d	7440-70-2		e				1000, 5000	
Chromium III		16065-83-1	80,000					2, 10	
Chromium VI		7440-47-3	400				0.000083	2, 10	
Chromium (Total)					100	f		10, 50	
Cobalt	d	7440-48-4		e				10, 50	
Copper		7440-50-8	3,000		1,300			5, 25	
Cyanide		57-12-5	1,600		200	h		2, 10	
Iron	d	1543-83-10		e				20, 100	
Lead		7439-92-1	400	i	50	j		0.6, 3	
Magnesium	d	7786-30-3		e				1000, 5000	
Manganese		7439-96-5	11,000		180		0.05	3, 15	
Mercury		7439-97-6	24		2	f	0.3	0.04, 0.2	
Molybdenum		7439-98-7	400		170				
Nickel		7440-02-0	1,600		100	f	0.0042	8, 40	
Nitrate			130,000		10,000	f			
Nitrite		14797-65-0	8,000		1,000	f			
Potassium	d	7447-40-7		e				1000, 5000	
Selenium		7782-49-2	400		50	f		1, 5	
Silver		7440-22-4	400		170			2, 10	
Sodium	d	7647-14-5		e				1000, 5000	
Strontium		7440-24-6	48,000		21,000				
Thallium		7440-28-0	6.4		2	f		2, 10	g
Vanadium		7440-62-2	560		240			10, 50	
Zinc		7440-66-6	24,000		10,000			4, 20	

TABLE 1

High Explosives									
2-amino-4,6-DNT (aminodinitrotoluene)	d	35572-78-2							
4-amino-2,6-DNT (aminodinitrotoluene)	d	19406-51-0							
Ammonium nitrate	d	6484-52-2							
Barium nitrate (soluble barium)		10022-31-8	5,600		2,000	f	0.49	40, 200	
CEF (tris(2-chloroethyl)-phosphate)	d	115-96-8							
1,3-DNB (dinitrobenzene)		99-65-0	8		3.5				
2,4-DNT (dinitrotoluene)		121-14-2	1		0.05			0.33, 10	g
2,6-DNT (dinitrotoluene)		606-20-2	1		0.05			0.33, 10	g
DPA (diphenylamine)		122-39-4	2,000		880				
HMX (cyclotetramethylenetetranitramine)		2691-41-0	4,000		1,800				
Nitrocellulose (nontoxic)	d	9004-70-0							
Nitrotoluenes			800		350				
Nitromethane	d	75-52-5							
NP (bis(2,2-dinitropropyl) acetal/formal)	d	5917-61-3							
PETN (pentaerythritol tetranitrate)		78-11-5	1,600		700				
RDX (trimethylenetrinitramine)		121-82-4	64		3.2				
TATB (triaminotrinitrobenzene)	d	3058-38-6							
Tetryl (N-methyl-N,2,4,6 tetranitrobenzeneamine)		479-45-8	800		350				
1,3,5-TNB (trinitrobenzene)		99-35-4	4		1.8				
2,4,6-TNT (trinitrotoluene)		118-96-7	40		12				
Organics									
Volatile Organic Compounds									
Acetone		67-64-1	8,000		3,500			0.01, 10	
Benzene		71-43-2	0.67		5	f	0.12	0.01, 10	g
Bromobenzene	d	108-86-1							
Bromochloromethane	d	74-97-5							
Bromodichloromethane		75-27-4	11		0.56			0.01, 10	g
Bromoform		75-25-2	89		4.4		0.9	0.01, 10	g
Bromomethane		74-83-9	0.43		49		4.9	0.01, 10	
2-Butanone (Methyl ethyl ketone)		78-93-3	4,000		1,700		1,000	0.01, 10	
n-Butylbenzene	d	104-51-8							
Carbon disulfide		75-15-0	7.4		3,500		10	0.01, 10	
Carbon tetrachloride		56-23-5	0.21		5	f	0.066	0.01, 10	g
3-Carene	d	13466-78-9							
Chlorobenzene		108-90-7	67		100	f	20	0.01, 10	
Chloroethane		75-00-3	2,900		14,000		10,000	0.01, 10	

TABLE 1

Chloroform		67-66-3	0.21		100	f	0.043	0.01, 10	g
Chloromethane		74-87-3	6.4		27		5.6	0.01, 10	
o-Chlorotoluene		95-49-8	1,600		700				
p-Chlorotoluene	d	106-43-4							
1,2-Dibromo-3-chloropropane		96-12-8	0.5		0.2	f	0.2		
Dibromochloromethane		124-48-1	83		4.2			0.01, 10	g
Dibromoethane		74-95-3	0.0082		0.0004		0.005		
Dichlorodifluoromethane (1,2)-(1,3)-(2,2)		75-71-8	16,000		7,000		200		
1,1-Dichloroethane		75-34-3	410		3500		500	0.01, 10	
1,2-Dichloroethane		107-06-2	0.2		5	f	0.038	0.01, 10	g
1,1-Dichloroethene		75-35-4	0.4		7	f	0.19	0.01, 10	g
cis-1,2-Dichloroethene		156-59-2	800		70	f		0.01, 10	
trans-1,2-Dichloroethene		156-60-5	1600		100	f		0.01, 10	
1,2-Dichloropropane		78-87-5	6.5		5	f	4	0.01, 10	
cis-1,3-Dichloropropene		10061-01-5	0.17		0.19		0.027	0.01, 10	g
trans-1,3-Dichloropropene		10061-02-6	0.17		0.19		0.027	0.01, 10	g
Ethyl benzene		100-41-4	3,100		700	f	1000	0.01, 10	
n-Hexane		110-54-3	4,800		2,100		200		
2-Hexanone	d	591-78-6						0.01, 10	
4-Hydroxy-4-methyl-2-pentanone	d	123-42-2							
Isopropylbenzene		98-82-8	3,200		1,400		9		
4-Isopropyltoluene	d	99-87-6							
Limonene	d	138-86-3							
Methanol		67-56-1	40,000		18,000				
Methyl iodide	d	74-88-4							
4-Methyl-2-pentanone (MIBK)		108-10-1	510		1,700		80	0.01, 10	
Methylene Chloride		75-09-2	5.6		5	f	2.2	0.01, 10	g
Propyl benzene	d	103-65-1							
Styrene		100-42-5	3,300		100	f	1,000	0.01, 10	g
1,1,2,2-Tetrachloroethane		79-34-5	3.9		1.8		0.18	0.01, 10	g
1,1,1,2-Tetrachloroethane		630-20-6	270		13		1.4		
Tetrachloroethene		127-18-4	5.9		5	f	1.8	0.01, 10	g
Toluene		108-88-3	910		1000	f	380	0.01, 10	
1,1,2-Trichloro-1,2,2-trifluoroethane		76-13-1							
1,1,1-Trichloroethane		71-55-6	1,000		200	f	1,000	0.01, 10	
1,1,2-Trichloroethane		79-00-5	6.3		5	f	0.63	0.01, 10	g
Trichloroethene		79-01-6	3.2		5	f	0.58	0.01, 10	g
Trichlorofluoromethane		75-69-4	24,000		11,000		700		
Trichloropropane (1,2,3)		96-18-4	480		210				
1,2,3-Trimethylbenzene	d	526-73-8							
1,2,4-Trimethylbenzene		95-63-6	40		18				

TABLE 1

1,3,5-Trimethylbenzene		108-67-8	32		14				
Vinyl Chloride		75-01-4	0.013		2	f	0.012	0.01, 10	g
Xylenes (O+N+P) (mixed-)		1330-20-7	160,000		10,000	f		0.01, 10	
Semivolatile Organic Compounds									
Acenaphthene		83-32-9	4,800		2,100				
Acenaphthylene	d	208-96-8						0.33, 10	
Aldrin		309-00-2	0.04		0.002		0.0002		
Aniline		62-53-3	120		6.1		1		
Anthracene		120-12-7	24,000		10,000			0.33, 10	
Azobenzene		103-33-3	6.4		0.32		0.032		
Benzeneacetic acid	d	103-82-2							
Benzidine		92-87-5	0.003		0.0002		0.00001		
Benzoic Acid		65-85-0	320,000		140,000			100, —	
2H-1-Benzopyran-2-one	d	91-64-5							
Benzo[a]anthracene		56-55-3	1		0.1	h		0.33, 10	
Benzo[a]pyrene		50-32-8	0.1		0.2	f		0.33, 10	g
Benzo[b]fluoranthene		205-99-2	1		0.2	h		0.33, 10	
Benzo[g,h,i]perylene	d	191-24-2						0.33, 10	
Benzo[k]fluoranthene		207-08-9	1		0.2	h		0.33, 10	
Benzyl alcohol		100-51-6	24,000		11,000				
alpha-BHC		319-84-6	0.1		0.0056		0.00056		
beta-BHC		319-85-7	4		0.19		0.018		
delta-BHC	d	319-86-8							
Bis(2-chloroethoxy)methane	d	111-91-1						0.33, 10	
Bis(2-chloroethyl)ether		111-44-4	0.12		0.032		0.0029	0.33, 10	g
Bis(2-ethylhexyl)phthalate		117-81-7	50		6	f		0.33, 10	g
4-Bromophenyl-phenylether	d	101-55-3						0.33, 10	
Butyl benzyl phthalate		85-68-7	16,000		100	h		0.33, 10	
Carbazole		86-74-8	35		1.8			0.33, 10	
Chlordane		57-74-9	0.54		2	f	0.0027	0.017, 0.05	
4-Chloro-3-methylphenol (p-chloro-m-cresol)	k	59-50-7	16,000		7,000			0.33, 10	
4-Chloro-o-polyoxyacetic acid	d								
4-Chloroaniline		106-47-8	320		140			0.33, 10	
2-Chloronaphthalene		91-58-7	6,400		2,800			0.33, 10	
2-Chlorophenol		95-57-8	400		170			0.33, 10	
Chlorophenoxyacetic acid (2-methy-4)		94-74-6	40		18				
4-Chlorophenyl phenyl ether	d	7005-72-3						0.33, 10	
Chrysene		218-01-9	96		0.2	h		0.33, 10	
2,4-D		94-75-7	800		70	f			

TABLE 1

Dalapon		75-99-0	2,400		200	f			
2,4-DB		94-82-6	640		280				
DDD		72-54-8	2.9		0.15			0.03, 0.1	
DDE		72-55-9	2.1		0.1		0.01	0.03, 0.1	
DDT		50-29-3	2.1		0.1		0.01	0.03, 0.1	
Di-n-butyl phthalate		84-74-2	8,000		3,500			0.33, 10	
Di-n-octyl phthalate		117-84-0	1,600		700			0.33, 10	
Dibenzofuran	d	132-64-9						0.33, 10	
Dibenzo[a,h]anthracene		53-70-3	0.1		0.3	h		0.33, 10	
Dicamba		1918-00-9	2,400		1,100				
2-(2,4-Dichlorophenoxy)-propionic acid	d	120-36-5							
1,2-Dichlorobenzene		95-50-1	1,600		600	f	200	0.33, 10	
1,3-Dichlorobenzene		541-73-1	7,200		600	f		0.33, 10	
1,4-Dichlorobenzene		106-46-7	29		75	f	800	0.33, 10	
3,3-Dichlorobenzidine		91-94-1	1.6		0.078			0.33, 10	g
2,4-Dichlorophenol		120-83-2	240		100			0.33, 10	
Dieldrin		60-57-1	0.044		0.002				
Diethylphthalate		84-66-2	64,000		5,000	h		0.33, 10	
Dimethylphthalate		131-11-3	800,000		350,000			0.33, 10	
Dimethylformamide		68-12-2	8,000		3,500		30		
2,4-Dimethylphenol		105-67-9	1,600		700			0.33, 10	
4,6-Dinitro-2-methylphenol									
(4,6-dinitro-o-cresol),	d	534-52-1						0.8, 25	
2,4-Dinitrophenol		51-28-5	160		70			0.8, 25	
Dinoseb		88-85-7	80		7	f			
Endosulfan sulfate		1031-07-8	4		1.8				
Endosulfan		115-29-7	4		1.8				
Endrin		72-20-8	24		2	f			
Ethyl acetate		141-78-6	72,000		32,000				
Ethylene glycol		107-21-1	160,000		70,000				
Fluoranthene		206-44-0	3,200		1,400			0.33, 10	
Fluorene		86-73-7	3,200		1,400			0.33, 10	
Heptachlor		76-44-8	0.16		0.4	f	0.0008		
Heptachlor epoxide,		1024-57-3	0.077		0.2	f	0.0004		
Hexachlorobenzene		118-74-1	0.44		1	f	0.0022	0.33, 10	g
Hexachlorobutadiene		87-68-3	90		4.5		0.45	0.33, 10	g
Hexachlorocyclopentadiene		77-47-4	560		50	f	0.07	0.33, 10	
Hexachloroethane		67-72-1	80		25		2.5	0.33, 10	
Hexadecanoic acid	d	57-10-3							
Indeno[1,2,3-cd]pyrene		193-39-5	1		0.4	h		0.33, 10	
Isophorone		78-59-1	7,400		370			0.33, 10	

TABLE 1

Lindane (gamma BHC)		58-89-9	0.54		0.2	f			
Mecoprop(MCPP)		93-65-2	80		35				
1,4-Methan azulene, decahydro-4,4,8	d								
Methoxychlor		72-43-5	400		40	f			
2-Methyl-4,6-dinitrophenol	d								
2-Methylnaphthalene	d	91-57-6						0.33, 10	
2-Methylphenol (o-cresol)		95-48-7	4,000		1,700			0.33, 10	
4-Methylphenol (p-cresol)		106-44-5	400		180			0.33, 10	
N-Nitrosodi-N-propylamine		621-64-7	0.1		0.005			0.33, 10	g
N-Nitrosodimethylamine		62-75-9	0.014		0.0007		0.00007		
N-Nitrosodiphenylamine		86-30-6	140		7.1			0.33. 10	g
Naphthalene		91-20-3	3,200		1,400			0.33, 10	
2-Nitroaniline (o-nitroaniline)		88-74-4					0.2	0.8, 25	g
3-Nitroaniline (m-nitroaniline)		99-09-2	240		110			0.8, 25	
4-Nitroaniline (p-nitroaniline)		100-01-6	240		110			0.8, 25	
Nitrobenzene		98-95-3	5.3		18		2	0.33, 10	
2-Nitrophenol	d	88-75-5						0.33, 10	
4-Nitrophenol		100-02-7	5,000		2,200			0.8, 25	
Octacosane	d	630-02-4							
Octadecanoic acid	d	57-11-4							
Octamethyl cyclotetrasiloxane	d	556-67-2							
2,2-Oxybis(1-chloropropane)									
(bis[2-chloroisopropyl]ether)		108-60-1	100		0.5		1	0.33, 10	
PCB (Aroclors)		1336-36-3	0.09		0.5	f		0.033, 1	
Pentachlorophenol		87-86-5	5.8		1	f		0.8, 25	g
Phenanthrene	d	85-01-8						0.33, 10	
Phenol		108-95-2	48,000		21,000			0.33, 10	
Pyrene		129-00-0	2,400		1,000			0.33, 10	
2,4,5-T		93-76-5	800		350				
Tetradecanoic acid	d	544-63-8							
Toxaphene		8001-35-2	0.64		3	f	0.0032		
2,4,5-TP		93-72-1	640		280				
1,2,4-Trichlorobenzene		120-82-1	160		70	f	9	0.33, 10	
2,4,5-Trichlorophenol		95-95-4	8,000		3,500			0.8, 25	
2,4,6-Trichlorophenol		88-06-2	64		3.2		0.32	0.33, 10	g
Vinyl Acetate		108-05-4	80,000		35,000		200		

TABLE 1

a. SALs based on methodologies given by EPA in Subpart S of the Proposed RCRA Corrective Action Program. SALs are rounded to two significant figures. Water SALs are used for both groundwater and surface water.
b. Chemicals include inorganics, high explosives, and organic compounds (volatile and semi-volatile organic compounds). Chemical Abstracts Service (CAS) numbers are unique for each chemical and allow efficient searching on various data bases.
c. Contract Laboratory Program Contract-Required Quantitation Limits (CRQLs) for soil (mg/kg) and water (µg/L), respectively. CRQLs are provided as an indicator of the analytical method detection limit and are not to be viewed in an absolute sense as a standard of performance for a given sample representing a given matrix and a given analyte. CRQLs are not available for air.
d. Toxicity data (e.g., RfDs and/or slope factors) were not available; therefore, SALs were not calculated.
e. Background comparison should be performed for this compound to determine if further action is required.
f. Safe drinking water regulations MCL water SALs were not calculated for compounds with MCLs in accordance with proposed EPA guidance.
g. The SAL is less than the CRQL; therefore, special analytical services may be required.
h. MCL is not final. Number presented is a draft or proposed MCL from EPA .
i. Soil SAL based on EPA guidance on establishing lead cleanup levels.
j. No MCL or toxicity information appropriate for SAL derivation is available for lead. The SAL presented is based on Federal ambient water quality criteria for the protection of human health based on water and fish consumption.
k. Based on subchronic RfD divided by 10; chronic RfD not available.

TABLE 2

SUMMARY OF SCREENING ACTION LEVELS FOR RADIONUCLIDES IN SOIL AND WATER FOR ENVIRONMENTAL CHARACTERIZATION ATLOS ALAMOS NATIONAL LABORATORY				
Radionuclide	Soil Screening Action Level (pCi/g dry soil) a	FN	Water Screening Action Level pCi/L b	FN
Americium-241	17		15	c
Carbon-14	46		2,600	d
Cerium-144	64			
Cesium-134	1.8		75	d
Cesium-137	4		110	d
Cobalt-57	40		4,600	d
Cobalt-60	0.9		200	d
Gross Alpha Particle Activity	NA		15	e
Iodine-129	41		20	d
Manganese-54	3.4		2,000	d
Plutonium-238	20		15	c
Plutonium-239	18		15	c
Radium-226	5	f	20	e
Radium-228	5	f	20	e
Ruthenium-106	14		200	d
Sodium-22	1.3		480	d
Strontium-90	5.9		8	g
Technetium-99	38			
Thorium-228	1.5		15	c
Thorium-230	5	f	15	c
Thorium-232	5	f	15	c
Tritium	810	h	20,000	g
Uranium-233	86			i
Uranium-234	86			i
Uranium-235	18			i
Uranium-238	59			i
Depleted Uranium		j		i
Natural Uranium		j		i

TABLE 2

a. Based on 10 mrem/yr (above background) dose limit. Input data are representative of mesa top environment at the Laboratory.
b. Water SALs are used for both groundwater and surface water.
c. The total of all alpha emitters, less 226Ra , 222Rn, and uranium, will not exceed 15 pCi/g, in accordance with EPA's proposed rule.
d. Calculated based on 4-mrem/yr dose limit using Federal Guidance Report No. 11 (EPA 1988, 0982). The total of all beta and gamma emitters, less 228Ra, will not exceed 4 mrem/yr in accordance with EPA's proposed rule.
e. MCL listed in EPA's proposed rule
f. SALs for 226Ra , 228Ra, 230Th, and 232Th are from DOE Order 5400.5 (DOE 1990, 0080), which establishes 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g averaged over each additional 15-cm interval.
g. MCL from Table A, Average Annual Concentrations Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr, in 40 CFR 141.
h. The SAL for tritium in soil is 810 pCi/g dry soil. If soil tritium concentrations are reported in pCi/mL soil moisture, the values must be converted to a dry soil basis by multiplying by M/[rw(1-M)], where M is the moisture fraction of the sample (g water/g total sample) and rw is the soil moisture density ≈1g/mL). For example., a soil with 10% moisture fraction containing 1000 pCi of tritium per milliliter of soil moisture contains 1000 x 0.1 / (1 x 0.9) = 111 pCi/g dry soil.
i. The MCL for total uranium concentration is 20 µg/L or 30 pCi/L.
j. Soil SALs for depleted uranium and natural uranium are 160 mg/kg and 95 mg/kg, respectively. These SALs are based on a 10 mrem/yr dose limit assuming the following isotopic abundances:

	Natural Uranium (%)	Depleted Uranium (%)
234U	0.0	0.0005
235U	0.7	0.25
238U	99.0	99.75

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Inorganics												
Aluminum[g], 7429-90-5												40, 200
Antimony, 7440-36-0	0.0004					32						12, 60[h]
Arsenic, 7440-38-2	0.0003	1.75, A		15, A		24	0.40				0.00023	2, 10[h]
Barium, 7440-39-3	0.07	ND, D	0.00014[i]	ND, D		5,600				0.49		40, 200
Beryllium, 7440-41-7	0.005	4.3, B2		8.4, B2		400	0.16				0.00042	1, 5[h]
Cadmium, 7440-43-9	0.001[j]			6.3, B1		80					0.00056	1, 5
Calcium[g], 7440-70-2												1000, 5000
Chromium III, 16065-83-1	1.0					80,000						2, 10
Chromium VI, 7440-47-3	0.005			42, A		400					0.000083	2, 10
Cobalt[g], 7440-48-4												10, 50
Copper, 7440-50-8	0.037[i]					3,000		1,300				5, 25
Cyanide, 57-12-5	0.02	ND, D		ND, D		1,600						2, 10
Iron[g], 1543-83-10												20, 100
Lead[g], 7439-92-1		ND, B2		ND, B2								0.6, 3
Magnesium[g], 7786-30-3												1000, 5000
Manganese (soil), 7439-96-5	0.14	ND, D	0.000014	ND, D		11,000		3,500		0.05		3, 15
Manganese (water)	0.005							180				
Mercury, 7439-97-6	0.0003[i]	ND, D	0.000086[i]	ND, D		24				0.30		0.04, 0.2
Nickel, 7440-02-0	0.02			0.84, A		1,600					0.0042	8, 40
Nitrate	1.6[k]					130,000						
Nitrite, 14797-65-0	0.1					8,000						
Potassium[g], 7447-40-7												1000, 5000
Selenium, 7782-49-2	0.005	ND, D		ND, D		400						1, 5
Silver, 7440-22-4	0.005					400		170				2, 10

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Sodium[g], 7647-14-5												1000, 5000
Thallium, 7440-28-0	0.00008[l]					6.4						2, 10[h]
Vanadium, 7440-62-2	0.007[i]					560		240				10, 50
Zinc, 7440-66-6	0.3	ND, D		ND, D		24,000		10,000				4, 20
Volatile Organic Compounds												
Acetone, 67-64-1	0.1				14,000	8,000		3,500				0.01, 10
Benzene, 71-43-2		0.029, A		0.029, A	5,700		0.67[m]				0.12	0.01, 10[h]
Bromobenzene[g], 108-86-1												
Bromodichloromethane, 75-27-4	0.02	0.062, B2		ND, B2	800	1,600	11	700	0.56			0.01, 10[h]
Bromoform, 75-25-2	0.02	0.0079, B2		0.0039, B2		1,600	89	700	4.4		0.90	0.01, 10[h]
Bromomethane, 74-83-9	0.0014	ND, D	0.0014	ND, D	390	0.43[m]		49		4.9		0.01, 10
2-Butanone (Methyl ethyl ketone), 78-93-3	0.6	ND, D	0.29	ND, D	19,000	4,000[m]		1,700		1,000		0.01, 10
n-Butylbenzene[g], 104-51-8												
Carbon disulfide, 75-15-0	0.1		0.0029[i]		3,200	7.4[m]		3,500		10		0.01, 10
Carbon tetrachloride, 56-23-5	0.0007	0.13, B2		0.053, B2	3,300	56	0.21[m]				0.066	0.01, 10[h]
3-Carene[g], 13466-78-9												
Chlorobenzene, 108-90-7	0.02	ND, D	0.0057[i]	ND, D	15,000	67[m]				20		0.01, 10
Chloroethane, 75-00-3	0.4		2.9		1,400	2,900[m]		14,000		10,000		0.01, 10
Chloroform, 67-66-3	0.01	0.0061, B2		0.081, B2	4,800	800	0.21[m]				0.043	0.01, 10[h]
Chloromethane, 74-87-3		0.013, C[i]		0.0063, C[i]	1,200		6.4[m]		27		5.6	0.01, 10
1,2-Dibromo-3-chloropropane 96-12-8		1.4, B2[i]	0.000057	0.0024, B2[i]			0.5			0.2	1.5	

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Dibromochloromethane, 124-48-1	0.02	0.084, C		ND, C		1,600	83	700	4.2			0.01, 10[h]
Dibromoethane, 74-95-3	0.0002	85, B2	0.000057[i]	0.770, B2		16	0.008	7	0.0004	0.2	0.005	
Dichlorodifluoromethane (1,2)-(1,3)-(2,2), 75-71-8	0.2		0.057[i]			16,000		7,000		200		
1,1-Dichloroethane, 75-34-3	0.1[i]	ND, C	0.14[i]	ND, C	3,800	410[m]		3,500		500		0.01, 10
1,2-Dichloroethane, 107-06-2		0.091, B2		0.091, B2	5,500		0.20[m]				0.038	0.01, 10[h]
cis-1,2-Dichloroethene, 156-59-2	0.01				4,600	800						0.01, 10
trans-1,2-Dichloroethene, 156-60-5	0.02					1600						0.01, 10
1,1-Dichloroethene, 75-35-4	0.009	0.6, C		0.18 C	2,100	720	0.4[m]				0.19	0.01, 10[h]
1,2-Dichloropropane, 78-87-5		0.068, B2[i]	0.0011	ND, B2[i]	7,100	6.5[m]	10			4.0		0.01, 10[h]
cis-1,3-Dichloropropene, 10061-01-5	0.0003	0.18, B2[i]	0.0057	0.13, B2[i]	6,800	14[m]	0.17[m]	11	0.19	20	0.027	0.01, 10[h]
trans-1,3-Dichloropropene, 10061-02-6	0.0003	0.18, B2[i]	0.0057	0.13, B2[i]	6,800	14[m]	0.17[m]	11	0.19	20	0.027	0.01, 10[h]
Ethyl benzene, 100-41-4	0.1	ND, D	0.29	ND, D	22,000	3,100[m]				1000		0.01, 10
n-Hexane, 110-54-3	0.06[i]		0.057			4,800		2,100			200	
2-Hexanone[g], 591-78-6					55,000							0.01, 10
4-Hydroxy-4-methyl-2-pentanone [g], 123-42-2												
Isopropyl benzene, 108-05-4	0.04		0.00257[i]			3,200		1,400		9.0		
4-Isopropyltoluene [g], 98-82-8												
Limonene[g], 138-86-3												
Methanol, 67-56-1	0.5					40,000		18,000				
Methyl iodide[g]												
4-Methyl-2-pentanone (MIBK), 108-10-1	0.05[i]		0.023[i]		32,000	510[m]		1,700		80		0.01, 10
Methylene Chloride, 75-09-2	0.06	0.0075, B2	0.86[i]	0.0016, B2	2,900	1,400[m]	5.6[m]			3000	2.2	0.01, 10[h]

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o-Chlorotoluene, 95-49-8	0.02					1,600		700				
p-Chlorotoluene[g], 106-43-4												
Propyl benzene[g], 103-65-1												
Styrene, 100-42-5	0.2		0.29		18,000	3,300				1,000		0.01, 10[h]
1,1,2,2-Tetrachloroethane, 79-34-5		0.2, C		0.2, C	29,000		3.9[m]		1.8		0.18	0.01, 10[h]
1,1,1,2-Tetrachloroethane, 630-20-6	0.03	0.0260, C		0.0259, C		2,400	270	1,100	13.0		1.4	
Tetrachloroethene, 127-18-4	0.01	0.052, B-C[n]		0.002, B-C[n]	6,000	800	5.9[m]				1.8	0.01, 10[h]
Toluene, 108-88-3	0.2	ND, D	0.11	ND, D	11,000	910[m]				380		0.01, 10
1,1,2-Trichloro-1,2,2-trifluoroethane 76-13-1	30		8.6									
1,1,1-Trichloroethane, 71-55-6	0.09[i]	ND, D	0.29[i]	ND, D	5,100	1,000[m]				1,000		0.01, 10
1,1,2-Trichloroethane, 79-00-5	0.004	0.057, C		0.056, C	11,000	320	6.3[m]				0.63	0.01, 10[h]
Trichloroethene, 79-01-6		0.011, B-C[n]		0.006, B-C[n]	5,800		3.2[m]				0.58	0.01, 10[h]
Trichlorofluoromethane, 75-69-4	0.3		0.20[i]			24,000		11,000		700		
Trichloropropane(1,2,3),96-18-4	0.006					480		210				
1,2,3-Trimethylbenzene[g], 526-73-8												
1,2,4-Trimethylbenzene,95-63-6	0.0005					40		18				
1,3,5-Trimethylbenzene, 108-67-8	0.0004					32		14				
Vinyl Chloride, 75-01-4		1.9, A[l]		0.3, A[l]	1,100		0.013[m]				0.012	0.01, 10[h]
Xylene (Total), 1330-20-7	2				9,600	160,000						0.01, 10

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Semivolatile Organic Compounds												
Acenaphthene, 83-32-9	0.06				340,000	4,800		2,100				0.33, 10
Acenaphthylene[g], 208-96-8					61,000							0.33, 10
Aldrin , 309-00-2	0.00003	17.0, B2		17.0, B2		2.4	0.04	1.1	0.002		0.0002	
Aniline, 62-53-3		0.0057, B2	0.000286				120		6.1	1.0		
Anthracene, 120-12-7	0.3	ND, D		ND, D	180,000	24,000		10,000				0.33, 10
Azobenzene, 103-33-3		0.110, B2		0.110, B2			6.4		0.32		0.032	
Benzene acetic acid[g], 103-82-2												
Benzidine, 92-87-5	0.003	230, A		230, A		240	0.003	110	0.0002		0.00001	
2H-1-Benzopyran-2-one[g], 91-64-5												
Benzoic acid, 65-85-0	4	ND, D		ND, D		320,000		140,000				100, —
Benzo[a]anthracene, 56-55-3		0.73[o], B2		ND, B2			1.0					0.33, 10
Benzo[a]pyrene, 50-32-8		7.3, B2		ND, B2			0.1					0.33, 10[h]
Benzo[b]fluoranthene, 205-99-2		0.73[o], B2		ND, B2			1.0					0.33, 10
Benzo[g,h,i]perylene, 191-24-2		ND, D		ND, D								0.33, 10
Benzo[k]fluoranthene, 207-08-9		0.073[o], B2		ND, B2			10					0.33, 10
Benzyl alcohol,100-51-6	0.3[l]					24,000		11,000				
alpha-BHC, 319-84-6		6.3, B2		6.3, B2			0.1		0.0056		0.00056	
beta-BHC, 319-85-7		1.8, C		1.9, C			4		0.19		0.018	
Bis-(2-ethylhexyl)phthalate, 117-81-7	0.02	0.014, B2		ND, B2		1,600	50					0.33, 10[h]
Bis-(2chloroethoxy)methane[g] 111-91-1		ND, D		ND, D								0.33, 10

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Bis-(2-chloroethyl)ether, 111-44-4		1.1, B2		1.2 B2	4.9e+04		0.12[m]		0.032		0.0029	0.33, 10[h]
4-Bromophenyl-phenylether[g], 101-55-3												0.33, 10
Butyl benzyl phthalate, 85-68-7	0.2	ND, C		ND, C		16,000						0.33, 10
Carbazole, 86-74-8		0.02, B2[i]		ND, B2[f]			35		1.8			0.33, 10
Chlordane, 57-74-9	0.00006	1.30, B2		1.30, B2		4.8	0.54				0.0027	
4-Chloro-3-methylphenol (p-chloro-m-cresol), 59-50-7	0.2[i,p]					16,000		7,000				0.33, 10
4-Chloro-o-polyoxyacetic acid[g]												
4-Chloroaniline, 106-47-8	0.004					320		140				0.33, 10
2-Chloronaphthalene, 91-58-7	0.08				140,000	6,400		2,800				0.33, 10
2-Chlorophenol, 95-57-8	0.005					400		170				0.33, 10
Chlorophenoxyacetic acid (2-methy-4), 94-74-6	0.0005					40		18				
4-Chlorophenyl phenyl ether[g], 7005-72-3												0.33, 10
Chrysene, 218-01-9		0.0073[o],B2		ND, B2			96					0.33, 10
2,4-D,94-75-7	0.01					800						
Dalapon, 75-99-0	0.03					2,400						
2,4-DB, 94-82-6	0.008					640		280				
DDD, 72-54-8		0.24, B2					2.9		0.15			0.03, 0.1
DDE, 72-55-9		0.340, .B2		0.34, B2			2.1		0.1		0.01	
DDT, 50-29-3	0.0005	0.34, B2		0.34, B2		40	2.1	18	0.1		0.01	0.03, 0.1
delta-BHC[g]												
Di-n-butyl phthalate, 84-74-2	0.1	ND, D		ND, D		8,000		3,500				0.33, 10
Di-n-octyl phthalate, 117-84-0	0.02[i]					1,600		700				0.33, 10
Dibenzofuran[g] 132-64-9												0.33, 10

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Dibenzo[a,h]anthracene, 53-70-3	0.09[k]	7.3[o], B2		ND, B2			0.1					0.33, 10
Dicamba, 1918-00-9	0.03					2,400		1,100				
(2,4-Dichlorophenoxy) propionic acid (dichloroprop)[g], 120-36-5												
1,3-Dichlorobenzene, 541-73-1	0.09[k]				33,000	7,200						0.33, 10
1,4-Dichlorobenzene, 106-46-7		0.024, B2[l]	0.23[l]	ND, B2	36,000	6,600[m]	29			800		0.33, 10
3,3-Dichlorobenzidine, 91-94-1		0.45, B2		ND, B2			1.6		0.078			0.33, 10[h]
2,4-Dichlorophenol, 120-83-2	0.003					240		100				0.33, 10
Dieldrin, 60-57-1	0.00005	16, B2		16, B2		4	0.04	1.8	0.002			
Diethylphthalate, 84-66-2	0.8	ND, D		ND, D		64,000						0.33, 10
Dimethylphthalate, 131-11-3	10[l]	ND, D		ND, D		800,000		350,000				0.33, 10
Dimethylformamide, 68-12-2	0.1[l]		0.0086			8,000		3,500			30	
2,4-Dimethylphenol, 105-67-9	0.02			ND, D	110,000	1,600		700				0.33, 10
4,6-Dinitro-2-methylphenol[g] (4,6-dinitro-o-cresol), 534-52-1												0.8, 25
2,4-Dinitrophenol, 51-28-5	0.002					160		70				0.8, 25
Dinoseb, 88-85-7	0.001					80						
Endosulfan sulfate[q], 1031-07-8	0.00005					4		1.8				
Endosulfan, 115-29-7	0.00005[l,r]					4		1.8				
Endrin, 72-20-8	0.0003					24						
Ethyl acetate,141-78-6	0.9					72,000		32,000				
Ethylene glycol, 107-21-1	2					160,000		70,000				
Fluoranthene, 206-44-0	0.04	ND, D		ND, D		3,200		1,400				0.33, 10
Fluorene, 86-73-7	0.04				510,000	3,200		1,400				0.33, 10
Heptachlor, 76-44-8	0.0005	4.50, B2		4.50, B2		40	0.16				0.0008	
Heptachlor epoxide, 1024-57-3	0.00001	9.10, B2		9.10, B2		1.0	0.077				0.0004	

TABLE 3

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Chemical, by Name and CAS#[b]	Chronic Oral RfD mg/kg-d	Oral Carcinogenic Slope Factor (mg/kg-d)$^{-1}$ and Group[c]	Chronic Inhalation RfD mg/kg-d	Inhalation Carcinogenic Slope Factor (mg/ kg-d)$^{-1}$ and Group[c]	VF[d] m^3/kg	Soil Screening Action Level, Systemic Toxicant mg/kg	Soil Screening Action Level, Carcinogen mg/kg	Water Screening Action Level, Systemic Toxicant µg/L	Water Screening Action Level, Carcinogen µg/L[e]	Air Screening Action Level, Systemic Toxicant µg/m^3	Air Screening Action Level, Carcinogen µg/m^3	CRQL[f] mg/kg and µg/L
Hexachlorobenzene, 118-74-1	0.0008	1.6, B2		1.6, B2		64	0.44				0.0022	0.33, 10[h]
Hexachlorobutadiene, 87-68-3	0.002[s]	0.078, C		0.077, C		160	90	70	4.5		0.45	0.33, 10[h]
Hexachlorocyclopentadiene, 77-47-4	0.007		0.00002[l]			560				0.07		0.33, 10
Hexachloroethane, 67-72-1	0.001	0.014, C		0.014, C		80	500	35	25		2.5	0.33, 10
Hexadeconoic acid[g]												
Indeno[1,2,3-cd]pyrene,193-39-5		0.73[o], B2		ND, B2			1.0					0.33, 10
Isophorone, 78-59-1	0.2	0.00095, C		ND, C		16,000	7,400	7,000	370			0.33, 10
Lindane (gamma BHC), 58-89-9	0.0003	1.30, B2/C[l]				24	0.54					
Mecoprop (MCPP),93-65-2	0.001					80		35				
1,4-methan azulene, decahydro-4,4,8[g]												
Methoxychlor, 72-43-5	0.005					400						
2-Methyl-4,6-dinitrophenol[g]												
2-Methylnaphthalene[g], 91-57-6					190,000							0.33, 10
2-Methylphenol (o-cresol), 95-48-7	0.05	ND, C		ND, C		4,000		1,700				0.33, 10
4-Methylphenol (p-cresol), 106-44-5	0.005[l]	ND, C		ND, C		4,00		180				0.33, 10
Naphthalene, 91-20-3	0.04[l]				68,000	3,200		1,400				0.33, 10
2-Nitroaniline (o-nitroaniline) 88-74-4			0.000057							0.2		0.8, 25
3-Nitroaniline (m-nitroaniline), 99-09-2	0.003		0.0000571			240		110				0.8, 25
4-Nitroaniline (p-nitroanline), 100-01-6	0.003					240		110				0.8, 25
Nitrobenzene, 98-95-3	0.0005	ND, D	0.00057[l]	ND, D	13,000	5.3[m]		18		2.0		0.33, 10
2-Nitrophenol, 88-75-5												0.33, 10
4-Nitrophenol, 100-02-7	0.062				19,000	5,000		2,200				0.8, 25

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Chemical, by Name and CAS#[b]	Chronic Oral RfD mg/kg-d	Oral Carcinogenic Slope Factor $(mg/kg\text{-}d)^{-1}$ and Group[c]	Chronic Inhalation RfD mg/kg-d	Inhalation Carcinogenic Slope Factor $(mg/kg\text{-}d)^{-1}$ and Group[c]	VF[d] m^3/kg	Soil Screening Action Level, Systemic Toxicant mg/kg	Soil Screening Action Level, Carcinogen mg/kg	Water Screening Action Level, Systemic Toxicant µg/L	Water Screening Action Level, Carcinogen µg/L[e]	Air Screening Action Level, Systemic Toxicant $\mu g/m^3$	Air Screening Action Level, Carcinogen $\mu g/m^3$	CRQL[f] mg/kg and µg/L
N-Nitrosodimethylamine, 62-75-9		51, B2					0.014		0.0007		0.00007	
N-Nitrosodi-N-propylamine, 621-64-7		7, B2		ND, B2			0.10		0.0050			0.33, 10[h]
N-Nitrosodiphenylamine, 86-30-6		0.0049, B2		ND, B2			140		7.1			0.33. 10[h]
Octacosane[g], 630-02-4												
Octadecanoic acid[g], 57-11-4												
Octamethyl cyclotetrasiloxane[g], 556-67-2												
2,2-Oxybis(1-chloropropane) (bis [2-chloroisopropyl]ether), 108-60-1	0.04	0.07, C[i]		0.035, C[i]		3,200	100	1,400	0.50		1.0	0.33, 10
PCB (aroclors), 1336-36-3		7.7, B2					0.09					0.033, 1
Pentachlorophenol, 87-86-5	0.03	0.12, B2		ND, B2		2,400	5.8					0.8, 25[h]
Phenanthrene carboxylic acid[g]												
Phenanthrene[g], 85-01-8		ND, D		ND, D	440,000							0.33, 10
Phenol, 108-95-2	0.6					48,000		21,000				0.33, 10
Pyrene, 129-00-0	0.03	ND, D		ND, D		2,400		1,000				0.33, 10
2,4,5-T, 93-76-5	0.01					800		350				
2,4,5-TP, 93-72-1	0.008					640		280				
Tetradecanoic acid[g], 544-63-8												
Toxaphene, 8001-35-2		1.10, B2		1.10, B2			0.64				0.0032	
1,2,4-Trichlorobenzene,120-82-1	0.01	ND, D	0.0026[i]	ND, D	9.5e+04	160[m]				9.0		0.33, 10
2,4,5-Trichlorophenol, 95-95-4	0.10					8,000		3,500				0.8, 25
2,4,6-Trichlorophenol, 88-06-2		0.011, B2		0.011, B2			64		3.2		0.32	0.33, 10[h]
Vinyl Acetate,108-05-4	1.0[i]		0.0571			80,000		35,000		200		

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Chemical, by Name and CAS#[b]	Chronic Oral RfD mg/kg-d	Oral Carcinogenic Slope Factor (mg/kg-d)$^{-1}$ and Group[c]	Chronic Inhalation RfD mg/kg-d	Inhalation Carcinogenic Slope Factor (mg/ kg-d)$^{-1}$ and Group[c]	VF[d] m^3/kg	Soil Screening Action Level, Systemic Toxicant mg/kg	Soil Screening Action Level, Carcinogen mg/kg	Water Screening Action Level, Systemic Toxicant µg/L	Water Screening Action Level, Carcinogen µg/L[e]	Air Screening Action Level, Systemic Toxicant µg/m^3	Air Screening Action Level, Carcinogen µg/m^3	CRQL[f] mg/kg and µg/L
High Explosives												
2-amino-2,6-DNT (aminodinitrotoluene)[g]												
4-amino-2,6-DNT (amino-dinitrotoluene)[g], 19406-51-0												
Ammonium nitrate[g], 6484-52-2												
Barium nitrate (soluble barium), 10022-31-8	0.07	ND, D	0.00014[f]	ND, D		5,600				0.49		40,200
CEF (tri(b-chloroethyl)-phosphate)[g], 115-96-8												
1,3-DNB (dinitrobenzene), 99-65-0	0.0001	ND, D		ND, D		8		3.5				
2,4-DNT (dinitrotoluene), 121-14-2	0.002	0.68, B2[i]		ND, B2		160	1	70	0.05			0.33,10[h]
2,6-DNT (dinitrotoluene), 606-20-2	0.001[k]	0.68, B2[i]		ND, B2		80	1	35	0.05			0.33,10[h]
DPA (diphenylamine), 122-39-4	0.025					2,000		880				
HMX (cyclotetramethylenete-tranitramine), 2691-41-0	0.05			ND, D		4,000		1800				
Nitrocellulose (non-toxic)[g/k], 9004-70-0												
Nitromethane[g], 75-52-5												
HMX (cyclotetramethylenete-tranitramine), 2691-41-0	0.05			ND, D		4,000		1800				
Nitrotoluenes	0.01[l]					800		350				
NP (bis(2,2-dinitropropyl) acetal/formal)[g], 5917-61-3												
PETN (pentaerythritolletra-nitrate), 78-11-5	0.02[t]					1,600		700				
RDX (trimethylenetri-nitramine), 121-82-4	0.003	0.11, C		ND, C		240	64	110	3.2			
TATB (triaminotrinitro-benzene)[g] 3058-38-6												
Tetryl (N-methyl-N,2,4,6-tetra-nitrobenzeneamine), 479-45-8	0.01					800		350				
1,3,5-TNB (trinitrobenzene), 99-35-4	0.00005					4		1.8				
2,4,6-TNT (trinitrotoluene), 118-96-7	0.0005	0.03, C		ND, C		40	230	18	12			

a. SALs based on methodologies given by EPA (1990, 0432; EPA 1991, 0302). Reference dose (RfD) and carcinogenic slope factor data obtained from EPA (1994, XXXX), unless otherwise noted. SALs are rounded to two significant figures. Water SALs are used for both groundwater and surface water. ND = not determined.
b. Chemicals include inorganics, organics (volatile and semivolatile organic compounds) and high explosives. Chemical Abstracts Service (CAS) numbers are unique for each chemical and allow efficient searching on various data bases.
c. Carcinogens grouped as follows: Group A—human carcinogen; Group B—probable human carcinogen; Group C—possible human carcinogen; Group D—not classifiable as to human carcinogenicity. ND=not determined; NA = not available.
d. Soil-to-air volatilization factor; calculated based on equation given by EPA (1991, 0302) and chemical-specific parameters given by Strenge and Peterson (1989, 0837) and EPA (1988, 0747). The volatilization factor (VF) is given only for substances with molecular weight less than 200 and Henry's Law constant greater than 10^{-5} atm/m^3-mole.
e. Water SALs not calculated for compounds with MCLs (see Table J-1 for chemical-specific MCLs).
f. Contract Laboratory Program, Contract-Required Quantitation Limits (CRQLs) for soil (mg/kg) and water (µg/L), respectively. CRQLs are provided as an indicator of the analytical method detection limit and are not to be viewed in an absolute sense as a standard of performance for a given sample. CRQLs are not available for air.
g. Toxicity data (e.g., RfDs and/or slope factors) were not available; therefore, SALs were not calculated.
h. The SAL is less than the CRQL; therefore, special analytical services may be required.
i. Toxicity data obtained from EPA (EPA 1993, yyyy; 1993, zzzz).
j. Oral RfD for cadmium in food/solids.
k. EPA 1993, 1071.
l. Oral RfD for thallium (I) sulfate.
m. Soil SAL incorporates inhalation pathway (only for substances with both an inhalation RfD or slope factor and a VF listed). The equation is given below.
n. Values obtained from the Superfund Health Risk Technical Support Center (1992, 1070).
o. Carcinogenic oral slope factor calculated on the basis of relative potency estimates for polycyclic aromatic hydrocarbons (EPA 1993, XXXX).
p. Based on subchronic RfD divided by 10; chronic RfD for 4-chloro-3-methylphenol not available.
q. Oral RfD for endosulfan.
r. Oral RfD was withdrawn on December 1, 1992, until further review (EPA 1994, XXXX).
s. Oral RfD was withdrawn on May 1, 1993 until further review (EPA 1994, XXXX).
t. Acceptable dose rate for oral route of exposure (Layton et al. 1987, 1060; p. 5).

General Equations for Calculating SALs

Systemic Toxicants

SAL = (THI x RfD x BW x CF)/(I x A),

where

SAL = soil screening action level: mg/kg for soil SALs, µg/L for water SALs, µg/m^3 for air SALs),
THI = target hazard index: 1,
RfD = chronic reference dose (mg/kg/day): oral RfD used for soil and water SALs, inhalation RfD used for air SAL;
BW = body weight: 16 kg for child (used for soil SAL), 70 kg for adult (used for water and air SALs);
CF = conversion factor: 10^6 mg/kg for soil SAL,1,000 ug/mg for water and air SALs;
I = intake assumption: 200 mg/day for soil SAL (child),2 L/day for water SAL,0 m^3/day for air SAL;
A = absorption factor: 1.

Carcinogenic Constituents

$SAL = (R \times BW \times LT \times CF)/(SF \times I \times A \times ED)$,

where

- R = target risk: 10^{-6} for Class A and B carcinogens, 10^{-5} for Class C carcinogens;
- BW = body weight: 70 kg;
- LT = assumed lifetime: 70 yr;
- CF = conversion factor: 10^6 mg/kg for soil SAL, 1,000 µg/mg for water and air SALs;
- SF = slope factor $(mg/kg\text{-}day)^{-1}$: oral SF used for soil and water SALs, inhalation SF used for air SALs;
- I = intake assumption: 100 mg/day for soil SAL, 2 L/day for water SAL, 20 m^3/day for air SAL;
- A = absorption factor: 1;
- ED = exposure duration: 70 yr.

Equations for Calculating Soil SALs for Volatile Contaminants

Systemic Toxicants

$SAL = (THI \times BW)/[(1/RfD_o \times 10^{-6}\ kg/mg \times ING) + (1/RfD_i \times INH \times (1/VF + 1/PEF))]$,

where

- THI = target hazard index: 1.
- BW = body weight: 16 kg.
- RfD_o = chronic oral reference dose (mg/kg-day).
- RfD_i = chronic inhalation reference dose (mg/kg-day).
- ING = ingestion intake assumption: 200 mg/day.
- VF = soil-to-air volatilization factor (m^3/kg, chemical-specific).
- INH = inhalation intake assumption: 20 m^3/day.
- PEF = particulate emission factor: 4.63×10^9 m^3/kg (EPA 1991, 0302).

Carcinogens

$SAL = [R \times BW \times LT)/(ED \times [(SF_o \times 10^{-6}\ kg/mg \times ING) + (SF_i \times INH \times (1/VF + 1/PEF))]$,

where

- R = target risk: 10^{-6} for Class A and B carcinogens, 10^{-5} for Class C carcinogens;
- BW = body weight: 70 kg;
- LT = assumed lifetime: 70 yr;
- ED = exposure duration: 70 yr;
- SF_o = oral slope factor $(mg/kg\text{-}day)^{-1}$;
- ING = ingestion intake assumption: 100 mg/day;
- SF_i = inhalation slope factor $(mg/kg\text{-}day)^{-1}$;
- INH = inhalation intake assumption: 20 m^3/day; VF and PEF as defined above.

TABLE 4

PUBLISHED US AVERAGE EFFECTIVE DOSE EQUIVALENT RATES[a] AND ESTIMATES FOR THE LOS ALAMOS AREA FROM NATURAL BACKGROUND RADIATION[b]

RADIATION SOURCE	US AVERAGE (mrem/yr)	LOS ALAMOS (mrem/yr)
Cosmic Rays	27	58
Cosmogenic Radiation	1	1
External Terrestrial	28	39
Radionuclides in Body	40	40
Inhaled Radionuclides	200	200
Rounded Total	340	340

a. The US average data are from Table 9.7 (NCRP 1990, 0985; p. 148)

b. With the exception of the cosmogenic source, the Los Alamos data come from "Environmental Surveillance at Los Alamos during 1990" (Environmental Protection Group 1992, 0740). The cosmic and external terrestrial components were based on measurements; the balance of the values in the report were obtained from the National Council on Radiation Protection (NCRP 1990, 0985).