URS

August 16, 2002 *Enclosed Submitted via Overnight Courier*

Mr. Gary Miller
Section Chief, Technical Section (6EN-HX)
Hazardous Waste Enforcement Branch
United States Environmental Protection Agency
1445 Ross Avenue
Dallas, Texas 75202

RE: General Electric Consent Decree, Civil Action No. 87-1073-jb,
Transmittal of the Revised Closure Plan, Final Corrective Measure Study Report & Preliminary Corrective Measure Implementation Work Plan

Dear Mr. Miller:

URS Corporation (URS), on behalf of General Electric Power Systems (GEPS), hereby submits three copies of the Revised Closure Plan, Final Corrective Measure Study Report & Preliminary Corrective Measure Implementation Work Plan for the Former GE Apparatus Service Center (USEPA ID Number NMD047140256) located at 4420 McLeod Road, NE, Albuquerque, New Mexico.

As previously agreed upon by all parties, the enclosed document has been streamlined while still meeting the requirements of the Consent Decree.

Please contact either Edward F. Jamison, P.G., of GEPS at (518) 385-7979 or myself at (518) 688-0015 following your review of this document to discuss any questions or concerns that you may have.

Very truly yours,

URS Corporation

Christopher Gaule
Senior Project Manager

cc: Edward F. Jamison, GE – Schenectady, New York
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General Electric Company

Apparatus Service Shop
4420 McLeod Road NE
Albuquerque, New Mexico
(EPA ID Number NMD047140256)

Revised Closure Plan, Final Corrective Measure Study Report & Preliminary Corrective Measure Implementation Work Plan

August 16, 2002

URS Corporation
Prepared by Karen Peppin
Reviewed by Don Porterfield, P.E.
Approved by Christopher Gaule

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1.0 INTRODUCTION

This *Revised Closure Plan, Final Corrective Measure Study Report, and Preliminary Corrective Measure Implementation Work Plan* (*CMS Report*) has been prepared by URS Corporation (URS) on behalf of General Electric Power Systems (GEPS) for the Former GEPS Apparatus Service Center (USEPA ID Number NMD047140256), located at 4420 McLeod Road, NE, in Albuquerque, New Mexico (site or facility).

The purpose of this *CMS Report* is to present corrective measure objectives and recommend an appropriate corrective measure alternative based on the conditions at the facility. The revised *CMS Report* was prepared based on the outcome of recent meetings and discussions between the United States Environmental Protection Agency (USEPA), the New Mexico Environmental Department (NMED), and GEPS in which the USEPA and NMED suggested that GEPS revisit the approach and activities necessary for closure of the site under the Resource Conservation and Recovery Act (RCRA) and expand the overall content/scope of this document to its current configuration.

In February 2002, URS submitted, on behalf of GEPS, a *Revised Corrective Measures Study Report dated February 14, 2002*. The *Revised Corrective Measures Study Report* superceded the preceding CMS Report that was prepared by Law Environmental, Inc., (Law) on behalf of GEPS and submitted to the USEPA and NMED in April 1992 pursuant to Consent Decree (Civil Action Number 87-1073-jb). The USEPA and NMED had not provided comments on the April 1992 *CMS Report* and it was understood that the USEPA and NMED would review and comment on the February 2002 CMS instead of the preceding 1992 CMS. On June 4, 2002 GEPS received comments on the February 2002 CMS from NMED. On June 18, 2002, GEPS received comments on the February 2002 CMS from USEPA. This *CMS Report*, which addresses NMED and USEPA comments, is submitted within the established 60-day period following receipt of both NMED and USEPA comments following the preceding submittal.

Following review and acceptance of this document by the USEPA and NMED, it is understood that the *CMS Report* will be subject to a 30-day public comment period per the Order on Consent.

This *CMS Report*, which also serves as a *Revised Closure Plan*, includes actions to address two dry wells at the site that have not yet been formally closed under RCRA. In July 1985, GEPS submitted a *Closure Plan* for an inactive dry well at the Albuquerque shop. The 1985 *Closure Plan* was never approved by NMED and has not been implemented. Therefore, it is GEPS' intent that the scope of work for the corrective measures at the facility will include formal closure of the former dry wells. Based on recent discussions with USEPA and NMED, GEPS understands that the agencies agree conceptually with this approach.

In accordance with the Order on Consent, this *CMS Report* includes elements of the design phase. Specifically, the *Preliminary Corrective Measure Implementation Work Plan* includes:

- Program Management Plan
- Community Relation Plan
- Preliminary Construction Schedule
- Quality Assurance Project Plan
- Health and Safety Plan

After this introductory section, background information and a summary of the RCRA facility investigation, are provided in Sections 2.0 and 3.0, respectively. Section 4.0 summarizes the revised and updated risk characterization conducted for the property. Section 6.0 presents the CMS and Section 7.0 discusses the Closure Plan. Section 8.0 presents the corrective measure implementation program. Section 9.0 discusses the project schedule.

2.0 BACKGROUND

This section provides background information about the site. The information in this section is based on previous reports prepared by Law.

2.1 SITE DESCRIPTION

The Former GEPS Apparatus Service Center is located at 4420 McLeod Road, NE, Albuquerque, New Mexico, on an approximate two-acre property within a light industrial park. The site is approximately four miles northeast of Albuquerque and approximately 4.5 miles east of the Rio Grande River, as shown on Figure 1.

The site layout is presented on Figure 2. There is one building on the property. The former service shop building is in the northeast quadrant of the property. An enclosure, which was formerly used for equipment storage and steam cleaning of parts, is attached to the south side of the building. The south end of this enclosure is open and a concrete slab extends approximately 20 feet beyond the enclosure. Asphalt pavement covers the area immediately north and northeast of the building. The remainder of the area to the east and the area to the south is covered with gravel and natural sparsely-vegetated soils. All equipment and materials were removed from outdoor areas when operations were discontinued and the facility was closed in 1994. There is no equipment or materials currently stored outdoors at the property and the property is not being used for any business purpose at this time.

GEPS retains a property manager to maintain the property. The entire parcel is secured by a perimeter chain link fence except for the McLeod Road frontage, which extends approximately 80 feet south from the McLeod Road curb to the front wall of the building, and the parking area at the northeast corner of the building.

The Former GEPS Apparatus Service Shop was constructed in 1969 for the repair of industrial equipment, primarily electrical motors. Transformers containing dielectric

fluids and insulating oils (some containing polychlorinated biphenyl [PCBs] compounds) were also repaired at the shop. Until 1983, wastewater from steam cleaning operations was discharged into two on-site dry wells. Site operations were discontinued and the facility was closed in 1994.

2.2 HYDROGEOLOGY

The geology underneath the site consists of gravel sediments. These deposits form a veneer on the river-cut surfaces and have a maximum thickness of approximately 50 feet. Borings conducted at the site indicated the presence of interbedded layers of sands with minor silt and clay layers (Law, 1990). Soils encountered in the vicinity of the dry wells are generally silty gravels that are partially cemented in some areas. Fine to coarse sands were encountered from a depth of 10 to 15 feet below the ground surface.

The depth to groundwater at the site ranges from approximately 250 feet below ground surface (bgs) to approximately 260 feet bgs. Based on the groundwater data presented by Law, groundwater generally flows to the south beneath the site.

3.0 RCRA FACILITY INVESTIGATION

In 1990, a RCRA Facility Investigation (RFI) was performed at the site by Law on behalf of GEPS to obtain information and other data to characterize the facility, identify sources of contamination, determine the nature and extent of contamination, and identify actual and potential receptors. The RFI Report was submitted to the USEPA Region VI, in November 1990.

The remainder of this section discusses the results of the RFI regarding sources, nature and extent, and receptors. Figure 2 presents the locations sampled during the RFI and supplemental investigations.

3.1 POTENTIAL SOURCES

Three former release areas were identified during the RFI:

- The former dry well areas;
- The former waste storage area; and
- The former drum rack area.

Each of these areas, which are shown on Figure 2, are described briefly below.

Former Dry Well Areas

The two dry wells were constructed in 1969 during the construction of the facility. Dry well #1 is approximately 10 feet northwest of the southwest corner of the building (see Figure 2). Dry well #1 is approximately 12 feet deep, with an inner diameter of approximately 2.5 feet at the top. The base of the dry well is slightly wider than the surface. The wall of the dry well is reportedly constructed of masonry blocks with the cavities oriented horizontally. A concrete lid, which spans the concrete blocks, is approximately one foot below the ground surface.

Dry well #2 is approximately 20 feet northwest of dry well #1 (see Figure 2). Dry well #2 is approximately 15 feet deep, with an inner diameter of approximately 3 to 5 feet, based on borings conducted during the supplemental soil boring investigation. The boring (B-7) advanced in dry well 2 encountered soil from the surface to approximately seven feet bgs, and cobbles from 7 feet bgs to the bottom of the dry well, approximately 15 feet. It has been assumed that the cobbles are confined to the dry well and were placed into the dry well when it was taken out of service.

Former Waste Storage Area

The former waste storage area is approximately 130 feet southwest of the building, as shown on Figure 2, and measures approximately 30 feet by 20 feet. This area was formerly used for the temporary storage of 55-gallon drums of waste oil from facility operations.

Former Drum Rack

The former drum rack is approximately 50 feet south of the building, and was used from approximately 1970 to 1985.

3.1.1 Nature and Extent of Contamination

The available site data provide a thorough and adequate delineation of the degree and extent of compounds of concern in soils at the site. A comprehensive presentation of all sampling locations completed as part of the various phases of RCRA investigations are presented on Figure 2. Areas of stained surface soil are shown on Figure 3. The results of laboratory analysis for PCBs performed on samples collected during the RFI and the supplemental investigations are presented on Figure 4. As can be seen from the results presented on Figure 4, PCBs were limited in their lateral extent and the vertical extent varied across the site from 0 to 0.5 foot bgs to as much as 30 feet bgs. The data indicate that the majority of impacts are limited to the upper 15 feet of soil surrounding the dry

wells. Data also indicate the presence of incidental near-surface PCB impacts at other locations south and southwest of the building.

The analytical results for the soil sampling conducted at the former waste storage and former drum rack areas did not indicate evidence of any extensive impact to those areas by analyzed chemicals. Furthermore, additional near-surface soil sampling and analysis was conducted in these areas to explore for previously undetected impacts (if any). Similarly, this additional sampling did not identify evidence of extensive impacts. Surface soil in the former waste storage and former drum rack areas contains low concentrations (below detection levels to 10.8 milligrams per kilogram [mg/kg]) of PCBs. In addition, stained surface soil, shown on Figure 3, has been observed near each area. These impacted areas will be addressed in this CMS.

The analytical results for the soil sampling conducted to investigate the former dry wells indicated the presence of compounds of concern at levels requiring additional investigation. Consequently, a series of additional investigations were conducted to thoroughly evaluate the degree and extent of compound of concerns in the vicinity of the former dry wells. Additional investigation in the area of the dry wells was proposed in a Work Plan prepared by Law on behalf of GEPS and submitted to the USEPA in January 1991, and revised and resubmitted in February 1991. Following approval, the workplan was implemented and the results of the investigation were presented in the Supplemental Soil Assessment Report, submitted to the USEPA in July 1991.

The findings of the RFI and supplemental investigations also indicated the presence of select volatile organics compounds (primarily xylene, ethylbenzene, and toluene) in the soils. Table 1 summarizes the locations within the upper 15 feet of soil at which the greatest concentration of these constituents have been detected. The results also indicated the presence of chlorinated volatile organic compounds in soils at much lower concentrations. Volatile organic compounds were predominantly found near the former dry wells.

During the RFI and supplemental investigations, select samples were analyzed for metals. The highest concentration of metals was in the soil sample collected from boring B-1 at the 11-12 foot bgs horizon. Boring B-1 was completed through dry well #1.

During the RFI, several monitoring wells and piezometers were installed across the site to characterize the groundwater quality, depth to the groundwater, and groundwater flow direction. The monitoring wells and piezometers are shown on Figure 2. The monitoring wells ranged in depth from approximately 279 feet bgs to 290 feet bgs. Groundwater was encountered at approximately 250 feet bgs to 260 feet bgs. Two groundwater sampling events were conducted during the RFI. The analytical results of these sampling events are summarized in Table 2. The results of the groundwater samples collected from the monitoring wells during two rounds of groundwater sampling at the site indicated that groundwater quality had not been impacted.

3.1.2 Potential Receptors

The RFI efforts included identification of potential migration pathways for site constituents and a review of potential human and environmental receptors. Based on the review of the potential exposure pathways and potential receptors, Law concluded that site workers could potentially be exposed to constituents in the soils via dermal contact and ingestion. Based upon the nature of the development near the service shop and population distribution discussed in the RFI, it is considered unlikely that potential environmental receptors would be affected by site-specific constituents detected in site soils.

Law also identified groundwater as a potential receptor. Based on the RFI work, Law concluded that the potential for exposure to site-specific constituents via the groundwater pathway is low to non-existent. Groundwater as a potential receptor has been further evaluated since the RFI and is discussed in Section 4.0.

4.0 RISK CHARACTERIZATION

On the behalf of GEPS, URS has revised the previously-completed Risk Assessment for the site. The Revised Risk Assessment is in Appendix A. In accordance with the USEPA's December 12, 2001 letter, the revision to the Risk Assessment was performed based on an uncontrolled, residential future land use scenario assumption to satisfy January 2001 changes in New Mexico law. Based on information provided by USEPA and NMED, GEPS understands that this revision to the risk assessment is required due to a change of the risk-based goals for RCRA corrective action remediation of soils by the NMED Hazardous Waste Bureau (HWB). Because the State of New Mexico currently has no available mechanism in place to restrict future land use and ensure that industrial use scenarios will permanently be met, under the new risk-based regulations, NMED HWB no longer allows the use of industrial screening levels (which was the basis of the previous Risk Assessment) to achieve a No-Further-Action (NFA) RCRA closure determination for soils. In conjunction with this, the NMED HWB has also revised the target excess risk level for determination of NFA closures from 10^{-6} to 10^{-5} for the total risk from all carcinogenic constituents in soil. NMED HWB target screening levels for non-carcinogenic compounds remain based on a Hazard Index (HI) of 1.

The risk assessment has been performed to evaluate non-PCB compounds of potential concern present in site soils. Quantitative risk assessment of PCB compounds has been excluded from the attached Revised Risk Assessment. Instead, PCB data are compared to TSCA guidance for PCB remediation waste (40 CFR §761.61), which has been adopted as the corrective measure objective (i.e., cleanup level) for the site. The risk assessment has employed standard values and approaches as set out by the USEPA, NMED, and relevant guidance, which are typically designed to be conservative and thus are likely to overestimate actual exposure potential. Use of these values and approaches in the Revised Risk Assessment should not be regarded as agreement that they represent the actual exposures at the site. Similarly, the use of published TSCA cleanup levels should not be regarded as agreement that these standards represent levels above which excess risks may be encountered. GEPS' election to use these inputs for PCBs and non-

PCB compounds does not represent a conclusion that this approach is appropriate for all sites.

The primary potential exposure pathways at the site are associated with potential ingestion or dermal contact with shallow soils (less than 15 feet bgs). The Revised Risk Assessment also evaluated a potential exposure pathway of inhalation of volatile organic compounds from the soil. The current potential human receptors at the site include the caretaker of the property. Potential future human receptors are likely to be industrial users of the site. However, as explained above, the Revised Risk Assessment considers an uncontrolled, residential future land use scenario in accordance with NMED requirements. Exposures associated with residential use are likely limited to the top five feet of soil. It was further assumed that a construction worker could be exposed to contaminants from the five feet to 15 feet interval during redevelopment of the site. Investigations conducted at the site have demonstrated that there is no potential for groundwater contamination at the site and as such, potential future use of the groundwater is not a complete potential exposure pathway for the site. Information presented in Section 4.2 demonstrates that there is no potential threat to site groundwater regardless of the depth at which chemical constituents are present.

As stated above, a PCB cleanup level of less than or equal to 1 milligram per kilogram (mg/kg) has been adopted as the corrective measure objective (i.e., cleanup goal) for soils from zero to 15 feet bgs at the site. As supported by the regulating agency, based on established potential exposure risk assessment scenarios, there is no potential for direct exposure to soil at depths greater than 15 feet bgs and the corresponding direct-contact exposure pathway to these deep soils can be eliminated from further consideration. Specifically in relation to PCBs, it is therefore understood that the proposed clean/NFA RCRA closure will also satisfy TSCA clean closure requirements and allow USEPA to also issue a TSCA closure certification for the site once corrective action measures are completed.

4.1 SOIL

The complete Revised Risk Assessment is presented in Appendix A. Based on the conservative inputs for the evaluated compounds, the results of the risk assessment (even in the absence of corrective action/remediation) demonstrate that there is no significant risk to human health or the environment posed by non-PCB compounds evaluated by the risk assessment at the site. This determination is based on the recently-promulgated revision to NMED HWB regulations that requires risk assessments petitioning for NFA RCRA closure utilize an uncontrolled, residential future land use scenario. Furthermore, this revised risk assessment was based upon all non-PCB data currently present at the site with the exception of the dry well data since it was assumed that the dry wells would be removed as part of closure activities.

The results of the exposure assessment were combined with the toxicity criteria to estimate lifetime excess cancer risk for carcinogenic chemicals and a hazard quotient for non-carcinogenic chemicals. A hazard quotient below one was assumed to be below the threshold for non-carcinogenic effects. In accordance with current NMED HWB regulations, both NMED and USEPA agree upon a target risk level of 10^{-5} for this site which meets the residential risk exposure scenario. The results of the Revised Risk Assessment demonstrate that corrective measures are not required for non-PCB compounds to achieve a condition supporting a complete NFA RCRA closure.

4.2 GROUNDWATER

The results of the RFI and subsequent investigations indicated that the groundwater at the site has not been affected by the former site operations or presence of compounds of potential concern at this site. Furthermore, as part of the previously submitted 1992 CMS effort, Daniel B. Stephens and Associates, Inc. (Stephens) of Albuquerque, New Mexico, under subcontract to Law, completed a conservative contaminant transport model for the site. Appendix B of this document presents Stephens' contaminant transport model for the site.

The results of this conservative modeling indicate that the concentrations of chemical constituents present at the site would not surpass drinking water standards at the point of regulatory compliance, which is the GE property boundary, at any point in the future regardless of site remedial activities. Furthermore, soil quality sampling indicate that in general the highest concentrations of compounds are relegated to within 15 feet of the surface that concentrations diminish with greater depth, and the results of groundwater sampling conducted at the site did not detect the presence of chemicals in groundwater. Also, the results of soil gas sampling conducted years after discontinuation of discharge of materials into the dry wells indicate no impact that would suggest the potential or possibility for groundwater contamination to occur at the site. The results of these evaluations including the conservative modeling, soil and groundwater sampling, and soil gas sampling provide sufficient evidence that there is no apparent potential for impact to the groundwater beneath the site from site-related compounds.

5.0 CORRECTIVE MEASURE AREAS

This CMS will address the closure of two former dry wells and soil that has been impacted by site activities. The primary contaminant of concern at the site is PCBs. Specifically, this *CMS Report* will address these four areas:

- Two former dry wells;
- The area west of the building, near the former dry wells, where PCB contamination extends to the subsurface soils;
- Several smaller areas at the site with surface soils that contain PCBs at concentrations greater than the TSCA cleanup objective of 1 mg/kg; and
- The three areas at the site with stained surface soil.

6.0 CORRECTIVE MEASURE STUDY

This section of the *CMS Report* is intended to serve as the *Final Corrective Measure Study Report*. As discussed previously, Law Environmental, Inc (Law) submitted a *CMS Report* on behalf of GEPS in April 1992. Based on the alternative comparison in Law's CMS, NMED, USEPA and GEPS agreed that excavation of PCB containing soil was the appropriate corrective measure for GEPS' Albuquerque site. Therefore, the *Revised CMS*, prepared by URS and submitted in February 2002, and this *CMS Report* include discussion of only one alternative.

This section of the *CMS Report* includes only a brief description of the CMS alternative. Section 8.0 of this report includes a *Preliminary Corrective Measure Implementation Work Plan,* which provides a detailed description of the proposed corrective measure.

6.1 CORRECTIVE MEASURE OBJECTIVES

The cleanup goals for the corrective measures planned for the site are based on the RFI information, public health and environmental criteria, USEPA guidance, and applicable state and federal statutes. Determination of site specific, non-PCB constituent cleanup goals has been based on NMED Technical Background Document for Development of Soil Screening Levels, dated December 18, 2000, and site specific risk assessment evaluations. Based on the results of the various phases of RFI and the revised Risk Assessment, volatile and semi-volatile organic compounds found in soils at the site do not present an unacceptable risk based on the exposure scenarios and pathways evaluated. As shown by the RFI results and the transport modeling previously conducted for the site, groundwater quality has not and will not be impacted by the site. Therefore, the cleanup goals for the corrective measures at the site are limited to PCB constituents.

The cleanup goal for PCBs in soils from zero to 15 feet bgs is equal to or less than 1 milligram per kilogram (mg/kg) (based on USEPA recommended TSCA bulk PCB remediation waste standard for high-occupancy areas without further conditions). As

stated previously in this document, soils at depths greater than 15 feet bgs that may exhibit PCBs do not pose a risk to human health or the environment and therefore do not require excavation.

In addition to this numerical cleanup goal for the corrective measures, these two additional cleanup goals have been established:

- Removal of stained surface soil west of the building, near the former waste storage area, and near the former drum storage rack; and

- Removal of two former dry well structures in order to close these units.

Fulfilling the corrective measure objective will require remediation of the areas discussed in Section 5.0 and presented on Figures 5 and 6. The areas shown on Figures 5 and 6 represent the minimum excavation limits to obtain the remedial goals based on current site-information. The areas identified for corrective measures are driven by the PCB concentrations and include the former dry well locations, stained surface soil, and several other localized areas where incidental impacts of PCBs have been identified. A more detailed discussion of the soil removal areas is presented in Section 8.3.

As discussed and reviewed with the USEPA and NMED, GEPS understands that completion of the corrective measure activities presented herein will facilitate complete closure of all environmental cases with the subject site and allow unrestricted use and possibly including divestment of the property. Specifically, the proposed corrective measure is intended to:

- Obtain a clean closure of two RCRA units (dry wells) at the site;

- Complete RCRA corrective actions at the site;

- Fulfill TSCA cleanup requirements for the site; and

- Obtain a No Further Action declaration from USEPA and NMED with respect to RCRA and TSCA.

GEPS will demonstrate that the site activities completed during this corrective measure meet the requirements of clean closure equivalency [40 CFR 270.1 (c) (5) and (c) (6)] through the collection of appropriate samples during closure and reliance on existing data previously collected during the RFI. Clean closure equivalency will be demonstrated in the Corrective Measure Certification Report, which will be prepared following successful implementation.

6.2 EVALUATION CRITERIA

The following criteria were used to evaluate and confirm the suitability of the corrective measure alternative recommended for the site.

Short Term Effectiveness:	The ability of the corrective measure to meet the corrective measure goals in the short term and be effective;
Long Term Effectiveness and Reliability:	The demonstrated and/or expected ability of the corrective measure alternative to function properly without frequent and/or complex operating or maintenance activities and maintain the corrective measure goals;
Remediation of Sources:	The ability of the corrective measure to remediate the source areas;
Implementability:	The technical and administrative feasibility of constructing and operating the corrective measure system including the time it takes to implement and the time required to achieve a given level of response;

Health and Safety:	The ability to comply with all regulatory requirements to protect human health and minimize human exposure to compounds of potential concern;
Community Acceptance:	The effectiveness to mitigate potential impacts to the environment and the ability to comply with environmental standards and criteria and be accepted by the public; and
Cost:	The affordability of the corrective measure alternative from capital, operational, and maintenance perspectives.

6.3 CORRECTIVE MEASURE ALTERNATIVE - EXCAVATION AND OFF-SITE DISPOSAL

This alternative includes excavation and off-site disposal of soil in the zero to 15-foot horizon that exceeds the cleanup goal of 1 mg/kg for PCBs.

Based upon the laboratory data, the extent of soil that exceeds the cleanup objectives was identified for shallow soil and soil at depth. Next, potential minimum limits of the proposed corrective action excavation areas were developed. Figures 5 and 6 show the minimum excavation limits for shallow soil and soil at depth, respectively. Section 8.0 describes how minimum excavation limits were developed. Figures 5 and 6 incorporate not only the areas of soil above 15 feet bgs with concentrations of PCBs greater than the cleanup objective but also include the three stained soil areas and the two dry well structures.

The actual extent of excavation and volume of soil removed is expected to vary based upon the results of the additional delineation sampling, excavation methodology, and the analytical results of post-excavation sampling. Because it would be impractical to excavate only the minimum excavation areas for soils at depth, depicted in Figure 6, the

anticipated excavation limits have been expanded, as shown in Figure 7. The anticipated limits of excavation for soils at depth are depicted in Figure 7. The anticipated removal volume is approximately 1,200 cubic yards of (in-situ) soil.

The following sub-sections summarize the corrective measure alternative and evaluate the alternative against the criteria listed above. Additional details concerning the implementation of this alternative are provided in Section 8.0, which presents the *Preliminary Corrective Measure Implementation Work Plan.*

6.3.1 Alternative Description

Excavation involves the physical removal of the contaminated materials from the ground. This can be accomplished using conventional excavation techniques and equipment such as a backhoe or front-end loader. Conventional excavation equipment should be capable of excavating soils down to the maximum excavation depth of 15 feet bgs.

Prior to excavation, additional soil samples will be collected to better delineate the lateral extent of PCB impacts. The scope of the pre-implementation investigation is discussed in Section 8.2.2. Based upon current site data, the depth and lateral limits of the soils that would be excavated are illustrated on Figures 5 and 7. Based on the distribution of PCBs in site soils and the maximum excavation depth of 15 feet bgs, it is estimated that approximately 1,200 cubic yards (in place) of soil would be excavated during implementation of the corrective measure. Actual excavation volumes and areas may vary depending on the results of the pre-implementation investigation, if unanticipated conditions arise, such as potential for building or utility instability, or if results of the post excavation sampling do not meet the cleanup goals.

Following excavation, post-excavation soil samples would be collected from exposed excavation surfaces above the maximum excavation depth for laboratory analysis of PCBs. This data would be evaluated to evaluate if the corrective measure objective has been achieved. Additional excavation, to a maximum depth of 15 feet, would be

contemplated for areas that indicate residual levels of PCBs are greater than the cleanup goals.

After post-excavation sampling demonstrates that the cleanup levels have been achieved, the excavated areas would be backfilled with clean soil obtained from an off-site source, which would be sampled/analyzed and confirmed clean prior to placement. Following backfilling operations the ground surface would be restored to pre-existing conditions.

1,200 yards

We anticipate that excavated soils will be temporarily stockpiled at the site in roll-off containers lined with and covered with plastic sheeting. However, the method of transportating removed soil to disposal facilities soil may be altered during implementation. Representative samples would be collected from the stockpiled materials and submitted to a laboratory for analyses to characterize the waste in accordance with RCRA 40 CFR §261 and TSCA 40 CFR §761 protocol. The method of waste disposal would be based on the waste characterization data, applicable regulations, GEPS waste management policy and cost. Landfilling is the probable off-site disposal option. However, off-site destruction by incineration (possibly for liquid wastes such as decontamination rinsates) may also be considered by GEPS.

6.3.2 Alternative Evaluation

This alternative has been evaluated against the seven criteria presented in Section 6.2.

6.3.2.1 Short Term Effectiveness

The excavation and off-site disposal of the soils would effectively address the areas considered for corrective action in a short period of time. It is anticipated that the effort can be coordinated and performed over a period of several months.

6.3.2.2 Long-Term Effectiveness and Reliability

Excavation and off-site disposal is a one time operation and does not require complex or frequent maintenance activities. Excavation and off-site disposal of soils would result in an effective long-term and permanent corrective measure.

6.3.2.3 Remediation of Sources

The excavation and off-site disposal of impacted soils would result in the removal of all potential source areas.

6.3.2.4 Implementability

Excavation and off-site disposal is a widely used corrective action measure and is considered to be both technically and administratively feasible. Since this alternative involves the excavation and off-site disposal of the contaminated materials the cleanup goals for the site would be met when the material is removed.

6.3.2.5 Health and Safety

Potential short-term impacts during the excavation and removal operations primarily involve exposure to air borne constituents and organic vapors and physical risks associated with construction equipment. The potential for physical risks and exposure would be reduced through the implementation of site health and safety controls such as site access restriction, dust control, decontamination and use of personnel protective equipment during site activities.

Potential exposure to the public due to accidental releases, can be minimized by utilizing sealed transport containers, decontamination of transport vehicles before exiting the site, and the use of reputable transportation companies.

The long-term impact to the public health would be minimal since this alternative involves the excavation and off-site disposal of soils to meet the cleanup goals and the placement of clean fill.

6.3.2.6 Community Acceptance

As presented in the RFI report, the soils at the site do not presently pose any adverse potential impacts to the environment. Removal of the impacted soils would meet the corrective measure objective and eliminate the potential for future potential environmental impacts. The removal and off-site disposal of the impacted soils is expected to meet with high community acceptance, any comments generated on the proposed corrective measure would be addressed during the public comment period.

6.3.2.7 Cost

The budgetary cost estimate associated with the implementation of this alternative is anticipated to be up to $750,000. However, GE and URS will work hard to control the costs and complete the project as economically as possible. This budgetary cost estimate is based on the excavation of approximately 1,200 cubic yards (in place) of soil and disposal of the majority of the soil (approximately 1,000 cubic yards) at a landfill as a non-regulated waste. Limited quantities of other wastes generated during the implementation of the corrective measure may also be generated. These wastes, including but not limited to equipment decontamination rinsates, would also be disposed appropriately.

7.0 CLOSURE PLAN

This section of the *CMS Report* serves as the *Revised Closure Plan.* A brief discussion of the work to be performed is presented in this section. Section 9.0 provides a more detailed discussion of the overall project.

7.1 INTRODUCTION

As discussed in Section 2.1, there are two out of service dry wells at the site that never underwent formal RCRA closure. As shown on Figures 2 and 7 the dry wells on the west side of the building and lie within the CMS soil removal area. Therefore, removal of the dry well structures has been included in the corrective measures for the site.

7.2 SCOPE OF WORK

During implementation of the CMS, the two dry well structures will be removed. The remediation waste generated from the dry well removal will be segregated from the waste generated during the soil removal efforts. Based on the analytical results from soil borings in the former dry wells, a portion of the dry well waste may be a characteristic hazardous waste due to elevated concentrations of cadmium, chromium, and lead. Therefore, this portion of the removed material will be segregated and managed separately during the remedial effort. A sample of the waste will be collected and characterized to determine the appropriate disposal method.

Upon removal of the dry well structures, two soil samples will be collected from the base of the excavation below each former dry well to document the quality of soil left in place. A backhoe will be used to collect soil from the base of the excavation and each soil sample will be collected from the backhoe bucket. The four soil samples will be analyzed for VOCs, SVOCs, and PCBs. We anticipate that contaminant concentrations in the post excavation samples will be comparable to previous analytical results for soil samples in the area. If contaminant concentrations are significantly greater than

anticipated, GEPS will discuss with NMED and USEPA the significance of the analytical results.

The dry well areas will be restored in the same manner as the PCB removal areas. The excavated area will be backfilled with clean soil obtained from an off-site source, which would be sampled/analyzed and confirmed clean prior to placement. Following backfilling operations the ground surface would be restored to pre-existing conditions.

7.3 REPORTING

An agent of GEPS will be on-site to document the removal activities. A description of the work performed will be included in the certification report that will document all CMS activities. The results of the post-excavation sampling and documentation of proper disposal of remediation waste will be included in the report.

8.0 PRELIMINARY CORRECTIVE MEASURE IMPLEMENTATION WORKPLAN

This section serves as the *Preliminary Corrective Measure Implementation Program Plan* and the *Preliminary Corrective Measure Design.* The estimated cost for implementing the corrective measure that was presented in Section 7.0 is intended to be detailed enough to meet the requirement in the Order that the preliminary design plan include a cost estimate.

8.1 CORRECTIVE MEASURE OBJECTIVES

As discussed in Section 6.1, the corrective measure objectives for the Albuquerque site are:

- Removal of soil in the 0 to 15-foot depth horizon that contains PCBs at concentrations greater than 1 mg/kg;

- Removal of stained surface soil west of the building, near the former waste storage area, and near the former drum storage rack; and

- Removal of two former dry well structures in order to close these units.

8.2 DESIGN APPROACH

This section describes the design approach for the CMS. The first part of this section describes how the excavation limits have been developed based on the existing analytical data. The second part of this section describes the areas targeted for additional delineation to refine the excavation limits.

8.2.1 Extent of Excavation

As discussed in Section 6.0, the soil targeted for excavation is based on data obtained during the preceding RFI and supplemental investigations. Figure 5 shows the minimum soil removal areas for shallow excavations and Figure 6 shows the minimum soil removal areas for the deeper excavations.

The minimum lateral limits of excavation were developed based on the analytical data and the following two guidelines:

- For isolated samples with PCB concentrations exceeding the cleanup objective, a lateral radius equal to half the distance to the nearest sample location with analytical results meeting the cleanup objective was applied. If the distance to the nearest adjacent soil sample exceeded twelve feet, a radius of twelve feet was applied.

- Similar logic was applied for areas with contiguous soil samples exceeding the cleanup objective in order to estimate the likely lateral extent of impacted soil beyond the contiguous area.

The anticipated minimum depth of each removal area was estimated based on the analytical data and these two guidelines:

- For most soil sampling locations the depth of impacted soil was estimated to be one foot below the bottom of the sample interval corresponding to the soil sample which exceed the cleanup objective. This approach is supported by existing analytical data.

- The minimum excavation depth was extended deeper in areas with considerably higher concentrations of PCBs and no contiguous sampling.

The actual extent of excavation and volume of soil removed is expected to vary based upon the results of the additional delineation sampling, actual excavation methodology, and the analytical results of post-excavation sampling. Because the minimum excavation areas for soil at depth depicted in Figure 6 would be impractical to excavate, the anticipated excavation limits have been expanded as shown in Figure 7. The total anticipated removal volume is approximately 1,200 cubic yards of (in-situ) soil.

8.2.2 Pre-Implementation Investigation

The RFI and subsequent investigations generated a significant amount of data regarding soil quality at the site. However, the lateral extent of the PCB impacts in some areas remains uncertain. GEPS intends to conduct additional soil sampling prior to excavation to better delineate the lateral and vertical extent of the PCB impacts. In addition, at least one sample will be sent for geotechnical testing to classify the soil type. As shown in Figure 8, additional sampling will be conducted in these four areas:

- From 0 to 15 feet below grade along the building foundation, which lies along the east side of deepest excavation area;

- From 0 to 15 feet below grade along the north, west, and south sides of the deepest excavation area;

- From 0 to 11 feet below grade around the 11 foot deep excavation area corresponding to soil boring 7B-6; and

- Surface soil samples along the southwestern boundary of the stained area immediately west of the building.

GEPS has proposed to NMED and USEPA that the pre-implementation sampling results be used in lieu of post-excavation sampling. GEPS has proposed to NMED and USEPA that the pre-implementation sampling around the deeper excavations be conducted at the

same grid sampling intervals (every 1.5 meters [five feet], as defined by TSCA) as will be used for post-excavation sampling. The pre-implementation sampling results would be used to establish the excavation boundary. The excavation effort would extend to the boundary established by the 'clean' samples. This data will be used to delineate the degree of excavation and true post-excavation samples will not be collected for these excavation faces.

Soil borings will be placed at five-foot intervals around the anticipated perimeter of the two deeper excavation areas using a geoprobe. Soil samples will be collected from the borings at five-foot intervals beginning at 5 feet bgs for the 15 foot deep excavation and beginning at 6 feet bgs for the 11 foot deep excavation area. Surface soil samples will not be collected from the borings because both areas lie within the large shallow excavation area west of the building, that will be removed to a depth of 1.5 feet. After the shallow excavation is completed, post-excavation samples will be collected from base of the excavation, including the grid nodes corresponding to the soil borings. All samples will be analyzed for PCBs by USEPA Method 8082. The following table summarizes the proposed sampling.

Location	**Number of Borings**	**Sample Depths**	**Number of Samples**	**Analysis**
Along Building Foundation	11	5, 10 and 15 feet bgs	33	PCBs
Dry Well Area (15 feet deep)	24	5, 10 and 15 feet bgs	72	PCBs
Near Boring 7B-6 (11 feet deep)	12	6 and 11 feet bgs	24	PCBs
Surface Soil	3	0 to 6 inches	3	PCBs

If evidence, such as staining or strong odor, indicates that the soil from a different sampling interval may be more contaminated than the designated sampling interval, the sampling depth will be adjusted so that the soil sample will be collected from the depth of suspected greater impact. If a judgmental soil sample is collected, the judgmental sample will replace the nearest planned grid location soil sample. For example, if staining is

encountered between eight and nine feet bgs, field personnel will collect the sample from the stained interval instead of the planned 10 foot grid location.

Additional surface soil samples will be collected from the locations shown on Figure 8. The locations are intended to delineate between soil impacted by site activities and soil not impacted by site activities. The locations of the surface soil samples may be adjusted in the field if evidence indicates the planned sampling locations are within the stained area. The surface soil samples will be analyzed for PCBs by USEPA Method 8082.

All soil sampling locations will be marked with wooden stakes. The sampling will be conducted in accordance with the sampling protocol, *Quality Assurance Project Plan* and URS' *Health and Safety Plan*, which are discussed in Section 9.3.

The results of the additional sampling will be used to finalize the excavation layout. If the results of the additional sampling do not provide sufficient information to delineate the lateral and vertical extent of PCB impacts, GEPS may elect to conduct additional sampling.

8.2.3 Finalize Excavation Layout

After the additional sampling is completed, the excavation layout will be finalized. Figures will be prepared that show the limits of excavation, the soils that will be segregated for waste disposal purposes, and the anticipated post-excavation sampling locations. These figures will be used to layout the excavation areas in the field and will be part of the final design package.

8.3 PRE-IMPLEMENTATION ACTIVITIES

This section describes the activities that will be completed before construction of the corrective measure.

8.3.1 Program Management Plan

The information required within the *Program Management Plan*, as defined by the Order, is incorporated throughout Section 8.0. Operation, maintenance, and monitoring have been omitted because the selected corrective measure is intended to be a permanent and final remedy for the site. As such, there will be no ongoing operation, maintenance, or monitoring activities once the corrective measure has been completed. During implementation, monitoring for health and safety purposes will be conducted.

The following table summarizes the key personnel involved in the project. As the design phase progresses, additional organizations and personnel will be identified. The qualifications of the identified personnel are presented in Appendix C.

Organization	**Role**	**Personnel**
General Electric Power Systems	Responsible Party/Owner Project Manager	 Edward Jamison
URS Corporation	Oversight Project Manager Engineer Field Oversight	 Christopher Gaule Steven Geiger, P.E. To be determined
To be determined	Surveyor	To be determined
To be determined	Excavation	To be determined
To be determined	Analytical Laboratory	To be determined
To be determined	Waste Disposal Facility(ies)	To be determined

8.3.2 Permits

Based on the preliminary design, no permits will be needed from the City of Albuquerque or Bernalillo County. A *Topsoil Disturbance Permit* may be required from the City of Albuquerque Department of Health if more than 0.75 acres will be excavated.

The City of Albuquerque Department of Health and the local fire department will be notified of the impending work before excavation begins.

8.3.3 Health, Safety, and Site Planning

Conducting the soil removal in a manner that is protective of the workers, public, and the environment is a priority. Figure 9 presents a site layout with the anticipated staging, exclusion, waste staging (within exclusion zone), and decontamination zones. Traffic flow through the site will be controlled to minimize the potential for migration of impacted soils. In addition, all equipment and at a minimum the tires of all transport vehicles (i.e trucks that transport the rolloff containers) will be decontaminated before leaving the site. Non-essential vehicles will remain in the paved or graveled portions of the site north of the shop building outside of the area of influence.

Dust monitoring will be conducted during excavation activities. The selected excavation contractor will be required to have dust suppression materials on-hand prior to commencing excavation. If dust suppression methods fail to reduce air borne dust levels to those listed in the *Health and Safety Plan*, excavation will be halted until after response actions have been implemented.

A copy of URS' *Health and Safety Plan* is included as Appendix D. The excavation contractor selected to perform the work will be required to prepare their own Health and Safety Plan, which will at least meet the requirements of URS' *Health and Safety Plan*. A copy of the contractor's Health and Safety Plan will be provided to NMED and USEPA before the start of work.

8.3.4 Contingency Plan

Implementation of the corrective measure represents a change in site activities that requires modification of the *Contingency Plan*. A *Contingency Plan* that is based on the scope of the proposed corrective measure is provided as Appendix E.

8.3.5 Community Relation Plan

Implementation of the corrective measure also requires modification of the Community Relations Plan. A *Community Relations Plan* that is based on the scope of the proposed corrective measure is provided as Appendix F.

8.4 IMPLEMETATION

Implementation of the corrective measure will include these five tasks:

- Preparations and Mobilization
- Excavation
- Verification Sampling, Analysis, and Evaluation
- Remediation Waste Handling
- Site Restoration

Some of these tasks will occur concurrently. Figure 10 presents the anticipated construction schedule. Progress towards completion of the CMS will be reported in the ongoing monthly progress reports submitted to the NMED and USEPA. Each of these tasks is described below.

8.4.1 Preparations and Mobilization

Prior to excavation, certain tasks and project coordination efforts will commence. The Table below summarizes these tasks and the responsible party.

Task Description	Responsible Party
Issue Notice to Proceed	GEPS
Coordinate with Selected Analytical Laboratory	URS
Coordinate with Selected Waste Disposal Facility	Selected Excavation Contractor
Lay out excavation areas and survey dry well locations	URS
Mobilize to site	Excavation Contractor and URS

During mobilization, the decontamination area, exclusion zone, and staging area will be set up on the site as shown on Figure 9. The extent of these areas may be modified in the field. Existing site fences will aid in delineation of the zones. Signs will be posted at the site that state "RCRA CORRECTIVE ACTION IN PROGRESS – STAY OUT." In addition, portable sanitary facilities will be brought to the site and placed outside of the decontamination area.

8.4.2 Excavation

This subsection describes the site layout and control measures, safety measures, and excavation procedures that will be employed during construction of the corrective measure.

8.4.2.1 Site Layout and Control

As shown on Figure 9, all excavation will occur within the exclusion zone. Remediation waste will be staged at the south end of the site. Prior to leaving the site, vehicles and workers will pass through the decontamination area. These areas are surrounded by existing fencing that will be secured at the end of each work day. The existing site fencing will prevent unauthorized personnel or passersby from entering the work area.

8.4.2.2 Safety

All work will be performed in accordance with applicable OSHA regulations and the site-specific Health and Safety Plans prepared by URS and the selected excavation contractor. The *Contingency Plan*, provided as Appendix E, contains procedures that will be followed in the event of an emergency.

Dust monitoring will be conducted throughout the period of excavation. If dust levels exceed 100 $\mu g/m^3$ or dust is visible leaving the site, dust control measures will be

implemented. If dust levels exceed 150 $\mu g/m^3$, work will stop and dust control methods will be re-evaluated.

Excavation will be performed in accordance with applicable OSHA regulations. All excavations greater than 5 feet in depth will be barricaded upon completion of work in that area and barricades will be placed around active work areas at the end of the work day. Barricades will conform with OSHA standards and may include wooden barricades or stakes and tape.

8.4.2.3 Excavation Procedures

As discussed in Section 8.2.3, figures showing excavation layout, excavation order, and portions of the soil that will be segregated and tracked separately will be finalized after the results of the additional delineation, presented in Section 8.2.2, are available. Based on current site knowledge, URS has prepared preliminary drawings that depict the excavation areas. Figures 11 and 12 present the excavation layout for shallow and deeper soils, respectively.

Excavation Approach

Excavation will begin with the shallow areas. After each shallow area is excavated, post-excavation samples will be collected from the base and sidewalls of the excavation to verify that the cleanup objectives were met. By starting with the shallow areas, verification results can be obtained and possible need for additional soil removal can be evaluated. Specifically, the area immediately west of the building includes removal of shallow and deeper soils. By starting in this area, results of verification samples for the shallow excavation area will be available prior to commencing with the deeper excavations. This approach will allow additional excavation of shallow soils, if necessary, prior to excavation of deeper soils that may cause collapse of sidewalls and

mixing of soil. A detailed discussion of verification sampling is provided in Section 8.4.3.

Shallow Excavation

As shown on Figure 11, the large shallow area immediately west of the building will be excavated first. The soil in the southeast portion of this area, labeled "1" on Figure 11, contains the higher concentration of PCBs found at the site and will be excavated to two feet. The concentration of PCBs in this soil exceeds 50 mg/kg, which will require that the soil be managed as a TSCA waste. Therefore, this soil will be segregated from other soils to be excavated. The remainder of the soil in the large shallow excavation area west of the building is expected to be a non-TSCA, non-hazardous waste. This portion is labeled "2" on Figure 11 and will excavated to 1.5 feet. The dry well structures are anticipated to begin deeper than the 1.5 foot depth of the shallow excavation. However, if the structures are encountered during shallow excavation, they will be segregated as well.

The other shallow excavation areas (labeled "3") will be excavated next. The excavation depths in these areas will range from 1 to 2.5 feet. The soil in these areas is anticipated to be a non-TSCA waste.

As excavation in each area is completed, URS will establish sampling grids and collect the post-excavation soil samples (see Section 8.4.3). For the large area west of the building, verification samples will not be collected from the portions of area where deeper soils will be subsequently excavated and disposed.

Deeper Excavation

Excavation of soil at depth will not begin until the results of the verification sampling for the surrounding shallow excavation area are available and have been evaluated. If sufficient shallow soil has not been removed from the surrounding shallow area to meet the cleanup objective, the excavation plan will be re-evaluated and adjusted as needed.

The remainder of this section describes the excavation plan that will be implemented following verification of clean shallow soils.

The sequence of excavation for the deeper areas will be chosen based on discussions with the selected excavation contractor. A primary consideration during development of the excavation sequence is the need to segregate portions of the deeper soil. Figure 12 shows the deeper excavations and the soil that will be segregated based on previous analytical results. A portion of the excavation area contains concentration of PCBs greater than 50 mg/kg, and therefore will be managed as a TSCA waste. The dry wells will also be segregated because they may contain characteristically hazardous waste. The remainder of the soil in the deeper excavation areas is anticipated to be a non-TSCA, non-hazardous waste.

Previous analytical results show that soil in the area of the dry wells contains elevated concentrations of VOCs. However, the concentrations of VOCs detected are not expected to be high enough to constitute a characteristically hazardous waste. Analytical results from the boring placed through dry well #1, show that material at the bottom of the dry well (11-12 feet bgs) contains elevated concentrations of cadmium, chromium, and lead. The concentrations of these metals are high enough that the sludge may be a characteristic hazardous waste. Therefore, the sludge from the base of both dry wells will be segregated during excavation for characterization prior to making a final determination of waste disposal.

As shown on Figure 12, one of the deep excavation areas will be excavated to 15 feet bgs and therefore, will not require post excavation sampling, with the exception of four samples, two from the base of each dry well, to document the quality of soil left in place. The other two deep excavation areas do not extend to 15 feet and therefore will require collection of post-excavation verification samples. After excavation of the areas that do not extend to a depth of 15 feet is complete, URS will establish the sampling grid and collect verification soil samples from the base and sidewalls of the excavation.

Excavation Methods

Excavation will be in accordance with applicable OSHA regulations. Currently, GEPS plans to leave the selection of using sloping or benching for deeper excavations to the excavation contractor.

8.4.3 Post-Excavation Verification Sampling, Analysis, and Evaluation

Post-excavation samples will be collected from the base and sidewalls of excavated areas. As discussed in Section 8.2.2, GEPS proposes to substitute pre-excavation borings for some of the post-excavation samples. TSCA (40 CFR 761) requires collection of post-excavation samples based on a 1.5 meter (approximately 5 feet) square grid. A five-foot by five-foot grid will be applied to each face of each excavation area less than 15 feet bgs. Post excavation samples will be collected from the node of each grid. Figure 8 shows the pre-excavation borings and the anticipated post-excavation sampling grid.

Each soil sample will be assigned a unique ID based on the location of the sample. Each grid that is established will be named after the boring or location it represents., such as drum rack or HB-30. The grid lines that extend north-south will be assigned letters and the grid lines that extend east-west will be assigned numbers. The sample ID will be comprised of the grid name, the grid location, and depth below grade surface (in feet) that that the sample represents. Therefore, a soil sample collected from 1.5 feet below grade at the intersection of grid line B and grid line 2 near the former drum rack will be given the sample designation DR-B2-1.5.

8.4.3.1 Sampling Procedure and Analysis

This section describes the sampling methods, sample handling procedures, and the planned analysis.

Manual Collection of Soil Samples

Soil samples collected from the surface during the pre-implementation investigation or from the base or sidewalls of excavated areas may be collected using hand augers or stainless-steel trowels. Samples collected from the base of the deeper excavation will be collected from the bucket of the excavator or backhoe. The remainder of this subsection describes the equipment and procedures for soil sample collection with a hand auger or stainless-steel trowel and general soil sampling procedures.

The trowel or hand auger will be decontaminated, examined for cleanliness, and checked for defects or any need of repair prior to sampling. A description of the sampling area from which the sample is being taken, and other pertinent sample information will be recorded on a field soil boring log or in a field notebook.

The soil sample will be scooped up with the trowel and put into a stainless steel bowl. If using a hand auger, scoop sample from auger into the stainless steel bowl using a trowel. If the soil will be analyzed for VOCs, an aliquot of soil will be immediately transferred into the VOC sample containers. The VOC sample containers will be completely filled in order to minimize head-space in the containers. A second aliquot of soil will be immediately retained for head-space analysis using a PID. The remaining soil will be mixed (homogenized) in the bowl and then the remaining sample containers will be filled (grab samples).

The field observations and sample details will be recorded on a field soil boring log or in a field notebook. All soil sample locations less than four feet bgs will be marked on the ground. Identification materials and markings that will last until the end of the project will be used.

To prevent cross-contamination of samples, the field personnel will wear disposable gloves when collecting and handling samples. The gloves will be changed between

samples. The hand augers and stainless-steel hand trowels will be decontaminated between samples.

Quality assurance samples, including matrix spike/matrix spike duplicates, duplicate samples, equipment rinseate blanks, and trip blanks will be collected as necessary in accordance with the procedures described in the *Quality Assurance Project Plan (QAPP)*. Once sample containers are filled, they will be immediately placed in the cooler with sufficient sealed bags of ice or ice packs to maintain the samples at 4°C. The field sampler will indicate sample designation/location number in the space provided on the appropriate chain-of-custody for each sample. The sample custody procedures are also described in the *QAPP*.

Soil Sampling Using Geoprobe ™ Equipped with MacroCore ™ Samples

Soil borings will be advanced using a Geoprobe unit mounted to a truck or van. Macro Core open samplers will likely be used to collect the samples. These samplers have an open tube design and measure approximately two-inches in diameter (outer) by 44-inches long. The samplers will be fitted with a removable cutting shoe and disposable acetate liners. Each of the samplers will be fitted with a new acetate liner prior to collection of a sample. The acetate liner will be split open to collect the soil.

The length of sample recovery, percent recovery, and soil description, including odors will be recorded on the boring log. The soil samples obtained from the Macro Core open samplers will be collected and handled in a similar manner as the soil samples obtained manually.

Delineation of a potential contaminated zone within a boring will be based on the following field screening parameters:

- Discoloration or staining;
- Unusual odors or VOC measurements (PID);

- Unusual textures; and
- Presence of sludges or other anthropogenic features.

All acetate liners will be disposed after use at an appropriate off-site facility. Upon completion of sampling at each location, all sampling equipment will be decontaminated in accordance with the procedures described below.

Rinseate blanks will be denoted with a "RB" followed by the six digit date (i.e.,: RBYYMMDD).

Collection of Soil Samples from Backhoe Bucket

Post-excavation soil samples that are to be collected from depths greater than four feet below original grade will be collected from the backhoe or excavator bucket. The equipment operator will be directed to bring soil from the desired sampling location to the ground surface. The sampling location will be as close as feasible to the intended grid sampling location. If the soil near the grid is disturbed, the equipment operator will be directed to move the disturbed soil and collect the sample from the undisturbed soil beneath.

After the soil has been brought to grade, a clean trowel will be used to transfer soil from the bucket of the excavator to a clean stainless steel bowl or directly into the VOC sample container, if a sample is to be collected for VOC analysis. The soil sample will be collected from the interior of the bucket where soil has not touched the bucket itself and is minimally disturbed. The soil samples obtained from the backhoe or excavator bucket will be collected and handled in a similar manner as the soil samples obtained manually.

Collection of Waste Characterization Soil Samples

Waste characterization soil samples will be collected and handled in a manner similar to the soil samples obtained manually. However, waste characterization soil samples will composite, except for the sample for VOC analysis. The soil collected for the VOC

analysis will be a grab sample. The samples will be collected from the rolloff container. Soil from a minimum of three separate locations will transferred to a clean stainless steel bowl to be composited.

If a composite sample is needed for non-volatile constituent analysis, additional soil will be placed in a clean stainless-steel bowl. After removal of any stones, large twigs, or other vegetation, the sample will be thoroughly homogenized by mixing the sample in the bowl with a stainless-steel spoon. The sample will then be quartered in the bowl and each quarter then will be mixed separately, before finally mixing the entire sample again. The sample will then be placed in sample containers using a trowel for non-volatile constituent analysis. This type of sample, defined as a composite sample, will not be analyzed for VOCs.

Duplicate Samples

The analysis of blind duplicate samples provides a means of evaluating the relative precision of the sample collection and analytical procedures. An important factor in evaluating the analytical data from sample pairs is the homogeneity of the analyte within the sample matrix. Therefore, whenever possible, one will homogenize an aliquot from a discrete location or interval before the sample and duplicate are collected. However, VOC samples must never be homogenized in order to prevent the loss of VOCs. In general, the handling of VOC samples will be minimized to preserve the physical integrity of the VOC fraction. Duplicate samples will be prepared for each sample matrix at a rate of one duplicate per twenty samples.

Duplicates of solid samples for VOC analysis will be obtained by alternately filling the sample containers for the sample and duplicate for VOC analysis with aliquots collected form the same discrete location or interval. Once samples for VOC analysis have been collected, the sample will be thoroughly homogenized. Following homogenization, the sample containers for the remaining parameters will be filled. Duplicates will be denoted with a "DUP" followed by the six digit date (i.e.,: DUP-MM/DD/YY).

Matrix Spike/Matrix Spike Duplicate Samples

Matrix spike/matrix spike duplicate (MS/MSD) samples provide a measurement of matrix effects, in which other sample components interfere with the analysis of the contaminants of interest. The laboratory will be supplied with sufficient sample volume in order to perform matrix spike and matrix spike duplicate analyses for each analysis. The MS/MD samples will be denoted with "MS" or "MSD" followed by the six digit date (i.e.,: MSYYMMDD). The COC will contain a notation explaining which sampling location the MS/MSD was obtained from.

Sampling Equipment Decontamination Procedures

Sampling equipment will be decontaminated in the laboratory or the field prior to site use and between sampling locations. The sampling device and equipment decontamination method will involve a non-phosphate detergent wash, tap water rinse, distilled/deionized water rinse, hexane rinse, air drying, and a second distilled/deionized water rinse.

Drilling tools will be steam cleaned between each drilling location to prevent cross-contamination. Decontamination will be conducted on the temporary decontamination pad. The decontamination water will be containerized for proper disposal.

Sample Handling and Analysis

All samples will be collected and handled in a manner such that sample agitation, cross-contamination, and contact with the atmosphere is reduced or kept to minimum. Field personnel will wear disposable gloves when collecting and handling samples.

As required, samples will be immediately preserved, and stored at 4°C until delivered to the laboratory. The samples will be kept cool at 4°C using insulated containers containing sufficient ice or ice packs. If ice is used, the ice will be double-bagged at a

minimum. VOC sample jars will be placed in resealable plastic bags prior to placement in coolers.

Analysis and Turnaround Time

Because proceeding with certain stages of the project (deep excavation, backfill) will be dependent on the analytical results of prior project stages, rapid turnaround time (TAT) will be requested for some samples. The following table summarizes the anticipated post-excavation sampling, analysis, and laboratory turnaround time.

Sampling Location	**Turnaround Time**	**Number of Samples**	**Analysis**
Post-Excavation Verification Samples			
Shallow Excavation West of Building	3 day TAT	124	PCBs
Other Shallow Excavation Areas	14 day TAT	101	PCBs
Deep Excavations	24 hour TAT	10	PCBs
Dry Well Soil Quality Samples			
Base of dry wells	3 day TAT	4	PCBs VOCs SVOCs

8.4.3.2 Evaluation of Post-Excavation Verification Sampling Results

The analytical results of the post-excavation verification sampling will be compared to the corrective measure cleanup objective of 1 mg/kg PCBs for soil less than 15 feet below ground surface. If the analytical results show that the cleanup objective has been met, work will continue as planned.

If the analytical results show that soil containing PCBs at concentrations greater than 1 mg/kg remains in place at less than 15 feet bgs, excavation will be continued until concentrations less than 1 mg/kg or 15 feet bgs has been reached.

8.4.4 Waste Handling

This section describes the waste handling procedures that will be used for the project. The majority of waste generated by this project will be excavated soil. Decontamination of equipment will generate a relatively small amount of liquid waste. The liquid wastes will be stored in drums and will be managed in a manner similar to the removed soil.

8.4.4.1 Storage of Excavated Material

We anticipate excavated material will be placed into rolloff containers that are lined with plastic sheeting. After being loaded, covers will be secured on the rolloff containers. Partially filled containers will be securely covered at the end of each work day. As each container is filled it will be labeled with a sign "Remediation Waste – Pending Analysis" and dated. During contractor and waste disposal facility selection, GE may re-evaluate the use of roll-off containers for transportation of remediation waste.

Waste generated during the remediation will be removed from the site within 90 days of generation. However, if the waste characterization sampling results indicate that the material is a non-TSCA non-hazardous waste, the soils will be disposed as soon as possible, but may remain on site longer than 90 days.

8.4.4.2 Waste Characterization

The majority of the soil to be removed is expected to be non-TSCA, non-hazardous remediation waste. As discussed in Section 8.4.2, excavated soil will be segregated based on the anticipated waste type (non-TSCA non-hazardous, TSCA waste, potentially hazardous waste).

The exact analyses required for waste characterization and the frequency of sampling will depend on the requirements of the selected disposal facilities. For the purpose of estimating the cost associated with implementing this corrective measure we assumed that one sample would initially be required for every three rolloff containers of each

anticipated waste type and that each sample would be analyzed for PCBs by EPA Method 8082, TLCP VOCs by EPA Method 8260, TCLP SVOCs by EPA Method 8270, TCLP metals by EPA Method 6010, corrosivity (pH) by EPA Method 9040/9045, and reactivity by EPA Method 7.3, ignitability (flashpoint) by EPA Method 1010, and paint filter test by EPA Method 9095. The frequency of waste characterization sampling is expected to decrease after sufficient data has been generated to document contaminant levels and waste characterization.

8.4.4.3 Waste Transportation and Disposal

Based on previous analytical results, most of the waste generated by this corrective measure is expected to be non-TSCA, non hazardous remediation waste. As such, it will landfilled as a non-regulated waste. A portion of the waste, approximately 60 cubic yards, is expected to be a TSCA waste and will therefore be disposed at a TSCA landfill. A small portion of the waste, approximately 7 cubic yards, may possibly be classified as a characteristic hazardous waste after the waste characterization sampling is complete. Wastes will be disposed based upon the characterization analysis performed.

All waste will be transported by licensed waste handlers to appropriately permitted facilities. Currently, waste disposal facilities have not been finalized.

8.4.5 Site Restoration

After the verification sampling results have been evaluated and the results demonstrate that the cleanup objectives have been met, the excavation areas will be backfilled and the area will be restored to approximate original grade. Prior to being brought to the site, a sample of the potential backfill will be analyzed for VOCs, SVOCs, PCBs, pesticides, and metals and confirmed to be clean. The results of this sampling will be included in the *Certification Report*.

8.5 POST-IMPLEMENTATION ACTIONS

This section describes the actions that will be taken after construction of the corrective measure is complete.

8.5.1 Decommission Groundwater Monitoring Wells

The results of the RFI and supplemental investigations indicate that groundwater has not been impacted site activities. In addition, modeling indicates that the constituents known to be present at the site are not present at sufficiently high concentrations to impact groundwater in the future. Because this corrective measure includes removal of the dry wells and nearby soil, it is anticipated that the soil, which suffered the greatest impacts from site activities will be removed. No threat to groundwater is anticipated. Therefore, there is no need to monitor groundwater quality in the future. After the corrective measure is implemented, and the post excavation sampling results verify that soil remaining at the site does not contain significantly greater concentrations of constituents than were identified during the RFI, the groundwater monitoring wells will be properly decommissioned.

Monitoring wells will be decommissioned in accordance with NMED *Monitoring Well Construction and Abandonment Guidelines*. The monitoring wells will either be removed and filled or the casing will be perforated and filled. After abandonment activities are complete, a letter report summarizing decommissioning method will be submitted to the Groundwater Pollution Prevention Section of NMED.

8.5.2 Construction Certification Report

After the corrective measure activities are completed, a *Construction Certification Report* that documents the corrective measure implementation will be prepared. The report will include a description of activities, sampling results, and copies of waste manifests. The report will also include certification by a professional engineer licensed in New Mexico.

8.5.3 Monitoring

As discussed previously, the corrective measure is intended to remove, in accordance with this plan, all soil at the site that has been impacted by site activities and that could pose a threat to human health or the environment. Therefore, neither long nor short term monitoring is anticipated to be required after completion of the corrective measure.

8.5.4 Progress Reports

GEPS will continue to submit monthly progress reports until the *Construction Certification Report* is accepted by NMED and USEPA.

9.0 PROJECT SCHEDULE

The corrective measure schedule will be established after NMED and USEPA approve this *CMS Report*.

After approval of this *CMS Report*, the pre-implementation investigation will be conducted. We estimate that the investigation phase will last approximately two to four months for collection of soil samples and evaluation of the analytical results. After the pre-implementation investigation is completed the corrective measure design will be refined. Public notice and the public comment period will follow. The corrective measure design will be finalized after the public comment period.

TABLES

TABLE 1
MAXIMUM CONTAMINANT CONCENTRATIONS IN SOIL
GENERAL ELECTRIC
ALBUQUERQUE, NEW MEXICO

Constituent	Maximum Concentration 0-5 feet mg/kg	Location of Maximum	Maximum Concentration 5-15 feet mg/kg	Location of Maximum
VOCS				
Acetone	-	-	2.1	B-1 (11-12)
Benzene	0.002D	HA-19 (1-1.5)	0.11	B-1 (11-12)
Ethylbenzene	0.06	HB-15 (1-1.5)	3,800	B-1 (11-12)
Toluene	0.019D	HA-19 (1-1.5)	29	B-1 (11-12)
Xylenes	0.057	HA-19 (1-1.5)	29,000	B-1 (11-12)
Tetrachloroethene	0.122	HB-15 (1-1.5)	1.7	B-1 (11-12)
1,2-Dichlorobenzene	0.002	HA-18 (1-1.5)	38*	B-5 (14-15)
1,3-Dichlorobenzene	0.018	HA-17 (0-0.5)	0.018	Multiple Locations
1,4-Dichlorobenzene	0.004D	HA-19 (1-1.5)	0.004	Multiple Locations
1,1,1-Trichloroethane	0.08	HB-15 (1-1.5)	0.58	B-1 (11-12)
Methylene chloride	1.13	HB-15 (1-1.5)	0.5C	B-7 (6-7)
1,1-Dichloroethane	-	-	2.2	B-1 (11-12)
Trichloroethene	-	-	0.12	B-1 (11-12)
4-Methyl-2-pentanone	-	-	0.13	B-1 (11-12)
Chlorobenzene	-	-	0.15	B-1 (11-12)
Styrene	-	-	34	B-1 (11-12)
Dichloromethane	0.5	B-7 (0-1)	0.5	B-7 (6-7)
SVOCS				
1,2,4,5-Tetrachlorobenzene	-		0.17	B-1A (12-14)
1,2,4-Trichlorobenzene	0.54	B-2 (4-5)	700	B-1 (9-10)
2-Methylnaphthalene	-	-	49	B-1 (9-10)
Naphthalene	-	-	14J	B-1 (9-10&11-12)

TABLE 1
MAXIMUM CONTAMINANT CONCENTRATIONS IN SOIL
GENERAL ELECTRIC
ALBUQUERQUE, NEW MEXICO

Constituent	Maximum Concentration 0-5 feet mg/kg	Location of Maximum	Maximum Concentration 5-15 feet mg/kg	Location of Maximum
N-nitrosodiphenylamine	-	-	25J	B-1 (9-10)
Phenanthrene	-	-	13J	B-1 (9-10)
Dimethylphthalate	-	-	0.17	B-12 (5-6.5)
Bis(2-ethylhexyl)phthalate	-	-	55	B-1 (11-12)
Di-n-butylphthalate	-	-	1.5*	B-12 (5-6.5)
2,4-Dimethylphenol	-	-	17J	B-1 (9-10)
PCBS				
Total PCBs	19,000	HB (1-1.5)	20.4	B-1 (9-10)
Arochlor 1254	19,000	HB-15 (1-1.5)	7.5	HB-14 (11-11.5)
Arochlor 1260	4.7*	B-6 (4-5)	0.43	B-13 (10-11.5)
Arochlor 1016	-	-	23.3	B-1 (11-12)
METALS				
Barium	-	-	479	B-1 (11-12)
Beryllium	-	-	0.64	B-1A (12-14)
Cadmium	-	-	68.1	B-1 (11-12)
Chromium	-	-	171	B-1 (11-12)
Cobalt	-	-	5.53	B-1A (12-14)
Copper	-	-	11.48	B-1A (12-14)
Lead	-	-	1,160	B-1 (11-12)
Nickel	-	-	7.02	B-1A (12-14)
Vanadium	-	-	20.84	B-1A (12-14)
Zinc	-	-	41.05	B-1A (12-14)
Tin	-	-	29.99	B-1A (12-14)

TABLE 1
MAXIMUM CONTAMINANT CONCENTRATIONS IN SOIL
GENERAL ELECTRIC
ALBUQUERQUE, NEW MEXICO

Constituent	Maximum Concentration 0-5 feet mg/kg	Location of Maximum	Maximum Concentration 5-15 feet mg/kg	Location of Maximum
Silver	-	-	24.6	B-1 (11-12)
Arsenic	-	-	8.69	B-1 (11-12)
Mercury	-	-	0.515	B-1 (11-12)
Selenium	-	-	8.24	B-1 (11-12)
Phenol	-	-	8.65	B-1 (11-12)
PESTICIDES				
Lindane	-	-	0.01F*	B-5 (14-15)
Aldrin	-	-	0.013F*	B-5 (14-15)
Endrin	-	-	0.021F*	B-5 (14-15)
TOTAL PETROLEUM HYDROCARBON				
TPH	-	-	1400	7B-6 (10)
GEO CHEMICAL PARAMETER				
Sulfide	-	-	73	B-1A (12-14)

* - Analyzed, extracted out of hold time
B – Estimated in blank
C – Estimated result greater than calibration limit
D – Bias high due to low internal STD area
J – Present below detection limit
F – Estimated, can not confirm due to PCB interference

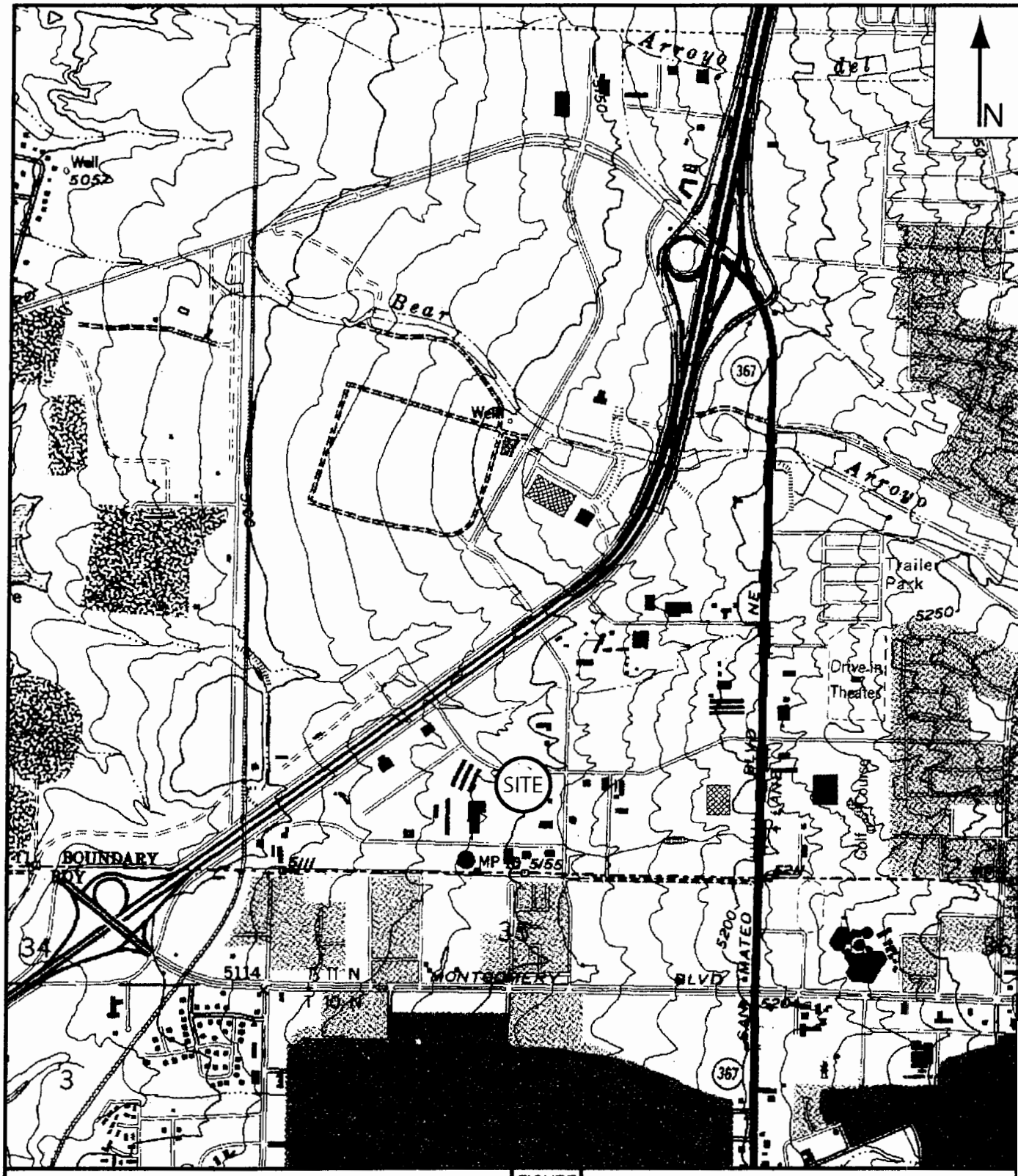
TABLE 2
SUMMARY OF ANALYTICAL RESULTS FOR GROUNDWATER SAMPLING EVENTS
GENERAL ELECTRIC COMPANY
ALBUQUERQUE, NEW MEXICO

All units ug/L

Parameter	MW-1	MW-1	MW-2	MW-2	MW-2A	MW-3	MW-3	MW-4	MW-4
	5/10/90	9/11/96	5/17/90	9/11/96	5/17/90	5/11/90	9/11/96	5/16/90	9/11/96
Acetone	14 G	ND	33 G	ND	11 G	<10	ND	13 G	ND
Methlene Chloride	<5	ND	<5	ND	<5	<5	ND	<5	ND
Di-N-Octoylphthalyte	<9	ND	<9	ND	<9	<9	ND	15	ND
Sulfide	.0022 B*	NS	.0013 B*	NS	.0015 B*	.00064 B*	NS	.00077 B*	NS
Antimony	<.023	NS	<.023	NS	<.023	<.023	NS	<.023	NS
Barium	0.173	NS	0.171	NS	0.179	0.187	NS	0.176	NS
Beryllium	0.001	NS	<.0001	NS	<.0001	0.001	NS	0.001	NS
Cadmium	<.004	NS	<.004	NS	<.004	<.004	NS	<.004	NS
Chromium	.066 J	NS	0.04	NS	0.035	.058 J	NS	0.033	NS
Cobalt	0.007	NS	0.007	NS	<.005	0.006	NS	0.006	NS
Copper	0.014	NS	0.01	NS	0.009	0.014	NS	0.01	NS
Lead	0.02	NS	<.017	NS	<.017	<.017	NS	<.017	NS
Nickel	0.038	NS	0.025	NS	0.014	0.037	NS	0.02	NS
Silver	<.002	NS	0.002	NS	<.002	<.002	NS	0.002	NS
Thallium	<.022	NS	<.022	NS	<.022	<.022	NS	<.022	NS
Vanadium	0.005	NS	0.004	NS	0.006	0.021	NS	0.011	NS
Zinc	0.021	NS	0.054	NS	0.042	0.059	NS	0.026	NS

Notes:
(1) G estimated - contamination due to using isopropanol in the field.
(2) B estimated - in method blank.
(3) J - estimated - bias high.
(4) * estimated - anaylzed past holding time.
(5) ND - Not Detected
(6) NS - Not Sampled

FIGURES



GRAPHIC SCALE

0 0.25 0.5 MILE

USGS Alameda, NM 7.5' Quadrangle, 1960 (Photorevised 1967 and 1972)

FIGURE 1

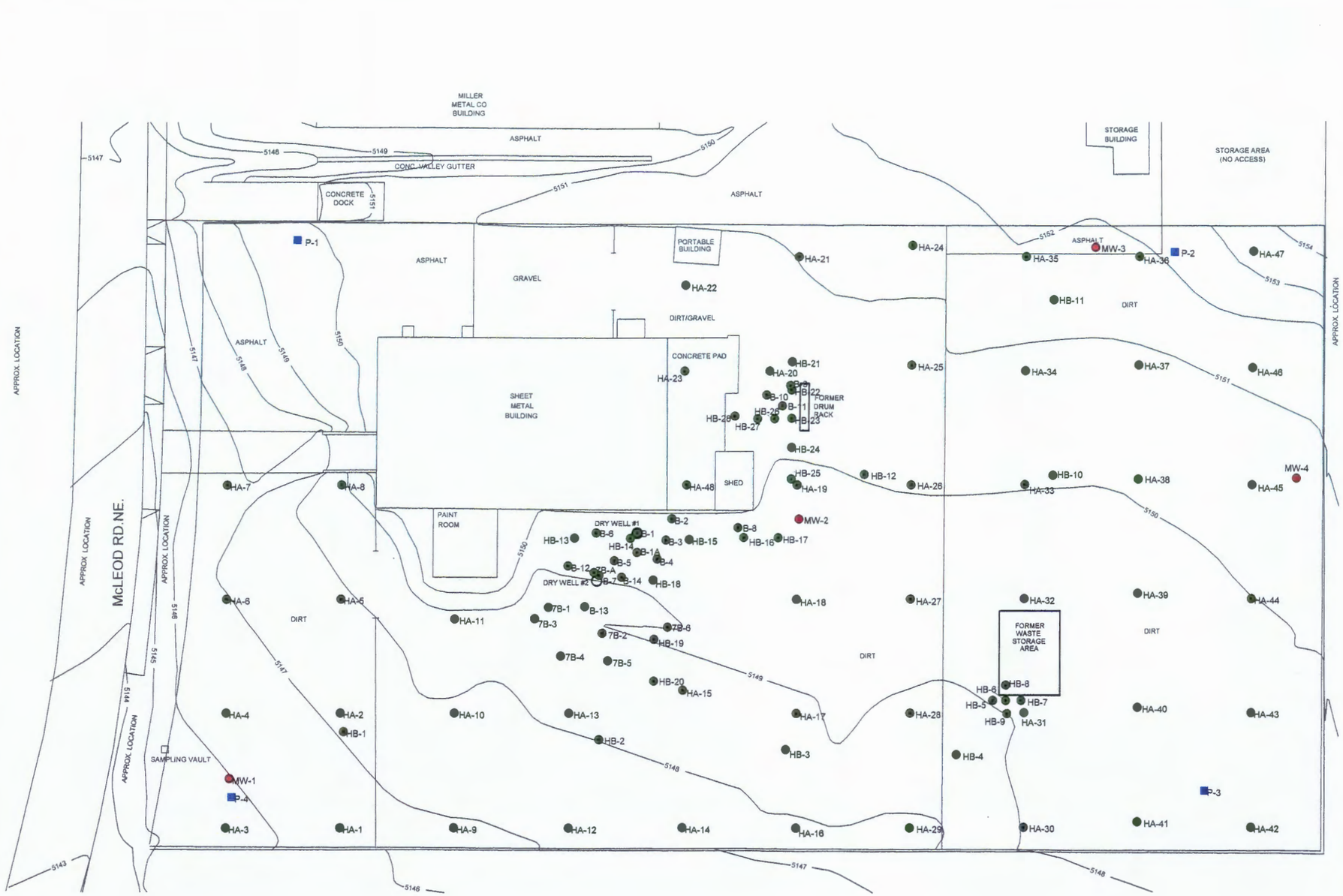
SITE LOCATION MAP

GENERAL ELECTRIC COMPANY
APPARATUS SERVICE SHOP
ALBUQUERQUE, NEW MEXICO

URS

646 PLANK ROAD SUITE 202
CLIFTON PARK, NEW YORK 12065

Job No. 38393778



LEGEND:

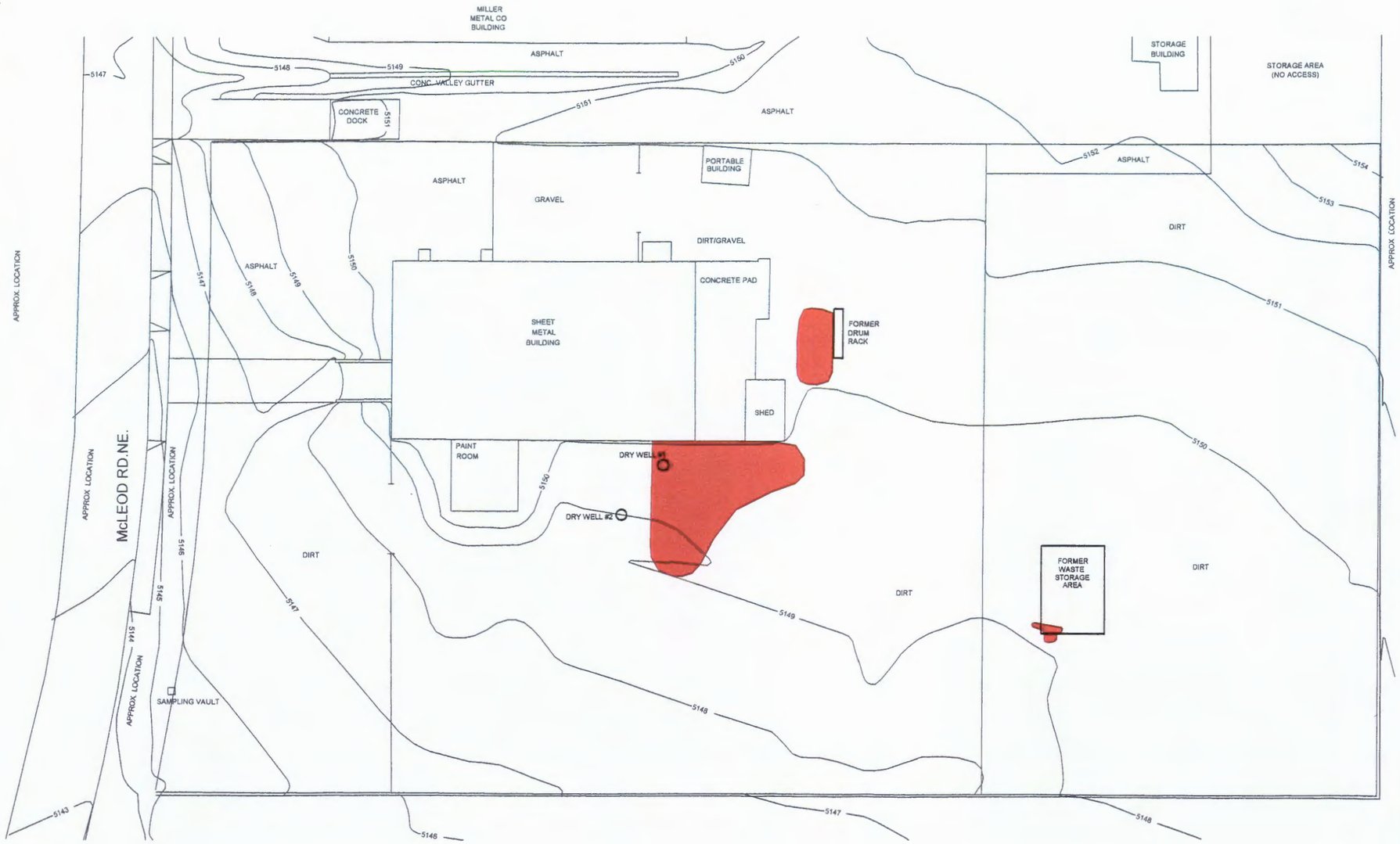
- MONITORING WELL LOCATION
- PIEZOMETER LOCATION
- SOIL BORING LOCATION

0 20 40 60 80 Feet

GRAPHIC SCALE

FIGURE 2	SITE LAYOUT AND SAMPLE LOCATIONS
	GENERAL ELECTRIC COMPANY APPARATUS SERVICE SHOP ALBUQUERQUE, NEW MEXICO
URS JOB NO. 38393778	646 PLANK ROAD SUITE 202 CLIFTON PARK, NEW YORK 12065

BASE MAP PROVIDED BY LAW ENVIRONMENTAL.



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LEGEND:
GROUND SURFACE STAINING

0 20 40 60 80 Feet
GRAPHIC SCALE

FIGURE 3	AREAS OF STAINED SURFACE SOIL
	GENERAL ELECTRIC COMPANY APPARATUS SERVICE SHOP ALBUQUERQUE, NEW MEXICO
URS JOB NO. 38393778	646 PLANK ROAD SUITE 202 CLIFTON PARK, NEW YORK 12065

BASE MAP PROVIDED BY LAW ENVIRONMENTAL.

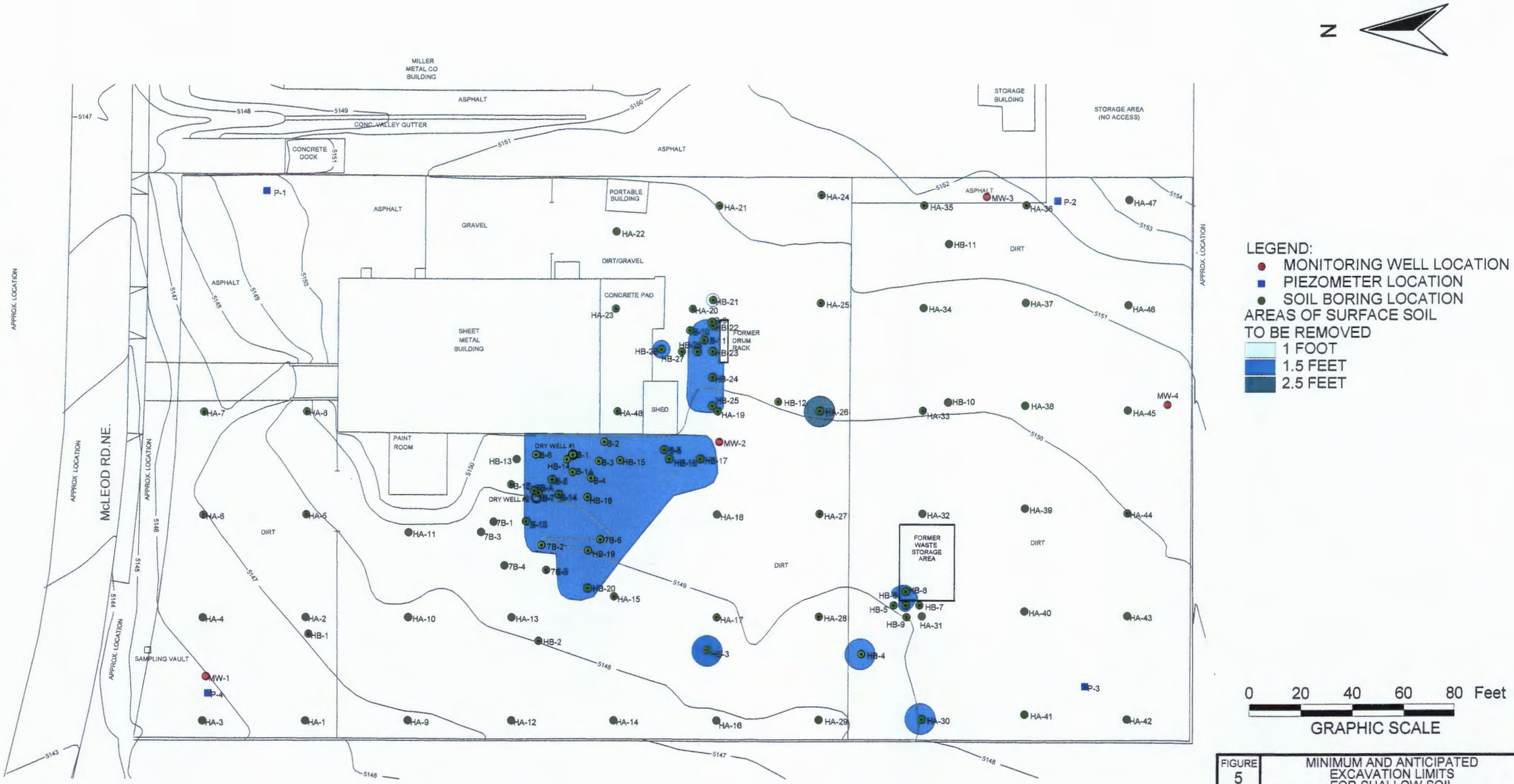
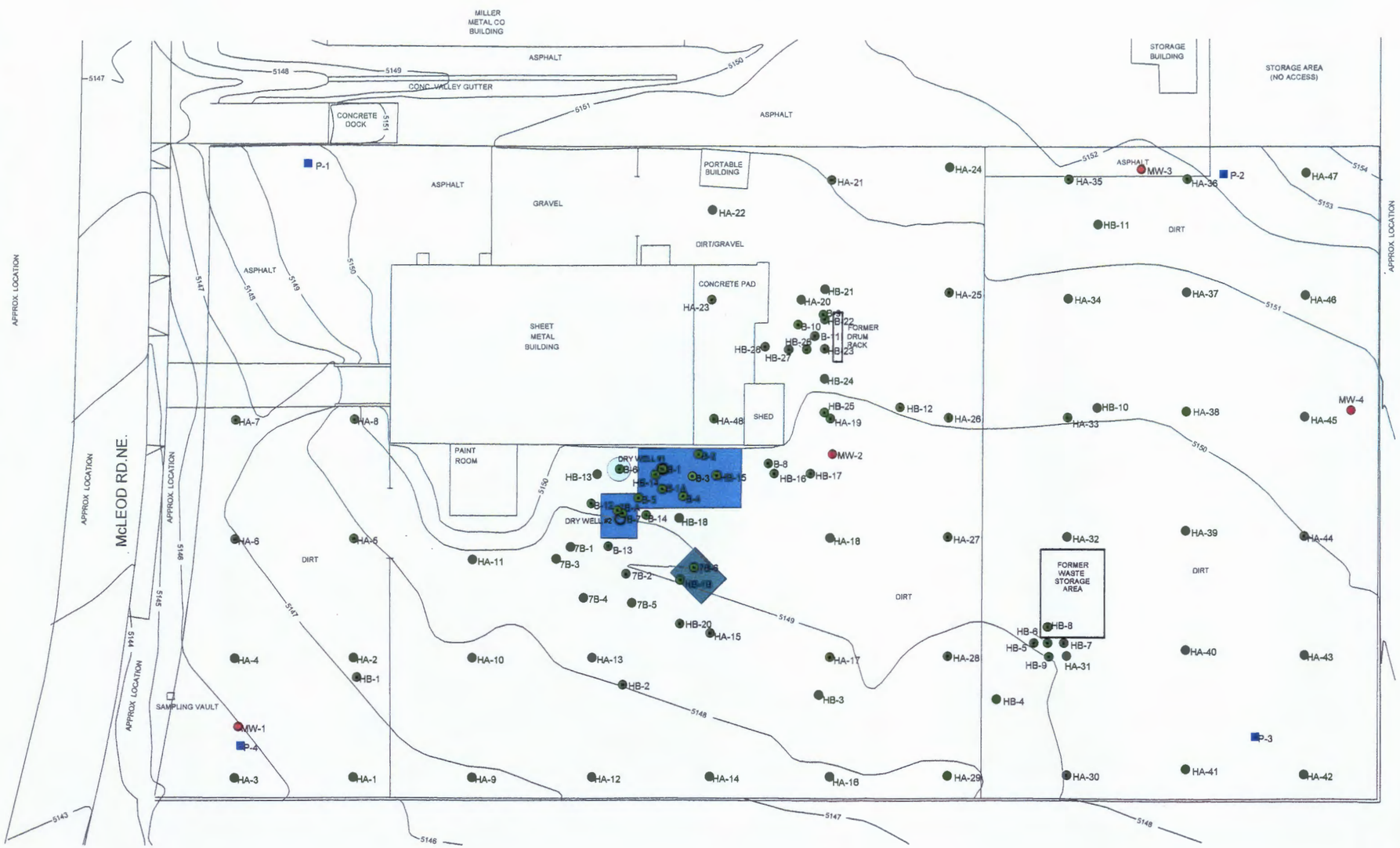


FIGURE 5	MINIMUM AND ANTICIPATED EXCAVATION LIMITS FOR SHALLOW SOIL
	GENERAL ELECTRIC COMPANY APPARATUS SERVICE SHOP ALBUQUERQUE, NEW MEXICO
URS JOB NO. 38393778	646 PLANK ROAD SUITE 202 CLIFTON PARK, NEW YORK 12065

BASE MAP PROVIDED BY LAW ENVIRONMENTAL.



N

LEGEND:

- MONITORING WELL LOCATION
- PIEZOMETER LOCATION
- SOIL BORING LOCATION

AREAS OF SUBSURFACE SOIL TO BE REMOVED

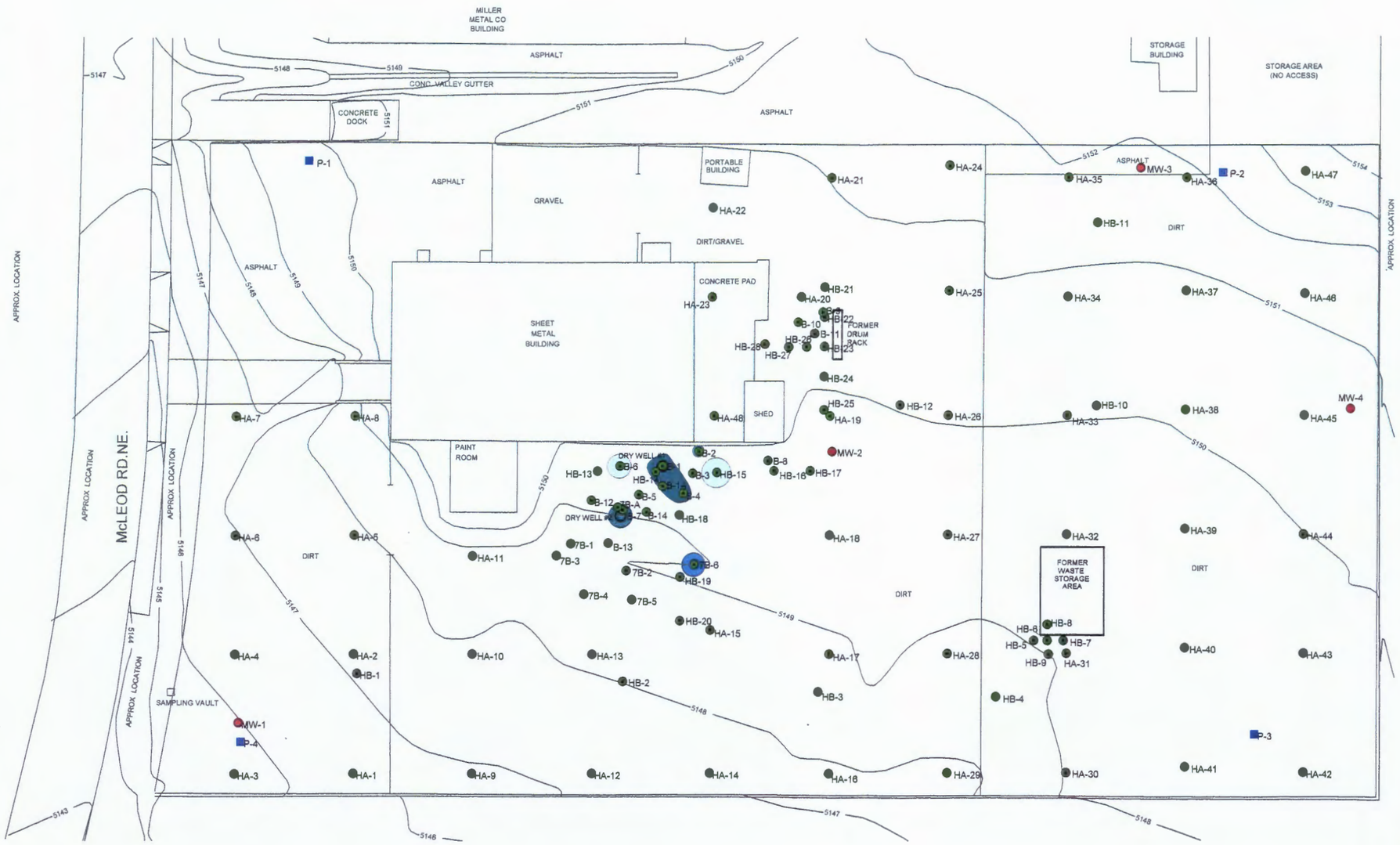
- 6 FEET
- 11 FEET
- 15 FEET

0 20 40 60 80 Feet

GRAPHIC SCALE

FIGURE 7	ANTICIPATED EXCAVATION LIMITS FOR SOIL AT DEPTH
	GENERAL ELECTRIC COMPANY APPARATUS SERVICE SHOP ALBUQUERQUE, NEW MEXICO
URS JOB NO. 38393778	646 PLANK ROAD SUITE 202 CLIFTON PARK, NEW YORK 12065

BASE MAP PROVIDED BY LAW ENVIRONMENTAL.



N

LEGEND:

- MONITORING WELL LOCATION
- PIEZOMETER LOCATION
- SOIL BORING LOCATION

AREAS OF SUBSURFACE SOIL TO BE REMOVED

- 6 FEET
- 7 FEET
- 11 FEET
- 15 FEET

0 20 40 60 80 Feet

GRAPHIC SCALE

FIGURE 6	MINIMUM EXCAVATION LIMITS FOR SOIL AT DEPTH

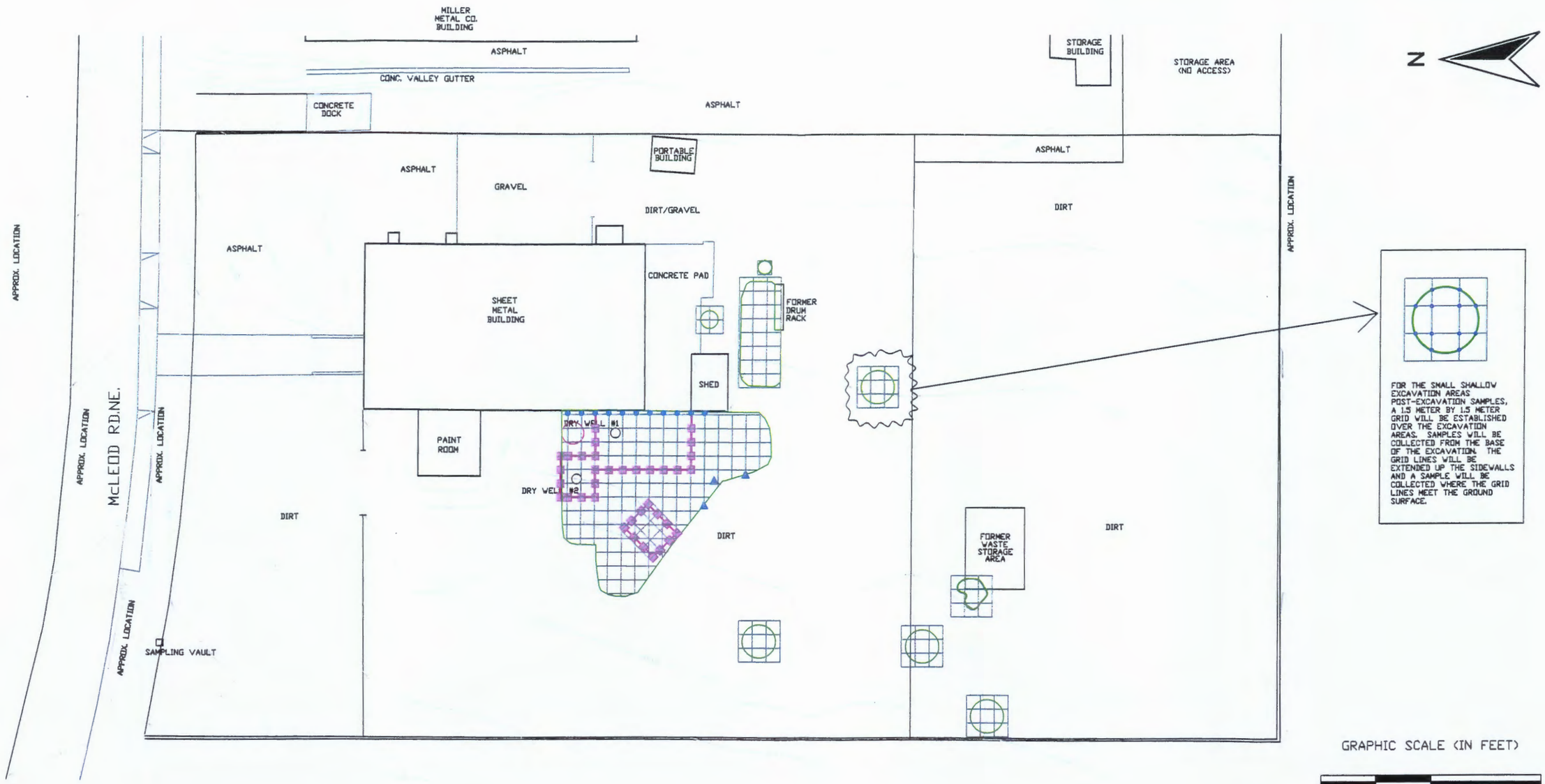
GENERAL ELECTRIC COMPANY
APPARATUS SERVICE SHOP
ALBUQUERQUE, NEW MEXICO

URS

646 PLANK ROAD SUITE 202
CLIFTON PARK, NEW YORK 12065

JOB NO. 38393778

BASE MAP PROVIDED BY LAW ENVIRONMENTAL.



GRAPHIC SCALE (IN FEET)

0 20 40 80

LEGEND

- SURFACE SOIL REMOVAL AREAS
- SUBSURFACE SOIL REMOVAL AREAS
- ANTICIPATED POST-EXCAVATION SAMPLING GRID
- SOIL BORING ALONG BUILDING FOUNDATION
- SOIL BORING AROUND DEEPER EXCAVATIONS
- PRE-IMPLEMENTATION SURFACE SOIL SAMPLE
- POST-EXCAVATION SOIL SAMPLE

BASE MAP PROVIDED BY LAW ENVIRONMENTAL

FIGURE 8

ADDITIONAL SAMPLING LOCATIONS

GENERAL ELECTRIC COMPANY
APPARATUS SERVICE SHOP
ALBUQUERQUE, NEW MEXICO

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646 PLANK ROAD, SUITE 202
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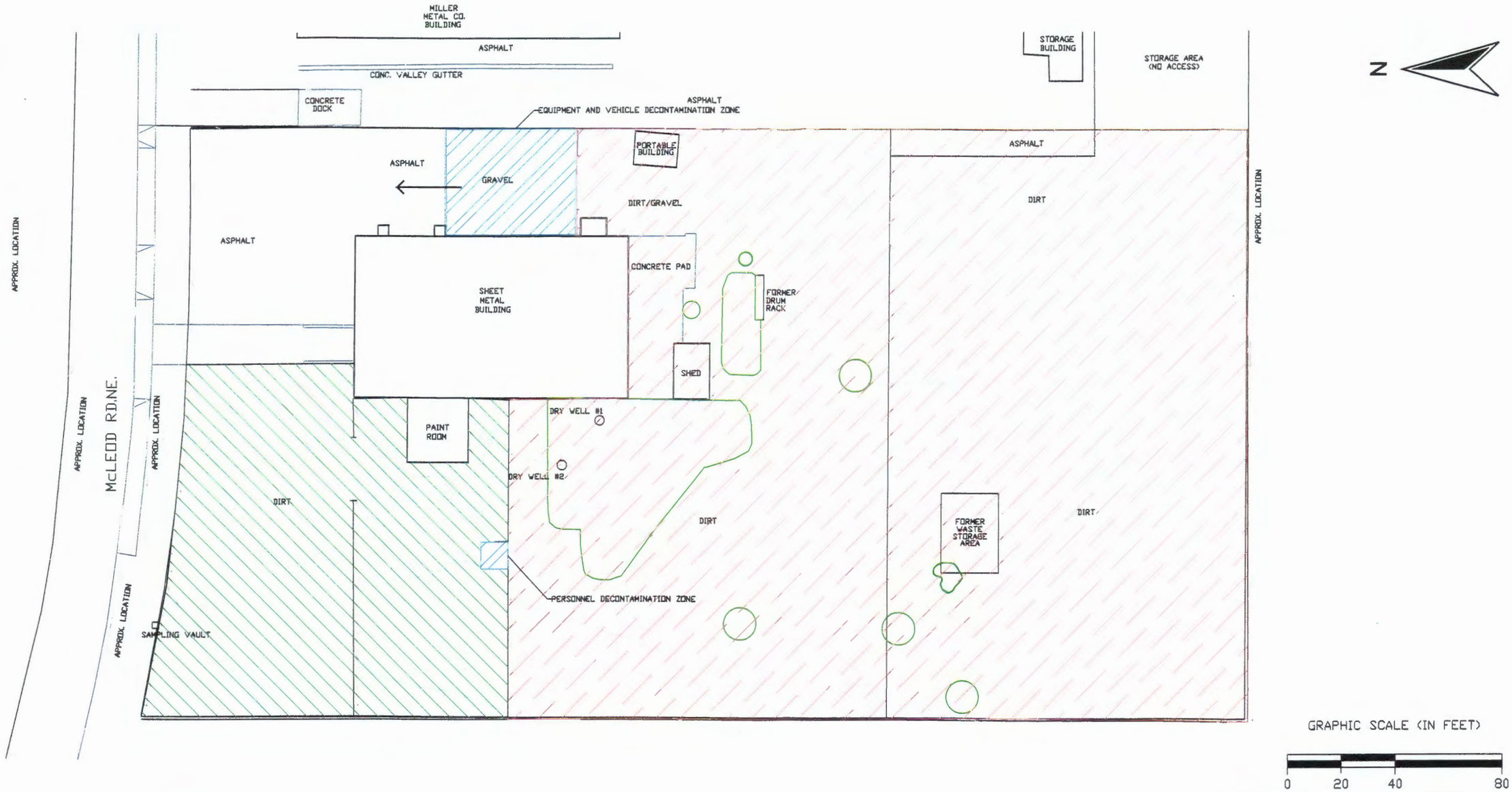
JOB NO. 38393778



GRAPHIC SCALE (IN FEET)

0 20 40 80

LEGEND

- SOIL REMOVAL AREAS
- EXCLUSION ZONE
- DECONTAMINATION AREA
- STAGING AREA

BASE MAP PROVIDED BY LAW ENVIRONMENTAL

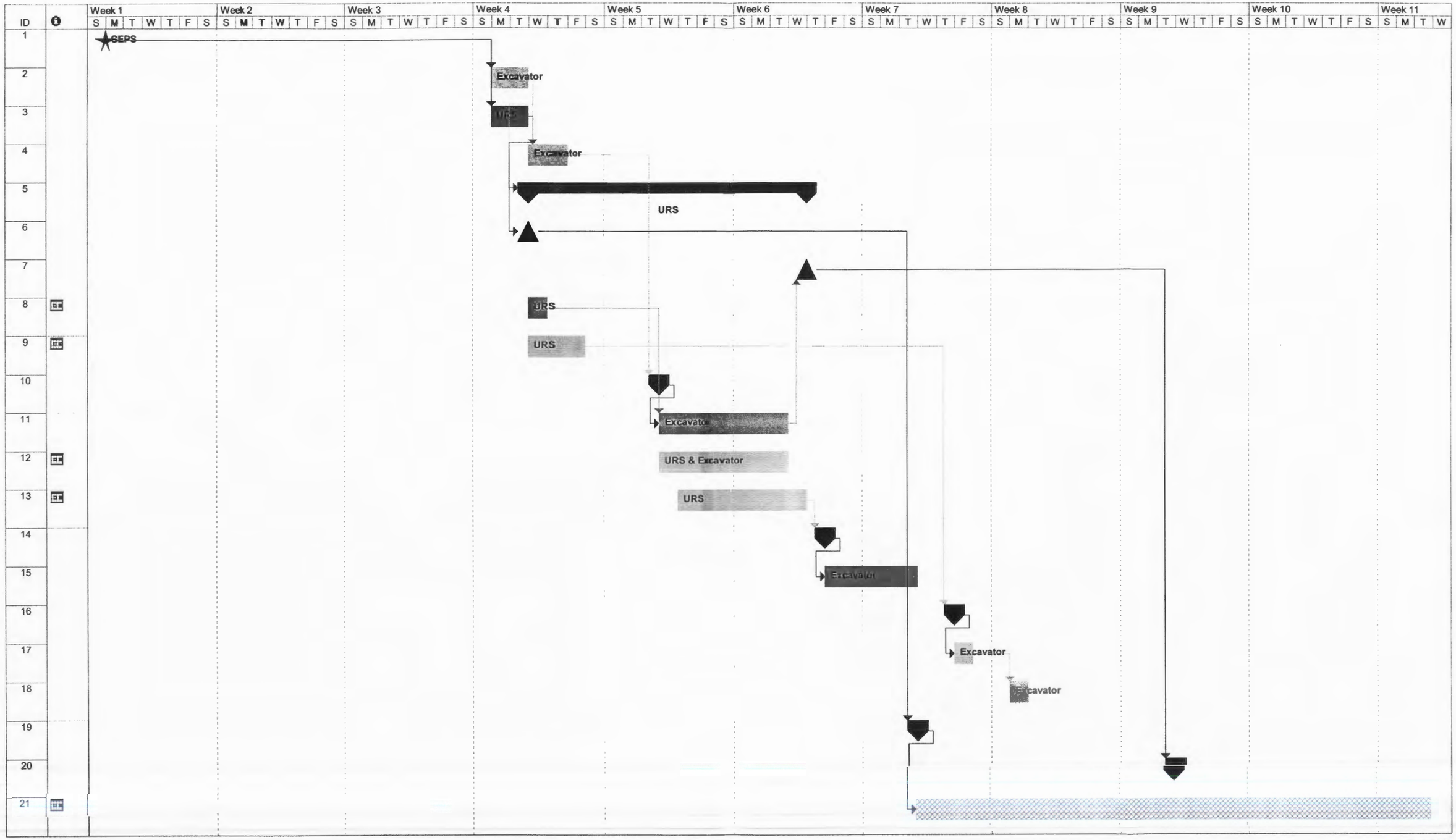
FIGURE	
9	WORK AREA LAYOUT

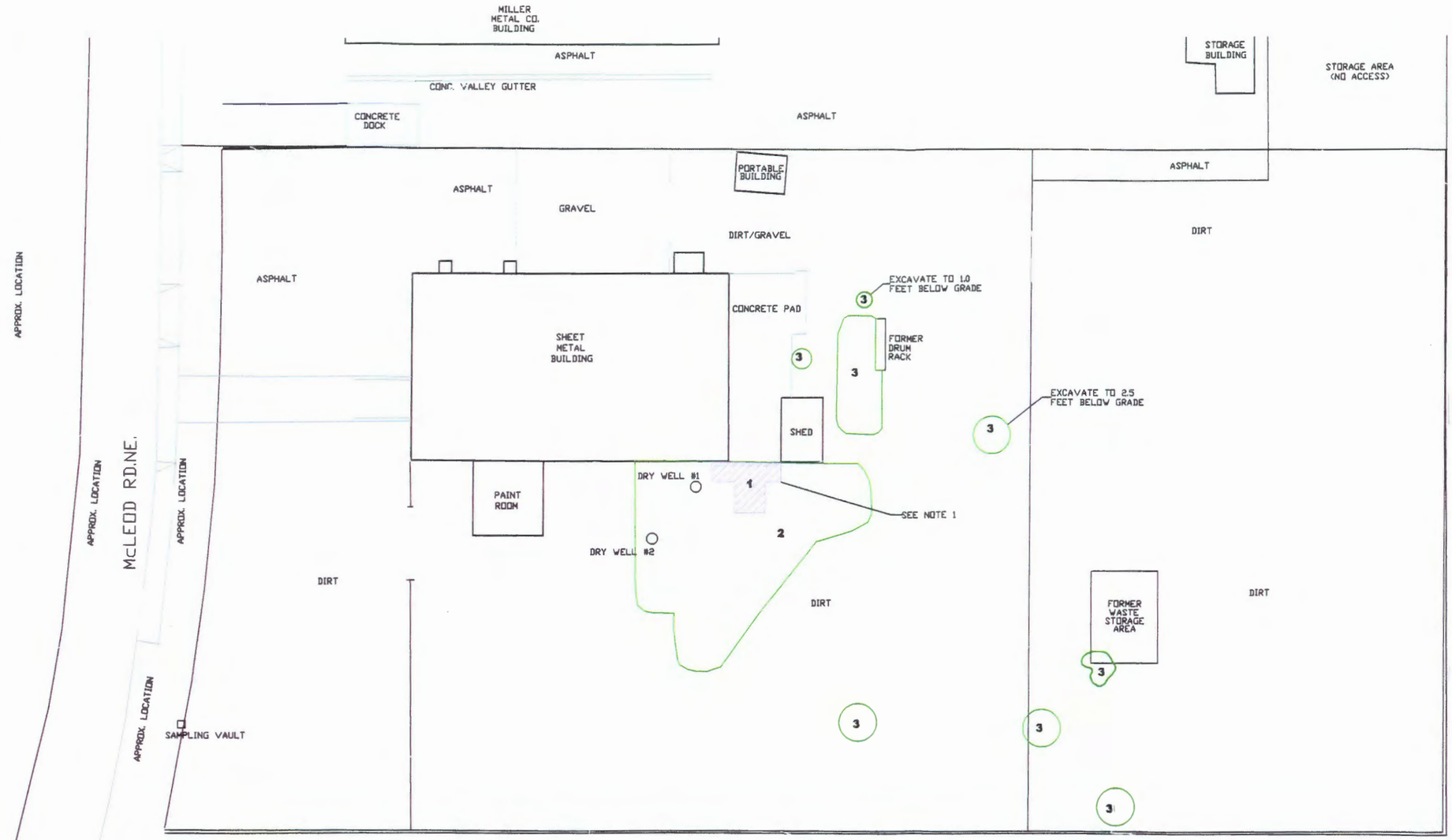
GENERAL ELECTRIC COMPANY
APPARATUS SERVICE SHOP
ALBUQUERQUE, NEW MEXICO

URS
646 PLANK ROAD, SUITE 202
CLIFTON PARK, NEW YORK 12065

JOB NO. 38393778

FIGURE 10
PRELIMINARY CORRECTIVE MEASURE CONSTRUCTION SCHEDULE
GENERAL ELECTRIC COMPANY
ALBUQUERQUE, NEW MEXICO





N

NOTES:

1- SURFACE SOIL FROM 0 TO 2 FEET BELOW GROUND SURFACE, LABELED 1, SHALL BE SEGREGATED AS A POTENTIAL TSCA WASTE. SOIL TO BE SEGREGATED SHALL BE AT A MINIMUM 10 FEET BY 10 FEET AREA CENTERED ON FORMER SOIL BORING HB-15 AND 27.5 FEET BY 5 FEET ALONG THE BUILDING, AS SHOWN.

GRAPHIC SCALE (IN FEET)

0 20 40 80

LEGEND

SURFACE SOIL REMOVAL AREAS, EXCAVATE TO 1.5 FEET BELOW GROUND SURFACE EXCEPT AS NOTED

SHALLOW SURFACE SOIL, 0 TO 2 FEET BELOW GRADE, TO BE SEGREGATED AS POTENTIAL TSCA WASTE

BASE MAP PROVIDED BY LAW ENVIRONMENTAL

FIGURE	PRELIMINARY LAYOUT FOR SHALLOW SOIL
11	

GENERAL ELECTRIC COMPANY
APPARATUS SERVICE SHOP
ALBUQUERQUE, NEW MEXICO

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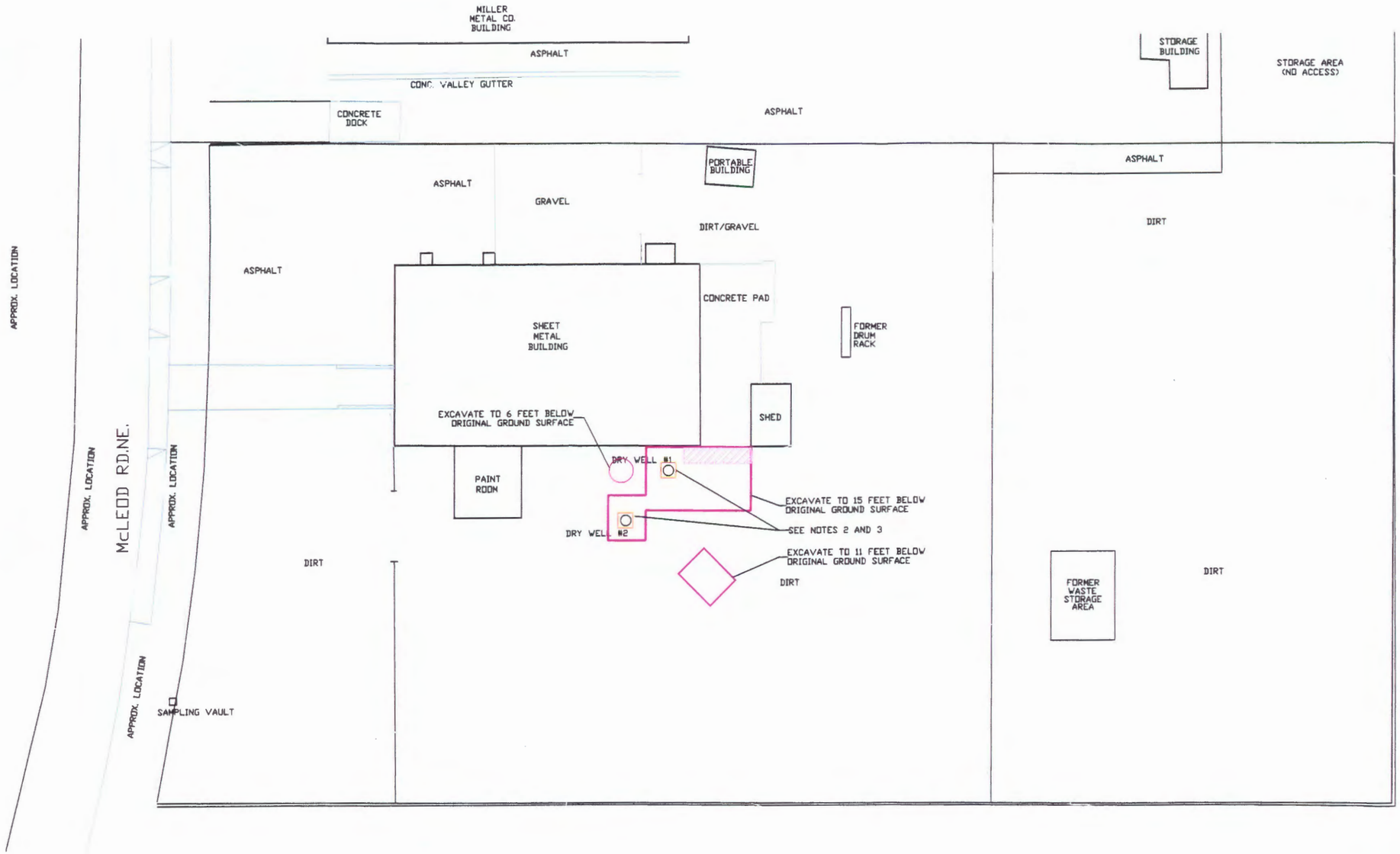
JOB NO. 38393778



N

NOTES:

1- SUBSURFACE SOIL FROM 2 TO 6 FEET BELOW GROUND SURFACE SHALL BE SEGREGATED AS TSCA WASTE. SOIL TO BE SEGREGATED SHALL BE AT A MINIMUM 27.5 FEET BY 5 FEET ALONG BUILDING AS SHOWN.

2- SUBSURFACE SOIL/SLUDGE FROM 11 TO 12 FEET BELOW GROUND SURFACE AT DRY WELL #1 SHALL BE SEGREGATED AS POTENTIALLY HAZARDOUS WASTE. SOIL TO BE SEGREGATED SHALL BE AT A MINIMUM 5 FEET BY 5 FEET CENTERED ON THE DRY WELL OR THE ENTIRE DRY WELL WIDTH, WHICHEVER IS GREATER. IF VISUAL OR OLFACTORY EVIDENCE INDICATES SLUDGE INTERVAL IS GREATER THAN THE 11 TO 12 FOOT BELOW GROUND SURFACE DEPTH INTERVAL, ADDITIONAL SOIL MAY BE SEGREGATED.

3- SUBSURFACE SOIL FROM 14 TO 15 FEET BELOW GROUND SURFACE AT DRY WELL #2 SHALL BE SEGREGATED AS POTENTIALLY HAZARDOUS WASTE. SOIL TO BE SEGREGATED SHALL BE AT A MINIMUM 5 FEET BY 5 FEET CENTERED ON THE DRY WELL OR THE ENTIRE DRY WELL WIDTH, WHICHEVER IS GREATER. IF VISUAL OR OLFACTORY EVIDENCE INDICATES SLUDGE INTERVAL IS GREATER THAN THE 14 TO 15 FOOT BELOW GROUND SURFACE DEPTH INTERVAL, ADDITIONAL SOIL MAY BE SEGREGATED.

GRAPHIC SCALE (IN FEET)

0 20 40 80

LEGEND

SUBSURFACE SOIL REMOVAL AREAS

SUBSURFACE SOIL TO BE SEGREGATED AS POTENTIAL HAZARDOUS WASTE (SEE NOTES 2 AND 3 FOR APPLICABLE DEPTHS)

SUBSURFACE SOIL, 2 TO 6 FEET BELOW GRADE TO BE SEGREGATED AS TSCA WASTE (SEE NOTE 1)

BASE MAP PROVIDED BY LAW ENVIRONMENTAL

FIGURE	PRELIMINARY LAYOUT FOR SOIL AT DEPTH
12	

GENERAL ELECTRIC COMPANY
APPARATUS SERVICE SHOP
ALBUQUERQUE, NEW MEXICO

URS
646 PLANK ROAD, SUITE 202
CLIFTON PARK, NEW YORK 12065

JOB NO. 38393778

L6313712

TO VIEW THE MAP AND/OR MAPS WITH THIS DOCUMENT, PLEASE CALL THE HAZARDOUS WASTE BUREAU AT 505-476-6000 TO MAKE AN APPOINTMENT

APPENDIX A

APPENDIX A

HUMAN HEALTH RISK ASSESSMENT

General Electric Power Systems

Former Albuquerque Apparatus Service Shop
4420 McLeod Road NE
Albuquerque, New Mexico
(EPA ID Number NMD047140256)

Human Health and Ecological Risk Assessment and Risk-Based Cleanup Levels

Final

August 16, 2002

URS Corporation
Prepared by M. Helen Flowers, M.S. M. Helen Flowers, M.S.
Reviewed by Steve Geiger, Ph.D., P.E.
Approved by Christopher Gaule

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Acronym List

bgs	Below ground surface
CMS	Corrective Measures Study
COPC	Contaminants of Potential Concern
EPA	Environmental Protection Agency
HI	Hazard Index
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
NMED	New Mexico Environment Department
PCB	Polychlorinated biphenyl
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
SSL	Soil Screening Level
SVOC	Semi-volatile Organic Compound
URF	Unit Risk Factor
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This human health and ecological baseline risk assessment is being conducted to evaluate whether residual soil contamination at the Power Systems (GEPS) Apparatus Service Center poses a risk under potential future development conditions and to develop cleanup levels for corrective action of the site. This approach is consistent with requests from the New Mexico Environment Department (NMED) Hazardous Waste Bureau and the United States Environmental Protection Agency (USEPA) that GE should evaluate uncontrolled, residential future land use.

Results of this risk assessment will be used to focus the Corrective Measures Study (CMS) that will identify, evaluate, and recommend a corrective measure alternative for the site. These studies are based on standard methodology recommended by USEPA for evaluating RCRA sites (EPA, 1989).

The results of the RCRA Facility Investigation (RFI) conducted at the GE Apparatus Service Center indicated that the soils at the site had been impacted by past releases associated with facility operations. Results of groundwater analyses indicate that the groundwater has not been impacted by past releases. Furthermore, estimates of time of transport (US EPA, 1986) indicated that there was essentially no potential that chemicals present in soils would migrate to groundwater (Law, 1997). Therefore, this risk assessment focuses on soil contamination found in the upper 15 feet of the site.

Methodologies and assumptions for the risk assessment are based on current guidance from US EPA and NMED including Risk Assessment Guidance for Superfund (US EPA 1989, 1991, 1996, 1997a, 1997b, 1999, and 2002) and NMED Technical Background Document for Development of Soil Screening Levels (NMED, 2000). Although PCBs are considered to be a COPC, PCBs are not evaluated in this risk assessment in a quantitative manner. Rather, at the recommendation of the USEPA, PCBs are evaluated on a qualitative manner and PCB data were compared to Toxic Substances Control Act

(TSCA) guidance for PCB remediation waste (40 CFR §761.61) to select on the appropriate corrective measure cleanup level for the site.

1.1 SITE CHARACTERISTICS

The GE Apparatus Service Shop is at 4420 McLeod Road NE in Albuquerque, New Mexico on a two-acre site in a light industrial park. The shop is no longer used although a metal building remains at the site. There is an asphalt parking lot to the north-northeast of the building with the rest of the site covered in gravel and vegetation. All adjacent properties are currently occupied and include offices and light industry. The site has a chain-link fence beyond the parking lot that limits access to the majority of the parcel, including the affected areas. The site layout is shown on Figure 1.

The general stratigraphy underlying the site consists of interbedded layers of sands and gravels with minor silt and clay layers. The stratigraphy near the dry wells consists of fine sands, silty sands, and sandy silts to a depth of 10 feet, with slightly silty, fine to coarse sands from 10 to 20 feet below ground surface (bgs). Thin silt and clay lenses were encountered in both zones. Groundwater occurs at a depth of about 250 feet bgs. Detailed characterization of the subsurface has been conducted in previous studies.

1.2 CONCEPTUAL SITE MODEL

The conceptual site model presents an overview of the sources of contamination at the site, the pathways and environmental media affected, and potentially complete exposure pathways and receptors. The conceptual site model is shown in Figure 2.

The primary source of contamination is washwater from pressure washing activities that discharged into two dry wells at the site. This material moved through soil and creates potential for exposure through the following pathways:

- direct exposure to soils (incidental ingestion and dermal contact);

- inhalation of resuspended soil/dust; and
- inhalation of volatiles released from the soil.

The potential current receptors at the site include the caretaker of the property. Potential future receptors are likely to be industrial users of the site. However, a residential scenario is considered in the risk assessment per NMED requirements that all property be evaluated for unrestricted future use. Direct exposures associated with residential use are likely limited to the top five feet of soil. However, it is further assumed that volatile contaminants could move through the subsurface to the foundation of a building. This pathway is evaluated for volatile contaminants from the five feet to 15 feet interval. The five to fifteen foot interval is also considered for a construction worker during redevelopment of the site.

Contamination below 15 feet is not considered to present a complete exposure pathway. The potential for migration to groundwater was previously evaluated and is not considered feasible (Law, 1997). Direct exposure to soil below 15 feet is considered highly unlikely since this is a depth greater than what would be associated with future construction and/or redevelopment of the site. Migration of volatile organics detected below 15 feet could occur but is not considered significant since the maximum values generally occur at depths of 15 feet or less and are evaluated in this risk assessment.

Due to the industrial nature of the site and its surrounding area, ecological habitats are not present at the site. Flora at the site consists of native grasses. Although there are threatened and endangered species in Bernalillo County including eight birds, the spotted bat, and the meadow jumping mouse, the site does not present suitable habitat for them (Law, 1992). Further, the contamination at the site is primarily beneath the surface thus limiting the exposure potential for ecological receptors. There are no surface water bodies within a three-mile radius of the site. Therefore, ecological receptors are not further evaluated in this risk assessment.

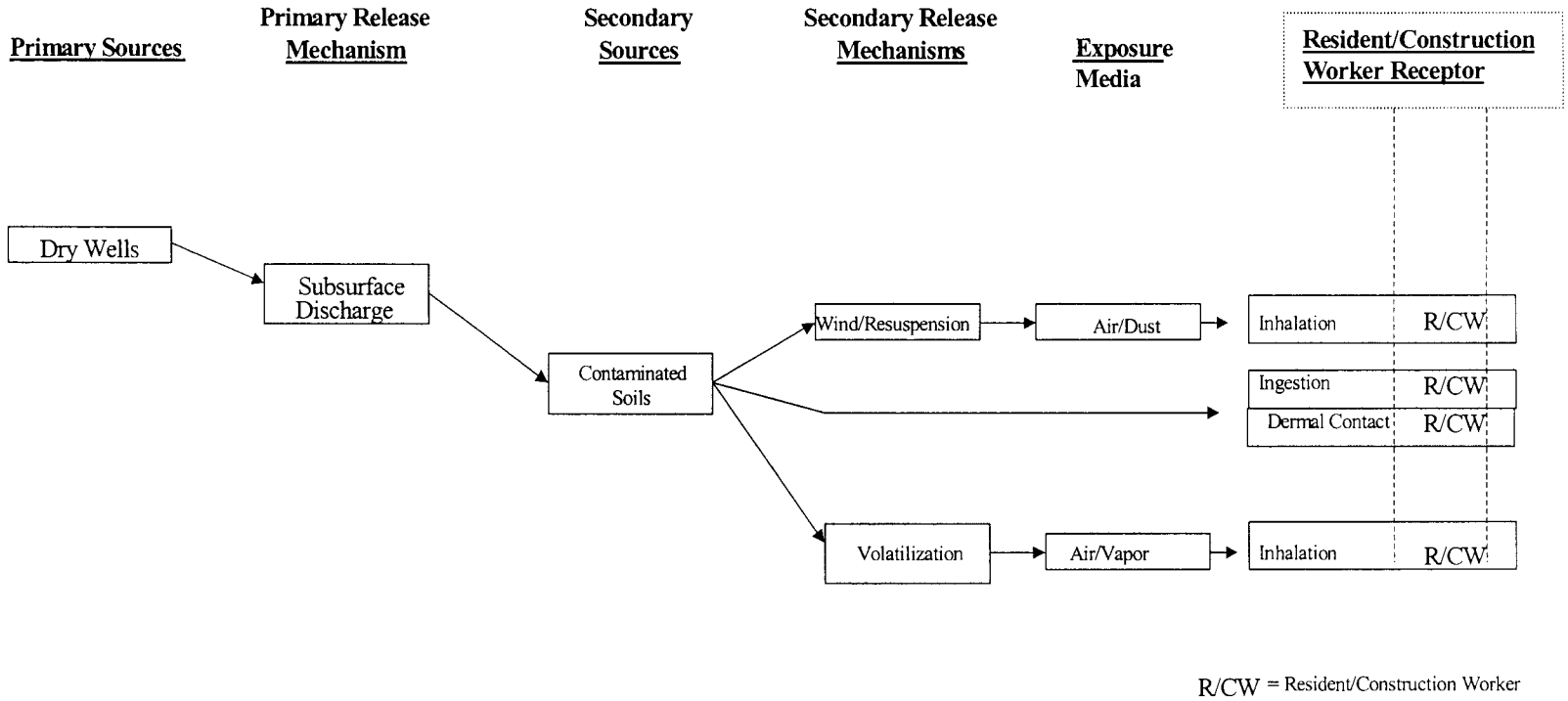

Figure 1
Conceptual Site Model

2.0 DATA EVALUATION AND IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

Soil and groundwater sampling at the GE Apparatus Service Shop has been conducted in support of numerous investigations, studies, remedial measures, and monitoring programs. This section describes how the non-PCB environmental data were screened for consideration in this risk assessment. Site contaminants of potential concern (COPC) and exposure media are identified.

2.1 DATA SUMMARY

Data screening is performed as the first step in paring down the entire data set to a meaningful and manageable set. The result of the data screening process is a list of media specific COPCs that are further considered in the risk assessment. Site contaminants were not detected in groundwater, so groundwater data are not further evaluated. Ambient air data were collected in a previous study but are not considered relevant to this risk assessment since the date of collection is too historic to represent current site conditions.

Soil data are considered relevant. However only data collected from samples in the upper 15 feet of soil is considered relevant. This includes samples collected from the 0 – 2 foot interval and samples collected from the 0 – 15 ft interval. The maximum detected values for these sampling depths are shown in Table 2.1. Contaminated soil was largely confined to the area around the two dry wells. Samples taken from the dry well are not included on the table, unless this was the only data for an analyte (e.g., metals).

Also relevant to this risk assessment are the soil vapor samples. Soil vapor samples were collected in 1996 at three boring locations at depths of 2, 17, 32, 47, 62, and 77 feet bgs. Data from the 2-foot and 17 foot bgs sampling depths are considered relevant to the risk assessment and are presented in Table 2.2.

2.2 SELECTION OF COPCS

COPCs were selected by comparison to the default NMED Soil Screening Levels (SSLs) for the upper 5 feet of surface soils per guidance from NMED and US EPA Region 6. The equations and assumptions for NMED SSL are shown in Table 2.3. The exposure pathways addressed by the SSLs include:

- Incidental ingestion of soil;
- Dermal contact with soil;
- Inhalation of fugitive dust; and
- Inhalation of volatiles in outdoor air.

The SSLs are based on a target cancer risk of 1×10^{-5} excess cancer risk over a lifetime for individual carcinogenic chemicals and a hazard quotient of one for individual noncarcinogenic chemicals. Because multiple chemicals were detected at the site, the SSLs for carcinogenic and noncarcinogenic effects were divided by ten to address additivity. The results of this screening are shown on Table 2.4. No constituents exceeded the screening level comparison for surface soil, as such, no surface soil COPC's are carried forward to the risk assessment.

All volatile constituents detected in subsurface soil and soil vapor are carried forward in this risk assessment, since the NMED SSL do not address indoor air volatilization from this depth. This includes all analytes identified in Tables 2.1 for 5 – 15 ft interval and Table 2.2 for 17- ft sample for soil vapors.

Only two soil samples were evaluated for metals at depths of 11-12 ft and 17-18 ft. A screening of subsurface soil concentrations against the NMED SSLs was conducted to determine if subsurface metals required further evaluation. Three metals exceeded 0.1 times the NMED SSL: arsenic, cadmium, and lead. Because the detected depths are greater than five feet and there is no volatilization pathway, these COPCs are further evaluated in the construction worker scenario.

Table 2.1 Maximum Soil Concentrations in the Upper 15 feet

Constituent	Maximum Concentration 0-5 feet mg/kg	Maximum Concentration 5-15 feet mg/kg
Benzene	0.002	0.002
Ethylbenzene	0.06	15
Toluene	0.019	0.019
Xylenes	0.057	520
Tetrachloroethene	0.122	0.58
1,2,4,5-Tetrachlorobenzene	-	0.17
1,2,4-Trichlorobenzene	0.54	25
1,2-Dichlorobenzene	0.002	38
1,3-Dichlorobenzene	0.018	0.018
1,4-Dichlorobenzene	0.004	0.004
1,1,1-Trichloroethane	-	0.12
Bis-(2-ethylhexyl)phthalate	-	0.93
Di-n-butylphthalate	-	1.5
Arsenic	-	8.69
Barium	-	479
Cadmium	-	68.1
Chromium	-	171
Lead	-	1160
Mercury	-	0.515
Selenium	-	8.24
Silver	-	24.6

Table 2.2 Maximum Soil Vapor Concentrations in the Upper 15 Feet

Constituent	Maximum Concentration 2 feet ppbv	Maximum Concentration 17 feet ppbv
Tetrachloroethene	1330	4520
Trichloroethene	7	1
1,1-Dichloroethene	-	34
1,1,1-Trichloroethane	1030	5860
1,1-Dichloroethane	-	28
1,2,4-Trichlorobenzene	-	5
Benzene	-	-
Toluene	2	608
Ethylbenzene	-	84200
Xylenes	52	445000
4-Ethyltoluene	3	1910
1,3,5-Trimethylbenzene	-	654
1,2,4-Trimethylbenzene	4	1460

Table 2.3 NMED SSL Equations

Equation 1
Combined Exposures to Noncarcinogenic Contaminants in Soil
Residential Scenario

$$C = \frac{THQ \times BW_c \times AT_n}{EF_r \times ED_c \left[\left(\frac{1}{RfD_o} \times \frac{IRS_c}{10^6 \, mg/kg} \right) + \left(\frac{1}{RfD_o} \times \frac{SA_c \times AF_c \times ABS}{10^6 \, mg/kg} \right) + \left(\frac{1}{RfD_i} \times \frac{IRA_c}{VF \text{ or } PEF} \right) \right]}$$

Parameter	Definition (units)	Default
C	Contaminant concentration (mg/kg)	Chemical-specific
THQ	Target hazard quotient	1
BW_c	Body weight, child (kg)	15
AT_n	Averaging time, noncarcinogens (days)	ED x 365
EF_r	Exposure frequency, resident (day/yr)	350
ED_c	Exposure duration, child (years)	6
IRS_c	Soil ingestion rate, child (mg/day)	200
RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
SA_c	Dermal surface area, child (cm^2/day)	2,800
AF_c	Soil adherence factor, child (mg/cm^2)	0.2
ABS	Skin absorption factor (unitless)	Chemical-specific
IRA_c	Inhalation rate, child (m^3/day)	10
RfD_I	Inhalation reference dose (mg/kg-day)	Chemical-specific
VF	Volatilization factor (m^3/kg)	See Equation 10
PEF	Particulate emission factor (m^3/kg)	NA

Equation 2
Combined Exposures to Carcinogenic Contaminants in Soil
Residential Scenario

$$C = \frac{TR \times AT_c}{EF_r \left[\left(\frac{IFS_{adj} \times CSF_o}{10^6 \, mg/kg} \right) + \left(\frac{SFS_{adj} \times ABS \times CSF_o}{10^6 \, mg/kg} \right) + \left(\frac{InhF_{adj} \times CSF_i}{VF \text{ or } PEF} \right) \right]}$$

Parameter	Definition (units)	Default
C	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1×10^{-5}
AT_c	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
IFS_{adj}	Age-adjusted soil ingestion factor ([mg-yr]/[kg-day])	114
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
SFS_{adj}	Age-adjusted dermal factor ([mg-yr]/[kg-day])	361
ABS	Skin absorption factor (unitless)	Chemical-specific
$InhF_{adj}$	Age-adjusted inhalation factor ([m^3-yr]/[kg-day])	11
CSF_i	Inhalation cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
VF	Volatilization factor (m^3/kg)	See Equation 10
PEF	Particulate emission factor (m^3/kg)	NA

Table 2.4 Comparison of Maximum Soil Concentrations in the Upper 5 feet to One-Tenth the NMED SSLs

Constituent	Maximum Concentration 0-5 feet[1] mg/kg	NMED Residential SSL (basis) mg/kg
Benzene	0.002	0.64 (ca)
Ethylbenzene	0.06	68 (sat)
Toluene	0.019	180 (sat)
Xylenes	0.057	63 (sat)
Tetrachloroethene	0.122	4.9 (ca)
1,2,4,5-Tetrachlorobenzene	0.17	1.8 (nc)
1,2,4-Trichlorobenzene	0.54	52 (nc)
1,2-Dichlorobenzene	0.002	85 (sat)
1,3-Dichlorobenzene	0.018	1.2 (nc)
1,4-Dichlorobenzene	0.004	3.2 (ca)
1,1,1-Trichloroethane	0.12	510 (sat)
Bis-(2-ethylhexyl)phthalate	0.93	35 (ca)
Di-n-butylphthalate	1.5	610 (nc)
Arsenic	8.69*	0.39 (ca)
Barium	479	520 (nc)
Cadmium	68.1*	7 (nc)
Chromium	171	10000 (nc)
Lead	1160*	40 (nc)
Mercury	0.515	0.65 (nc)
Selenium	8.24	38 (nc)
Silver	24.6	38 (nc)

[1] If a detected value was not available for 0-5 ft, then the detected value from 5-15 ft was used.

* - exceeds 0.1 times NMED Residential SSL

ca - cancer endpoint

nc - noncancer endpoint

sat - soil saturation limit (less than toxicity-based endpoint)

3.0 EXPOSURE ASSESSMENT

The COPCs identified in Section 2 are further evaluated in this risk assessment. An exposure assessment was performed to identify current or reasonably foreseeable exposure scenarios by which chemicals present at the site may reach potential human receptors in the absence of further site remediation. Although PCBs are considered to be a COPC, PCBs are not further evaluated in this risk assessment in a quantitative manner. Rather, at the recommendation of the USEPA, PCBs are evaluated qualitatively and PCB data were compared to Toxic Substances Control Act (TSCA) guidance for PCB remediation waste (40 CFR §761.61) to select on the appropriate corrective measure cleanup level for the site for depths from 0 to 15 feet bgs.

This risk assessment for the non-PCB COPCs includes an exposure assessment and a toxicity assessment (Section 4). These results are combined in Section 5 for the risk characterization, which also includes an uncertainty assessment. This risk assessment has employed standard values and approaches as set out by NMED and USEPA. The standard values are typically conservative and thus are likely to overestimate actual exposures and risks. As such, use of these assumptions should not be regarded as agreement that they represent the actual exposures at the site. These conservative inputs demonstrate that there is no significant risk posed by this site now or with regard to possible future uses, and thus, no further risk assessment activities are necessary. The use of these conservative inputs does not represent a conclusion that this approach is appropriate for all sites.

3.1 EXPOSURE SETTING AND PATHWAYS

The residential receptor was evaluated in the risk assessment. The residential receptor is assumed to have the following exposure routes:

- Incidental ingestion of soil;

- Dermal contact with soil;
- Inhalation of resuspended soil/dust;
- Inhalation of indoor air containing volatile COPCs from soil; and
- Inhalation of indoor air containing volatile COPCs from soil vapor.

These pathways are addressed by NMED SSLs with the exception of inhalation of volatiles in indoor air. The inhalation of volatiles from the subsurface is further evaluated for constituents in the 5- to 15-ft soil interval. The pathways addressed for surface soil in the NMED SSLs were shown to be insignificant in the screening assessment and are not further evaluated. The inhalation pathway for volatiles in indoor air is described below.

A construction worker was also considered for exposure to soil contaminants detected in the 5- to 15-ft soil interval. The construction worker is assumed to have exposure through the following routes:

- Incidental ingestion of soil;
- Dermal contact with soil;
- Inhalation of suspended soil/dust generated from construction activities; and
- Inhalation of volatile COPCs from soil.

3.2 EXPOSURE QUANTIFICATION

Exposure to volatile compounds in subsurface soil (5 to 15 feet) was considered for the resident. Exposure assumptions are based on US EPA Soil Screening Guidance and are consistent with NMED SSL assumptions. Subsurface soil was evaluated both for soil data and soil vapor data. The Johnson and Ettinger Model was used to estimate indoor air exposures associated with possible future residential development. Further description of the parameters used in the Johnson and Ettinger Model is provided in Section 3.3.

The construction worker at this site has a sort-term exposure potential during redevelopment of the site. It is assumed that the site could be re-graded and portions excavated, and that heavy equipment used at the site would cause significant dust resuspension. However, the site is relatively small and level with existing utilities. Adjacent properties are developed and paved. Future construction activities for redevelopment are likely to be of short duration. Additionally, the area of contaminated soil is quite limited. Therefore, a site-specific particulate emission factor (PEF) was developed for the site in accordance with the US EPA Supplemental Soil Screening Guidance (EPA 2001). The PEF equation and assumptions are shown in Table 3.1.

The construction worker intake is calculated according to the equation below.

Construction Worker Intake

mg/kg-day = (EC x EF x ED x ((IR x CF1) + (IhR x (1/PEF)) + (CF1 x SA x AF x ABS)))/(BW x AT)

Where:

EC	=	Exposure Concentration in Soil (mg/kg)
BW	=	Body Weight (70 kg)
AT	=	Averaging Time (365 days for noncarcinogens, 25550 days for carcinogens)
EF	=	Exposure Frequency (80 d/yr)
ED	=	Exposure Duration (1 yr)
IR	=	Ingestion rate (330 mg/d)
CF1	=	Conversion Factor ($1E^{-6}$ kg/mg)
IhR	=	Inhalation Rate ($20m^3/d$)
PEF	=	Particulate Emission Factor (5.24×10^7 m^3/kg)
SA	=	Dermal Surface Area (3300 cm^2/d)
AF	=	Dermal Adherence Factor (0.3 mg/cm^2)
ABS	=	Dermal Absorption Factor (chemical specific)

3.3 JOHNSON AND ETTINGER MODEL INPUT PARAMETERS

The Johnson and Ettinger Model was used to evaluate potential risk associated with indoor air exposures due to subsurface vapor intrusion from soil contamination. The model uses a one-dimensional analytical solution to estimate vapor phase transport from both diffusive and advective mechanisms, and incorporates assumptions of building geometry, construction, and ventilation to estimate vapor flux into the building. Then,

based on assumed toxicity parameters, the model provides an estimated incremental risk (carcinogenic) or hazard quotient (non-carcinogenic) attributable to the modeled contaminant.

Input parameters used for the Johnson and Ettinger Model for the Risk Assessment are described in Table 3-3. All parameters used in the Johnson and Ettinger Model were either site-specific values or were conservative assumptions based on ranges provided in User's Guide for Johnson and Ettinger Model (1997).

The Johnson and Ettinger (1991) Model calculates incremental risks for carcinogens according to the following equation:

$$Risk = \frac{URF \times EF \times ED \times C_{building}}{AT_C \times 365 days / yr}$$

Where:
URF = Unit risk factor
EF = Exposure frequency (days/yr)
ED = Exposure duration (yr)
$C_{building}$ = Vapor concentration in the building
AT_C = Averaging time for carcinogens (yr)

For noncarcinogenic contaminants, the hazard quotient (HQ) is calculated in the model according to:

$$HQ = \frac{EF \times ED \times \frac{1}{RfC} \times C_{building}}{AT_{NC} \times 365 days / yr}$$

Where all variables are as previously defined and AT_{NC} represents the averaging time for noncarcinogens in years.

Table 3.1 Particulate Emission Factor for the Construction Worker

$$PEF_{CW} = Q/C_{CW} \times \frac{1}{F_D}\left[\frac{T \times A_R}{556 \times \left(\frac{W}{3}\right)^{0.4} \times \frac{(365\ \text{days/yr} - P)}{365\ \text{days/yr}} \times \sum VKT}\right]$$

Parameter	Definition (units)	Default
PEF_{CW}	Particulate emission factor (m^3/kg)	5.24E7
Q/C_{CW}	Inverse of a mean concentration at center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	47.3
F_D	Dispersion correction factor (unitless)	0.185
T	Total time over which construction occurs (s)	7.2E6
A_R	Surface area of road segment (m^2)	274.2
W	Mean vehicle weight (tons)	8
P	Number of days with at least 0.01 inches of precipitation (days/yr)	80
ΣVKT	sum of fleet vehicle kilometers traveled during the exposure duration (km)	15

Table 3.2. Input Parameters for the Johnson and Ettinger Model

Parameter	Value	Notes
Chemical CAS No.	Variable	Varies for model scenario (see Tables 2-1 and 2-2).
Initial Soil or Soil Vapor Conc.	Variable	Max value from sampling data (see Tables 2-1 and 2-2).
Avg. Soil Temp.	16° C	Value based on Figure 8, User's Guide for Johnson and Ettinger Model (1997).
Depth to Bottom of Floor Space	200 cm	Residential default value, User's Guide for Johnson and Ettinger Model (1997).
Depth to Contamination	Variable	455 cm for 15-foot samples and 210 cm to emulate two foot sample range (assumed as 10 cm below basement depth.)
Thickness of Soil Stratum A	Variable	Set equal to the depth of affected soil or soil vapor (assumed no vertical variability between basement and contaminant zone). Homogeneity is a conservative assumption as lithological data indicate presence of thin silt layering, which has lower intrinsic permeability than the modeled lithology.
Thickness of Soil Stratum B	0	Not used
Thickness of Soil Stratum C	0	Not used
SCS Soil Type Above Water Table	Sandy Silt	Soil modeled as homogenous sandy silt, per lithologic logs for top 15 feet. Intrinsic permeability input separately (k = 1E-09 cm^2) explicitly described in model. Used value from low end of range for silty sand as reported in User's Guide for Johnson and Ettinger Model (1997).
Soil Dry Bulk Density	1.6 g/cm^3	Back calculated from assumed porosity and density of solids.
Soil Total Porosity	0.40	Assumed value for sandy silt.
Soil Water-filled Porosity	0.075	Lowest reported value from boring B-1 analysis.
Soil Organic Carbon Fraction	0.002	Default value (User's Guide for Johnson and Ettinger Model, 1997.)
Enclosed Space Floor Thickness	15 cm	Recommended default for residential buildings (User's Guide for Johnson and Ettinger Model, 1997.)
Soil Building Pressure Differential	40 g/cm-s^2	Conservative default value (User's Guide for Johnson and Ettinger Model, 1997.)
Enclosed Floor Space	961 cm	Default value for residential dwelling (User's

Parameter	Value	Notes
Length		Guide for Johnson and Ettinger Model, 1997.)
Enclosed Floor Space Width	961 cm	Default value for residential dwelling (User's Guide for Johnson and Ettinger Model, 1997.)
Enclosed Space Height	488 cm	Default value for residential dwelling (User's Guide for Johnson and Ettinger Model, 1997.)
Floor-wall Seam Crack Width	0.1 cm	Assumed value (User's Guide for Johnson and Ettinger Model, 1997.)
Indoor Air Exchange Rate	0.45/hr	Assumed value (User's Guide for Johnson and Ettinger Model, 1997.)

4.0 TOXICITY ASSESSMENT

Toxicity values were identified for the COPCs to be evaluated in the risk assessment. USEPA Region 9 reports most current USEPA toxicity factors from the Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), and National Criteria and Environmental Assessment (NCEA) guidance.

The Johnson and Ettinger Model uses unit risk factors (URFs) for carcinogens, and reference concentrations (RfCs) for non-carcinogens. The Johnson and Ettinger Model includes either the URF or the RfC for a given compound, based on which is the controlling factor (i.e., which component is associated with greater risk). Parameters for some compounds were not included in the Johnson and Etttinger Model database, and were obtained from the EPA Region 9 database.

Table 4.1. Toxicity Factors

COPC	RfD (mg/kg-d)		Slope Factor $(mg/kg\text{-}d)^{-1}$	
	Oral	Inh	Oral	Inh
Benzene	0.003	0.0017	0.055	0.027
Ethylbenzene	0.1	0.29		
Toluene	0.2	0.11		
Xylenes	2.0	0.2		
Tetrachloroethylene	0.01	0.11	0.05	0.002
1,2,4,5-Tetrachlorobenzene	0.0003	0.0003		
1,2,4-Trichlorobenzene	0.01	0.057		
1,2-Dichlorobenzene	0.09	0.057		
1,3-Dichlorobenzene	0.0009	0.0009		
1,4-Dichlorobenzene	0.03	0.23	0.024	0.022
1,1,1-Trichloroethane	0.02	0.029		
Bis-(2-ethylhexyl)phthalate	0.02	0.02	0.014	0.014
Di-n-butylphthalate	0.1	0.1		
Arsenic	0.0003		1.5	15
Cadmium	0.0005			6.3
Lead	0.003[1]			

[1] Extrapolated from soil PRG based on US EPA Lead Model
Source: USEPA Region 9 PRG Database

Reference concentrations are converted from reference doses (RfDs) by assuming an average breathing rate (20 m^3 per day) and body weight (70 kg). RfDs represent acceptable intake values for long-term exposure to noncarcinogenic chemicals. These values are estimates of route-specific exposure levels that would not be expected to cause adverse health effects when exposure occurs for a significant portion of the lifetime. The RfDs include uncertainty factors that account for uncertainties associated with limitations of the toxicological database, including extrapolating animal studies to humans and accounting for variability in response from sensitive individuals.

Unit risk factors are derived from carcinogenic inhalation slope factors by applying the same assumptions about average body weight and average daily inhalation volume. Inhalation slope factors conservatively represent the increased cancer risk due to a lifetime of exposure to the compound. Slope factors are represented in dimensions of inverse mass of chemical per mass of body weight per day of exposure.

5.0 RISK CHARACTERIZATION

The results of the exposure assessment are combined with the toxicity criteria to estimate lifetime excess cancer risk for carcinogenic chemicals and a hazard quotient for noncarcinogenic chemicals. A hazard quotient below one is assumed to be below the threshold for noncarcinogenic effects. Lifetime excess cancer risks are compared to the acceptable risk range specified in the National Contingency Plan (10^{-4} to 10^{-6} lifetime excess cancer risk). In accordance with NMED Hazardous Waste Bureau (HWB) regulations, the NMED and Region 6 USEPA have agreed upon a target risk level of 10^{-5} (NMED residential target risk level) for this site.

Risks associated with the site are summarized in Table 5.1, 5.2 and 5.3. None of the COPCs evaluated in this risk assessment exhibit a cancer risk greater than 1×10^{-5} individually or when summed. Carcinogenic effects are therefore within the range considered acceptable for a future resident and for a construction worker.

For noncarcinogenic effects, all hazard indices were less than 1. This indicates the concentrations would be below the threshold for noncarcinogenic health effects for a future resident or a construction worker.

5.1 UNCERTAINTY ANALYSIS

Uncertainty arises in risk assessment since data gaps exist regarding the ability to predict exposure to environmental contaminants and to determine potential toxicity associated with these exposures. It is common for uncertainties to span several orders of magnitude in health risk assessments. However, the current practice of risk assessment is to err on the side of caution in order to be conservative and protective. This assessment was undertaken in a similar manner. The potential health risks are therefore likely to be overestimated. However, the extent to which the risks are overestimated is unknown. The most significant sources of uncertainty are discussed below.

Sources of uncertainty can be identified, at first, in the time- and space-limited samples. The evaluation of chronic risks is based on soil samples, which may not accurately characterize the site. Volatile COPC samples taken 10 years ago may not reflect current site conditions, particularly at the surface where they are likely to have volatilized.

The vapor intrusion model contains uncertainties. In ambient air, chemical concentrations depend on temperature, air exchange rate and pressure differential that can vary both in a 24 hours time and seasonally. Furthermore, even though some site-specific parameters were calculated in order to obtain a more accurate model, other parameters, such as wind speed and mixing zone height were taken from literature. Operative working systems and ventilation rates could change air concentrations during a day and seasonally.

Uncertainty is also related to different adsorption behavior to soil matrix, aromatic and chlorinated compounds show different adsorption values that can justify a different transport mechanism and the different results obtained for predicted ambient air concentrations.

Uncertainty in the exposure assumptions include assuming continuous exposure for 30 years at a relatively high inhalation rate, soil ingestion rate, and dermal contact rate. The assumption of occupancy for 350 days per year and 24 hours per day are also likely to overestimate exposure.

Uncertainty in toxicity criteria include factors of 10 to 1000 to account for extrapolating across species, short to long term duration, and sensitive members of the population.

5.1 Johnson and Ettinger Modeled Risk for VOCs in Soil

Analyte	Depth	Conc (ug/kg)	Cancer Risk	HQ
Xylenes	455 cm (15')	520,000		5.80E-02
PCE	455 cm (15')	580	1.80E-06	
1,2,4,5-Tetrachlorobenzene	455 cm (15')	170		1.50E-02
1,2,4-Trichlorobenzene	455 cm (15')	25,000		1.10E-02
1,2-Dichlorobenzene	455 cm (15')	38,000		7.70E-02
1,3-Dichlorobenzene	455 cm (15')	18		3.00E-03
1,4-Dichlorobenzene	455 cm (15')	4		2.70E-06
1,1,1-Trichloroethane	455 cm (15')	120		2.00E-03
Bis-(2-ethylhexyl)phthalate	455 cm (15')	930		6.60E-16
Di-n-butylphthalate	455 cm (15')	1,500		2.50E-10
Total			2.E-06	0.2

5.2 Johnson and Ettinger Modeled Risk Associated with VOCs in Soil Vapor

Analyte	Depth	Conc (ppbv)	Cancer Risk	HQ
PCE	210 cm	1,330	2.90E-08	
PCE	455 cm (15')	4,520	9.60E-08	
TCE	210 cm	7	3.60E-10	
1,1-Dichloroethene	455 cm (15')	34	3.90E-08	
1,1,1-Trichloroethane	210 cm	1,030		7.30E-05
1,1,1-Trichloroethane	455 cm (15')	5,860		4.10E-04
1,1-Dichloroethane	455 cm (15')	28		2.90E-06
1,2,4-Trichlorobenzene	455 cm (15')	5		2.10E-06
Toluene	210 cm	2		2.50E-07
Toluene	455 cm (15')	608		7.60E-05
Ethylbenzene	455 cm (15')	84,200		4.60E-03
Xylenes	210 cm	52		4.20E-07
Xylenes	455 cm (15')	445,000		3.50E-03
Total			1.E-07	0.009

6.0 RISK-BASED CORRECTIVE ACTION GOALS

Based on the risk assessment conducted for this study, none of the non-PCB COPCs at the site pose unacceptable risk at their present concentrations under foreseeable future land use assumptions (unrestricted, residential scenario) for soil 0 to 5 feet bgs. Similarly, no non-PCB COPCs pose unacceptable risk under foreseeable future land use assumptions for soil from 5 to 15 feet bgs.

As mentioned in preceding sections of this document, corrective action measures will be conducted to mitigate PCB compounds from site soils in accordance with TSCA guidance/regulations based on a bulk PCB remediation waste (high occupancy/unrestricted use) scenario as recommended by USEPA and NMED. As such, a cleanup level of 1 mg/kg will be used for PCBs to a depth of 15 ft. PCBs present below 15 feet do not pose a risk because there is no complete exposure pathway to these materials, all excavation which will take place in the future under utility worker scenario will take place at depths shallower than 15 feet. In addition, the analytical data for the site has shown that the majority of the high levels of contamination are present at depths shallower than 15 feet, and these soils will be excavated and disposed of off-site. As a result of removing the highest levels and the limited depth of contamination, groundwater would not be impacted.

7.0 REFERENCES

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APPENDIX B

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DANIEL B. STEPHENS & ASSOCIATES, INC.
CONTAMINANT MODELING IN THE VADOSE AND SATURATED ZONES

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ENVIRONMENTAL SCIENTISTS AND ENGINEERS

APPENDIX B

CONTAMINANT MODELING IN THE VADOSE AND SATURATED ZONES

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APPENDIX B

CONTAMINANT MODELING IN THE VADOSE AND SATURATED ZONES

B.1 Introduction

To evaluate the potential impact of constituents detected in the soils associated with the drywell area, modeling of contaminant transport through the vadose zone to ground water and subsequent saturated zone flow to the regulatory point of compliance was performed by Daniel B. Stephens & Associates, Inc. of Albuquerque, New Mexico. The following sections described the selection of the models used, model input parameters and the results of the modeling efforts.

B.2 Vadose Zone Modeling

B.2.1 Model Selection

The model we selected for predicting the concentration of leachate entering the aquifer is VLEACH. This is a one-dimensional finite difference code for predicting chemical concentrations in the vadose zone which are affected by liquid phase advection, solid phase adsorption, and gas phase diffusion. The model assumes that there is a steady state liquid flow downward through the chemically affected soil zone. Because the flow field is one-dimensional and no dispersion is taken into account, this model should produce conservatively high concentrations. As the natural recharge contacts this zone, the model assumes equilibrium occurs between the three phases.

The code was developed under contract from the U.S. EPA (CH2M-Hill et al., 1990), and it was approved for use at this site by Mr. Vincent Malott, the EPA project manager. A listing of the computer code and users guide are included as Attachment B1 to this appendix, and a copy of the program is provided on floppy disk.

B.2.2 Model Input

The model input requirements are listed in Table B-1. The parameters for the VLEACH model were chosen based on field data, available literature and professional judgment. During the course of our analysis, we conducted a sensitivity test of model results to uncertainty in the parameters. This information was provided to Mr. Vincent Malott who, after independent analysis, agreed that the parameters listed in Table B-1 were representative of the site and protective of the environment (see letter from Mr. Malott to Mr. Barry York, March 27, 1992). Each source of information used in the model will be discussed.

The horizontal cross-sectional area of the chemically affected soil zone is the AREA. Based on field data presented in the main body of the text, there are two zones close to one another which have a combined area of about 400 square feet (Figure B-0). For purposes of simplifying the analysis, we assumed that the chemically affected soil zones were are combined into a single zone 20 feet by 20 feet.

DELZ is the vertical spacing between cells used to calculate chemical concentrations. The size of the cell is selected to afford reasonable accuracy and computational efficiency, based on our professional experience.

Q is the ground-water recharge rate; that is, the rate at which fresh water percolates through the affected soil zone. This is a Darcian velocity, and not an average fluid particle velocity. Our firm has extensive experience and professional publications dealing on the subject of recharge in arid environments. Most scientists regard vegetated desert soils as areas where virtually no recharge occurs. Throughout New Mexico, from Farmington to Las Cruces, diffuse, areally distributed recharge on desert landscapes usually is less than 0.01 ft/yr in most places (e.g., Stone, 1984; Stephens et al., 1986; Phillips et al., 1988; Aguilar and Aldon, 1991; Scanlon, 1992). Owing to the importance of recharge in the analysis of leachate generation, we selected a conservatively high recharge value of 0.075 ft/yr or 10% of mean annual precipitation. This value is estimated to exceed the true value for the mean soil-water flux by at least a factor of 10.

THETA is the volumetric water content of the soil. This parameter was calculated from measurements of gravimetric water content, θ_m, using the following equation:

$$\theta_v = \theta_m \rho_b / \rho_w$$

where ρ_b is the dry bulk density and ρ_w is the density of water. The measurements of θ_m and ρ_b for three different soils is given in Table 3 of the RFI report. These are:

	θ_m (%)	ρ_b (dry unit weight, PCF)
Silty Sand	7.4	114.6
Sandy Silt	18.2	89.0
Lean Clay	17.7	103.6

Noting that 1 PCF = 0.016 g/cc and ρ_w = 1.0 g/cc, the volumetric water content, θ_v for three different soils are:

	θ_v
Silty Sand	0.136
Sandy Silt	0.259
Lean Clay	0.293

Since the vadose zone is composed of large amounts of sand (approximately 90%) and small amounts of silt and clay (approximately 10%), we have used an average value of θ_v based on the following weighting method:

$$\theta_v = 90\% \times 0.136 + 10\% \times (0.259 + 0.293)/2 = 0.15$$

RHOB is the dry bulk density for the soil. We assumed that the soil is a composite of the sand, silt, and clay layers. Using the same soil texture weighting factors (90% sand, 10% silt and clay) as used to calculate moisture content, the soils' average dry bulk density is 1.80 g/cc. The basis for using an RHOB of 1.74 g/cc (assuming 50% sand and 50% silt and clay) is the fact that there is more silt and clay in the source block, which is at a shallow depth of 12 to 24 ft below the ground surface. However, the sensitivity analysis has shown that this minor difference in dry bulk density will cause a negligibly small difference in concentration results.

POR represents the soil porosity. We have used a porosity of n = 0.4 for the soils in the vadose zone for the same reasons noted above. Since the difference between total effective porosity and volumetric water content represents the cross-sectional area of the path way for gas diffusion, any reduction of the total effective porosity will reduce the gas diffusion to the atmosphere and thus increase the concentration of volatile chemicals in ground water.

FOC is the organic carbon fraction expressed as mass of carbon per unit mass of soil. For the GE site, we assumed the f_{oc} is 0.001. In arid climates the soils typically have very low natural organic matter (e.g., humus). For another project in the Albuquerque area further upslope on the alluvial fan, our firm collected uncontaminated soil samples and found that f_{oc} was 0.00017 to 0.0021. The higher the f_{oc}, the more retardation occurs. When we used a mean value of f_{oc} = 0.001 for modeling of the GE site, and assumed the source concentration of the soil is 1400 ppm, our sensitivity analysis indicated that free phase xylene would occur. We have not identified any information to suggest that free-phase xylene exists at this site. Consequently, either the f_{oc} is much greater than 0.001 or mean soil concentrations of xylene are less than 1400 ppm. We believe that the mean soil concentrations of xylene in the contaminated zone are much less than 1400 ppm. However, to be conservative, we assumed that the entire block of soil was at the maximum measured concentration, 1400 ppm, and that the f_{oc} was 0.001.

NCELL is the number of cells in the vertical dimension. It is calculated simply by dividing the thickness of the vadose zone, 266 feet, by the thickness of each cell, DELZ.

CINF is the concentration of the contaminant in the percolating water entering the affected soil zone. We assumed that there is no background contamination in rainwater, snowmelt or in the soils above the chemically affected soil.

CATM is the concentration of the contaminant in the ambient air. We assumed that the concentration of contaminants in the air is zero. There is no reason to believe that organic compounds occur in the atmosphere near this site which are of environmental significance in this case.

CGW describes the nature of gas diffusion across the lower boundary of the vadose zone. We assumed that there would be no diffusion into the water table because all the pores would be filled with water, thus the permeability of the soil to gas would be essentially zero. Previous investigators followed a similar approach (e.g., Weeks, 1978). This assumption forces the contaminants to be more concentrated in the liquid phase. Consequently, we believe our treatment of the water table as a gas diffusion barrier is reasonable.

Table B-1b shows the VLEACH parameters which are specific to the individual chemicals of interest. As indicated by the footnotes, the sources of the initial source concentration data are from field measurements reported by LAW elsewhere in this document. And, the various transport coefficients are obtained mostly from standard chemical references.

B.2.3 Modeling Results

The results of interest in VLEACH are the liquid phase concentration leaving the base of the vadose zone and entering the aquifer below. Table B-2 lists the output mass from a 1 ft^2 area below the source and the liquid phase concentration for each of the seven organic chemicals of interest. Figures B-1(a-g) illustrate histograms for the mass loading rates calculated from data in Table B-2. These figures show that the peak loading will occur after approximately 200 years for 1,1,1-trichloroethane and after more than 6000 years for 1,2,4-trichlorobenzene. The large rectangle (dashed line) in each of the histograms in Figures B-1(a-g) represents the manner in which we accounted for the VLEACH output in the ground-water transport model.

B.3 Saturated Zone Transport Model

B.3.1 Model Selection

We considered three different analytical models for predicting ground water concentrations. The first is that by Wilson and Miller (1978). This solution is not completely accurate near the source, so it was discarded. The second is a public domain software package called SOLUTE which was recommended to us by Mr. Dan Ashenberg, a consultant to the EPA. This is based on the Wilson and Miller solution. In our opinion, this code appears to contain programming errors which lead to mass balance problems. The third alternative, the one we finally selected, was an in-house program called PS2D which is based upon the same mathematical equation solved by Wilson and Miller (1978). Our version differs from the Wilson and Miller solution in the manner in which an integral expression is evaluated. Wilson and Miller evaluated the integral by a truncated infinite series, whereas in PS2D we evaluated the integral more exactly by using a numerical integration scheme. (The PS2D program is included as Attachment B2. It is considered proprietary and is not for public distribution or use without DBS&A consent.)

PS2D is a two-dimensional transport model for a point source of contamination. The model allows for one-dimensional horizontal flow in the aquifer and for hydrodynamic dispersion in the longitudinal and transverse directions.

The analytical solution for the transport problem due to point injection is actually borrowed from the field of heat conduction, e.g., Carslaw and Jaeger (1959). The difference is that there are retardation and decay effects, and the solution (water with chemicals) only occupies part of the space such that the source strength is magnified by a factor of 1/n (n is the porosity, which is less than 1.0). For a horizontal aquifer with uniform thickness, H, this source strength should be divided by H because we assume a complete instant mixing in the vertical direction. With these considerations, the analytical solution for the concentration that results from a point injection to the aquifer with steady uniform flow field is:

$$C(x, y, t) = \frac{q}{4\pi\sqrt{D_x D_y}} \int_0^t \frac{e^{-(x-x_1-\bar{v}t)^2/4D_x t - (y-y_1)^2/4D_y t - \lambda t}}{t} \, dt$$

(Wilson & Miller, 1978)

where:

C - the concentration at (x, y) and at time t;

q - point source strength per unit thickness of aquifer;

$q = \frac{\dot{m}}{H \cdot n}$ with $\dot{m}$ representing the mass release rate; H, the thickness of the aquifer; and n, the porosity;

D_x, D_y - the "retarded" dispersion coefficient;

$D = (\alpha\bar{v} + D_0)/R$

- α - dispersivity
- $\bar{v}$ - pore velocity (in x direction)
- D_0 - molecular dispersion coefficient in water
- R - retardation factor;

t - time since injection begins (after the contaminants reach the aquifer);

x, y - coordinates of the point of interest;

x_1, y_1 - coordinates of the point source;

$\bar{v}$ - mean pore velocity, equal to the real pore velocity divided by the retardation factor R; and

λ - decay constant.

We compare PS2D with the Wilson and Miller solution in Figures B-2(a-c). For comparative testing purposes, we assume a continuous point source of xylene. Figures B-2(a-c) indicate that the PS2D concentration result is slightly less than the Wilson and Miller prediction near the source, but the agreement between the solutions is excellent at greater distances.

The PS2D model actually allows us to model concentrations input over an area, rather than just at a point. We do this by superimposing many point sources within the area of interest. In the GE case, we assume the leachate from the vadose zone is confined to the area immediately beneath the 400 ft^2 area of impacted soil. We divided the total mass loading rate from VLEACH among 25 cells, each having an area of 16 ft^2 and each carrying 1/25 of the total mass loading rate. We apply the PS2D solution for each cell and sum the concentrations in space at points downstream from the source area. This is possible because of the linear nature of the solution shown above.

B.3.2 Model Input

The input data requirements for PS2D are given in Table B-3. Key data requirements include hydraulic conductivity, hydraulic gradient, effective porosity, and dispersivity, as discussed below.

The hydraulic conductivity of the aquifer is obtained from summaries of aquifer tests in the Albuquerque basin east of the Rio Grande (Logan, 1990). A mean value for hydraulic conductivity of 21 feet per day is considered reasonably typical of a fine to medium sandy aquifer. The hydraulic gradient, 0.005, was derived from water level elevations measured in on-site monitor wells, as reported by LAW elsewhere in this document. Based upon our experience and standard textbook literature, we assumed that the effective porosity was 0.25. We followed a similar line of reasoning to select longitudinal and transverse dispersivity. The dispersivity values we selected in Table B-3 are in the low range, inasmuch as larger values would tend to decrease the predicted concentrations. To be conservative, that is, to obtain predicted concentrations which would probably exceed the measured concentrations, we neglected any retardation or chemical decay in the aquifer.

The final input to the model is the mixing depth. The mixing depth is the depth of the aquifer in which the leachate from the vadose zone will mix with the ambient ground water. We selected 18 feet as the mixing depth, that is, the aquifer in the ground-water transport model is assumed to be only 18 feet thick. Actually, the aquifer is more than 650 feet thick and off-site domestic well depths range from 18 feet to more than 71 feet. In on-site monitor wells, the average length of well screen below the water table is about 18 feet. Our mixing depth was selected to be

consistent with monitor well sampling intervals and to be representative of a conservative prediction.

The source strength of chemical input to the aquifer from the vadose zone is derived from the VLEACH simulations. As shown in Figures B-1(a-g), the VLEACH model predicts a slow increase in mass loading rate over time until a peak occurs (solid line), followed by a gradual decline. To simplify the application of the analytical solution, we approximate this curve by a pulse input. The loading to the aquifer model is shown by the rectangle (dashed line) in Figures B-1(a-g). The same peak loading rate and total mass are input to the aquifer as predicted by VLEACH. The coordinate system and flow domain for the model are shown in Figure B-3.

B.3.3 Modeling Results

Contaminant concentrations are predicted at the property boundary 250 feet immediately downgradient from the source (Figures B-4(a-g)). The peak concentrations at the property boundary for each chemical of interest are shown in Table B-4. Also shown in this table are the ground-water standards set for these constituents by the US EPA and the New Mexico Water Quality Control Commission. Based upon the model results, none of the constituents will exceed the drinking water standards for ground water at the property boundary. The property boundary is the point of regulatory compliance, based upon our discussions with Mr. Vincent Malott.

The spatial distribution of the seven constituents are shown in Figures B-5(a-g). The constituent which has the largest concentration appears to be the xylenes. Relative to xylenes, the spatial plume distribution of other chemicals of interest exhibits much lower concentrations throughout the area.

B.4 Conclusion

On the basis of our analyses, we conclude that leaching of chemicals from the vadose zone will not cause concentrations in ground water to exceed drinking water standards at the point of regulatory compliance.

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Table B-1. Input Data for the Program VLEACH

(a) Common Parameters Used for All Seven Chemicals

PARAMETER NAMES & MEANINGS	VALUE	SOURCE
AREA, area of polygon	400 ft^2	Field data
DELZ, vertical cell spacing	2 ft	Modeling
Q, ground water recharge rate	0.075 ft/yr	LAW and 10% P
THETA, volumetric water content	0.15	Average calculated from field data
RHOB, dry bulk density	1.74 g/cc	Calculated from porosity data
POR, total porosity	0.4	Lab measurements
FOC, organic carbon content	0.001	Estimate from D. Stephens' experience
NCELL, number of cells	133	Depth to water, 266 ft
CINF, concentration in recharge	0	Professional judgement
CATM, atmospheric concentration	0	Professional judgement
CGW, water table boundary condition	-1	Professional judgement

(b) Different Parameters Used for Different Chemicals

CHEMICALS	XCON AT SOURCE	K_{oc}	C_{max}	D_{air}	K_h
Xylenes	1,400,000	240.0	198.0	0.61	0.22
Ethylbenzene	160,000	396.0	152.0	0.61	0.37
1,2,4-Tetrachlorobenzene	18,000	1,080.0	19.0	0.57	0.043
PCE (Tetrachloroethene)	1,100	283.0	150.0	0.64	0.35
Methylene Chloride	1,100	8.8	20,000.0	0.90	0.104
1,1,1-Tetrachloroethane	1,900	95.7	4,400.0	0.69	0.77
Toluene	6,700	115.0	515.0	0.68	0.28

XCON initial concentration in each cell (ppb)
K_{OC} organic carbon distribution coefficient (ml/g)
K_h Henry's constant (dimensionless)
C_{max} aqueous solubility (mg/l or ppm)
D_{air} free air diffusion coefficient (m^2/day)

NOTE: (1) XCON, K_{oc}, and C_{max} for xylenes are from LAW.
(2) The values of C_{max} and K_h for methylene chloride are from Montgomery and Welkom, 1990, *Groundwater Chemicals Desk Reference.*
(3) The value of D_{air} for methylene chloride is estimated by the values for other chemicals.
(4) The values of C_{max}, D_{air}, and K_h for the rest of the chemicals are from Environmental Systems & Technologies, Inc., 1990, *MOFAT User's Manual.*

Table B-2(a). Mass and Concentration to Ground Water: Xylenes

TIME (years)	MASS* (g)	C** (g/ft^3)
100.00	0.16237	0.0604
200.00	0.87028	0.1952
300.00	2.1377	0.3993
400.00	3.8526	0.6482
500.00	5.7881	0.9078
600.00	7.6811	1.1444
700.00	9.3034	1.3328
800.00	10.505	1.4596
900.00	11.228	1.5225
1000.00	11.488	1.5281
1100.00	11.355	1.4878
1200.00	10.922	1.4145
1300.00	10.288	1.3203
1400.00	9.5348	1.2155
1500.00	8.7310	1.1074
1600.00	7.9240	1.0014
1700.00	7.1451	0.9006
1800.00	6.4129	0.8069
1900.00	5.7368	0.7208
2000.00	5.1200	0.6427
2100.00	4.5620	0.5723
2200.00	4.0601	0.5091
2300.00	3.6104	0.4526
2400.00	3.2087	0.4021
2500.00	2.8506	0.3572
2600.00	2.5317	0.3172
2700.00	2.2480	0.2816
2800.00	1.9958	0.2500
2900.00	1.7718	0.2220

* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-2(a). Mass and Concentration to Ground Water: Xylenes
(continued)

TIME (years)	MASS* (g)	C** (g/ft^3)
3000.00	1.5727	0.1970
3100.00	1.3960	0.1749
3200.00	1.2391	0.1552
3300.00	1.0998	0.1378
3400.00	0.97612	0.1223
3500.00	0.86635	0.1085
3600.00	0.76892	0.0963
3700.00	0.68244	0.0885
3800.00	0.60569	0.0759
3900.00	0.53756	0.0673
4000.00	0.47710	0.0598

* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-2(b). Mass and Concentration to Ground Water: Ethylbenzene

TIME (years)	MASS* (g)	C** (g/ft^3)
100.00	0.01348	0.0049
200.00	0.06771	0.0147
300.00	0.15450	0.0279
400.00	0.25981	0.0424
500.00	0.36743	0.0562
600.00	0.46379	0.0677
700.00	0.54027	0.0762
800.00	0.59327	0.0816
900.00	0.62310	0.0841
1000.00	0.63260	0.0841
1100.00	0.62576	0.0823
1200.00	0.60680	0.0791
1300.00	0.57953	0.0750
1400.00	0.54715	0.0705
1500.00	0.51210	0.0657
1600.00	0.47617	0.0610
1700.00	0.44062	0.0563
1800.00	0.40626	0.0518
1900.00	0.37359	0.0476
2000.00	0.34287	0.0437
2100.00	0.31423	0.0400
2200.00	0.28768	0.0366
2300.00	0.26318	0.0335
2400.00	0.24063	0.0306
2500.00	0.21992	0.0279
2600.00	0.20093	0.0255
2700.00	0.18355	0.0233
2800.00	0.16764	0.0213
2900.00	0.15309	0.0194

* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-2(b). Mass and Concentration to Ground Water: Ethylbenzene
(continued)

TIME (years)	MASS* (g)	C** (g/ft^3)
3000.00	0.13980	0.0178
3100.00	0.12765	0.0162
3200.00	0.11655	0.0148
3300.00	0.10641	0.0135
3400.00	0.09716	0.0123
3500.00	0.08870	0.0113
3600.00	0.08099	0.0103
3700.00	0.07394	0.0094
3800.00	0.06750	0.0086
3900.00	0.06163	0.0078
4000.00	0.05626	0.0071

* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-2(c). Mass and Concentration to Ground Water: 1,2,4-Tetrachlorobenzene

TIME (years)	MASS* (g)	C** (g/ft^3)
1000.00	0.00568	0.0002
2000.00	0.04505	0.0011
3000.00	0.17333	0.0037
4000.00	0.46770	0.0089
5000.00	0.96473	0.0163
6000.00	1.46030	0.0210
7000.00	1.51900	0.0185
8000.00	1.14530	0.0125
9000.00	0.72054	0.0075
10000.00	0.42579	0.0044
11000.00	0.24852	0.0025
12000.00	0.14487	0.0015
13000.00	0.08446	0.0009
14000.00	0.04926	0.0005
15000.00	0.02873	0.0003

* The mass loading to ground water per unit area (1 ft^2) in the last 1000 years.
** The concentration at the base of the vadose zone.

Table B-2(d). Mass and Concentration to Ground Water: Tetrachloroethene

TIME (years)	MASS* (g)	C** (mg/ft^3)
100.00	0.16932E-03	0.0627
200.00	0.86891E-03	0.1880
300.00	0.19472E-02	0.3458
400.00	0.31421E-02	0.4998
500.00	0.42082E-02	0.6237
600.00	0.49946E-02	0.7051
700.00	0.54538E-02	0.7438
800.00	0.56125E-02	0.7466
900.00	0.55347E-02	0.7232
1000.00	0.52931E-02	0.6828
1100.00	0.49523E-02	0.6330
1200.00	0.45621E-02	0.5794
1300.00	0.41574E-02	0.5257
1400.00	0.37602E-02	0.4740
1500.00	0.33836E-02	0.4257
1600.00	0.30341E-02	0.3812
1700.00	0.27143E-02	0.3407
1800.00	0.24244E-02	0.3041
1900.00	0.21631E-02	0.2712
2000.00	0.19286E-02	0.2417
2100.00	0.17188E-02	0.2154
2200.00	0.15312E-02	0.1919
2300.00	0.13639E-02	0.1709
2400.00	0.12146E-02	0.1522
2500.00	0.10816E-02	0.1355
2600.00	0.96312E-03	0.1207
2700.00	0.85756E-03	0.1074
2800.00	0.76355E-03	0.0957
2900.00	0.67984E-03	0.0852

* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-2(e). Mass and Concentration to Ground Water: Methylene Chloride

TIME (years)	MASS* (g)	C** (mg/ft^3)
100.00	0.18684E-02	0.7555
200.00	0.11495E-01	2.6049
300.00	0.27167E-01	4.7063
400.00	0.40000E-01	5.7455
500.00	0.42345E-01	5.2472
600.00	0.34674E-01	3.8530
700.00	0.24261E-01	2.6040
800.00	0.16240E-01	1.7303
900.00	0.10764E-01	1.1445
1000.00	0.71149E-02	0.7561
1100.00	0.46996E-02	0.4994
1200.00	0.31037E-02	0.3298
1300.00	0.20496E-02	0.2178
1400.00	0.13535E-02	0.1438
1500.00	0.89377E-03	0.0950
1600.00	0.59021E-03	0.0627
1700.00	0.38975E-03	0.0414
1800.00	0.25738E-03	0.0273
1900.00	0.16996E-03	0.0181
2000.00	0.11224E-03	0.0119

* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-2(f). Mass and Concentration to Ground Water: 1,1,1-Tetrachloroethane

TIME (years)	MASS* (g)	C** (mg/ft^3)
100.00	0.20868E-02	0.7413
200.00	0.78708E-02	1.2884
300.00	0.97826E-02	1.2547
400.00	0.86718E-02	1.0268
500.00	0.68981E-02	0.7968
600.00	0.53075E-02	0.6085
700.00	0.40437E-02	0.4626
800.00	0.30720E-02	0.3512
900.00	0.23319E-02	0.2666
1000.00	0.17696E-02	0.2023
1100.00	0.13429E-02	0.1535
1200.00	0.10190E-02	0.1165
1300.00	0.77323E-03	0.0884
1400.00	0.58674E-03	0.0671
1500.00	0.44522E-03	0.0509
1600.00	0.33784E-03	0.0386
1700.00	0.25636E-03	0.0293
1800.00	0.19453E-03	0.0222
1900.00	0.14761E-03	0.0169
2000.00	0.11201E-03	0.0128

* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-2(g). Mass and Concentration to Ground Water: Toluene

TIME (years)	MASS* (g)	C** (mg/ft^3)
100.00	0.33250E-02	1.2859
200.00	0.18030E-01	3.8670
300.00	0.38548E-01	6.5288
400.00	0.55810E-01	8.2777
500.00	0.64848E-01	8.8566
600.00	0.65782E-01	8.5265
700.00	0.61285E-01	7.6897
800.00	0.54189E-01	6.6686
900.00	0.46460E-01	5.6541
1000.00	0.39142E-01	4.7343
1100.00	0.32661E-01	3.9375
1200.00	0.27114E-01	3.2629
1300.00	0.22447E-01	2.6988
1400.00	0.18556E-01	2.2299
1500.00	0.15328E-01	1.8415
1600.00	0.12656E-01	1.5203
1700.00	0.10448E-01	1.2550
1800.00	0.86244E-02	1.0359
1900.00	0.71184E-02	0.8550
2000.00	0.58753E-02	0.7057
2100.00	0.48491E-02	0.5824
2200.00	0.40022E-02	0.4807
2300.00	0.33031E-02	0.3967
2400.00	0.27262E-02	0.3274
2500.00	0.22500E-02	0.2702
2600.00	0.18570E-02	0.2230
2700.00	0.15326E-02	0.1841
2800.00	0.12649E-02	0.1519
2900.00	0.10440E-02	0.1254
3000.00	0.86163E-03	0.1035

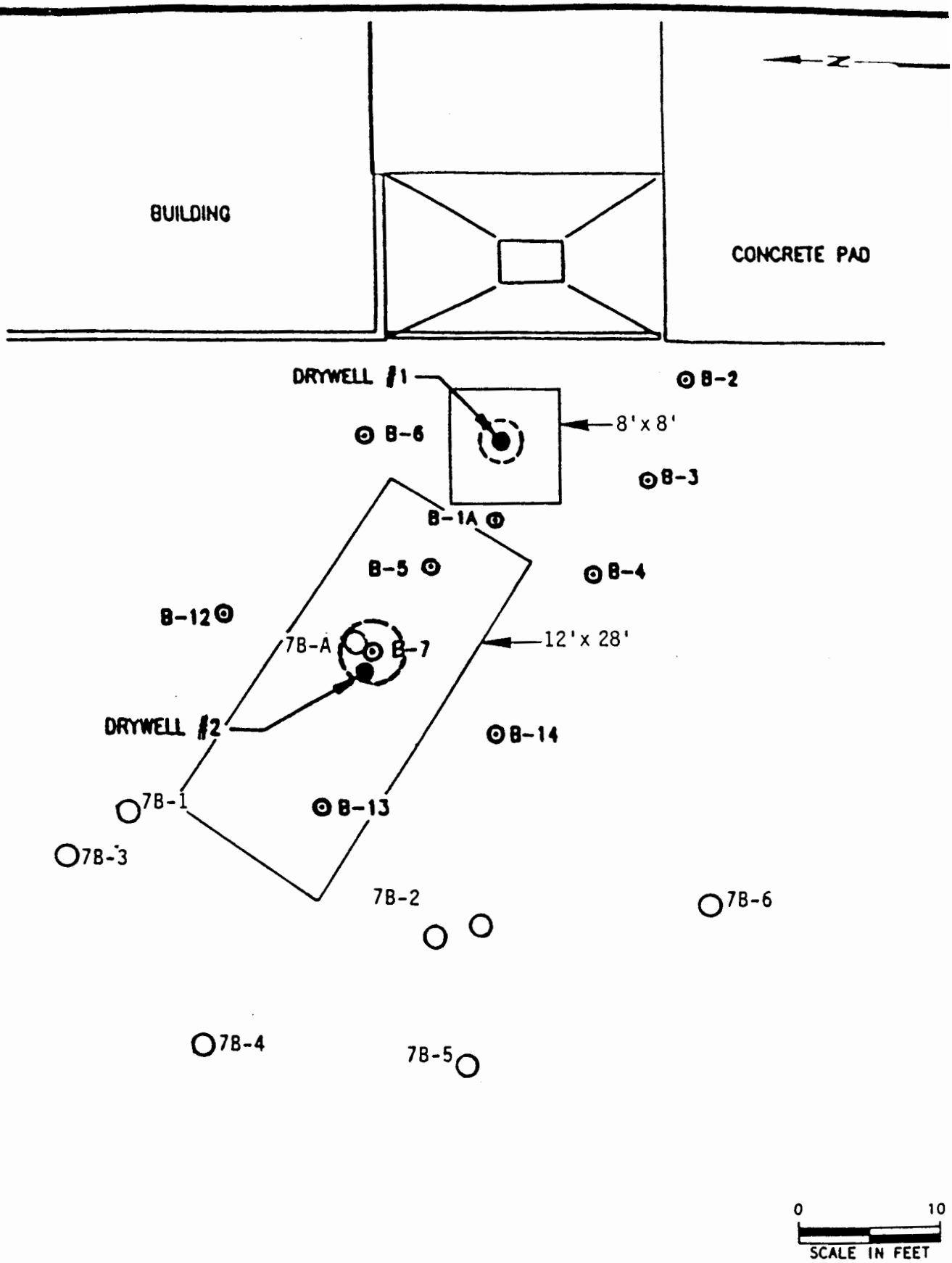
* The mass loading to ground water per unit area (1 ft^2) in the last 100 years.
** The concentration at the base of the vadose zone.

Table B-3. Model Input Parameters for PS2D

PARAMETER	VALUE	REFERENCE
Hydraulic Conductivity	21 ft/d	Logan, 1990
Hydraulic Gradient	0.005	Figure 16, LAW Environmental (RFI)
Effective Porosity	0.25	Assumed
Longitudinal Dispersivity	α_L = 10 ft	Personal experience
Transverse Dispersivity	α_T = 2 ft	Personal experience
Retardation Factor	R = 1.0	Professional judgement
Decay Constant	λ = 0.0	Professional judgement
Mixing Depth	18 feet	Monitor and domestic well depths

Table B-4. Modeling Results for Different Chemicals

CONSTITUENT	PEAK CONCENTRATION AT PROPERTY LINE (ppm)	DRINKING WATER STANDARDS (ppm)	
		EPA	New Mexico
Xylenes	0.029	10.0	0.62
Ethylbenzene	0.0016	0.7	0.75
1,2,4-Tetrachlorobenzene	0.00038	0.009	No standard
Tetrachloroethene	0.000014	0.005	0.02
Methylene Chloride	0.00011	(PMCL) 0.005	0.1
1,1,1-Tetrachloroethane	0.000025	0.2	0.06
Toluene	0.00017	1.0	0.75



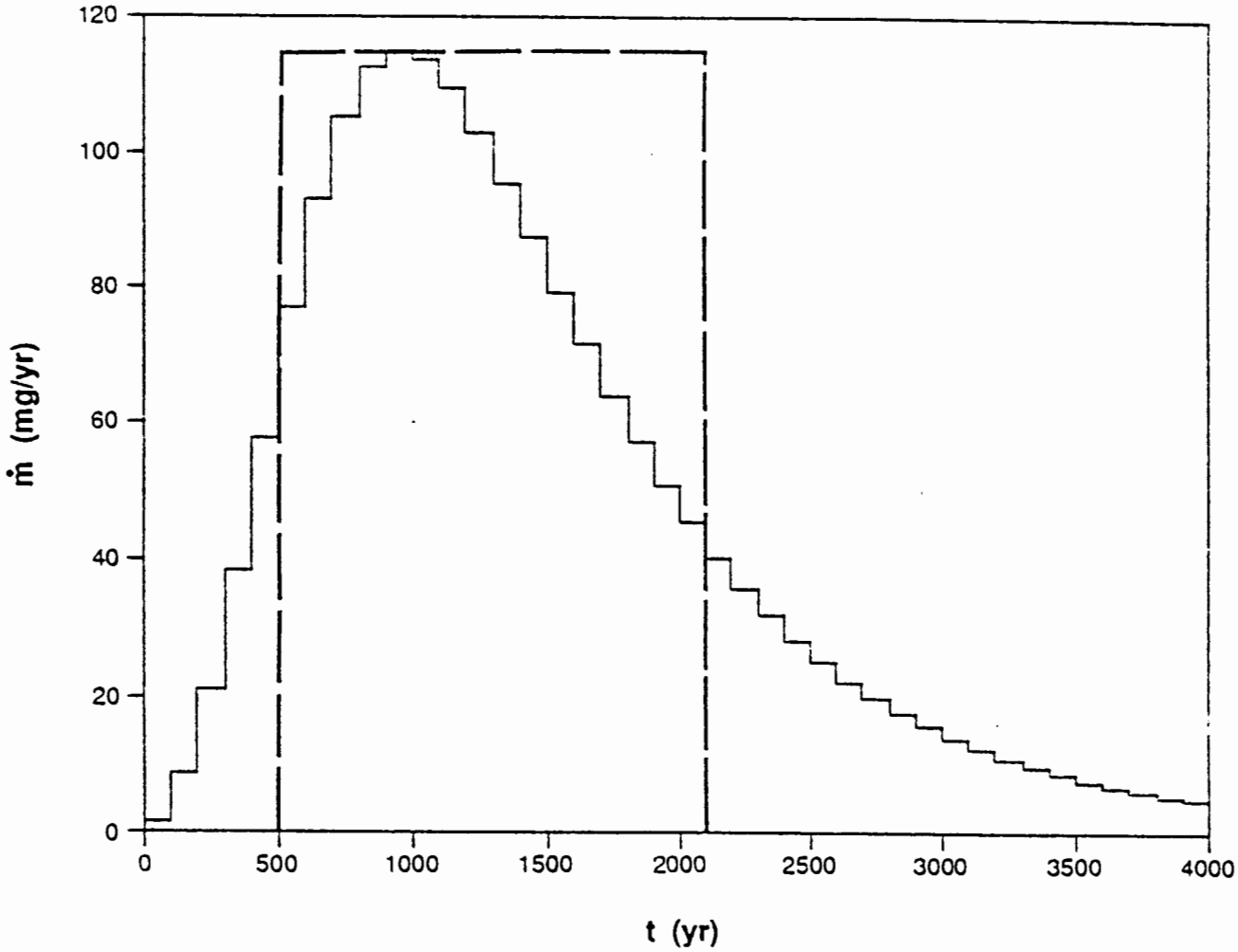
GE SERVICE SHOP
ALBUQUERQUE,
NEW MEXICO

LAW ENVIRONMENTAL INC.

APPROXIMATE DELINEATIO
OF CHEMICALLY
AFFECTED AREAS

JOB NO. 55-4342 FIGURE

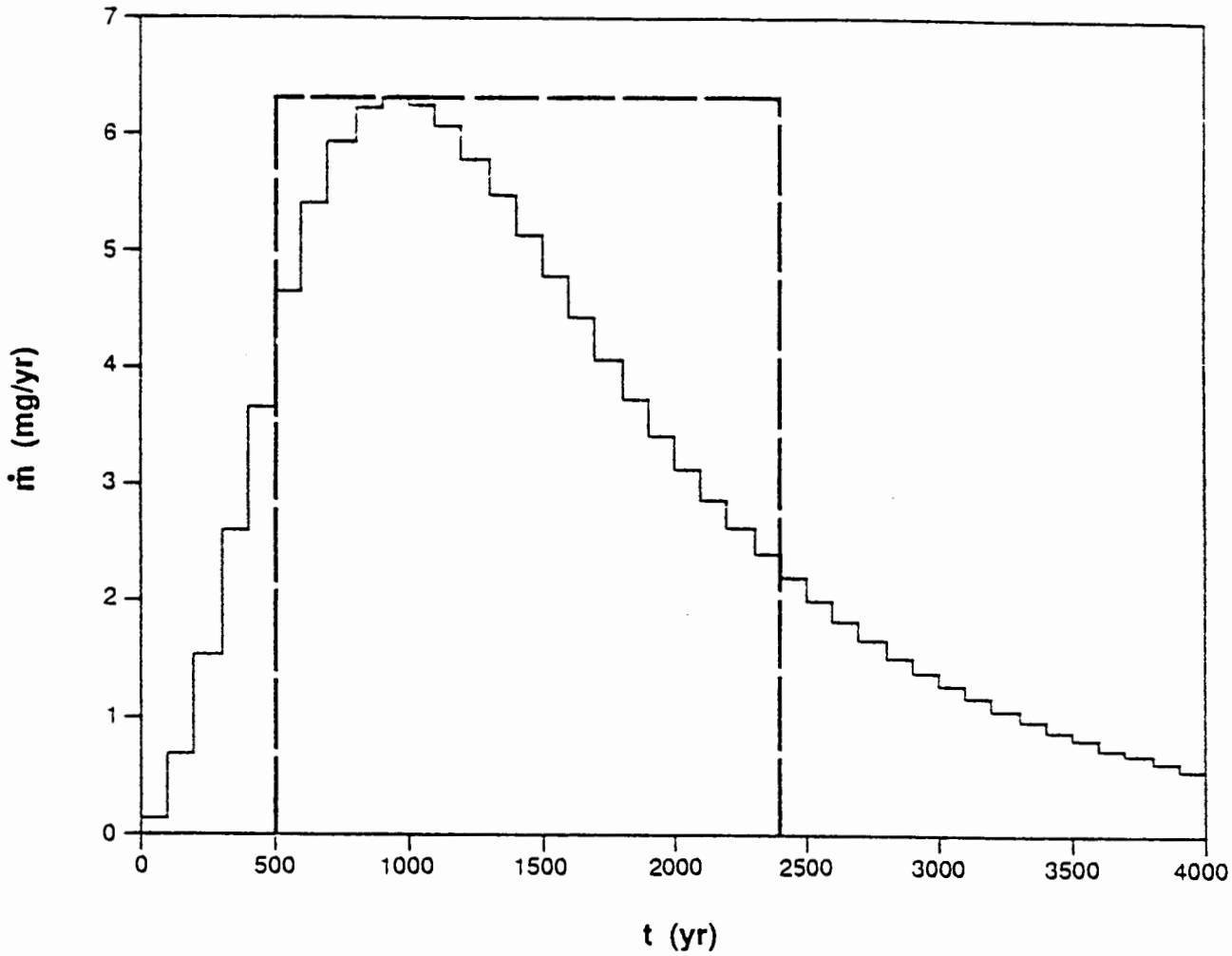
322207



Mass Loading Rate
(per ft^2) of Xylenes

DANIEL B. STEPHENS & ASSOCIATES, INC.

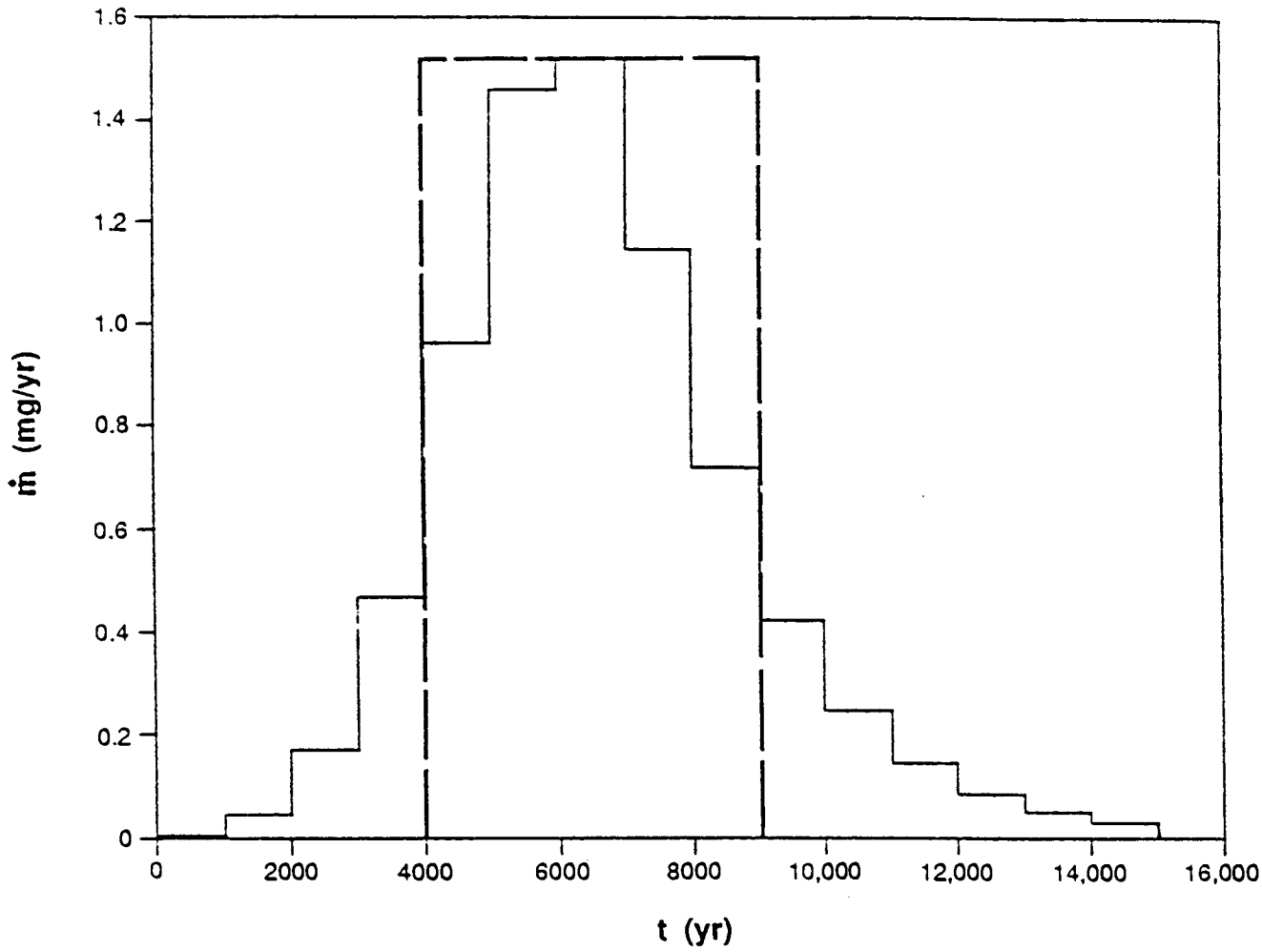
Figure B-



Mass Loading Rate
(per ft^2) of Ethylbenzene

DANIEL B. STEPHENS & ASSOCIATES, INC.

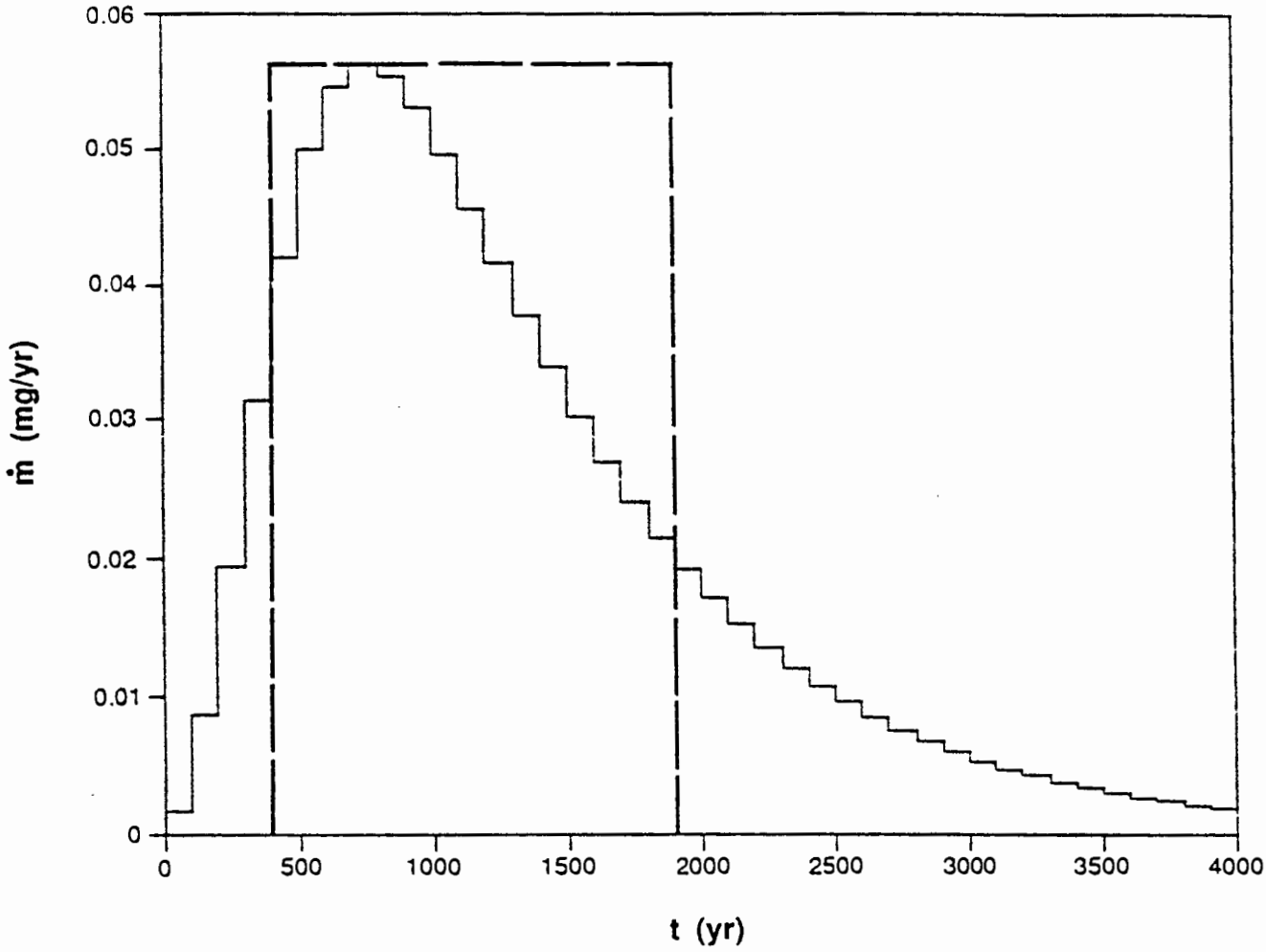
Figure 8



Mass Loading Rate (per ft^2) of 1, 2, 4 - Trichlorobenzene

DANIEL B. STEPHENS & ASSOCIATES, INC.

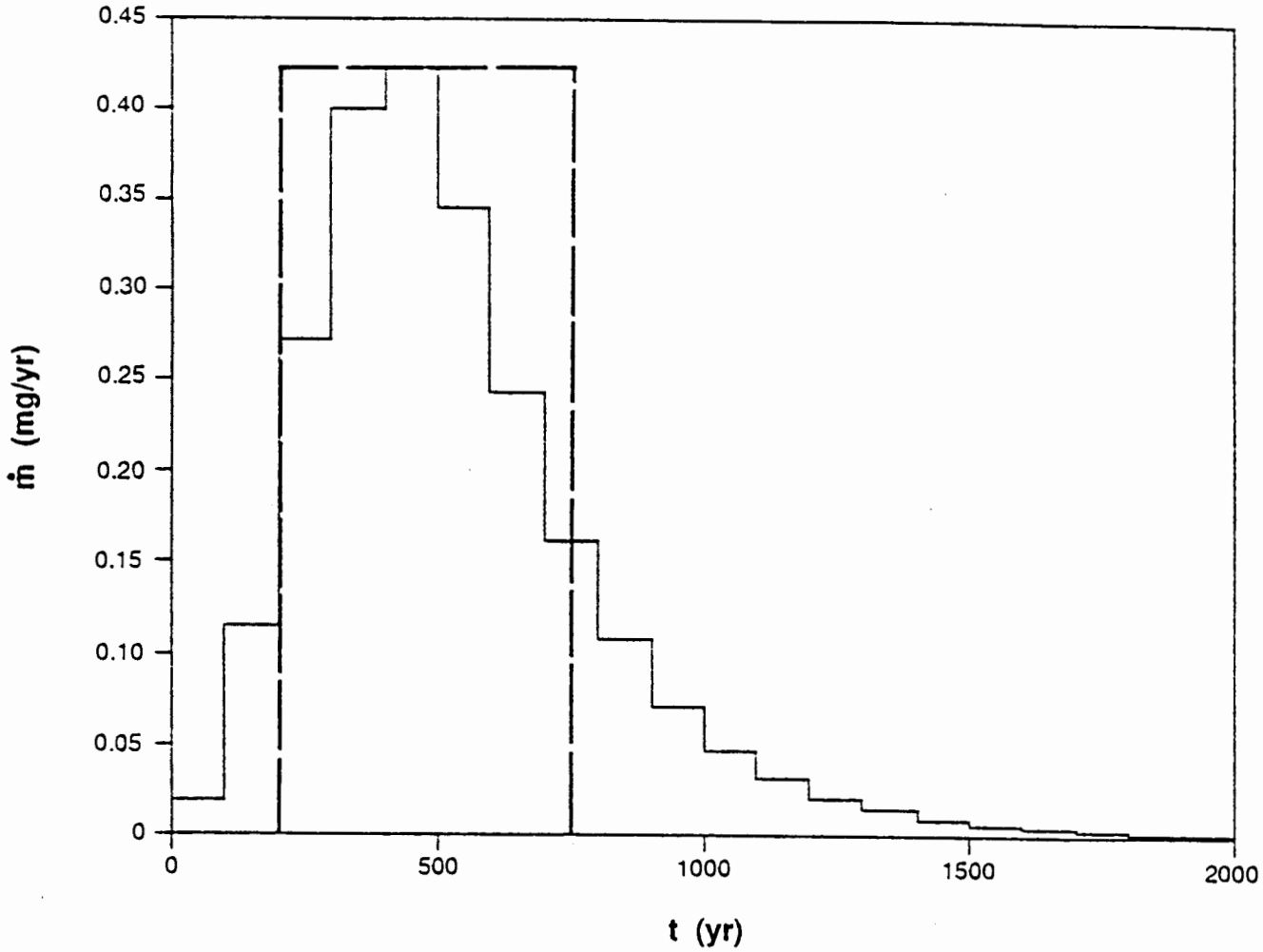
Figure B-



Mass Loading Rate
(per ft^2) of Tetrachloroethene

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure B-

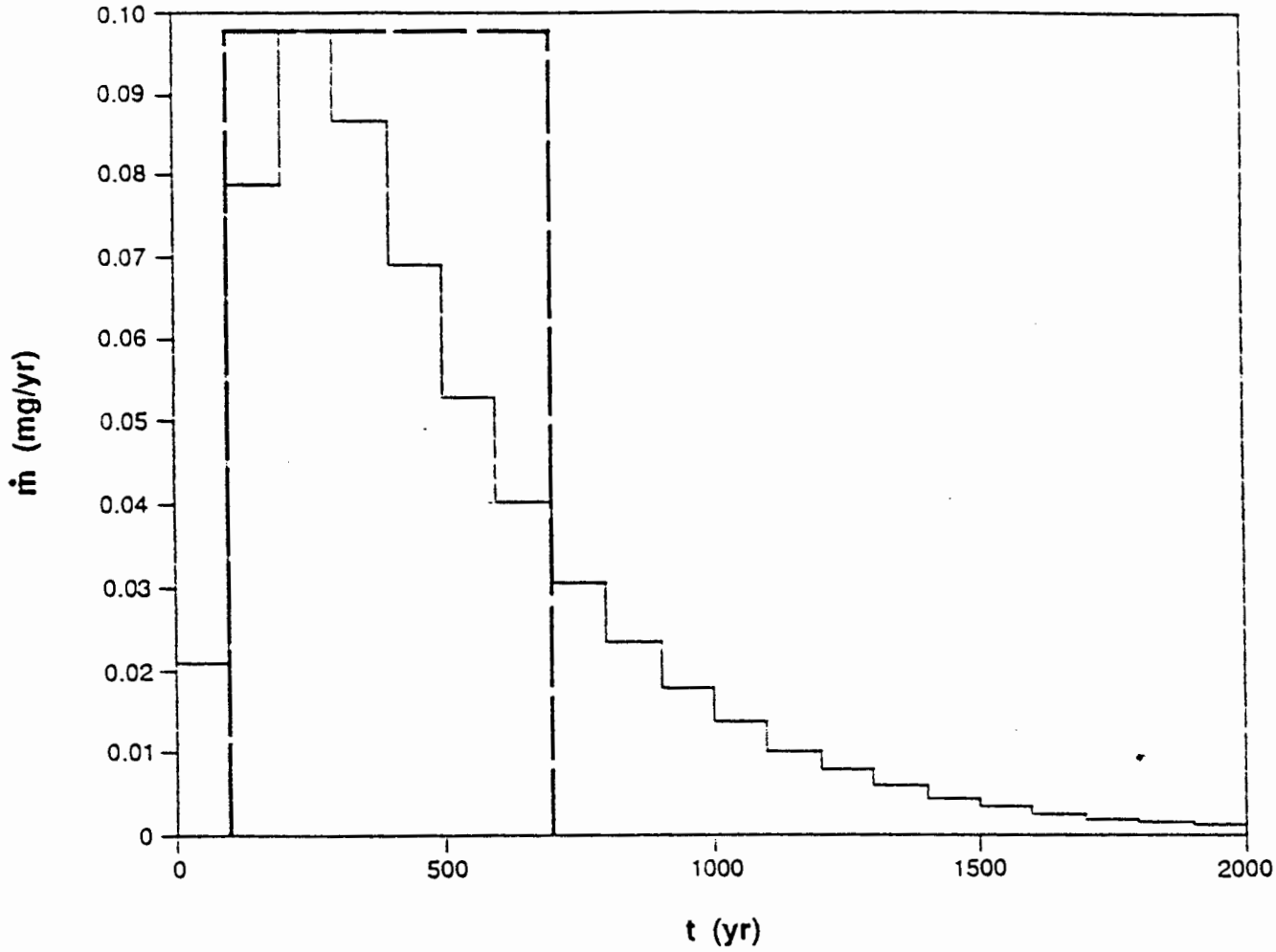


Mass Loading Rate (per ft^2) of Methylene Chloride

DANIEL B. STEPHENS & ASSOCIATES, INC.

4-92 JN 1290

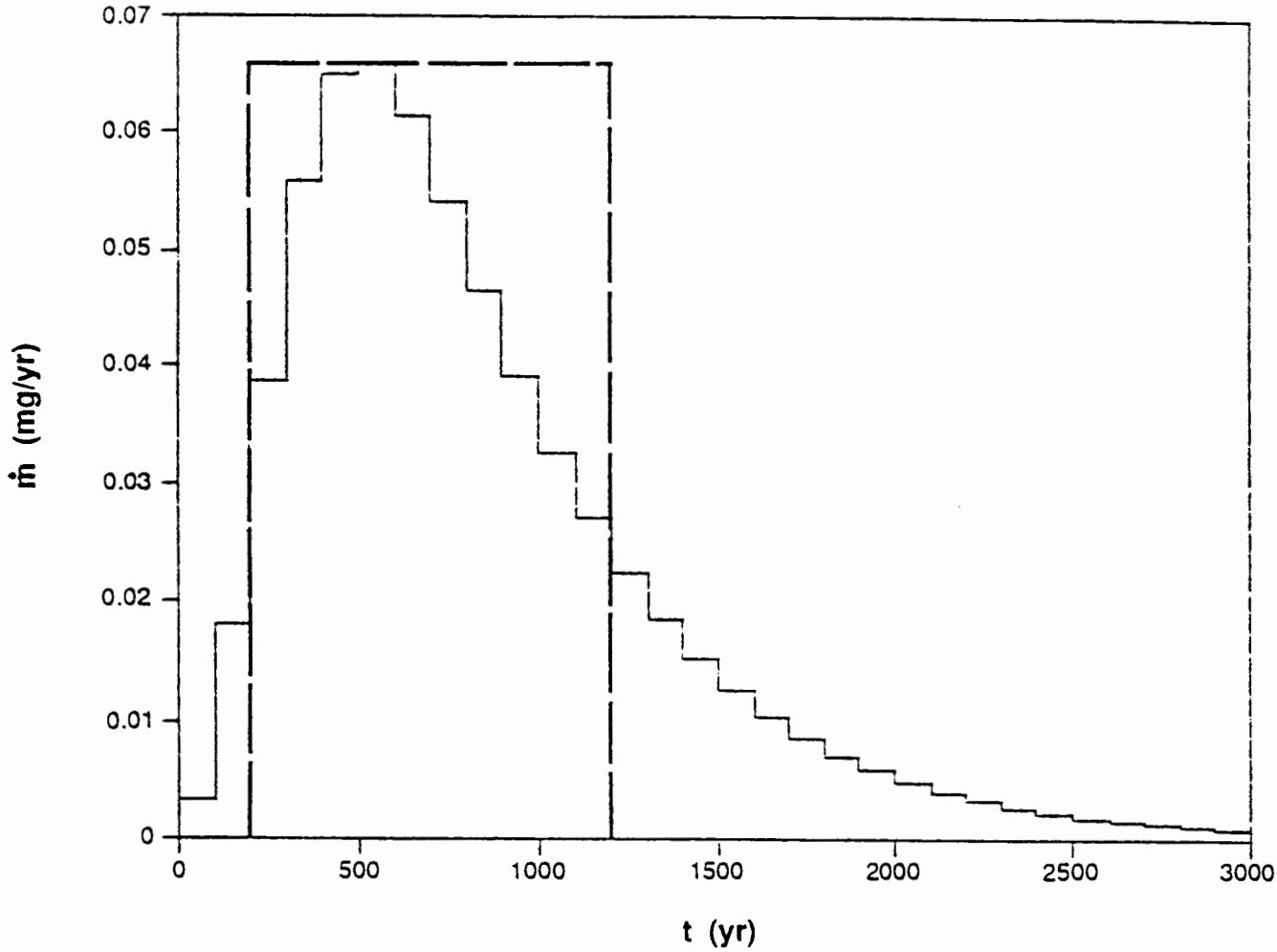
Figure B-



Mass Loading Rate (per ft^2) of
1, 1, 1 - Trichloroethane

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure 8

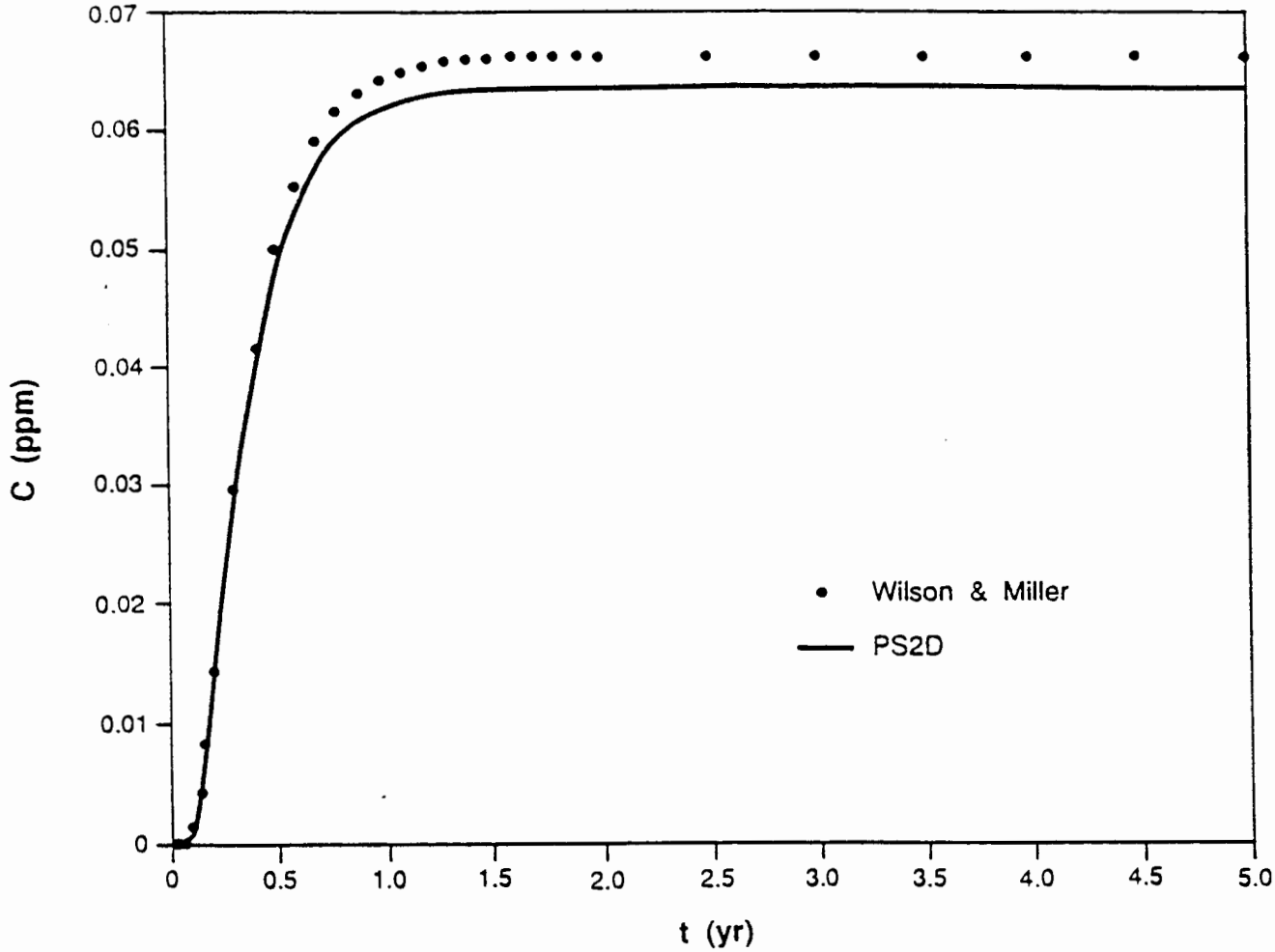


Mass Loading Rate (per ft^2) of Toluene

DANIEL B. STEPHENS & ASSOCIATES, INC.

4-92 JN 1280

Figure B-

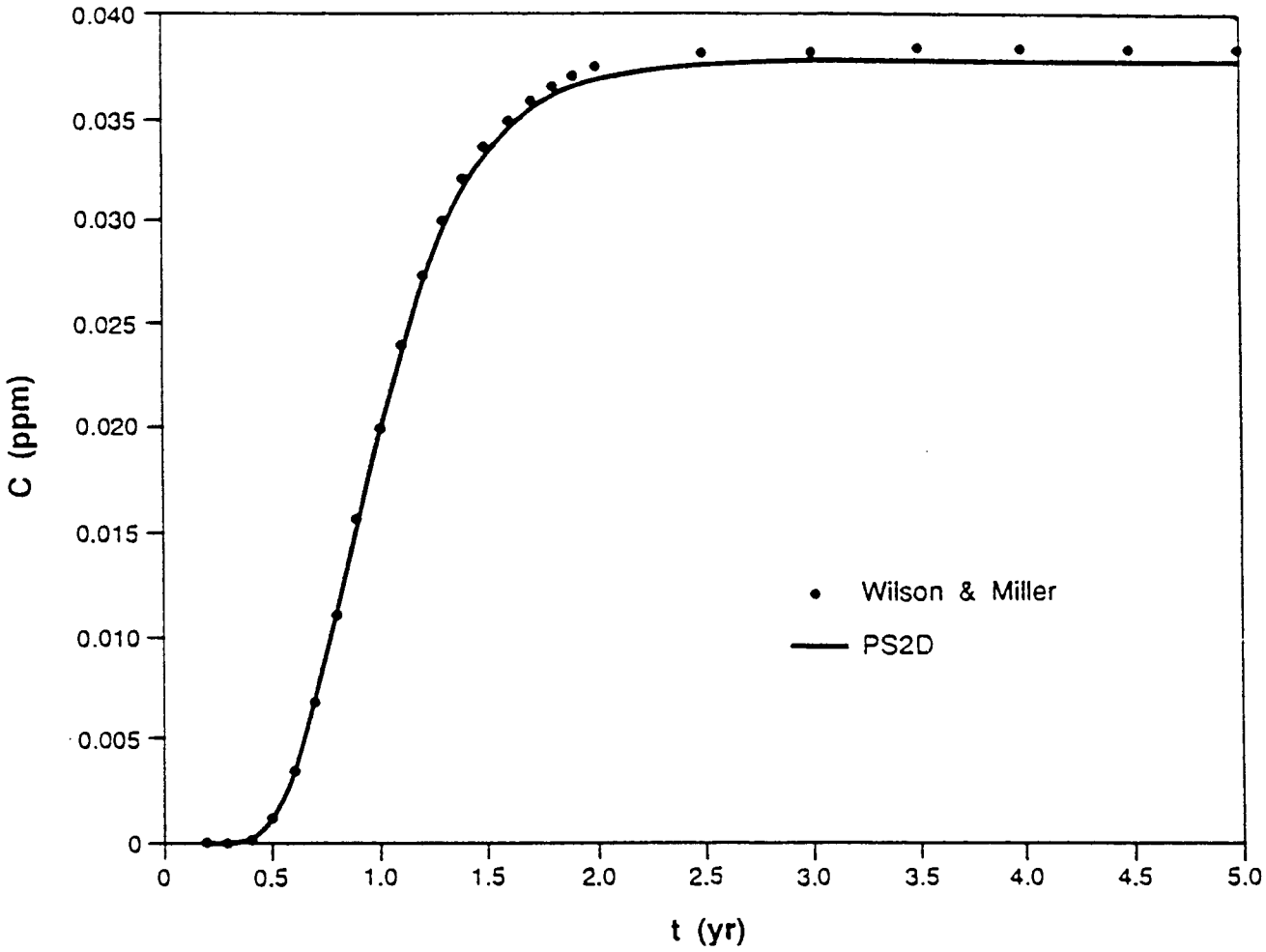


Note:
For concentration at a point 50 feet directly downgradient from the point source.

Test Case to Compare PS2D with Wilson and Miller (1978) Solution

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure B

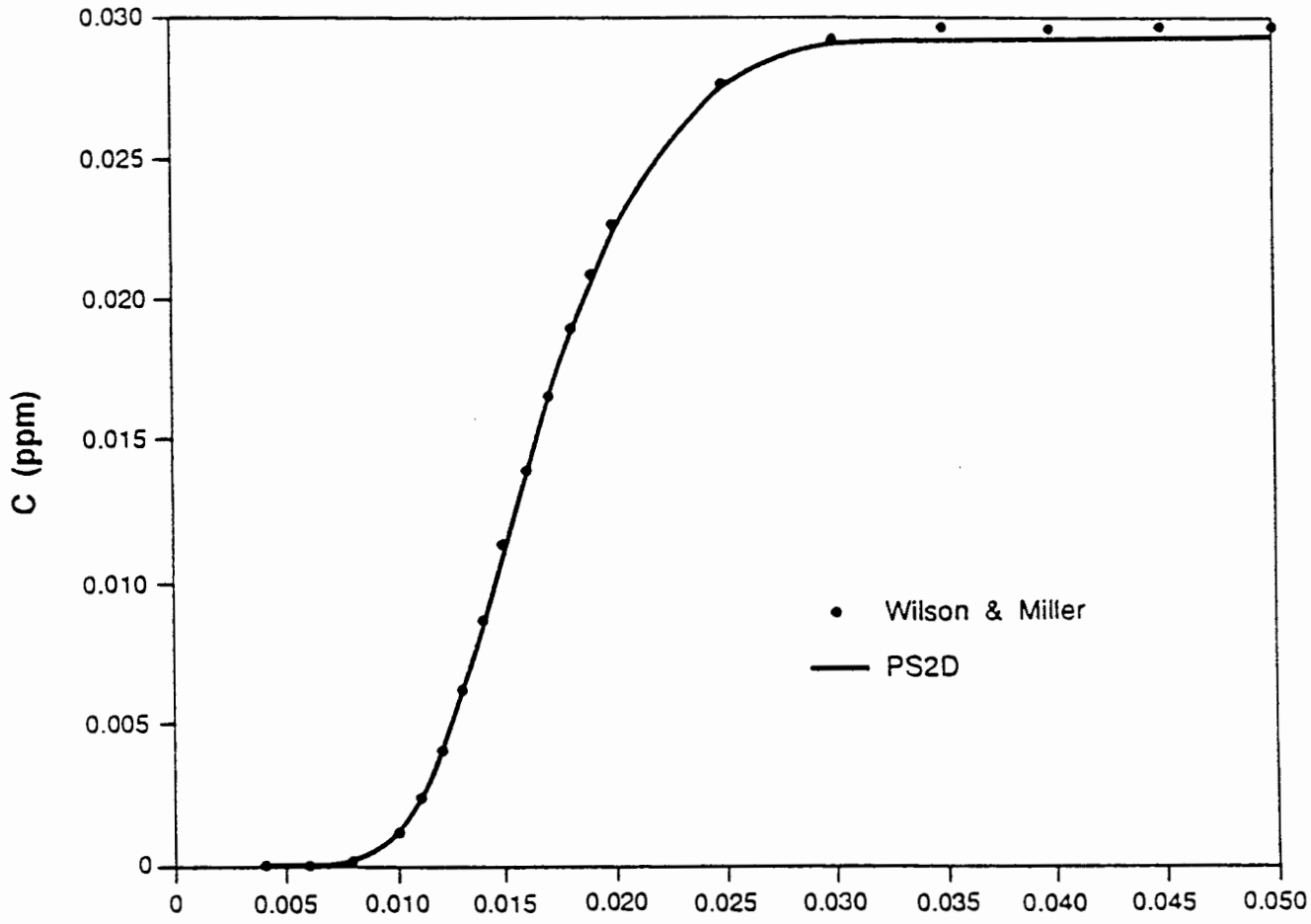


Note:
For concentration at a point 150 feet directly downgradient from the point source.

Test Case to Compare PS2D with Wilson and Miller (1978) Solution

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure B-

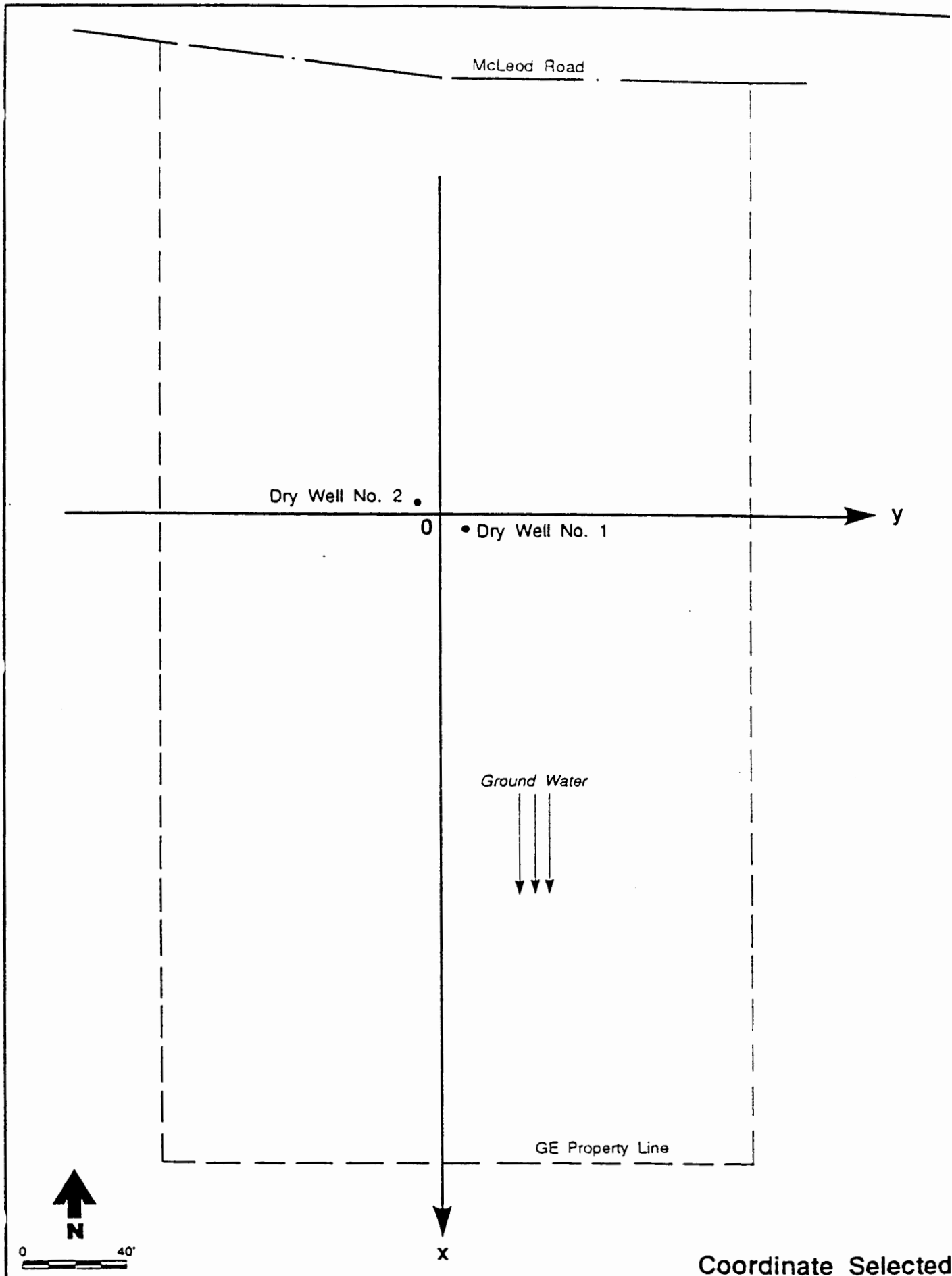


Note:
For concentration at a point 250 feet directly downgradient from the point source.

Test Case to Compare PS2D with Wilson and Miller (1978) Solution

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

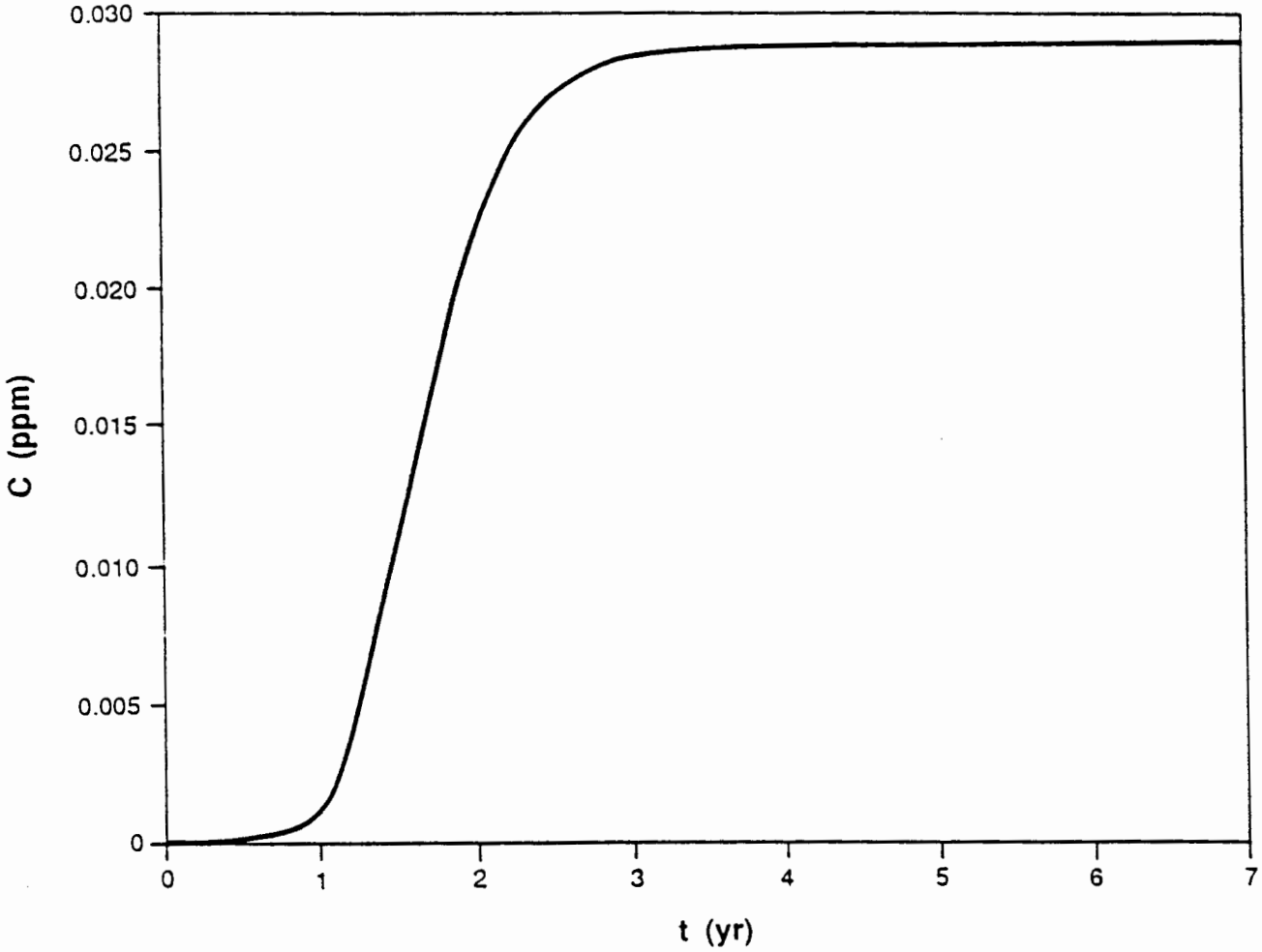
Figure B



Coordinate Selected
for Aquifer Modeling

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure 5

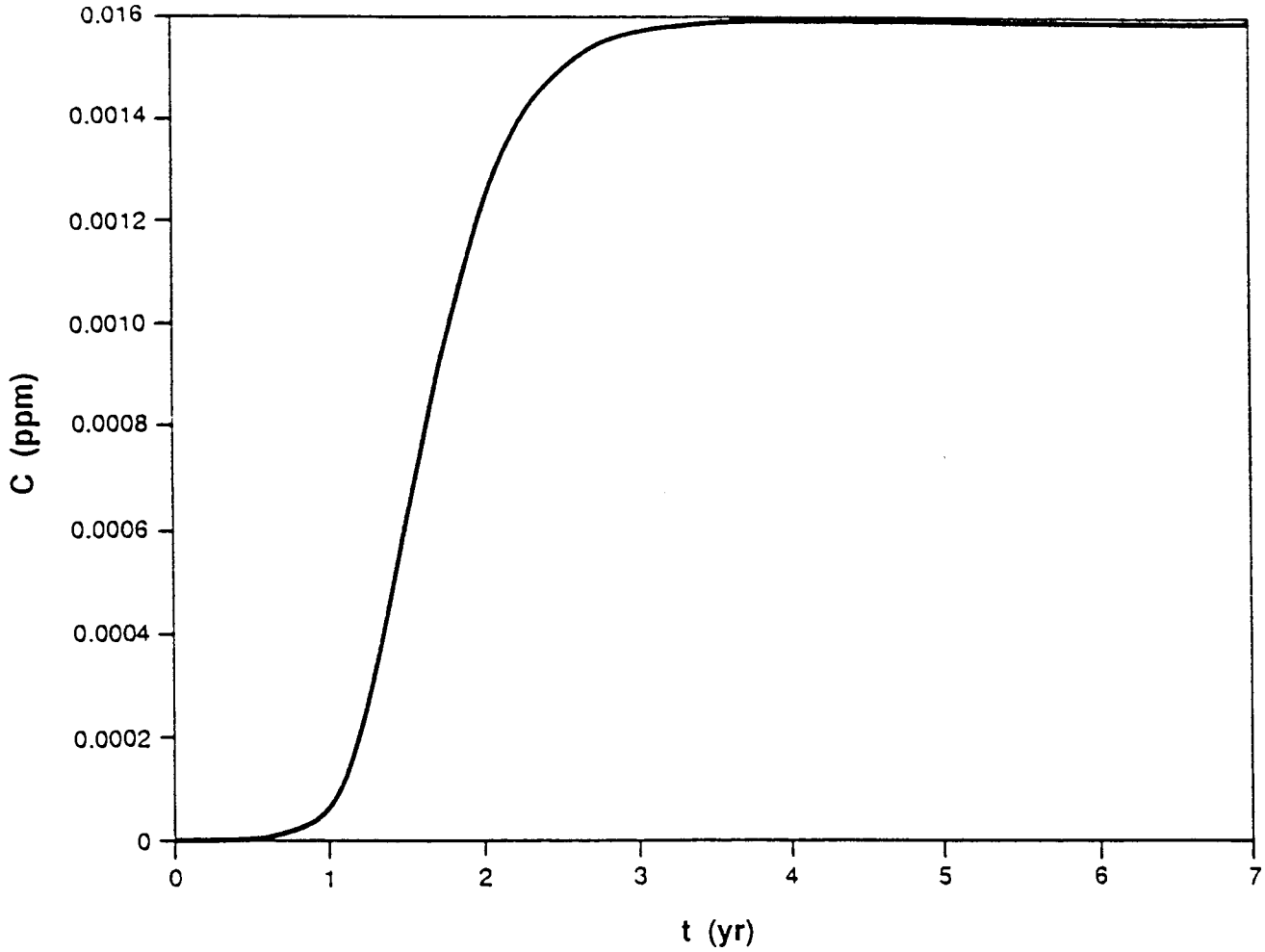


Note:
The year represents the time since contamination entered the aquifer from the base of the vadose zone.

Concentrations of Xylenes at the Property Line

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure B-

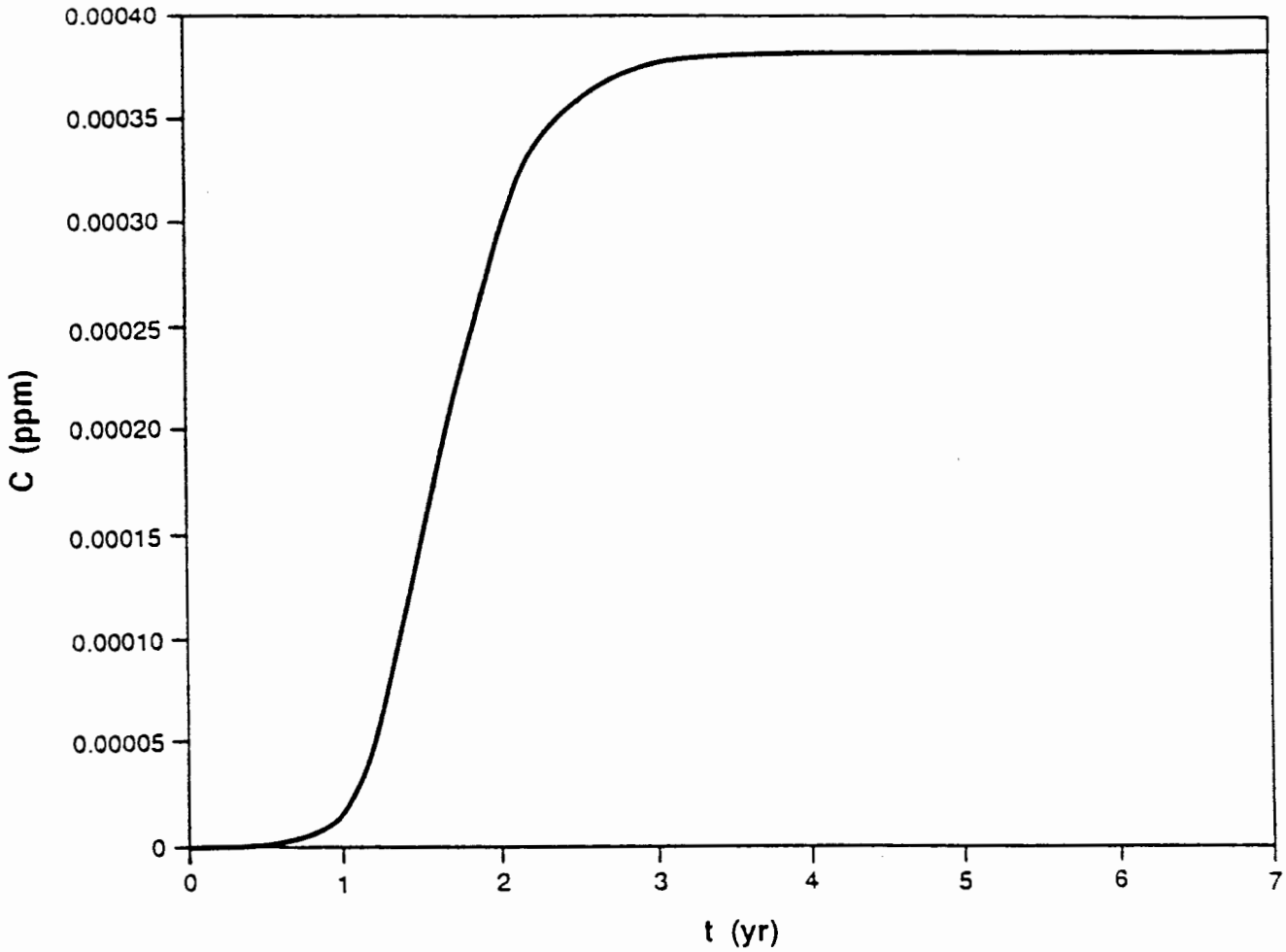


Note:
The year represents the time since contamination entered the aquifer from the base of the vadose zone.

Concentration of Ethylbenzene at the Property Line

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure B-

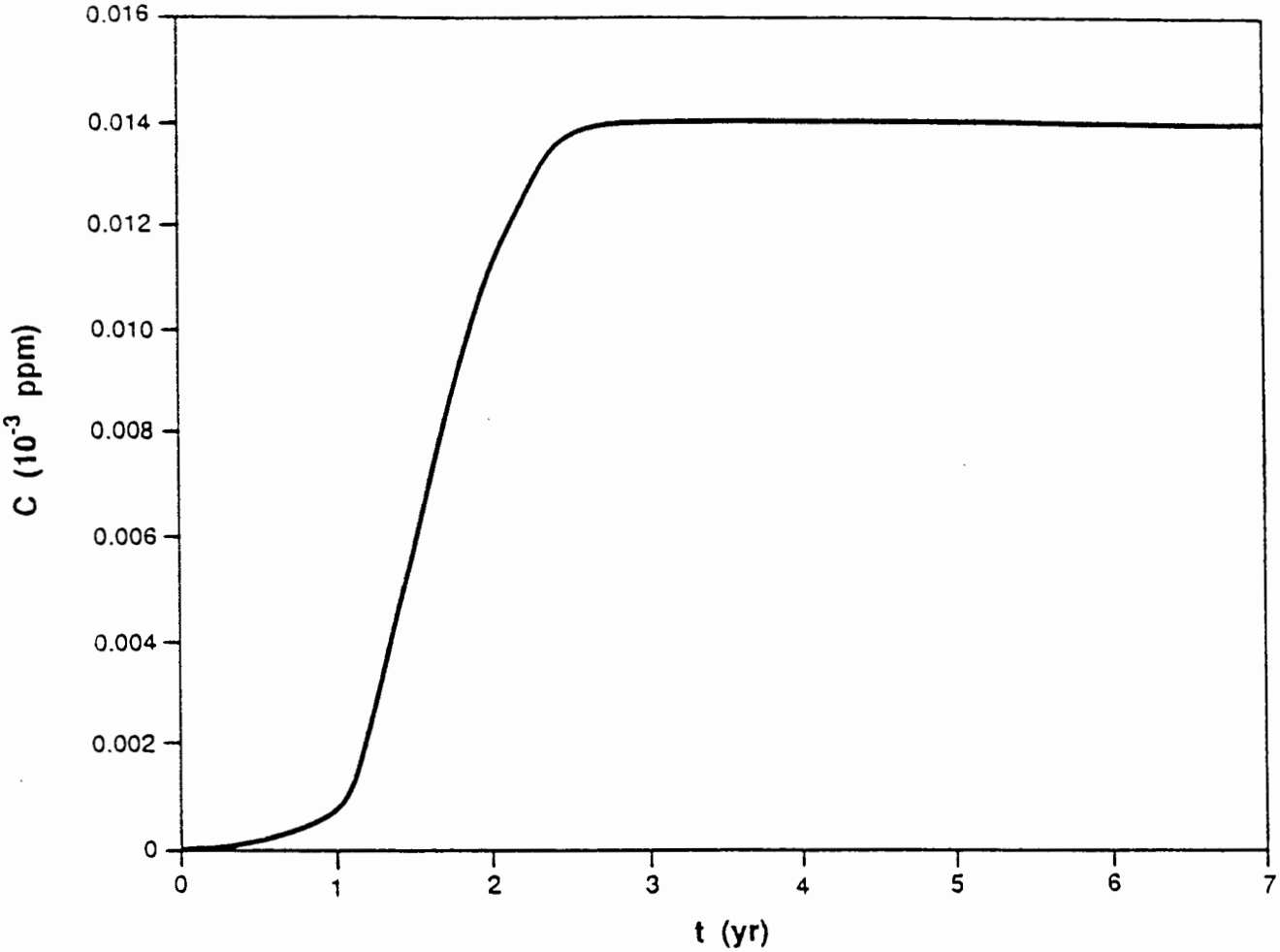


Note:
The year represents the time since contamination entered the aquifer from the base of the vadose zone.

Concentration of 1, 2, 4 -
Tetrachlorobenzene at the Property Line

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1280

Figure B

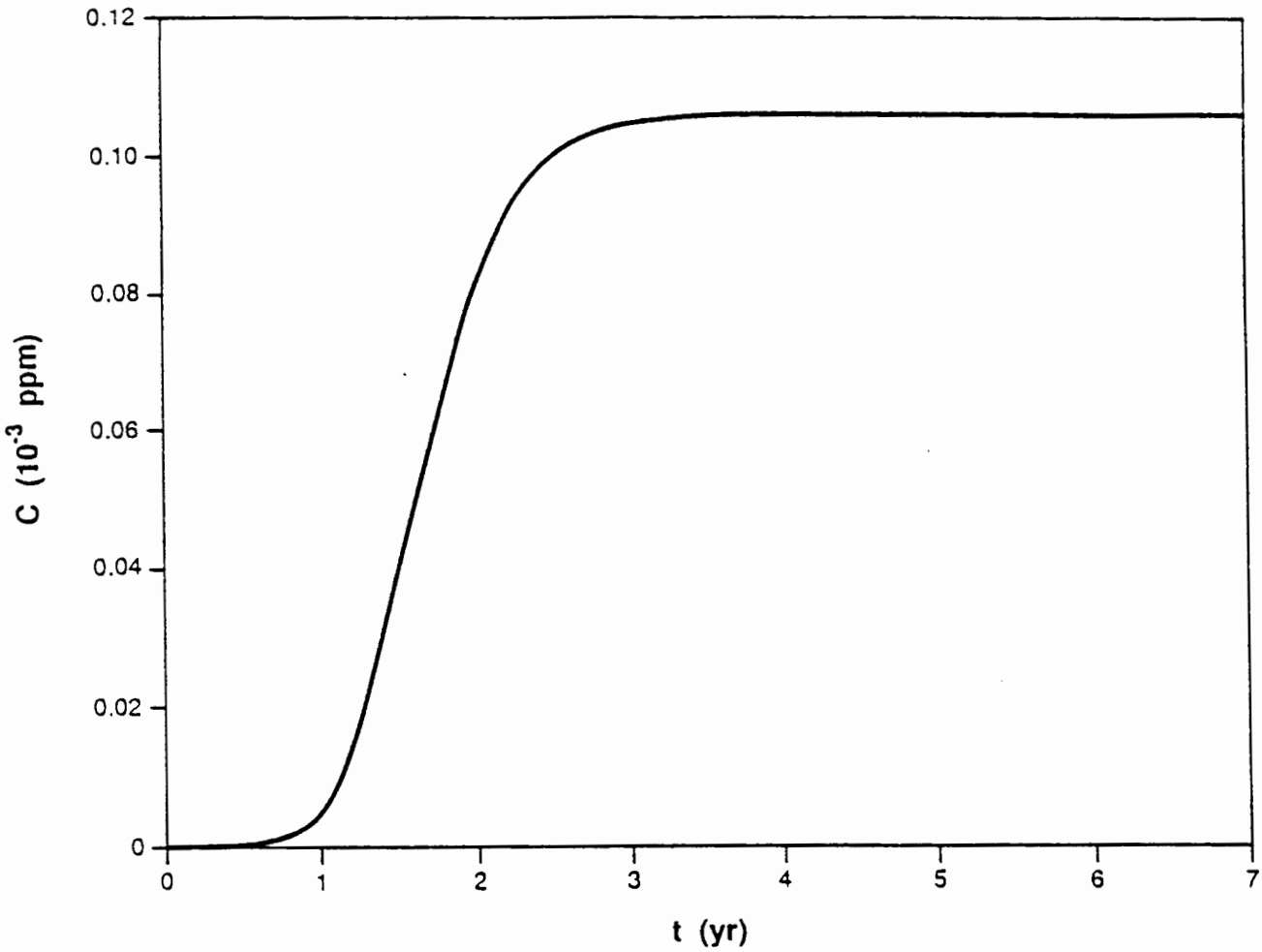


Note:
The year represents the time since contamination entered the aquifer from the base of the vadose zone.

Concentration of Tetrachloroethene at the Property Line

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1290

Figure B-4



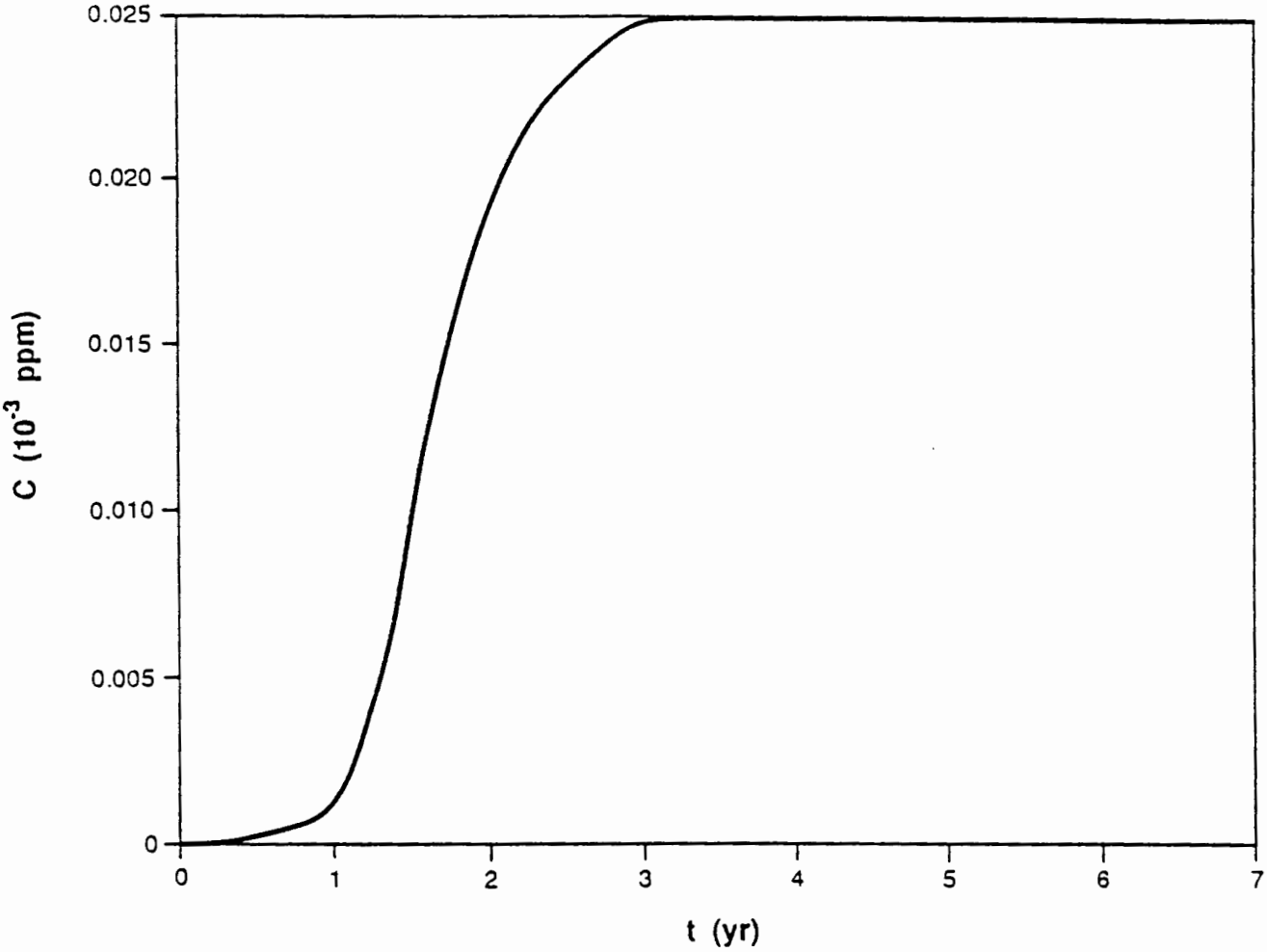
Note:
The year represents the time since contamination entered the aquifer from the base of the vadose zone.

Concentration of Methylene Chloride at the Property Line

DANIEL B. STEPHENS & ASSOCIATES, INC.

4-92 JN 1280

Figure 5

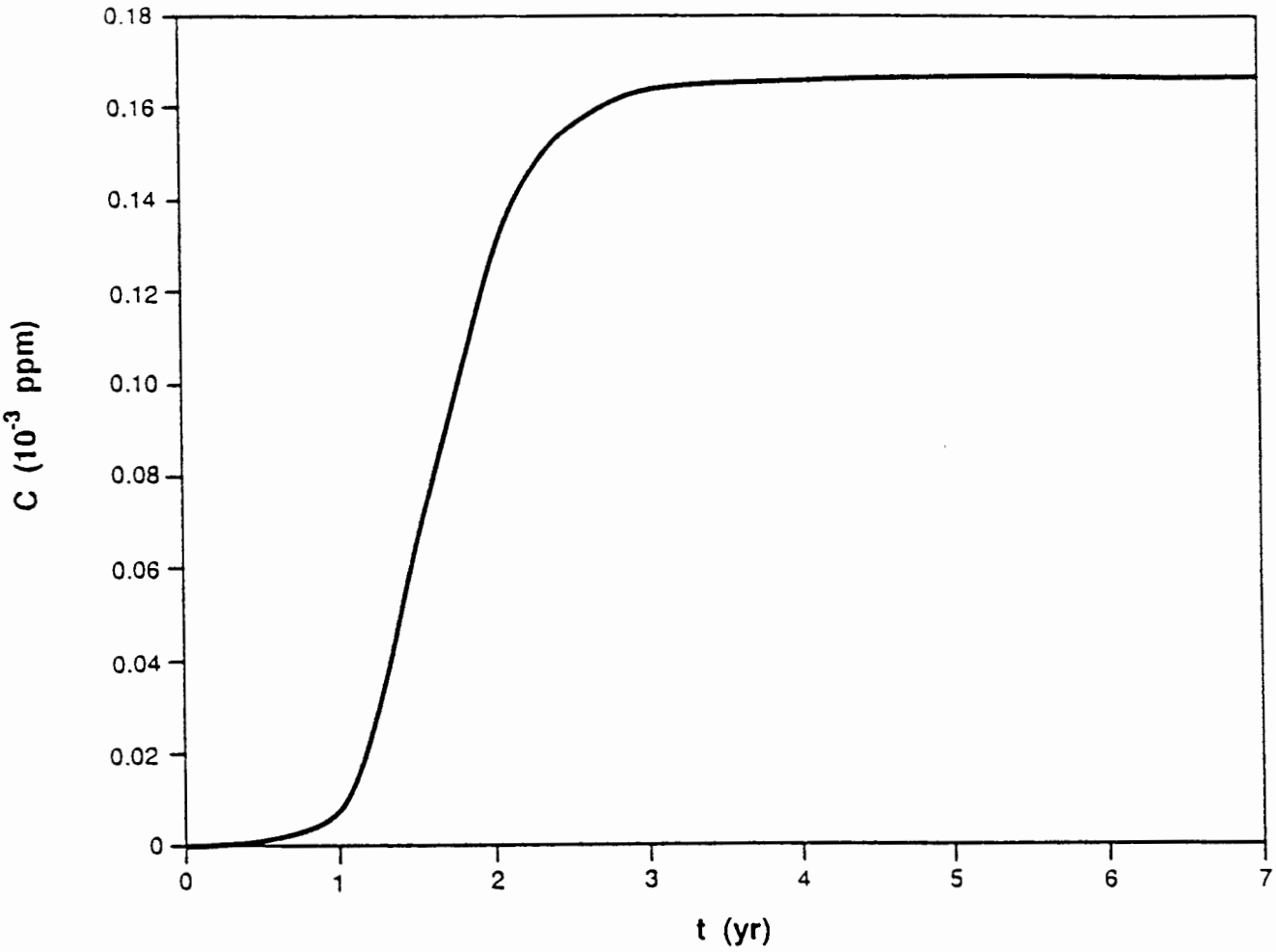


Note:
The year represents the time since contamination entered the aquifer from the base of the vadose zone.

Concentration of 1, 1, 1
Trichloroethane at Property Line

DANIEL B. STEPHENS & ASSOCIATES, INC.
4-92 JN 1290

Figure



Note:
The year represents the time since contamination entered the aquifer from the base of the vadose zone.

Concentration of Toluene at Property Line

DANIEL B. STEPHENS & ASSOCIATES, INC.

4-92 JN 1280

Figure B

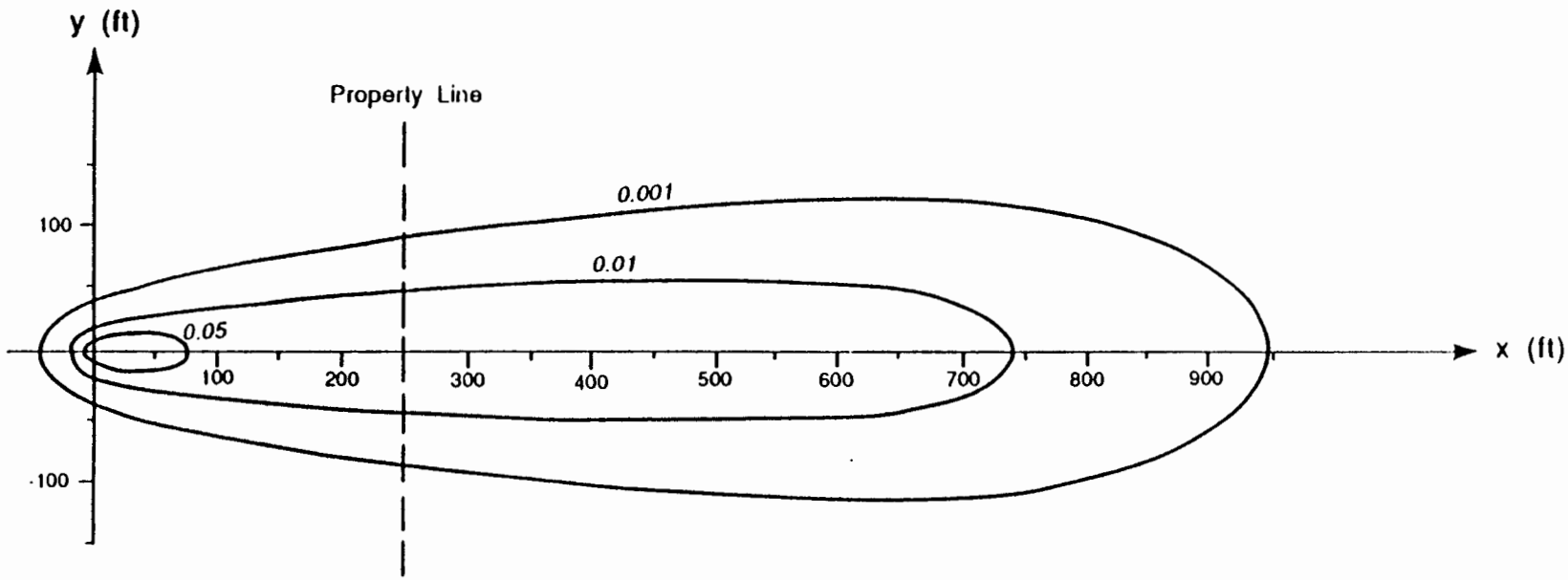


Figure B

Xylenes Plume (in ppm) at Five Years After Loading

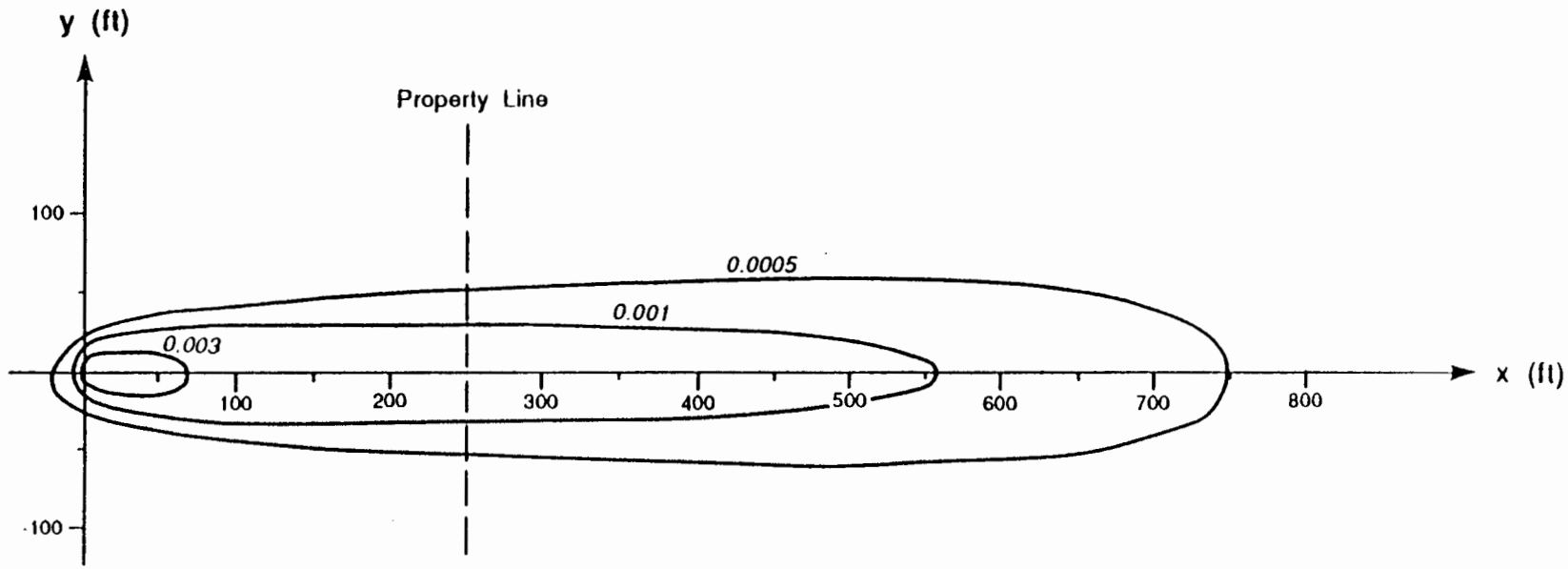


Figure 1

Ethylbenzene Plume (in ppm) at

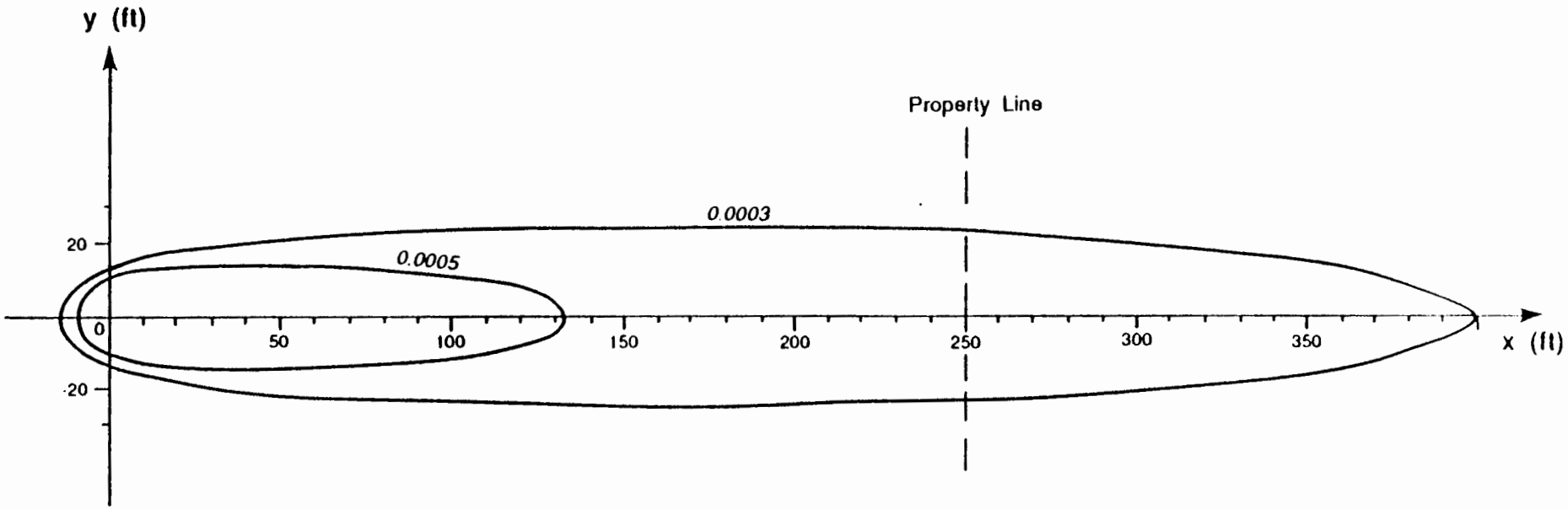
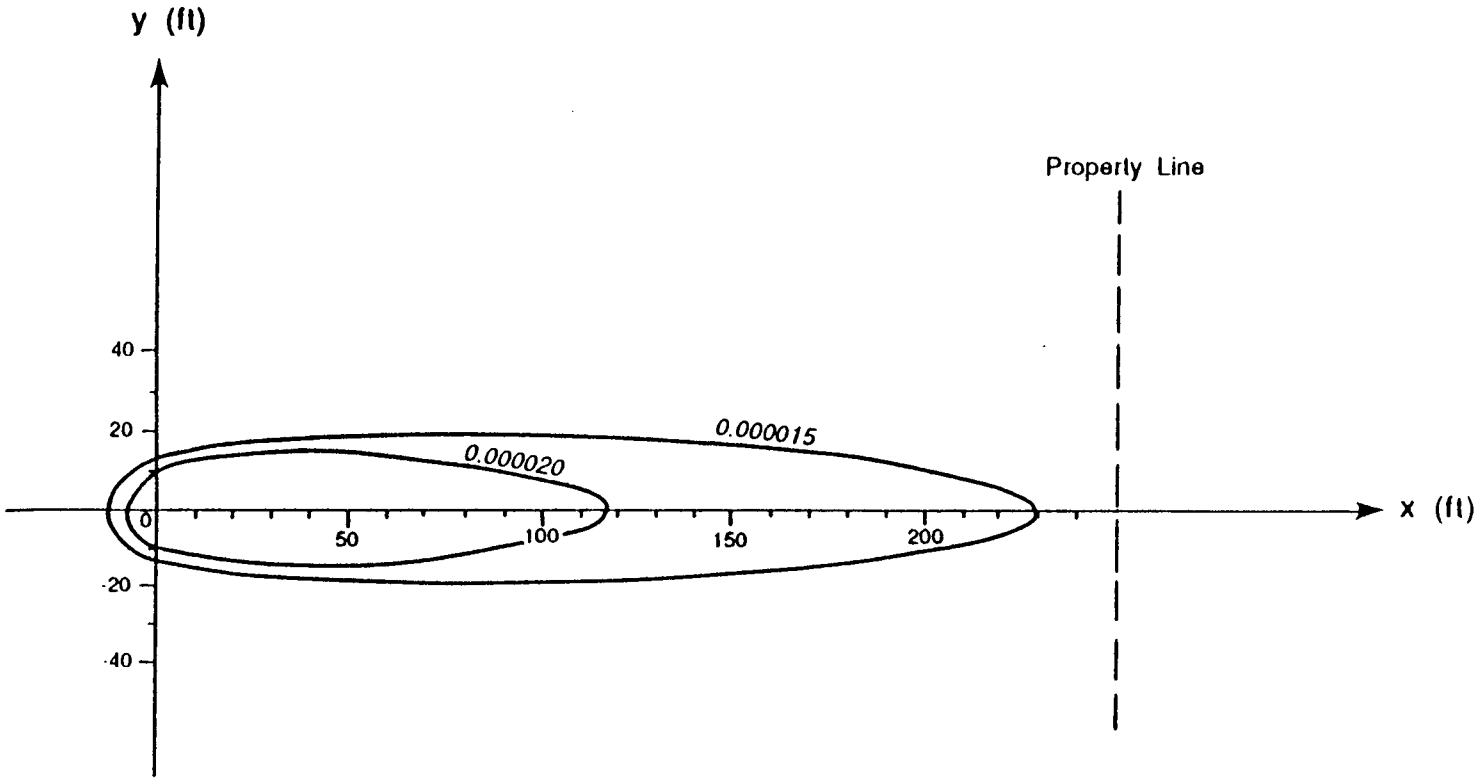


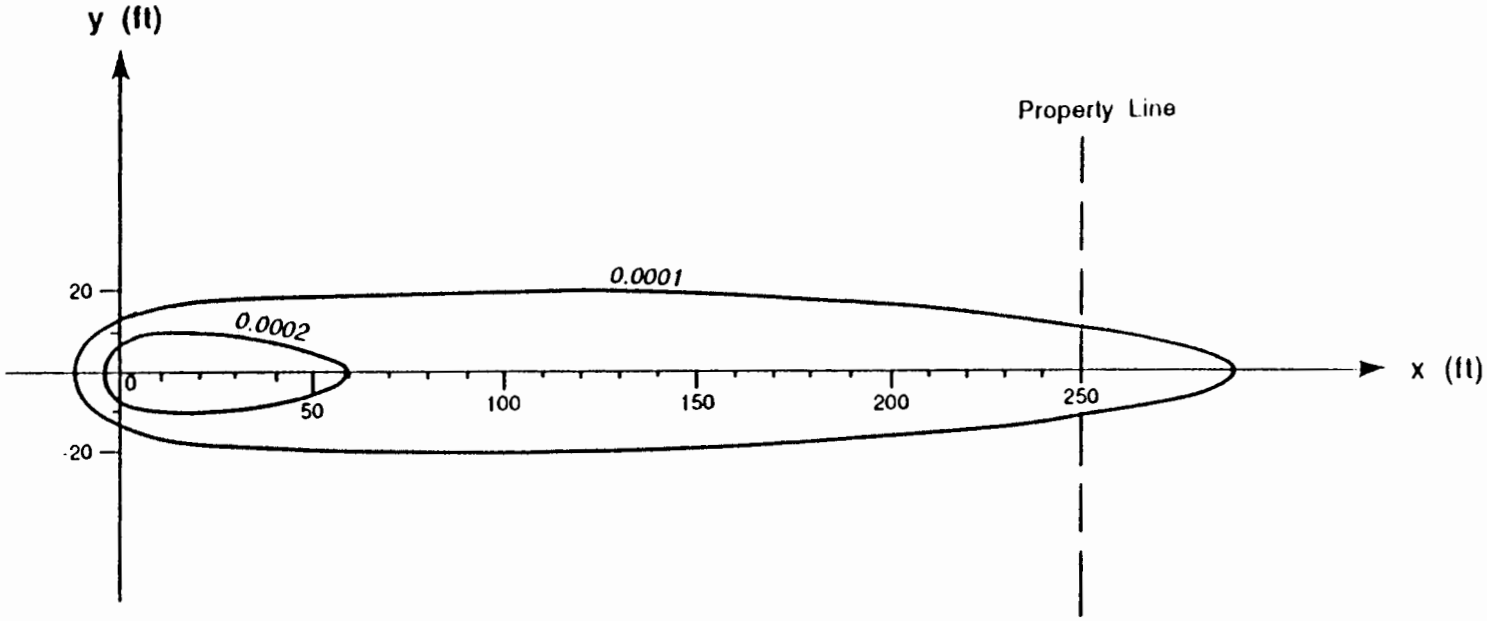
Figure B-

1, 2, 4 - Trichlorobenzene Plume (in ppm) at Five Years After Loading



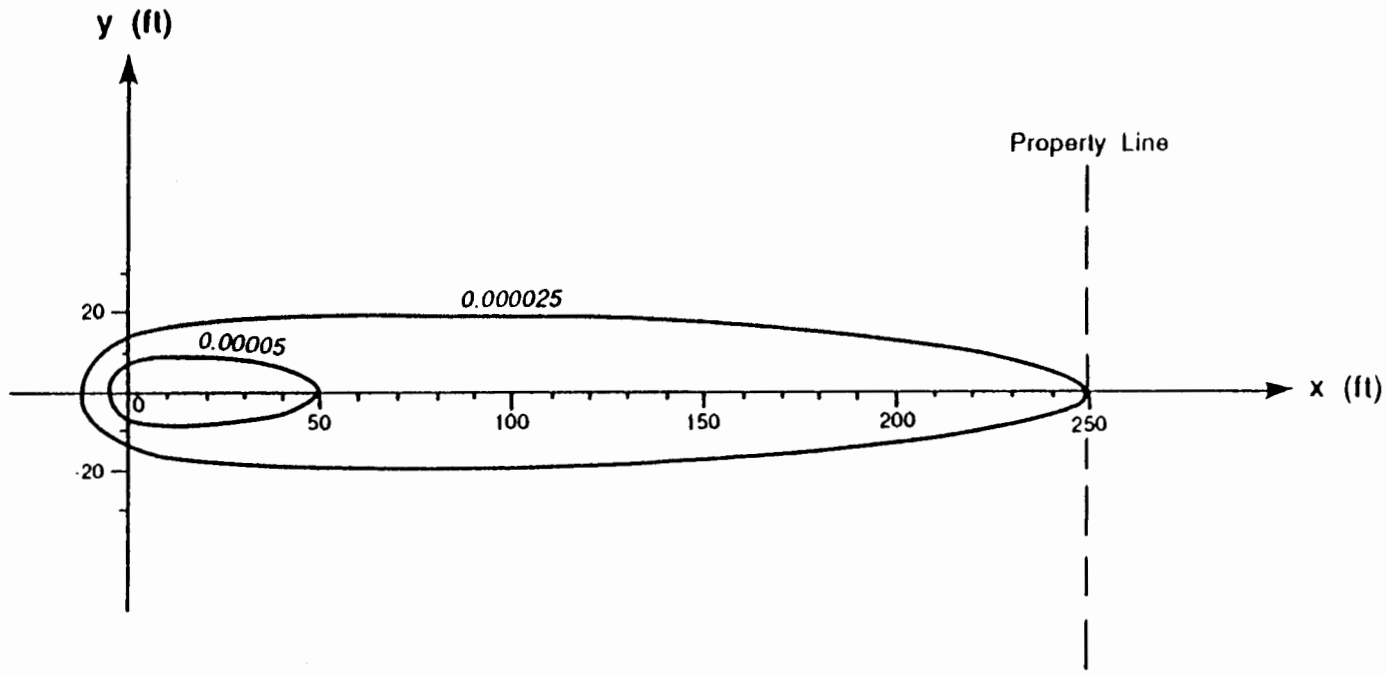
Figure

Tetrachloroethene Plume



Methylene Chloride Plume
(in ppm) at Five Years After Loading

Figure B



1, 1, 1 - Trichloroethane Plume
(in ppm) at Five Years After Loading

Figure B

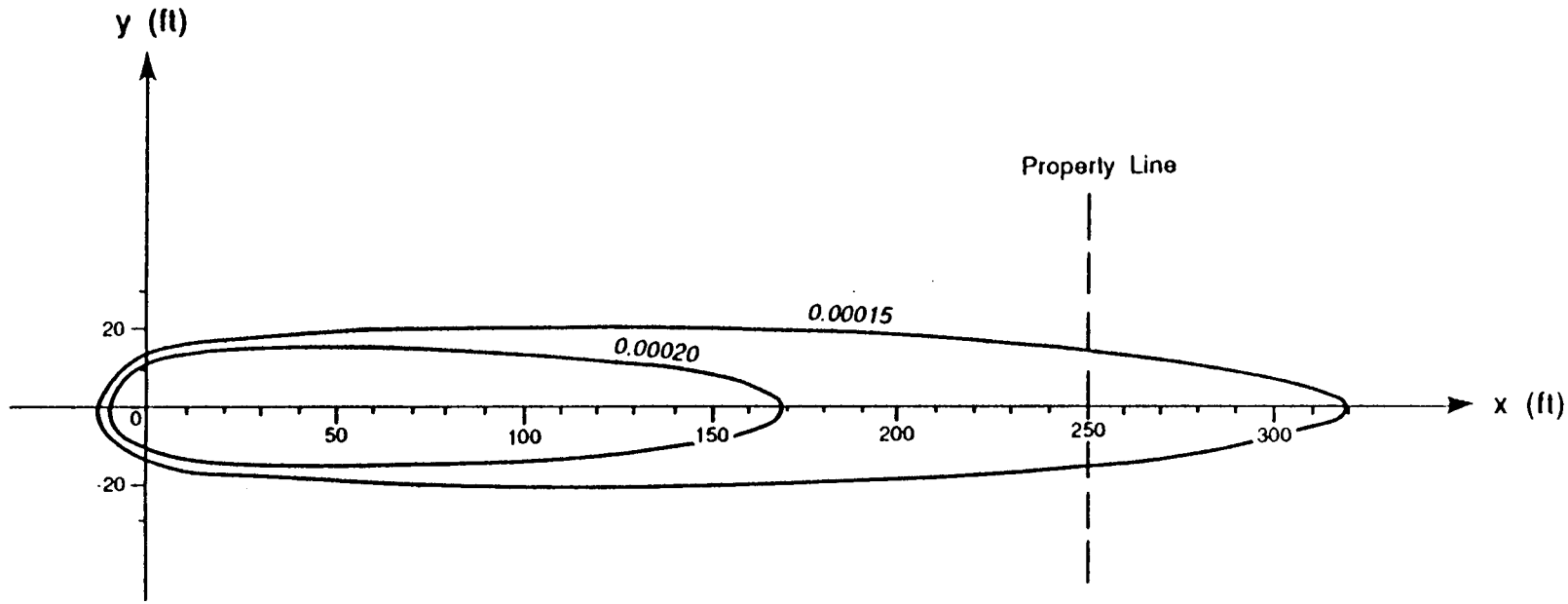


Figure B

Toluene Plume (in ppm) at Five Years After Loading

Attachment B1

VLEACH: A One-Dimensional Finite Difference Vadose Zone Leaching Model

REM IV

Remedial Planning Activities
at Selected Uncontrolled
Hazardous Waste Sites–Zone II

Environmental Protection Agency
Hazardous Site Control Division
Contract No. 68-01-7251

VLEACH
A ONE-DIMENSIONAL FINITE DIFFERENCE VADOSE ZONE LEACHING MODEL

CH2M HILL

Black & Veatch
ICF
PRC
Ecology and Environment

VLEACH
A ONE-DIMENSIONAL FINITE DIFFERENCE VADOSE ZONE LEACHING MODEL

DISCLAIMER

The program VLEACH was written by CH2M HILL for EPA for use specifically on the Phoenix-Goodyear Airport project. Because software is inherently complex and may not be completely free of errors, the user is advised to verify all work performed using this program. CH2M HILL makes no warranties, express or implied, regarding the program or documentation, their fitness for any purpose, their quality, their merchantability, or otherwise. In no event will CH2M HILL be liable for direct, indirect, special, incidental, or consequential damages arising out of the use or inability to use the program or documentation. Its applicability to other sites and conditions has not been evaluated.

Attachment B2

PS2D

```
      PROGRAM PS2D
C-----------------------------------------------------------------
C
C     1) THE PROGRAM IS BASED ON THE ANALYTICAL SOLUTION OF TRANSPORT
C        CAUSED BY A POINT INJECTION IN STEADY UNIFORM 1-D FLOW FIELD.
      2) THE MASS INJECTION RATE IN THIS APPLICATION CAN BE EITHER A
C        CONSTANT OR A STEP FUNCTION.
C     3) THE NUMBER OF POINT SOURCES CAN BE AS MANY AS NECESSARY.
C     4) THIS VERSION IS FOR TRANSPORT IN AQUIFER WITH 2-D DISPERSION.
C     5) THE X AXIS IS SET ALONG THE FLOW DIRECTION
C
C-----------------------------------------------------------------
C
C     INTRODUCTION TO INPUT PARAMETERS:
C     ---------------------------------------------------------
C
C     DX - DISPERSION COEFFICIENT (X) DIVIDED BY RETARDATION FACTOR
C     DY - DISPERSION COEFFICIENT (Y) DIVIDED BY RETARDATION FACTOR
C     DLAMDA - DECAY CONSTANT
C     VX - PORE VELOCITY DIVIDED BY RETARDATION FACTOR
C     FACTOR - A FACTOR FOR CONVERTING THE CONCENTRATION TO THE UNIT
C              YOU LIKE. IF YOU DON'T WANT TO DO IT, PLEASE REMEMBER
C              TO INPUT 1.0 HERE!
C     DELTAT - TIME LAG FOR CONTAMINANTS TO REACH THE AQUIFER,
C              YOU DON'T HAVE TO SPECIFY IT IF IT IS ZERO
C     I - NUMBER OF COLUMNS IN X DIRECTION, MAXIMUM = 60
C     J - NUMBER OF ROWS IN Y DIRECTION, MAXIMUM = 20
C     K - NUMBER OF TIME INSTANTS WHEN CONCENTRATION IS CALCULATED,
C        MAXIMUM = 20. PLEASE ALWAYS INPUT THEM IN AN INCREASE ORDER!
C     IPRINT - SET 1 FOR OBTAINING PLUME DATA; OTHERWISE, YOU GET AN
C              OUTPUT WITH CONCENTRATION BUILD-UP INFORMATION AT ALL
C              POINTS OF CALCULATION.
C     XC - SPECIFIED X COORDINATES
C     YC - SPECIFIED Y COORDINATES
C     T - SPECIFIED TIME VALUES
C     NP - NUMBER OF POINT SOURCES, UNLIMITED
C     XP - X COORDINATE OF THE POINT SOURCE
C     YP - Y COORDINATE OF THE POINT SOURCE
C        NOTE: YOU MUST TRY TO AVOID THE CASE WHERE THE POINT SOURCE
C              IS EXACTLY ONE OF THE CALCULATION POINTS. THIS CAN BE
C              EASILY DONE BY GIVING A VERY SMALL DIFFERENCE IN ONE
C              OF THE COORDINATES (X OR Y).
C     Q1 - MASS RATE CONSTANT ( 0<T<TC )
C     Q2 - MASS RATE CONSTANT ( T>TC )
C     TC - TIME INSTANT WHEN THE MASS RATE CHANGES FROM Q1 TO Q2
C     EPS - MAXIMUM ERROR ALLOWED IN NUMERICAL INTEGRATION, (e.g. 0.00001)
C    ---------------------------------------------------------------
C
      open(unit=8,file='ps2d.dat',status='old')
      open(unit=9,file='ps2d.out',status='new')
C
      CALL MAIN
C
      STOP
      END
C
C
      SUBROUTINE MAIN
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
      REAL*8 A, B, EPS, SUM, Q1, Q2, TC, PI, FACTOR, DELTAT
      INTEGER I, J, K, NP, II, IPRINT
      DIMENSION T(20), C(60,20,20), SC(60,20,20)
      COMMON/DAT/L,M,N,DX,DY,DLAMDA,VX,XC(60),YC(20),XP,YP
      EXTERNAL F
C
      PI = 3.1415926535
```

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Albuquerque, New Mexico

```
C
C     READ INPUT INFORMATION
C
      READ (8,10) DX,DY,DLAMDA,VX,FACTOR,DELTAT
   10 FORMAT (6E10.4)

      READ (8,20) I,J,K,IPRINT
   20 FORMAT (4I5)
C
      READ (8,30) (XC(L),L=1,I)
C
      READ (8,30) (YC(M),M=1,J)
C
      READ (8,30) (T(N),N=1,K)
C
   30 FORMAT (5E10.4)
C
      READ (8,5) NP
    5 FORMAT (I5)
      DO 50 II = 1, NP
      READ (8,15) XP, YP
   15 FORMAT (2E10.4)
      READ (8,25) Q1,Q2,TC,EPS
   25 FORMAT (4E10.4)
      DO 40 L = 1, I
      DO 40 M = 1, J
      DO 40 N = 1, K
      IF (T(N)-TC) 35, 35, 45
   35 IF (N.EQ.1) THEN
      A = 0.001
      B = T(1)
      CALL GAINT (F,A,B,EPS,SUM)
      C(L,M,1) = Q1*SUM/DSQRT(DX*DY)/4.0/PI
      SC(L,M,1) = SC(L,M,1) + C(L,M,1)
       ELSE
      A = T(N-1)
      B = T(N)
      CALL GAINT (F,A,B,EPS,SUM)
      C(L,M,N) = Q1*SUM/DSQRT(DX*DY)/4.0/PI
      C(L,M,N) = C(L,M,N) + C(L,M,N-1)
      SC(L,M,N) = SC(L,M,N) + C(L,M,N)
       ENDIF
      GOTO 40
C
   45 IF (N.EQ.1) THEN
      A = 0.001
      B = T(1)
      CALL GAINT (F,A,B,EPS,SUM)
      C(L,M,1) = Q1*SUM/DSQRT(DX*DY)/4.0/PI
      B = T(1) - TC
      CALL GAINT (F,A,B,EPS,SUM)
      C(L,M,1) = C(L,M,1) -
     A (Q1-Q2)*SUM/DSQRT(DX*DY)/4.0/PI
      SC(L,M,1) = SC(L,M,1) + C(L,M,1)
       ELSE
      A = T(N-1)
      B = T(N)
      CALL GAINT (F,A,B,EPS,SUM)
      C(L,M,N) = Q1*SUM/DSQRT(DX*DY)/4.0/PI
      IF (T(N-1).GT.TC) THEN
        A = T(N-1) - TC
      ELSE
        A = 0.001
      ENDIF
        B = T(N) - TC
      CALL GAINT (F,A,B,EPS,SUM)
```

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```
      C(L,M,N) = C(L,M,N) -
     A (Q1-Q2)*SUM/DSQRT(DX*DY)/4.0/PI
      C(L,M,N) = C(L,M,N) + C(L,M,N-1)
      SC(L,M,N) = SC(L,M,N) + C(L,M,N)
       ENDIF
     0 CONTINUE
    50 CONTINUE
C
      IF (IPRINT.EQ.1) THEN
      DO 70 N = 1, K
      WRITE (9,55) T(N)+DELTAT
    55 FORMAT ('Plume Data at Time =',F10.1)
      WRITE (9,60)
    60 FORMAT ('     X        Y        C')
      DO 70 L = 1, I
      DO 70 M = 1, J
      WRITE (9,65) XC(L),YC(M),SC(L,M,N)*FACTOR
    65 FORMAT (2F10.1,F10.6)
    70 CONTINUE
C
      ELSE
      DO 90 L = 1, I
      DO 90 M = 1, J
      WRITE (9,75) XC(L),YC(M)
    75 FORMAT ('X, Y =',2F10.1)
      WRITE (9,80)
    80 FORMAT ('     t        C')
      DO 90 N = 1, K
      WRITE (9,85) T(N)+DELTAT, SC(L,M,N)*FACTOR
    85 FORMAT (F10.1,F10.6)
    90 CONTINUE
C
      ENDIF

      RETURN
      END
C
C
      SUBROUTINE GAINT (F,A,B,EPS,SUM)
C
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
      DIMENSION RA(3), X(2), HV(30), HM2(30)
      DIMENSION EST2(30), PVAL(60), LRTRN(30)
      COMMON/DAT/L,M,N,DX,DY,DLAMDA,VX,XC(60),YC(20),XP,YP
C
      SUM = 0.0
      VM = 0.5*(B-A)
      XM = 0.5*(B+A)
      LVL = 0
      EST = 1.0
C
      RA(1) = 2.3692688505619D-01
      RA(2) = 4.7862867049937D-01
      RA(3) = 5.6888888888889D-01
      X(1)  = 9.0617984593866D-01
      X(2)  = 5.3846931010568D-01
C
  100 LVL = LVL + 1
      HV(LVL) = VM
      XM1 = XM - 0.5*VM
      XM2 = XM + 0.5*VM
      HM2(LVL) = XM2
      EST1 = RA(3)*F(XM1)
      EST2(LVL) = RA(3)*F(XM2)
C
      DO 110 I = 1, 2
```

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```
      DD = X(I)*VM*0.5
      EST1 = EST1 + RA(I)*( F(XM1-DD) + F(XM1+DD) )
  110 EST2(LVL) = EST2(LVL) + RA(I)*( F(XM2-DD) + F(XM2+DD) )
      EST1 = EST1*VM*0.5
      EST2(LVL) = EST2(LVL)*VM*0.5
      SUM = EST1 + EST2(LVL)
C
      ABSAR = DABS(EST1) + DABS(EST2(LVL))
      IF(DABS(EST-SUM) - EPS*ABSAR) 120, 120, 130
  120 IF(EST - 1.0) 150, 130, 150
  130 IF(LVL - 30) 140, 150, 150
  140 LRTRN(LVL) = 1
C
      EST = EST1
      XM = XM1
      VM = 0.5*VM
      GOTO 100
C
  150 LVL = LVL - 1
      IND2 = LRTRN(LVL)
      IX1 = LVL
      IF(IND2.EQ.2) IX1 = LVL + 30
      PVAL(IX1) = SUM
      GOTO (160, 170) IND2
C
  160 LRTRN(LVL) = 2
      EST = EST2(LVL)
      XM = HM2(LVL)
      VM = HV(LVL)*0.5
      GOTO 100
C
  170 SUM = PVAL(LVL) + PVAL(LVL+30)
      IF(LVL-1) 180, 180, 150

  180 RETURN
      END
C
C
      REAL*8 FUNCTION F(Y)
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
      REAL*8 Y
      COMMON/DAT/L,M,N,DX,DY,DLAMDA,VX,XC(60),YC(20),XP,YP
C
      F = 0.0
      F = DEXP( - (XC(L)-XP-VX*Y)**2/4.0/DX/Y
     A          - (YC(M)-YP)**2/4.0/DY/Y - DLAMDA*Y ) / Y
      RETURN
      END
```

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XCON: Initial concentration of contaminant in each of cells J1 through J2 (mg/kg).

REPEAT Card 5 as necessary, until each cell has been described and J2 equals NCELL.

An example input file is attached as Appendix B.

Appendix A
VLEACH PROGRAM LISTING

```
      PROGRAM VLEACH
* Vadose Zone Leaching Model, Version 1.02
* June 1989, Jake Turin

* This version updated by Fritz Carlson/RDD in July 1989 to allow
* contaminant concentrations to be input in the units of ug/Kg of soil.
* Program further updated by Mike Sukop and Peter Lawson/RDD in January
* 1990 to allow an impermeable boundary condition to be set for gaseous
* diffusion at the soil/atmosphere interface. A negative value input for
* CATM will impose this boundary upper condition.

* This program models liquid advection, gas diffusion, and
*  three-phase equilibration in the vadose zone.
* Current limitations include constant cell dimensions and
*  homogeneous soil properties for each polygon throughout the profile.
* Advection solution is time-centered (Crank-Nicholson), space-upward.
* Diffusion solution is backward-difference (fully-implicit), space-cent
* Simultaneous equations are solved in matrix form using the Thomas algo

* Maximum number of cells and printout times is controlled by dimension
*  statements below.

* V-Leach operates either in batch mode or interactive mode.
* If file BATCH.INP exists, program uses it for input, writes
* output to BATCH.PRM and BATCH.OUT.  If it doesn't exist, it seeks
* interactive user input.

      IMPLICIT REAL (M,K)

      COMMON /FILES/ IINP,IPRM,IOUT,IPRF
      COMMON /CHEM/ KOC,KH,CMAX,DAIR
      COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL

* dimension on next line is max number of printout intervals
      DIMENSION GTOTAL(200),GWIMP(200)
* dimension on next line is max number of cells
      DIMENSION CGAS(150),CLIQ(150),CS(150),
     &  AGAS(3,150),ALIQ(3,150),RHS(150)
      CHARACTER TITLE1*80,FINAME*12
      LOGICAL BATCH

* Input data:
*  Simulation Parameters:
* TITLE1:       Description of problem
* NPOLY :       Number of Polygons
* DELT  :       Computational time-step (years)
* STIME :       Total simulation duration (years)
* PTIME :       Time interval for mass-balance & g.w. impact reports
* PRTIME:       Time interval for vertical concentration profile repor
*  Chemical Parameters:
* KOC   :       Organic carbon distribution coefficient (ml/g)
* KH    :       Henry's constant (dimensionless)
* CMAX  :       Aqueous solubility (mg/l)
* DAIR  :       Free air diffusion coefficient (m2/d)
*  Polygon-specific parameters:
* TITLE :       Description of polygon
* AREA  :       Area of polygon (sq. ft.)
* DELZ  :       Vertical spacing of cells (ft)
* Q     :       Groundwater recharge rate (ft/yr)
* RHOB  :       Dry bulk density of soil (g/ml)
```

```
* POR   :        Total effective porosity of soil (dimensionless)
* THETA :        Volumetric water content of soil (dimensionless)
* FOC   :        Organic carbon content of soil (dimensionless)
* CINF  :        Concentration of solute in infiltrating water (mg/l)
* CATM  :        Concentration of solute in atmosphere (mg/l)
*       CATM < 0., soil surface is impermeable to gas diffusion
*       CATM >= 0., fixed atmospheric concentration at soil surface, (mg
* CGW   :        Lower b'dry condition for gas diffusion:
*       CGW < 0., water table is impermeable to gas diffusion
*       CGW >= 0., fixed concentration at water table, (mg/l)
* NCELL :        Number of vertical cells


* prints heading and version number
        WRITE(*,21)
21      FORMAT (' V-Leach, VER 1.02'/' J. Turin, 6/89; F. Carlson, 7/89
     &  M. Sukop and P. Lawson, 1/90')

* test for batch mode
        INQUIRE(FILE='BATCH.INP',EXIST=BATCH)

* assign unit numbers
        IINP = 21
        IPRM = 22
        IOUT = 23
        IPRF = 24

* open files
        IF (BATCH) THEN
* batch mode
        WRITE (*,*) 'Batch Mode.'
        OPEN (IINP,FILE='BATCH.INP')
        OPEN (IPRM,FILE='BATCH.PRM')
        OPEN (IOUT,FILE='BATCH.OUT')
        OPEN (IPRF,FILE='BATCH.PRF')
        ELSE

* interactive mode
        WRITE (*,*) 'Interactive Mode.'
        WRITE(*,'(A\)') ' Enter input file name: '
        READ(*,'(A)') FINAME
        OPEN (IINP,FILE=FINAME,STATUS='OLD')


        WRITE(*,'(A\)') ' Enter parameter output file name: '
        READ(*,'(A)') FINAME
        OPEN (IPRM,FILE=FINAME)

        WRITE(*,'(A\)') ' Enter groundwater impact output file name: '
        READ(*,'(A)') FINAME
        OPEN (IOUT,FILE=FINAME)

        WRITE(*,'(A\)') ' Enter vertical profile output file name: '
        READ(*,'(A)') FINAME
        OPEN (IPRF,FILE=FINAME)

        ENDIF
        WRITE (*,*)

* read overall simulation input data
```

```
      READ (IINP,11) TITLE1
      READ (IINP,12) NPOLY
      READ (IINP,14) DELT,STIME,PTIME,PRTIME
      READ (IINP,14) KOCI,KH,CMAXI,DAIRI

* convert ml/g to ft3/g
      KOC = KOCI/28317.
* convert mg/l TO g/ft3
      CMAX = CMAXI*.028317
* convert m2/d TO ft2/yr
      DAIR = DAIRI*3929.

* write data back to IPRM
      WRITE (IPRM,21)
      WRITE (IPRM,11) TITLE1
      WRITE (IPRM,101) NPOLY
      WRITE (IPRM,102) DELT,STIME,PTIME,PRTIME
      WRITE (IPRM,103) KOCI,KOC
      WRITE (IPRM,104) KH
      WRITE (IPRM,105) CMAXI,CMAX
      WRITE (IPRM,106) DAIRI,DAIR

101   FORMAT(I3,' polygons.')
102   FORMAT('Timestep = ',F6.2,' years.  Simulation length = ',
     &  F7.2,' years.'/'Printout every ',F6.2,' years.  ',
     &  'Vertical profile stored every ',F6.2,' years.')
103   FORMAT('Koc = ',G15.5,'ml/g,  ',G15.5,'cu.ft./g')
104   FORMAT('Kh = ',G15.5,' (dimensionless).')
105   FORMAT('Aqueous solubility =',G15.5,' mg/l, ',G15.5,' g/cu.ft
106   FORMAT('Free air diffusion coefficient = ',G10.5,
     &  ' sq. m/day,  ',G10.5,' sq.ft./yr')

11    FORMAT (A)
12    FORMAT (16I5)
14    FORMAT (8F10.0)
16    FORMAT (2I5,F10.0)

* set up output file
      WRITE (IOUT,21)
      WRITE (IOUT,11) TITLE1

      NTIME=INT(STIME/PTIME)


* initialize total gw impact array
      DO 100 I=1,NTIME
100   GTOTAL(I) = 0.

* call MAIN for each polygon
      DO 200 IPOLY=1,NPOLY

      WRITE(IPRM,107) IPOLY
107   FORMAT(//'Polygon ',I3)
      WRITE (*,*)

      CALL MAINS(GWIMP,CGAS,CLIQ,CS,AGAS,ALIQ,RHS,IPOLY)

* accumulate grand totals
      DO 150 IT = 1,NTIME
150   GTOTAL(IT) = GTOTAL(IT) + GWIMP(IT)
```

```
200     CONTINUE

* write grand total results to output file
        WRITE (IOUT,201)
        GCUM = 0.
        DO 250 IT = 1,NTIME
        GCUM = GCUM+GTOTAL(IT)
250     WRITE (IOUT,202) IT*PTIME,GTOTAL(IT),GCUM

201     FORMAT(/'*****************************************************
     &   /'TOTAL GROUNDWATER IMPACT'//
     &   ' Time (yr)          Mass (g)      Cumulative Mass (g)')
202     FORMAT(F10.2,5X,2G15.5)

        STOP
        END


*****************************************************************


        SUBROUTINE MAINS(GWIMP,CGAS,CLIQ,CS,AGAS,ALIQ,RHS,IPOLY)

* this is the main subroutine which runs the simulation for each poly


        IMPLICIT REAL (M,K)
        COMMON /FILES/ IINP,IPRM,IOUT,IPRF
        COMMON /CHEM/ KOC,KH,CMAX,DAIR
        COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL
        COMMON /BDRY/ CINF,CATM,CGW
        COMMON /SOIL/ RHOB,POR,THETA,FOC
        COMMON /PROCESS/ GASDIF,LIQADV,SORBED,GASPHS

        DIMENSION CGAS(NCELL),CLIQ(NCELL),CS(NCELL),FACT(2,3),
     &   GWIMP(NTIME),AGAS(3,NCELL),ALIQ(3,NCELL),RHS(NCELL)
        LOGICAL LIQADV,GASDIF,SORBED,GASPHS
        CHARACTER*80 TITLE

        DO 10 I=1,NCELL
        CGAS(I)=0.
        CLIQ(I)=0.
10      CS(I)=0.

* read polygon-specific input data

        READ (IINP,11) TITLE
        READ (IINP,14) AREA,DELZ,Q,RHOBI,POR,THETA,FOC
        READ (IINP,14) CINFI,CATMI,CGWI
        READ (IINP,12) NCELL,ICODE
* icode determines type of initial conditions
* read initial conditions - for time being, assume total mass
60      READ (IINP,16) J1,J2,XCON
* convert input as ug/kg to g/ft**3
        xcon=xcon*rhobi*1e-6*28.31605
        IF (J2 .GT. NCELL) J2=NCELL
        DO 70 ICELL = J1,J2
70      CLIQ(ICELL)=XCON/(THETA*DELZ)
        IF (J2 .LT. NCELL) GOTO 60
```

NOTE: An erro
was discovered
the original p
(THETA*DELZ) s
be replaced by
(THETA).

```
11      FORMAT (A)
12      FORMAT (16I5)
14      FORMAT (8F10.0)
16      FORMAT (2I5,F10.0)

* convert g/ml to g/cu.ft.
        RHOB = RHOBI*28317.
* convery mg/l to g/cu.ft.
        CINF = CINFI*.028317
        CATM = CATMI*.028317
        CGW = CGWI*.028317
* write data back to IPRM
        WRITE(IPRM,11)TITLE
        WRITE(IPRM,201)AREA
        WRITE(IPRM,202)NCELL,DELZ
        WRITE(IPRM,203)RHOBI,RHOB,POR,THETA,FOC
        WRITE(IPRM,204)Q,CINFI,CINF,CATMI,CATM
        IF (CGW .LT. 0.) THEN
                WRITE(IPRM,205)
        ELSE
                WRITE(IPRM,206)CGWI,CGW
        ENDIF

201     FORMAT('Polygon area = ',G15.5,'sq. ft.')
202     FORMAT( I3,' cells, each cell ',F6.3,' ft. thick.')
203     FORMAT('Soil Properties:'/' Bulk density =',G15.5,
     &   'g/ml,  ',G15.5,'g/cu.ft.'/' Porosity = ',F6.4,
     &   ' Volumetric water content = ',F6.4/
     &   ' Organic carbon content = ',F10.8)
204     FORMAT('Recharge Rate = ',F10.8,' ft/yr'/
     &   'Conc. in recharge water = ',G15.5,'mg/l,  ',G15.5,'g/cu.ft'/
     &   'Atmospheric concentration = ',G15.5,'mg/l,  ',G15.5,'g/cu.ft'
205     FORMAT('Water table is impermeable to gas diffusion.')
206     FORMAT('Water table has a fixed concentration of ',G15.5,
     & 'mg/l,  ',G15.5,'g/cu.ft.'/'   with respect to gas diffusion.')

* check for active processes
        GASPHS = .TRUE.
        IF (KH .EQ. 0.) GASPHS = .FALSE.

        GASDIF = .TRUE.
        IF (KH .EQ. 0. .OR. DAIR .EQ. 0.) GASDIF = .FALSE.

        LIQADV = .TRUE.
        IF (Q .EQ. 0.) LIQADV = .FALSE.

        SORBED = .TRUE.
        IF (KOC .EQ. 0. .OR. FOC .EQ. 0.) SORBED = .FALSE.

* initial calculations - gas diffusion
        IF (GASDIF) THEN
                D = DAIR*((POR-THETA)**(10./3.))/(POR*POR)
                ALPHA = (DELT*D)/(DELZ*DELZ)
                CALL IGAS(ALPHA,AGAS)
        ENDIF

* initial calculations - liquid advection
        IF (LIQADV) THEN
                BETA = (Q*DELT)/(2.*THETA*DELZ)
```

```
                CALL ILIQ(BETA,ALIQ)
        ENDIF

* initial calculations - equilibration
        CALL IEQUIL(FACT)


* initial equilibration
        CALL EQUIL(CGAS,CLIQ,CS,MGTOT,MLTOT,MSTOT,MTOTAL,FACT,IFLAG)
        IF (IFLAG .GT. 0) WRITE (IOUT,401) 0.,IFLAG

401     FORMAT('WARNING!!!  At time = ',F10.2,
     &   ', aqueous solubility was exceeded in ',I3,' cells.')

        WRITE (IOUT,301) IPOLY,0.,MTOTAL,MGTOT,MLTOT,MSTOT
301     FORMAT(//'Polygon ',I3/'At time = ',F10.2,
     &   ', total mass in vadose zone =',G15.5,'g/sq.ft.'/
     &   'Mass in gas phase      =  ',G15.5,'g/sq.ft.'/
     &   'Mass in liquid phase   =  ',G15.5,'g/sq.ft.'/
     &   'Mass sorbed            =  ',G15.5,'g/sq.ft.')

        MTO = MTOTAL
        MTP = MTOTAL
        MLTCUM = 0.
        MLBCUM = 0.
        MGTCUM = 0.
        MGBCUM = 0.
        MLTINT = 0.
        MLBINT = 0.
        MGTINT = 0.
        MGBINT = 0.

* initialize for time steps
        ITIME = 0

        WRITE (*,1001) IPOLY
1001    FORMAT ('+Beginning Calculations for Polygon ',I3)

* write vertical concentration profiles
        WRITE(IPRF,101) TITLE,0.
        DO 450 I=1,NCELL
450     WRITE(IPRF,102) I,CGAS(I),CLIQ(I),CS(I)

1000    ITIME = ITIME + 1
        TIME = ITIME * DELT

* gas diffusion step
        IF (GASDIF) THEN

        CALL GAS(AGAS,CGAS,ALPHA,RHS)

* b'dry flux calculations
* fully implicit
        MGT = (POR-THETA)*DELT*D*(CATM - CGAS(1))/DELZ
        MGB = (POR-THETA)*DELT*D*(CGW - CGAS(NCELL))/DELZ
        IF (CGW .LT. 0.) MGB = 0.
        IF (CATM .LT. 0.) MGT = 0.
        ENDIF

* liquid advection step
```

```
      IF (LIQADV) THEN

      CBOT = CLIQ(NCELL)

      CALL LIQ(ALIQ,CLIQ,BETA,RHS)

* b'dry flux calculations
      MLT = DELT*Q*CINF
      MLB = -DELT*Q*(CBOT+CLIQ(NCELL))/2.

      ENDIF

* mass equilibration step
      CALL EQUIL(CGAS,CLIQ,CS,MGTOT,MLTOT,MSTOT,MTOTAL,FACT,IFLAG)
      IF (IFLAG .GT. 0) WRITE (IOUT,401) TIME,IFLAG

* mass balance calculations
      MLTCUM = MLTCUM + MLT
      MLBCUM = MLBCUM + MLB
      MGTCUM = MGTCUM + MGT
      MGBCUM = MGBCUM + MGB
      MLTINT = MLTINT + MLT
      MLBINT = MLBINT + MLB
      MGTINT = MGTINT + MGT
      MGBINT = MGBINT + MGB

      IF (MOD(TIME,PTIME) .EQ. 0.) THEN

      WRITE (*,1002) IPOLY,TIME
1002  FORMAT ('+Calculating Polygon ',I3,' at time ',F10.4)

* write output data
      GWIMP(INT(TIME/PTIME)) = -AREA*(MLBINT+MGBINT)
      CALL OUTPUT(TIME,MTO,MTP,MLTCUM,MLBCUM,MGTCUM,MGBCUM,
     &  MLTINT,MLBINT,MGTINT,MGBINT,MGTOT,MLTOT,MSTOT,MTOTAL,IPOLY)

      ENDIF

      IF (MOD(TIME,PRTIME) .EQ. 0.) THEN
* write vertical concentration profiles

      WRITE(IPRF,101) TITLE,TIME
      DO 500 I=1,NCELL
500   WRITE(IPRF,102) I,CGAS(I),CLIQ(I),CS(I)
101   FORMAT (/A/'Time: 'F10.3/
     &  'Cell       Cgas(g/cu.ft.)   Cliq(g/cu.ft.)  Csol')
102   FORMAT (I5,3G15.5)

      ENDIF

      IF (TIME .LT. STIME) GOTO 1000

      WRITE (*,1003) IPOLY
1003  FORMAT ('+Polygon ',I3,' complete.                                  ')

      WRITE (IOUT,1011) IPOLY
      DO 250 IT = 1,NTIME
250   WRITE (IOUT,1012) IT*PTIME,GWIMP(IT)/AREA,GWIMP(IT)
      WRITE (IOUT,1013)
```

```
1011    FORMAT(///'GROUNDWATER IMPACT OF POLYGON ',I3//
     &   ' Time          Mass per area (g/sq.ft.)       Total Mass (g)'
1012    FORMAT(F10.2,5X,G15.5,10X,G15.5)
1013    FORMAT('*****************************************************

        RETURN
        END

*****************************************************************

        SUBROUTINE IGAS(ALPHA,AGAS)

* this subroutine sets up the left-hand side matrix for gas
* diffusion, and reduces it using the Thomas algorithm

        DIMENSION AGAS(3,NCELL)
        COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL
        COMMON /BDRY/ CINF,CATM,CGW

        DO 10 I=1,3
        DO 10 J=1,NCELL
10      AGAS(I,J)=0.

        A1 = -ALPHA
        A2 = 1.+2.*ALPHA

        DO 20 I=1,NCELL
        AGAS(1,I) = A1
        AGAS(2,I) = A2
20      AGAS(3,I) = A1

* impermeable lower boundary
        IF (CGW .LT. 0.) AGAS(2,NCELL) = 1.+ALPHA
* impermeable upper boundary
        IF (CATM .LT. 0.) AGAS(2,1) = 1.+ALPHA

        CALL THOMAS(AGAS,NCELL)

        RETURN
        END

*****************************************************************

        SUBROUTINE ILIQ(BETA,ALIQ)

* this subroutine sets up the left-hand side matrix for liquid
* advection, and reduces it using the Thomas algorithm

        COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL
        DIMENSION ALIQ(3,NCELL)

        DO 10 I=1,3
        DO 10 J=1,NCELL
10      ALIQ(I,J)=0.

        A1 = -BETA
        A2 = 1.+BETA

        DO 20 I=1,NCELL
```

```
      ALIQ(1,I) = A1
20    ALIQ(2,I) = A2

      CALL THOMAS(ALIQ,NCELL)

      RETURN
      END

*****************************************************************

      SUBROUTINE IEQUIL(FACT)

      IMPLICIT REAL (M,K)
      COMMON /SOIL/ RHOB,POR,THETA,FOC
      COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL
      COMMON /CHEM/ KOC,KH,CMAX,DAIR
      COMMON /PROCESS/ GASDIF,LIQADV,SORBED,GASPHS

      LOGICAL GASDIF,LIQADV,SORBED,GASPHS
      DIMENSION FACT(2,3)

* initial calculations - equilibrium factors
      KD = KOC*FOC
      CGW = CGW*KH
* FACT(1,I) converts from concentration in phase I to mass in phase I
* phases: 1:gas, 2:liquid, 3: sorbed
      FACT(1,1) = (POR-THETA)*DELZ
      FACT(1,2) = THETA*DELZ
      FACT(1,3) = RHOB*DELZ
* FACT(2,I) partitions total mass to concentration in phase I
      IF (GASPHS) THEN
      FACT(2,1) = 1./(DELZ*(THETA/KH + (POR-THETA) + RHOB*KD/KH))
            ELSE
      FACT(2,1) = 0.
      ENDIF

      FACT(2,2) = 1./(DELZ*(THETA + (POR-THETA)*KH + RHOB*KD))

      IF (SORBED) THEN
      FACT(2,3) = 1./(DELZ*(THETA/KD + (POR-THETA)*KH/KD + RHOB))
            ELSE
      FACT(2,3) = 0.
      ENDIF

      RETURN
      END

*****************************************************************

      SUBROUTINE GAS(AGAS,CGAS,ALPHA,RHS)
* this subroutine sets up the right-hand side of the gas-diffusion
* calculation, calls SOLVET to do the calculation, computes b'dry flux
* time-forward, fully implicit

      COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL
      COMMON /BDRY/ CINF,CATM,CGW
      DIMENSION AGAS(3,NCELL),CGAS(NCELL),RHS(NCELL)

      DO 10 I=1,NCELL
10    RHS(I) = CGAS(I)
```

VLEACH
A ONE-DIMENSIONAL FINITE DIFFERENCE VADOSE ZONE LEACHING MODEL.

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VLEACH
A ONE-DIMENSIONAL FINITE DIFFERENCE VADOSE ZONE LEACHING MODEL

MODEL DESCRIPTION

INTRODUCTION

VLEACH is a one-dimensional finite difference model designed to simulate the leaching of a volatile, sorbed contaminant through the vadose zone. (Although the term "contaminant" is used throughout this guide, VLEACH could be used to model the transport of any non-reactive chemical that displays linear partitioning behavior). It models four main processes: liquid-phase advection, solid-phase sorption, vapor-phase diffusion, and three-phase equilibration. In its current version, VLEACH is subject to a number of major assumptions:

- Contaminant partitioning between phases follow linear relationships, i.e., both K_D and K_H are constants.
- The three phases present (liquid, vapor, sorbed) are in a state of equilibrium in each cell.
- The moisture content profile within the vadose zone is constant, i.e., the vadose zone is in a steady state with respect to water.
- Liquid-phase dispersion is neglected.
- No "free product" is present.
- The contaminant is not subject to in situ production or degradation.
- The vadose zone soil within a particular model polygon is completely homogeneous, and behaves as a uniform porous medium, with no preferential pathways to flow.
- Volatilization from the soil surface is either completely unimpeded or completely restricted.

Some of these limitations may be relaxed in future versions of VLEACH.

DATA REQUIREMENTS

The data requirements fall into four main categories.

Chemical Parameters

These parameters describe the behavior of the contaminant in question. The parameters include the organic carbon distribution coefficient (K_{OC}), Henry's constant (K_H), the aqueous solubility, and the free air diffusion coefficient.

Soil Properties

Dry bulk density, total porosity, volumetric water content, and organic carbon fraction.

Site Properties

Recharge rate, depth to water, and the area of the polygon in question.

Model Parameters

These parameters affect the way the calculations are performed, and include the time step length, cell dimensions, and output intervals.

THEORY OF OPERATION

VLEACH is a relatively simple one-dimensional finite difference model. The code can simulate leaching in a number of distinct "polygons" during each run. The polygons may differ in soil properties, recharge rate, depth to water, or initial conditions. Each polygon is treated separately, and at the end of the run, an overall area-weighted groundwater impact is presented.

Each polygon is represented by a vertical stack of cells, reaching from the land surface to the water table. The mass of contaminant within each cell is partitioned among three phases: liquid (dissolved in water), vapor, and sorbed to solid surfaces. For simulation purposes, time is divided into user-specified discrete time steps. During each time step, three separate processes take place. Contaminant in the liquid phase is subject to downward advection; contaminant in the vapor phase is subject to gas diffusion; and finally each cell is re-equilibrated according to the distribution coefficients. Each process will be described in greater detail. All symbols used in the following equations are defined in Table 1.

Table 1 Equation Variable Definitions		
M_T	=	Total mass of contamination in a model cell [M]
ΔZ	=	Thickness of cells in VLEACH calculation [L]
n	=	Total porosity of soil [dimensionless]
θ	=	Water-filled porosity of soil [dimensionless]
ρ_b	=	Bulk density of soil [M/L^3]
K_D	=	Distribution coefficient for soil-water partitioning [L^3/M]
K_H	=	Henry's constant for air-water partitioning [dimensionless]
C_s	=	Contaminant concentration in sorbed phase [M/M]
C_l	=	Contaminant concentration in the liquid phase [M/L^3]
C_g	=	Contaminant concentration in the gas phase [M/L^3]
C_{INF}	=	Contaminant concentration in infiltrating water [M/L^3]
C_{NCELL}	=	Contaminant concentration in water in bottom cell [M/L^3]
C_{ATM}	=	Contaminant concentration in atmospheric air above soil surface [M/L^3]
C_{gw}	=	Contaminant concentration in groundwater (with respect to gas phase exchange between water table and vadose zone [M/L^3]
f_{oc}	=	Fraction organic carbon in soil [dimensionless]
K_{oc}	=	Organic carbon partition coefficient [L^3/M]
D	=	Effective diffusion coefficient [L^2/T]
D_{AIR}	=	Free air diffusion coefficient [L^2/T]
q	=	Darcian flux of percolating water [L/T]
In finite difference equations:		
$C_{i-1}^{t+\Delta t}$		
C	=	Refers to concentration of gas or liquid, depending on the equation [M/L^3].
$t+\Delta t$	=	Refers to the time step at which the concentration is calculated.
i-1	=	Refers to the cell number in which the concentration is calculated.

INITIAL CALCULATIONS

The first calculations performed include unit conversions (all internal calculations are conducted in consistent units of grams, feet, and years) and calculations of K_D and D, the effective diffusion coefficient. The equations are as follows:

$$K_D = K_{oc} \times f_{oc}$$

$$D = D_{AIR} \times \frac{(n-\theta)^{10/3}}{n^2}$$

LIQUID ADVECTION

Liquid advection is driven by the downward flux of recharging groundwater, according to the following equation:

$$\frac{\partial C}{\partial t} = \frac{-q}{\theta} \frac{\partial C}{\partial z}$$

For modeling purposes, the partial differential equation (PDE) is approximated by the following finite difference equation (FDE). The FDE is space-upward (in keeping with the asymmetric nature of advection), and time-centered (Crank-Nicholson).

$$\frac{C_i^{t+\Delta t} - C_i^t}{\Delta t} = \frac{-q}{2\theta\Delta z} \left[\left(C_i^{t+\Delta t} - C_{i-1}^{t+\Delta t}\right) + \left(C_i^t - C_{i-1}^t\right) \right]$$

One FDE results for each cell, so NCELL similar equations must be solved simultaneously. VLEACH solves these equations in matrix form using the Thomas algorithm.

The mass fluxes at the top and bottom of the vadose zone are derived from the following equations:

$$J_{TOP} = Cq|_{z=0} = q\ C_{INF}$$

$$J_{BOTTOM} = Cq|_{z=DTW} = qC_{NCELL}$$

GAS DIFFUSION

Gas diffusion is described by Fick's Second Law:

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial z^2}$$

This PDE is converted to a space-centered, backward-difference FDE:

$$\frac{C_i^{t+\Delta t} - C_i^t}{\Delta t} = \frac{D}{(\Delta z)^2} \left(C_{i-1}^{t+\Delta t} - 2\, C_i^{t+\Delta t} + C_{i+1}^{t+\Delta t} \right)$$

Although space-centered (Crank-Nicholson) equation is intuitively more appealing, it led to unexpected stability problems not encountered with the backward-difference formulation.

The mass fluxes at the top and bottom of the vadose zone are derived from the following equations:

$$J_{TOP} = (n-\theta)\, D \left.\frac{\partial C}{\partial z}\right|_{z=0} = (n-\theta)\, D \frac{(C_{ATM} - C_1)}{\Delta z}$$

$$J_{BOTTOM} = (n-\theta)\, D \left.\frac{\partial C}{\partial z}\right|_{z=DTW} = (n-\theta)\, D\, K_H \frac{(C_{NCELL} - C_{gw})}{\Delta z}$$

EQUILIBRATION

Equilibration among the three phases within each cell is performed by first converting the three phase concentrations to mass, summing to determine total mass, partitioning this mass among three phases, and finally converting back to concentrations. The equations are as follows:

$$M_T = \Delta z \left(\theta C_l + C_g\, (n-\theta) + \rho_b\, C_s \right)$$

$$C_g = \frac{M_T}{\Delta z \left(\frac{\theta}{K_H} + (n-\theta) + \rho_b \left(\frac{K_D}{K_H} \right) \right)}$$

$$C_l = \frac{M_T}{\Delta z \left(\theta + K_H\, (n-\theta) + \rho_b\, K_D \right)}$$

$$C_s = \frac{M_T}{\Delta z \left(\frac{\theta}{K_D} + (n-\theta) \left(\frac{K_H}{K_D} \right) + \rho_b \right)}$$

NOTE: l = liquid phase; g = gas phase; and s = sorbed phase.

OUTPUT

The output consists of mass balance calculations and groundwater impact estimates. The mass balance calculations compare the change in mass within the profile to the calculated boundary fluxes, while the groundwater impact calculations are based on the downward flux at the water table, due to diffusion and advection.

USER'S GUIDE

INTRODUCTION

VLEACH is written in MS-Fortran and compiled under FORTRAN Version 4.0. A program listing is attached as Appendix A. The program reads one input file, and writes up to three different output files.

Input File (_____.inp)

The user must prepare this file prior to the run, in accordance with the attached directions.

OUTPUT FILES

Parameter File (_____.prm)

This file "reads back" the input data in an easy-to-read, annotated form. This file will be primarily used for troubleshooting problems with the input file.

Profile File (_____.prf)

This file contains complete vertical concentration profiles for the vadose zone for all three phases. These profiles are printed out at user-selected intervals throughout the run.

Main Output File (_____.out)

This is the primary output file and contains mass balance data and groundwater impact data. These data are also printed out at user-selected intervals throughout the run.

SPECIAL NOTES AND CAUTIONS

- K_h, Henry's constant, must be in dimensionless form, for example:

$$\frac{[M/L^3_{AIR}]}{[M/L^3_{WATER}]}$$

- Groundwater impacts are not annual rates--they are cumulative over the printout interval or the entire run. If you are using a 10-year printout interval, the impact indicates how many grams of contaminant have entered the groundwater during those 10 years.

INTERACTIVE AND BATCH OPERATING MODES

Like its predecessor LEACHCAL, VLEACH can solicit file name information in either an interactive or batch mode. If a file name "BATCH.INP" exists in the current directory, VLEACH will enter batch mode processing, using BATCH.INP as the input file, and creating BATCH.PRM, BATCH.PRF, and BATCH.OUT for output. This feature allows the user to create a simple batch file that will call on VLEACH to perform a series of runs unattended. The batch file would take a series of input files, and one by one, rename the input file to BATCH.INP, call VLEACH, and then rename the output files before starting with another input file.

An example batch file is attached. If this file were named RUN.BAT, and a series of VLEACH input files were named AREAA.INP, AREAB.INP, and AREAC.INP, they could be executed in sequence by typing "RUN AREAA AREAB AREAC."

If VLEACH does not find a file named "BATCH.INP," it enters an interactive mode, and asks the user for filenames for the input file and each output file.

Example Batch File:

```
ECHO OFF
IF NOT EXIST BATCH.*GOTO START
DEL BATCH.*
:START
IF NOT EXIST%1.INP GOTO END
```

```
ECHO processing File %1
REN %1.INP BATCH.INP
VLEACH
IF NOT EXIST %1.OUT GOTO A
DEL %1.OUT
:A
IF NOT EXIST %1.PRM GOTO B
DEL %1.PRM
:B
IF NOT EXIST %1.PRF GOTO C
DEL %1.PRF
:C
REN BATCH.* %1.*
SHIFT
GOTO START
:END
```

VLEACH INPUT FILE FORMAT

The input file for VLEACH consists of two groups of data: simulation data, presented once per run; and polygon-specific data, presented once for each polygon.

SIMULATION DATA (this set appears only once, at the top of the file)

Card 1: TITLE (A80)
80 characters of project identification information that will be stamped on each output file. VLEACH does not use this information.

Card 2: NPOLY (I5)

NPOLY: Number of polygons to be considered in this run.

Card 3: DELT,STIME,PTIME,PRTIME (4F10.5)
DELT: Computational timestep (years)
STIME: Total length of simulation (years)
PTIME: Interval at which groundwater impact and mass balance results are printed to .OUT file (years)
PRTIME: Interval at which vertical concentration profile results are printed to .PRF file (years)

Card 4: KOC,KH,CMAX,DAIR (4F10.5)

KOC: Organic carbon distribuiton coefficient (ml/g)
KH: Henry's constant (dimensionless)

CMAX:	Aqueous solubility (mg/l)
DAIR:	Free air diffusion coefficient (m^2/day)

POLYGON DATA (this set is repeated NPOLY times)

Card 1: TITLE (A80)

80 characters of polygon identification information that will be stamped on each output file. VLEACH does not use this information.

Card 2: AREA,DELZ,Q,RHOB,POR,THETA,FOC (7F10.5)

AREA:	Area of polygon (sq. ft.)
DELZ:	Vertical cell spacing (ft)
Q:	Groundwater recharge rate (ft/yr)
RHOB:	Dry bulk density of soil (g/cc)
POR:	Total effective porosity (dimensionless)
THETA:	Volumetric water content (dimensionless)
FOC:	Soil organic carbon content (dimensionless - NOT percent)

Card 3: CINF,CATM,CGW (3F10.5)

CINF: Concentration of contaminant in recharge water (mg/l)

CATM: Determines upper boundary condition for gas diffusion. If CATM is negative, the soil surface is impermeable to gas diffusion. If CATM is non-negative it indicates the fixed concentration of contaminant in the atmosphere above the soil surface (mg/l).

CGW: Determines lower boundary condition for gas diffusion. If CGW is negative, the water table is impermeable to gas diffusion. If CGW is non-negative, it indicates the (fixed) concentration of contaminant in groundwater (mg/l) below the water table, affecting gas diffusion only.

Card 4: NCELL (I5)

NCELL: Number of vertical cells in simulation. Note that NCELL*DELZ should equal the depth to water.

Card 5: J1,J2,XCON (2I5,F10.5)

J1:	Top cell described by couplet
J2:	Bottom cell described by couplet

```
* fixed lower b'dry
      IF (CGW .GE. 0.) RHS(NCELL) = CGAS(NCELL)+ALPHA*CGW
* fixed upper b'dry
      IF (CATM .GE. 0.) RHS(1) = CGAS(1)+ALPHA*CATM

      CALL SOLVET(AGAS,CGAS,RHS,NCELL)

      RETURN
      END

*****************************************************************

      SUBROUTINE LIQ(ALIQ,CLIQ,BETA,RHS)
* this subroutine sets up the right-hand side of the liquid advection
* calculation, calls SOLVET to do the calculation, computes b'dry flux

      DIMENSION ALIQ(3,NCELL),CLIQ(NCELL),RHS(NCELL)
      COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL
      COMMON /BDRY/ CINF,CATM,CGW

      RHS(1) = CLIQ(1)-BETA*(CLIQ(1)-2.*CINF)

      DO 10 I=2,NCELL
10    RHS(I) = CLIQ(I)-BETA*(CLIQ(I)-CLIQ(I-1))

      CALL SOLVET(ALIQ,CLIQ,RHS,NCELL)


      RETURN
      END

*****************************************************************

      SUBROUTINE EQUIL(CGAS,CLIQ,CS,MGTOT,MLTOT,MSTOT,
     &   MTOTAL,FACT,IFLAG)

* this subroutine re-equilibrates all three phases

      IMPLICIT REAL (K,M)
      DIMENSION CGAS(NCELL),CLIQ(NCELL),CS(NCELL),FACT(2,3)
      COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL
      COMMON /CHEM/ KOC,KH,CMAX,DAIR

      MGTOT = 0.
      MLTOT = 0.
      MSTOT = 0.
      MTOTAL = 0.
      IFLAG = 0

      DO 500 N=1,NCELL

      MT = CGAS(N)*FACT(1,1) + CLIQ(N)*FACT(1,2) + CS(N)*FACT(1,3)

      MTOTAL = MTOTAL + MT

      CGAS(N) = MT * FACT(2,1)
      CLIQ(N) = MT * FACT(2,2)
      CS(N) = MT * FACT(2,3)
```

```
      MG = CGAS(N)*FACT(1,1)
      ML = CLIQ(N)*FACT(1,2)
      MS = CS(N)*FACT(1,3)
      MGTOT = MGTOT + MG
      MLTOT = MLTOT + ML
      MSTOT = MSTOT + MS

      IF (CLIQ(N) .GT. CMAX) IFLAG=IFLAG+1

500   CONTINUE

      RETURN
      END

*************************************************************************

      SUBROUTINE OUTPUT(TIME,MT0,MTP,MLTCUM,MLBCUM,MGTCUM,MGBCUM,
     &  MLTINT,MLBINT,MGTINT,MGBINT,MGTOT,MLTOT,MSTOT,MTOTAL,IPOLY)

      IMPLICIT REAL (M,K)

      COMMON /FILES/ IINP,IPRM,IOUT,IPRF
      COMMON /SIMUL/ DELT,STIME,PTIME,PRTIME,NTIME,DELZ,NCELL

      WRITE (IOUT,201) IPOLY,TIME,MTOTAL,MGTOT,MLTOT,MSTOT
201   FORMAT(//'Polygon ',I3/'At time = ',F10.2,
     &  ', total mass in vadose zone =',G15.5,'g/sq.ft.'/
     &  'Mass in gas phase      =  ',G15.5,'g/sq.ft.'/
     &  'Mass in liquid phase   =  ',G15.5,'g/sq.ft.'/
     &  'Mass sorbed            =  ',G15.5,'g/sq.ft.')

      DEL1 = MTOTAL-MTP
      DEL2 = MLTINT+MLBINT+MGTINT+MGBINT
      WRITE (IOUT,102) TIME-PTIME
      WRITE (IOUT,103) DEL1
      WRITE (IOUT,104) MLTINT,MLBINT,MGTINT,MGBINT
      WRITE (IOUT,105) DEL2
      WRITE (IOUT,106) DEL1-DEL2

      DEL1 = MTOTAL-MT0
      DEL2 = MLTCUM+MLBCUM+MGTCUM+MGBCUM
      WRITE (IOUT,107)
      WRITE (IOUT,103) DEL1
      WRITE (IOUT,104) MLTCUM,MLBCUM,MGTCUM,MGBCUM
      WRITE (IOUT,105) DEL2
      WRITE (IOUT,106) DEL1-DEL2

102   FORMAT(/'Since last printout at time = ',F10.2)
103   FORMAT(15X,'Change in Total Mass = ',G15.5,'g/sq.ft.')
104   FORMAT(20X,'Advection in from atmosphere =  ',G15.5,'g/sq.ft.
     &       20X,'Advection in from water table = ',G15.5,'g/sq.ft.
     &       20X,'Diffusion in from atmosphere =  ',G15.5,'g/sq.ft.
     &       20X,'Diffusion in from water table = ',G15.5,'g/sq.ft.
105   FORMAT(15X,'Total inflow at boundaries = ',G15.5,'g/sq.ft.')
106   FORMAT(15X,'Mass discrepancy = ',G15.5,'g/sq.ft.')
107   FORMAT(/'Since beginning of run at time = 0.0')


      MLTINT = 0.
      MLBINT = 0.
```

```
MGTINT = 0.
MGBINT = 0.
MTP = MTOTAL

RETURN
END
```

Appendix B
SAMPLE VLEACH INPUT FILE

```
PGA V-leach model, TEST 1 -- TCE
    2
        1.0       100.        10.        50.
        .63       .473      1100.        .4
Area 473-18, subsection 12
      1000.         1.        .20       1.5        .4        .2       .005
         0.         0.        -1.
   50    1
    1   20        1.0
   21   30         0.
   31   40        5.0
   41   50         0.
Area 229-54, subsection B-12
       750.         1.        .10       1.5        .4        .1       .005
         0.         0.        -1.
   45    1
    1   20        5.0
   21   30         0.
   31   40        2.5
   41   45         0.
```

APPENDIX C

APPENDIX C

PERSONNEL QUALIFICATIONS

URS

Christopher Gaule

Senior Project Manager/Senior Hydrogeologist

Expertise

- Subsurface Investigations
- Fractured Bedrock Studies
- Remediation of Contaminated Properties
- Program Management

Education

B.Sc (Hons) Geology, Polytechnic of North London (1987)

Affiliations

Member, National Groundwater Association (NGWA)
Member, Society of American Military Engineers, Buffalo District

Training

Bloodborne Pathogens Exposure Control *29 CFR 1910.1030(g)(2)* OSHA *Valid through 04/09/02*

Cardiopulmonary Resuscitation *29 CFR 1910.151(b)* OSHA *Valid through 04/09/03*

Construction Safety Awareness *29 CFR 1926.21(b)* OSHA
First Aid *29 CFR 1910.151(b)* OSHA *Valid through 04/09/03*

Hazardous Materials Transportation Training *49 CFR 172.704 (HM-126F)* DOT *Valid through 04/10/03*

Hazardous Waste Operations Eight (8) hour refresher *29 CFR 1910.120(e)(8)* OSHA *Valid through 04/10/02*

Hazardous Waste Operations Site Supervisor *29 CFR 1910.120(e)(4)* OSHA Medical *Valid through 07/27/02*

Respiratory Protection *29 CFR*

Experience

Mr. Gaule has 15 years of environmental experience in New York State. Prior to joining URS Corporation, Mr. Gaule worked for Malcolm Pirnie, Inc. and Dunn Geoscience Corporation. His experience includes complex investigations of large industrial and military facilities where innovative tools for investigation have been used, and the site sitting and closure of solid waste facilities. Mr. Gaule has been responsible for the implementation of large Federal and State programs requiring the coordination with numerous office and project staff. Over the last 15 years Mr. Gaule has been responsible for the delineation of sole source aquifers throughout New York, these delineation activities have ranged from aquifer testing and modeling through geologic mapping and paper studies.

Monofill Landfill Siting/Investigation, St. Lawrence Cement Corporation, New York
Project Leader for the hydrogeologic siting studies for a monofill disposal area for St. Lawrence Cement Corporation. The investigation involved the installation of monitoring wells and soil borings in accordance with NYS Part 360 Regulations. For the same client, an investigation of a release from an old disposal area was also investigated and included the evaluation of groundwater influence on the generation of leachate from the landfill and remedial alternatives to stop the generation of leachate.

Landfill Investigation/Expansion, Town of Colonie, New York
Completed and managed the subsurface investigation and report for the permitting of the piggyback expansion. Investigations included the installation of monitoring wells, the collection of pre-construction groundwater samples, and the evaluation of historical groundwater data for the determination of potential future releases for the landfill cell. Also managed the quarterly groundwater sampling and reporting required by the Part 360 Operating Permit. The reporting included statistical analysis of the groundwater data in the area of the expansion and the previous closed areas of the landfill.

Landfill Investigation, Town of Rotterdam, New York
Project Leader for the investigation of the old Rotterdam Landfill leachate seeps, which was conducted under a NYS Consent Order to abate the release of leachate to the Great Flats Aquifer. The investigation involved evaluation as to the source of the water entering the landfill waste, which was generating the leachate, and determining appropriate remedial measures to eliminate the leachate. The investigations included the installation of several groundwater monitoring wells at the parameter of the landfill wastes, as well as the installation of wells in the waste to determine the vertical gradients of groundwater into the waste and the extent of groundwater mounding beneath the landfill cap. As a result of the investigation, an Interim Remedial Measure was completed to collect the leachate at the downgradient edge of the landfill prior to its impact of the aquifer.

Sidney Landfill Remedial Investigation/Feasibility Study, Sidney, New York, United Environmental Protection Agency
Project Leader for the investigation of a 75-acre municipal/ industrial landfill federal Superfund site. Mr. Gaule participated in the installation of bedrock

1910.134 OSHA

monitoring wells, along with the completion of bedrock pumping tests. The monitoring wells were installed to investigate the extent of a nonaqueous-phase liquid (NAPL) on the groundwater. Also completed the RI/FS documents for the site, and completed remedial action oversight of the PRP's.

U.S. Army Corps of Engineers, Baltimore District RCRA Corrective Action at the Watervliet Arsenal
Project Manager for RCRA investigations and RCRA Corrective Measures at several areas of concern at the Watervliet Arsenal, for the Baltimore Corps of Engineers. Where the bedrock aquifer has been contaminated with chlorinated solvents (including the presence of DNAPL) and petroleum products. The investigations included packer testing within the bedrock and innovative borehole geophysical tests to evaluate the area of influence for potential recovery efforts. This project also included the use of various remedial technologies including permeable reactive walls and in-situ bioremediation of PAH contaminated soils. As project manager Mr. Gaule was responsible for the negotiation of project scopes with the NYSDEC and USEPA.

Comprehensive Site Assessment, Brimbal Avenue Landfill, City of Beverly, Massachusetts
Project Leader for the implementation of an initial site assessment and comprehensive site assessment (ISA/CSA) study for the inactive landfill. The studies include the evaluation of site conditions and the preparation of an updated topographic map. The CSA included the installation and sampling of groundwater monitoring wells and the preparation of a baseline risk assessment for determination of corrective measures for the site. Evaluated use of alternative grading materials to reduce the cost of closure.

C&D Landfill Investigations, New State Department of Environmental Conservation
Project Manager for the hydrogeologic investigation of several construction and demolition waste landfills under the New York State Superfund Program.

Confidential Client RCRA Corrective Action, Albuquerque, New Mexico
Project Manager for RCRA Corrective Measures at a former apparatus service shop, where PCB containing equipment was repaired and the residual materials were discharged to a dry well system. The project involves the evaluation of corrective measures for the soils and construction debris at the site. All site activities are required to be compliant with the RCRA Consent Order and TSCA.

American Valve Corporation, New State Department of Environmental Conservation
Project Leader responsible for the evaluation and preparation of a remedial investigation at a former brass foundry where contaminants of concern are metals and chlorinated solvents. During the investigation, dense nonaqueous-phase liquid (DNAPL) was detected and additional studies were conducted to evaluate the nature and extent of DNAPL contamination. Aided in the preparation of a feasibility study for the remediation of a foundry sand disposal area, and assisted in the remedial contractor coordination.

Technical Review and Oversight, Various Sites, United States Environmental Protection Agency
Lead technical reviewer for the USEPA ARCS II project oversight projects in New York State. The projects reviewed include Seneca Army Depot RI/FS, York Oil RI/FS and RD, and the Sidney Landfill RI/FS and pilot studies. Mr. Gaule responsible for the review of all associated project documents for these projects and the preparation of comment documents to the USEPA.

Former Mohasco Mills, Amsterdam, New York, City of Amsterdam
Manager for a NYSDEC Brownfields site investigation and remedial assessment report for the former Mohasco carpet mill. The site consisted of a 22 acre building complex. The investigation included the evaluation of asbestos-containing material and building demolition. The investigations included the installation of ten monitoring wells, along with numerous soil samples to characterize the site. The site soils contained elevated concentrations of PCBs, PAHs, heavy metals, and pesticides. Groundwater beneath a former electrical transformer contained elevated concentrations of dissolved phase PCBs above NYS Class GA Standards. Responsible for the completion of the Site Investigation Report and the Remedial Action Report for the site.

Pesticide Facility Remedial Investigation, New State Department of Environmental Conservation
Conducted a remedial investigation, under the New York State Superfund Program, at a pesticide/ herbicide spill site. The work involved the oversight of drilling and excavation activities, field screening of soils for pesticides, and drum sampling.

Interim Remedial Measure, Campbell Plastics Facility, Rotterdam, New York
Project Manager for the investigation, design, and implementation of an interim remedial measure (IRM) for contaminated soil beneath a building foundation. The project involved the removal of the building floor, contaminated with PCBs, and excavation of contaminated soils beneath the foundation while the building was still in operation. The completion of the IRM allowed the property to be reclassified from a Class 2A to a Class 4 and allowed the transfer of the property to another tenant.

Publications

Gaule, C, Goldstein, K. J, Anderson , G. A, "Innovative Techniques to Investigate Contamination in Fractured Bedrock," presented at the 2001 International Containment & Remediation Technology Conference and Exhibition, Orlando Florida, June 2001.

Gaule, C, Lang, D. C, "Reactive Barrier Walls for the Remediation of Chlorinated Hydrocarbon Contamination, Design and Installation of an Innovative Technology," presented at the Defense Environmental Restoration Program 2000 Workshop, New Orleans LA, December 12.

Goldstein, K. J, McDonald, S. J., Gaule, C, Anderson , G. A, Marsh , R. R., Senick M,"Dual Reactive Barrier Walls for the Remediation of CHC

Contamination, Watervliet Arsenal, New York," presented at the Petroleum Hydrocarbons Conference of the National Ground Water Association, November 1999.

Gaule, C, Goldstein, K. J, Hobert, L. A, Hiss, D. R, "Evaluation of Petroleum Hydrocarbon Contamination of a Fractured Bedrock Aquifer, presented at the Focus Conference on Eastern Regional Groundwater Issues, October 1993.

Gaule, C, "An Interim Remedial Measure for a Sole-Source Aquifer" Technical Symposium September 10-11, 1993.

URS

STEVEN L. GEIGER

Staff

Education

Ph.D, 1997	Dept. of Chemical and Bioresource Engineering	Colorado State University
M.S., 1992	Dept. of Civil Engineering	University of New Mexico
B.S., 1990	Dept. of Civil Engineering	University of New Mexico

Chronological Work Experience

Engineer/Scientist – Project Manager, URS Corporation, 1998-Present
USDA National Needs Fellow, Department of Chemical and Bioresource Engineering, Colorado State University, Fort Collins, Colorado, 1994-1998.
Water Resources Engineer, Ayres Associates, Fort Collins, Colorado, 1994.
Staff Water Resources/Civil Engineer, Scanlon and Associates, Santa Fe, New Mexico, 1992-1993.
Junior Civil Engineer, Scanlon and Associates, Albuquerque, New Mexico, 1991-1992.
Research Assistant, Department of Civil Engineering, University of New Mexico, Albuquerque, New Mexico, 1990-1992.

Professional Registrations

New Mexico Registered Professional Engineer (NMPE # 15338)

General Work Experience

Mr. Geiger is currently a Staff Engineer and Project Manager contributing to projects in the fields of groundwater hydrology, development of information system (IS) tools, VBA programming, contaminant transport modeling, RCRA corrective measure studies (CMSs), risk assessments, environmental sampling, environmental/chemical management, and construction quality assurance (CQA). Mr. Geiger's areas of professional experience also include basin scale modeling of surface water hydrology for municipal and private sector clients and water surface profile modeling for FEMA studies. Mr. Geiger has contributed to projects in the areas of airport planning, municipal utility design, landfill location, storm water retention basin design, and monitoring well development and analysis. Mr. Geiger received his Ph.D at Colorado State University (Groundwater Program) where he participated in groundwater contamination and transport studies, and developed heuristic methods for predicting infiltration stability and wetting patterns. Mr. Geiger has used numerous unsaturated flow models including HYDRUS, SWMS2D, and VS2D.

Project Assignments

Civil Engineering/General

As Project Engineer made field visits and collected information to complete the Cannon AFB Air Combat Command Sewer System Infiltration and Inflow (I/I) Study.

As Construction Quality Assurance (CQA) Inspector, performed QA observation, inspection and testing during construction of the Corrective Action Management Unit (CAMU) Waste Containment Cell at Sandia National Laboratory. Oversaw field-testing for soil compaction, monitoring system construction, and engineered liner installation. Managed a field technician performing 3rd party destructive liner sampling during liner installation.

As Project Engineer oversaw completion of all phases for the San Juan Pueblo Airport Preliminary Master Plan, San Juan Pueblo, NM. Performed Project Management duties including cost tracking, cost-to-completion estimation, and invoicing.

URS

As Staff Engineer provided design calculations and conceptual drawings for detention ponds. In conjunction with hydrologic/hydraulic modeling, designed the size and placement for underground storm sewers. Conducted quantity take-offs for cost estimates on sewer, highway, and detention/pump facility designs. Compiled data for on-going quality control of landfill liner analysis and participated in an arid region landfill location study, Artesia, NM.

As Field Technician/Surveyor acted as survey team member for field surveys of a private airport and a highway intersection. Conducted groundwater sample collection, monitoring well development and slug testing for private housing development site screening wells.

Hydrology

As Task Leader for the City of Santa Fe Master Drainage Plan, created a basin-scale hydrological model (AHYMO model) to address water quantity, floodplain, and erosion issues for the City of Santa Fe, New Mexico. Acted as team coordinator for collection of field data associated with the Santa Fe Master Drainage Plan.

Performed duties of project hydrologist in conducting groundwater flow modeling and particle tracking (VisModflow, Modpath) for the off-base extraction well system at Hill AFB, Utah.

As Task Leader performed groundwater simulations in MODFLOW for pumping and extraction systems used for contaminant capture and in-situ treatment alternatives for remediation of cyanide in groundwater at White Sands Missile Range, NM.

Conducted vadose zone transport assessment at the former Albuquerque Tie Treating Facility using the EPA Hydraulic Evaluation of Leachate Potential (HELP) model.

Conducted vadose zone transport analysis for the Sandia National Laboratory TSCA permit with regard to PCBs in a landfill using the VLEACH model.

Worked as Staff Engineer for conducting the Colorado Springs Country Club rainfall/runoff simulation (TR20 model) for water quantity issues related to development of an on-site storm water retention pond.

As Junior Staff Engineer worked with numerical model (AHYMO) to evaluate planning alternatives for the Amole Arroyo Watershed, Albuquerque, NM.

As Junior Staff Engineer created runoff hydrographs for incorporation into design criteria for the Claremont Street Storm Water Retention Facility, Albuquerque, NM.

Consulted with URS, the Volunteer Citizens Taskforce, and Los Alamos County representatives in determining hydrologic approach for a burned and recovering watershed with regard to conducting the North Road Reconstruction and Flood Detention project, Los Alamos, NM.

Environmental

Currently managing a Baseline Human Health and Ecological Risk Assessment for the former Open Burn and Open Detonation Pits at the Hazardous Materials Testing Area, White Sands Missile Range.

As Project Manager, oversaw development and completion of a site specific Risk Assessment and Corrective Measures Study for remediation of cyanide in groundwater at a DoD facility. The site includes over one square kilometer of affected, unconfined aquifer in the Tularosa Basin of southern New Mexico. Currently working with the client and New Mexico Environment Department to establish a risk-based closure involving the use of Monitored Natural Attenuation and risk-based abatement standards as a remedial approach.

As Project Manager, completed a RCRA Corrective Measure Study for a site with 21 identified Solid Waste Management Units (SWMUs).

As Project Manager, directed a team in completing the High Energy Laser System Test Facility (HELSTF) Baseline Human Health and Ecological Risk Assessment.

As Project Manager, completed a RCRA Corrective Measures Study for cyanide groundwater contamination at White Sands Missile Range.

As Project Engineer/Task Leader developed the High Energy Laser System Test Facility (HELSTF) Subsurface Contaminant Database and Conceptual Site Model in MS Access and ESRI ArcView (GIS) using open database connectivity (ODBC) standard.

As Project Engineer conducted vapor-phase transport and risk modeling for building vapor intrusion at two sites using the Johnson and Ettinger Model.

As Project Engineer completed the water resource, hydrology, floodplain, and wetlands sections for two Environmental Assessment documents, Los Alamos County, NM.

As Project Engineer completed the water resource, hydrology, and floodplain sections for a Preliminary Airport Master Plan document, Double Eagle II Airport, Albuquerque, NM.

As Task Leader, performed multiple duties in completing the Holloman AFB Lead Cable Sampling Study.

As Project Engineer, completed Chemical and Waste Management Plans for General Electric Aircraft Engines Plant, Albuquerque, NM.

As Field Technician participated in collection of storm water samples in support of the NPDES permit for General Electric Aircraft Engines Plant, Albuquerque, NM.

As Project Engineer investigated and wrote a Spill Prevention Control and Countermeasures Plan (SPCC) for a Verizon phone center switching station, Albuquerque, NM.

As Task Leader oversaw development of the SPCC for the General Electric Aircraft Engines (GEAE) plant, Albuquerque, NM.

Hydraulic/Water Surface Profile Modeling

As Project Engineer conducted water surface profile modeling (HEC-2, WSPRO models) for the Alameda County FEMA Floodplain Study, Alameda County, CA.

Conducted floodplain analysis (HEC-2) for the City of Colorado Springs for FEMA floodplain studies and FEMA LOMRs, Colorado Springs, CO.

As Staff Engineer modeled closed conduit flow (SWMM - EXTRANS model) for design of underground storm sewers and detention ponds in association with the City of Albuquerque Claremont St. Storm Water Retention Facility.

IS/GIS

Developed the Sandia National Laboratory Chemical Evaporation Database tool.

URS

Developed the Cannon AFB Waste Stream Process Mapping/Modeling Tool, which connects an MS Access front end with an interactive flow-charting component developed in MS Visio.

Developed the Kirtland AFB AirCOP GIS Dispersion Modeling Module integrating the ESRI Map Objects control in an MS Access database.

Co-developed the General Electric Safety Contacts health and safety database tool.

Performed QC Review of the Los Alamos National Laboratory (LANL) Environmental Health and Safety group Equipment Room Inventory and Calibration databases.

Utilized ArcView GIS to integrate environmental sample databases with conceptual site models for two RCRA sites at White Sands Missile Range. Developed automated visualization coverages of contaminant distributions with ArcView 3-D Analyst and ArcView Surface Analyst.

Performed field surveying with GPS survey unit in support of the Holloman AFB Lead Cable Sampling Study GIS.

As Teaching Assistant/Researcher

As Laboratory Instructor and Teaching Assistant conducted aquifer pump tests, borehole slug tests, soil classification and analyses, tracer tests, hydraulic conductivity tests and moisture retention tests. Occasionally filled in as substitute teacher for graduate level groundwater hydrology courses.

As researcher participated in physical modeling studies of infiltration transport mechanisms, multiphase DNAPL and LNAPL fate and transport studies, and TCLP and ESM studies. Conducted numerical simulation of unsaturated flow (HYDRUS, SWMS2D, VS2D models) and aquifer flow with reactive transport (MODFLOW, USGS PTM-MOC and BIOPLUM II models).

Presented research findings at academic and private industry seminars.

Other Training

40 hr. OSHA

Publications

Geiger, S.L. and D. Durnford. 2000. "Infiltration in Homogenous Sands and a Mechanistic Model of Unstable Flow. Soil Science Society of America Journal. Vol 64. March/April 2000.

Geiger, Steven L. and Deanna Durnford. 1998. Infiltration Stability in Homogeneous Soils. p. 99-110. In: Morel-Seytoux, H.J. (ed.) Proc. of the Eighteenth Annual American Geophysical Union Hydrology Days. Mar. 30-April 2, 1998, Fort Collins, CO. Hydrology Days Publications, Atherton, CA.

Geiger, S.L., T.J. Ross, and L.L. Barton. 1993. Environmental Scanning Electron Microscope (ESEM) Evaluation of Crystal and Plaque Formation Associated with Biocorrosion. Microscopy Research and Technique. 25:429-433

Special Information

Professional Societies

New Mexico Society of Professional Engineers
Chi Epsilon Civil Engineering Honor Society

URS

Clearances

Languages

Patents

ISO Experience

Last Edited: 2002-06-16 10:30:04
Employee Number: 19538
Radian Start Year: 1998
Professional Start Year: 1991
Location: ALQ

APPENDIX D

APPENDIX D

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
GE ALBUQUERQUE
INVESTIGATION AND CORRECTIVE MEASURE IMPLEMENTATION

PREPARED FOR:

GE POWER SYSTEMS
ONE RIVER ROAD
BUILDING 43, ROOM 237
SCHENECTADY, NY 12345

PREPARED BY:

URS CORPORATION
646 PLANK ROAD, SUITE 202
CLIFTON PARK, NY 12019

HEALTH AND SAFETY PLAN
GE ALBUQUERQUE
INVESTIGATION AND CORRECTIVE MEASURES IMPLEMENTATION

	PHONE
Project Number: 3839375.00000	
Project Manager: Mr. Christopher Gaule	518-688-0015
Site Manager: (to be determined)	_____
Site Safety Officer: (to be determined)	_____
Plan Preparer: Mr. Thomas Shine	518-688-0015
Preparation Date: July 5, 2002	
Expiration Date: (date is one year after this goes final)	

APPROVALS

Health and Safety Representative:

_____
(DATE)

Regional Health and Safety Manager:

Philip Jones, CIH 8/7/02
CIH/CSP (DATE)

Project Manager:

Gaule 8/14/02
(DATE)

This Health and Safety Plan is valid only for this specific project as described in Section 3.0. It is not to be used for other projects or subsequent phases of this project without the written approval of the Regional Health and Safety Manager. A copy of this plan is to be maintained at the site at all times.

HEALTH AND SAFETY PLAN
GE ALBUQUERQUE
INVESTIGATION AND CORRECTIVE MEASURES IMPLEMENTATION

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APPENDICES

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GLOSSARY OF TERMS, ACRONYMS, AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
analyzer	refers to the field instrument described in Section 6.1
atm	atmosphere
°C	centigrade
Carcinogen	a substance that can cause cancer
cc	cubic centimeter
CGI	Combustible Gas Indicator
CNS	Central Nervous System
eV	Electron Volts
°F	Fahrenheit
HSP	Health and Safety Plan
kg	kilogram
LEL	Lower Explosive Limit
Lpm	liters per minute
MSDS	Material Safety Data Sheet
m	meter
mg	milligram
mg/M^3	milligrams per cubic meter
ml	milliliter
mm	millimeter
ND	not detected
NIOSH	National Institute for Occupational Safety and Health
OBZ	operator's breathing zone
OEL	occupational exposure limit
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PM	project manager
ppb	parts per billion
ppm	parts per million
REL	Recommended Exposure Limit
RHSM	Regional Health and Safety Manager
SMS	Safety Management Standard
SSO	Site Safety Officer
SSR	Subcontractor's Safety Representative
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
UEL	Upper Explosive Limit
URS	URS Corporation and Subsidiaries
VOC	Volatile Organic Compound

1.0 PLAN-AT-A-GLANCE

HSP SUMMARY SHEET – This summary sheet is provided as a quick reference / overview only. The remainder of this site-specific HSP is integral to the safe conduct of site operations and must be applied in its entirety.

EMERGENCY INFORMATION

Ambulance - 911 (Superior Ambulance Service-5901 Pan American West Freeway, NE, (505) 247-8840)
Fire - 911 (AFD-Station 19- 3520 San Andres Ave, NE, (505) 888-8110)
Police - 911 (New Mexico State Police-2501 Carlisle Blvd, NE, (505) 841-9271)
Hospital - 911 (University of New Mexico Hospital – 2211 Lomas Blvd, NE #3, (505) 272-2111)

Project Manager: Mr. Christopher Gaule
Health and Safety Representative: (to be determined)
Regional Health and Safety Manager: Mr. Phil Jones

Alternates

National Response Center	(800) 424-8802
URS Spill Hotline	(800) 381-0664
Chemtrec	(613) 996-6666

HOSPITAL DIRECTIONS:

To reach the hospital from the site, travel east on McLeod Road and turn right onto Jefferson Street. Travel south on Jefferson Street for approximately 0.5-miles and turn right onto Montgomery Boulevard. Travel west on Montgomery Boulevard for approximately 0.6-miles and turn left on Carlisle Boulevard. Travel south on Carlisle Boulevard for approximately 3.0-miles and turn right onto Lomas Boulevard. Travel west on Lomas Boulevard for approximately 0.8-miles. The Hospital will be on the right-hand side.

Additional information concerning emergency procedures is located in Section 12.0 and the hospital route map is located in Figure 2. A copy of the hospital route map must be readily available in each site vehicle that may be used to transport accident victims to the hospital.

CONSTITUENTS OF CONCERN

1. Polychlorinated Biphenyls (PCBs)
2. Volatile Organic Compounds (VOCs), including benzene, ethylbenzene, toluene, xylene, Chlorinated Organics, and Metals (including lead, cadmium, and chromium).

Additional information regarding site history, constituents of concern, and scope of work activities is located in sections 2.0 and 5.0.

PROJECT HAZARD ANALYSIS

Task	Chem. Hzds.	Heat/Cold Stress	Noise	Slip/Trip/ Fall	Lifting Hzds.	Mech'l. Hzds.	Electro-cution	Explosion	Excav-ation
1. Hand Augering	Med.	Med.	N/A	Med.	Med.	Low	N/A	N/A	N/A
2. Geoprobe Oversight and Sample Collection	Med.	Med.	Med.	Med.	Med.	High	Low	N/A	N/A
3. Excavation	Med.	Med.	Med.	Med.	Low	High	Low	N/A	High

High - Exposure likely more than 50% of the time
Med - Exposure likely 10-50% of the time
Low - Exposure likely less than 10% of the time
n/a – Exposure not anticipated

Additional information concerning Project Hazards and their control can be found in Section 5.0.

TASK	MINIMUM PROTECTIVE CLOTHING/EQUIPMENT REQUIREMENTS
1	Steel-toed boots, hard hat, safety glasses, work gloves, nitrile gloves when handling potentially contaminated materials, surgical nitriles for handling samples.
2	Steel-toed boots, hard hat, safety glasses, hearing protection, work gloves, nitrile gloves when handling potentially contaminated materials, surgical nitriles for handling samples.
3	Steel-toed boots, hard hat, safety glasses, hearing protection, work gloves, nitrile gloves when handling potentially contaminated materials, surgical nitriles for handling samples.

PROTECTIVE CLOTHING (First Action Level)

Chemical Protective Clothing

Outer Coveralls:	- Kleenguard® or Tyvek®‡
Outer Gloves:	- Nitrile
Inner Gloves:	- Surgical Nitriles
Boots:	- Chemical-resistant boot covers over steel-toed boots

‡ Substitute poly-Coated Tyvek® if there is a potential for contact with liquids (groundwater, mud, etc.)

The HSP Preparer has conducted a Hazard Assessment for this project based upon information provided by the Project Manager, in accordance with 29 CFR 1910.132(d).

FOR PHOTOIONIZATION DETECTOR

For more information on PPE and respiratory protection requirements, see the Action Levels table (Page 4) and Section 7.0.

ENGINEERING CONTROLS TO BE USED (as applicable)

- Water spray for dust suppression (This will be the responsibility of the subcontractor)
- Natural wind forces to reduce exposure to airborne contaminants
- Forced air ventilation (fans) to reduce potential airborne exposures
- Light colored PPE to reduce solar load for heat stress control
- Dining canopy to provide shaded work/rest area for heat stress control

For more information, see Section 5.0

INSTRUMENTATION TO BE USED

_x_ OVM PID w/ 10.6 eV lamp
_x_ Combustible Gas/O_2 Indicator
_x_ Miniram Real-time Dust Monitor
_x_ Drager pump with Benzene tubes

For more information, see Section 6.0

PERSONAL EXPOSURE SAMPLING

__ Will be conducted
_x_ Will be conducted if PID readings require the use of respiratory protection as described in the Action Level Table (page 4) and in Section 6.1.1
__ Is not anticipated

For more information on Monitoring, see Section 6.0

HAZ-COM MATERIALS INVENTORY

- TSP or Alconox (decontamination)
- Isobutylene (calibration gas)
- Hexane (decontamination)
- Diesel Fuel (drill rig)
- Gasoline (vehicles)
- Motor Oil (drill rig/vehicles)

ACTION LEVELS FOR PHOTOIONIZATION DECTECTOR

Analyzer Reading*	Location	Duration	Action	Personal Protective Equipment
<(1) ppm	Point of Operations/Release Source point	-----	Continued periodic monitoring	Minimum site ensemble
>(1) ppm (1st Action Level)	Point of Operations/Release Source point	> 1 minute	Monitor OBZ; take confirmation sample using Drager tube for benzene, don protective clothing; establish work zones as described in Section 9.2	Minimum Site Ensemble, PLUS: Chemical-resistant boot covers, Tyvek ® coveralls‡, Nitrile Outer Gloves, with Nitrile Inner (surgical) gloves
>(5) ppm (Benzene)	OBZ	> 5 minute	Stop work, move upwind while vapors dissipate. Use engineering controls to suppress organic vapors. If elevated levels remain, cover boring, evacuate upwind and notify RHSM or PM.	Minimum Site Ensemble, PLUS: Chemical-resistant boot covers, Tyvek ® coveralls‡, Nitrile Outer Gloves with Nitrile Inner (surgical) gloves, full face respirator with organic vapor cartridges.
>(100) ppm (2nd Action Level)	OBZ	> 1 minute	Provide respiratory protection; establish decon area as described in 10.0. Contact the RHSM to perform personal monitoring as described in Section 6.1	Minimum Site Ensemble, PLUS: Chemical-resistant boot covers, Tyvek ® coveralls‡, Nitrile Outer Gloves with Nitrile Inner (surgical) gloves, full face respirator with organic vapor cartridges
>(150) ppm OR >(900) ppm	OBZ OBZ	>1 minute instantaneous	Stop work; move upwind while vapors dissipate. If elevated levels remain, cover boring and cuttings, evacuate upwind and notify RHSM or PM.	As specified by RHSM

*above background readings
‡Substitute poly-coated Tyvek® if there is potential for contact with liquids (groundwater, mud, etc)
OBZ= Operator's Breathing Zone

ACTION LEVELS FOR COMBUSTIBLE GAS INDICATOR

LEL Reading	Location	Action
<10% LEL	Point of Operations/General Work Area	Continue site operations and continue periodic monitoring
10-20% LEL	Point of Operations/General Work Area	Continue site operations and perform continuous monitoring
>20% LEL	Point of Operations/General Work Area	Shutdown operations, evaluate source, ventilate work area

LEL = Lower Explosive Limit

ACTION LEVELS FOR DUST

PM-10 Particulate Level	Location	Action
<100 ug/m^3 above background	Point of Operations/General Work Area	Continue site operations and continue periodic monitoring
>100 ug/m^3 above background or visible dust	Point of Operations/General Work Area	Employ dust control measures
>150 ug/m^3 above background or visible dust continues	Point of Operations/General Work Area	Stop work and re-evaluate dust control and work procedures.

For additional information on Action Levels and their implementation, see Sections 6.0 and 7.0

HEALTH AND SAFETY EQUIPMENT LIST

YES	NO	EQUIPMENT
✓		URS Safety Management Standards (relevant to project - see next page)
✓		OSHA "Safety on the Job" Posters
✓		Hardhats
✓		Safety glasses
✓		Ear plugs or muffs
	✓	Cotton coveralls
✓		Traffic safety vest (as needed)
✓		Tyvek® coveralls
	✓	Polycoated Tyvek® Q-23 Coveralls
✓		Steel-toed boots
✓		Chemical-resistant steel-toed boots or chemical-resistant boot covers
✓		Work gloves
✓		Nitrile outer gloves
✓		Surgical nitrile inner gloves
✓		Plastic sheeting (visqueen)
	✓	55 gallon 17-H drums (for contaminated solids)
	✓	55 gallon 17-E drums (for liquids)
	✓	Drum liners

YES	NO	EQUIPMENT
✓		Barricade tape and barricades
✓		Wash tubs and scrub brushes
✓		Decon solution (i.e., TSP)
	✓	Folding chairs
	✓	5 or 10 gallon portable eyewash
✓		Respirator sanitizing equipment (as needed)
✓		First Aid kit
✓		Infection control kit
✓		Drinking water
✓		Gatorade or similar drink
✓		Type ABC fire extinguishers
	✓	Half-face respirators (NIOSH approved)
✓		Full-face respirators (NIOSH approved)
✓		Respirator cartridges [Organic Vapor/HEPS]
✓		Photoionization Detector (PID) w/[10.6ev] lamp and calibration kit
✓		Combustible Gas Indicator and calibration kit (as needed)
	✓	Garden sprayer
✓		Compressed gas horn
✓		Duct tape
✓		Paper towels and hand soap
	✓	Spill sorbent
✓		Plastic garbage bags
	✓	Broom and/or shovel

SAFETY MANAGEMENT STANDARDS REFERENCED BY THIS HSP

SMS	TOPIC	HSP SECTION
002	Worker Right to Know	5.1.2
003	Emergency Action Plans	12.0
010	Confined Space Entry	6.6
013	Excavation Safety	5.2.9
014	Fire Prevention	12.2
017	Hazardous Waste Operations	3.0
018	Heat Stress	5.2.1
019	Heavy Equipment Operations	5.2.6
022	Lead in Constructions	5.2.10
023	Lock Out / Tag Out	5.2.7
026	Noise and Hearing Conservation	5.2.3
029	Personal Protective Equipment	7.0
030	Sanitation	10.1
032	Traffic Control	5.2.8
034	Utility Clearances	5.2.7
040	Fall Hazards	5.2.4
042	Respiratory Protection	8.3/8.9
043	I.H. Monitoring	6.1.1
045	Back Injury Prevention	5.2.5
049	Incident Reporting	12.6

56	Drilling / Geoprobe Safety	5.2.6.1
59	Cold Stress	5.2.2

Copies of Safety Management Standards are available on the URS Safety Intranet at health and safety/ or 10.1.5.21 (internal access only). Use the "Print This SMS" function on the "Safety Management Standards" page to print the complete SMS.

Copies of the SMSs referenced by this HSP are to be maintained on site. Project Managers are responsible to see that other SMSs relevant to field activities but not directly referenced by this HSP are also available on-site.

2.0 FACILITY BACKGROUND/WORK PLAN

2.1 SITE DESCRIPTION AND HISTORY

The Former GE Apparatus Service Center is located at 4420 McLeod Road, NE, Albuquerque, New Mexico, on an approximately two-acre property within a light industrial park. The site is approximately four miles northeast of Albuquerque and approximately 4.5 miles east of the Rio Grande River.

There is one building on the property. The former service shop building is in the northeast quadrant of the property. An enclosure, which was formerly used for equipment storage and steam cleaning of parts, is attached to the south side of the building. The south end of this enclosure is open and a concrete slab extends approximately 20 feet beyond the enclosure. Asphalt pavement covers the area immediately north and northeast of the building. The remainder of the area to the east and the area to the south is covered with gravel and natural sparsely-vegetated soils. All equipment and materials were removed from outdoor areas when operations were discontinued and the facility was closed in 1994. There is no equipment or materials currently stored outdoors at the property and the property is not being used for any business purpose at this time.

The Former GE Apparatus Service Shop was constructed in 1969 for the repair of industrial equipment, primarily electrical motors. Transformers containing dielectric fluids and insulating oils (some containing polychlorinated biphenyl [PCBs] compounds) were also repaired at the shop. Until 1983, wastewater from steam cleaning operations was discharged into in two on-site dry wells. Site operations were discontinued and the facility was closed in 1994.

In 1990, a RCRA Facility Investigation (RFI) was performed at the site by Law on behalf of GE Power Systems to obtain information and other data to characterize the facility, identify sources of contamination, determine the nature and extent of contamination, and identify actual and potential receptors. The RFI Report was submitted to the USEPA, Region VI, in November 1990.Three former release areas were identified during the RFI:

- The former dry well areas;
- The former waste storage area; and
- The former drum rack area.

The analytical results for the soil sampling conducted at the former waste storage and former drum rack areas did not indicate evidence of any extensive impact of analyzed chemicals to those areas. Furthermore, additional near-surface soil sampling and analysis was conducted in these areas to explore for previously undetected impacts (if any). Similarly, this additional sampling did not identify evidence of contaminant sources or releases in the former waste storage or former drum rack areas.

However, the analytical results for the soil sampling conducted to investigate the former dry wells indicated the presence of compounds of concern at levels requiring additional

investigation. Consequently, a series of additional investigations were conducted to thoroughly evaluate the degree and extent of compound of concerns in the vicinity of the former dry wells. Additional investigation in the area of the dry wells was presented in a Work Plan prepared by Law on behalf of GE Power Systems and submitted to the USEPA in January 1991, and revised and resubmitted in February 1991. Following approval, the work plan was implemented and the results of this investigation were presented in the Supplemental Soil Assessment Report, submitted to the USEPA in July 1991.

The available site data provide a thorough and adequate delineation of the degree and extent of compounds of concern in soils at the site. PCBs were limited in their lateral and vertical extent. The data indicate that the majority of impacts are limited to the upper 15 feet of soil surrounding the dry wells. Data also indicate the presence of incidental near-surface PCB impacts at other locations south and southwest of the building. The findings of the RFI and supplemental investigations also indicated the presence of select volatile organics compounds (primarily xylene, ethylbenzene, and toluene) in the soils. The results also indicated the presence of chlorinated volatile organic compounds in soils at much lower concentrations. Volatile organic compounds were predominantly found near the former dry wells.

During the RFI, several monitoring wells and piezometers were installed across the site to characterize the groundwater quality, depth to the groundwater, and groundwater flow direction. The monitoring wells ranged in depth from approximately 279 feet bgs to 290 feet bgs. Groundwater was encountered at approximately 250 feet bgs to 260 feet bgs. The results of the groundwater samples collected from the monitoring wells during two rounds of groundwater sampling at the site indicated that the subject site had not impacted groundwater quality.

2.2 PURPOSE AND SCOPE OF WORK

Scope for Hasp

The scope of work for this project includes a pre-implementation investigation and corrective measure implementation (CMI). During the investigation, soil samples will be collected from geoprobe borings and from the ground surface to better delineate the lateral extent to PCBs in soil at the site.

The CMI includes excavation and off-site disposal of PCB impacted soil and two former dry wells. Most of the soil at the site contains concentrations of PCBs less than 50 mg/kg. However, some of the soil contains concentrations of PCBs between 50 mg/kg and 19,000 mg/kg. Soil at the base of the former dry wells contains elevated concentrations of VOCs (primarily xylene, ethylbenzene, and toluene with concentrations up to 29,000 mg/kg, 3,800 mg/kg, and 29 mg/kg respectively) and metals. The highest detected concentrations of cadmium, chromium, and lead are 68.1 mg/kg, 171 mg/kg, and 1,160 mg/kg, respectively.

The planned excavation areas include numerous smaller areas where PCB impacts extend to less than 2.5 feet below ground surface (bgs). However three of the planned excavation areas are deeper. These areas are planned to extend 6.5, 11, and 15 feet bgs. Soil samples will be collected from the base of the excavated areas to confirm that sufficient soil has been removed.

For excavations less than 15 feet bgs, additional soil removal may be performed if the cleanup objectives have not been met. For excavations greater than 4 feet bgs, the excavation equipment will be used to bring soil to the ground surface for sampling.

After verification samples show that no additional soil removal is needed, the areas will be restored. The areas will be backfilled to approximate original grade and covered with gravel.

3.0 APPLICABILITY

The purpose of this plan, which was developed specifically for operations at the GE Albuquerque site in Albuquerque, New Mexico is to assign responsibilities, establish personal protection standards and mandatory safety procedures, and provide for contingencies that may arise while operations are being conducted at the site. This plan complies with, but does not replace, Federal Health and Safety Regulations as set forth in 29 CFR 1910 and 1926, and applicable state regulations. This plan is to be used by URS personnel as a supplement to such rules, regulations, and guidance. This health and safety plan is to be augmented by the URS Health and Safety Program and Management System, relevant standards from which are required to be available on site during all activities.

The provisions of the plan are mandatory for all on-site URS employees engaged in hazardous material management activities associated with this project which may involve health and safety hazards.

Changing and/or unanticipated site conditions may require modification of this site safety plan in order to maintain a safe and healthful work environment. Any proposed changes to this plan should be reviewed with an URS Health and Safety Professional prior to implementation. If this is not feasible, the Site/Project Manager may modify the plan and record all changes in the field logbook; under no circumstances will modifications to this plan conflict with Federal, state, or other governmental health and safety regulations.

URS is providing a copy of this Health and Safety Plan to each site subcontractor in order to fulfill its obligation under 29 CFR 1910.120(b) to inform subcontractors of site hazards. Each subcontractor is to provide a health and safety plan that complies with 29 CFR 1910.120 and addresses the activities of its employees relative to this project.

The specifications for a hazardous waste field operation are outlined in URS Safety Management Standard 017, a copy of which shall be maintained at the site. It shall be the responsibility of the Project Manager of the site for the implementation of this procedure.

4.0 RESPONSIBILITIES

URS will have site safety and health oversight and coordination responsibilities for URS personnel; each subcontractor will be held accountable for the safe and healthful performance of work by each of their employees, subcontractors, or support personnel who may enter the site.

URS will strictly adhere to the provisions of this health and safety plan, along with the applicable regulations issued by governmental entities.

4.1 PROJECT MANAGER (URS)

The Project Manager (PM) shall direct URS on-site operations. The PM may delegate all or part of these duties to a properly qualified URS employee who is designated as the Site Manager. At the site, the PM, assisted by the Site Safety Officer (SSO), has primary responsibility for:

1. Seeing that appropriate personal protective equipment and monitoring equipment is available and properly utilized by all on-site URS employees.

2. Establishing that URS personnel are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies.

3. Establishing that all URS on-site personnel have completed a minimum of 40 hours of health and safety training and have appropriate medical clearance as required by 29 CFR 1910.120, and have been fit tested for the appropriate respirators.

4. Seeing that URS personnel are aware of the potential hazards associated with site operations.

5. Monitoring the safety performance of all URS personnel to see that the required work practices are employed.

6. Correcting any URS work practices or conditions that may result in injury or exposure to hazardous substances.

7. Preparing any accident/incident reports for URS activities (see Section 12.6).

8. Seeing to the completion of Plan Compliance Agreements by URS personnel (See Attachment A).

9. Halting URS site operations, if necessary, in the even of an emergency or to correct unsafe work practices.

10. Seeing that utility clearances are obtained prior to the commencement of work (see Section 5.2.7).

11. Seeing that the appropriate Safety Management Standards are appended to this HSP and are available on site (see "Plan at a Glance").

12. Reviewing and approving this project health and safety plan.

4.2 SITE SAFETY OFFICER (URS)

The Site Safety Officer's (SSO) duties may be carried out by the PM or other qualified URS site manager. The SSO is responsible for:

1. Implementing project Health and Safety Plans, and reporting any deviations from the anticipated conditions described in the plan to the PM, and, if necessary, the RHSM.

2. Determining that monitoring equipment is used properly by URS personnel and is calibrated in accordance with manufacturer's instructions or other standards, and that results are properly recorded and filed.

3. Check with Health and Safety Representative to assure URS personnel have current medical clearance and training.

4. Assuming any other duties as directed by the PM or RHSM.

5. Coordinating with URS Health and Safety Professional to identify URS personnel on site for whom special PPE, exposure monitoring, or work restrictions may be required.

6. Conducting safety meetings for all site personnel in accordance with Section 13.

7. Conducting daily site inspections prior to the start of each shift. All inspections must be documented (preferably in a bound field logbook).

8. Providing ongoing review of the protection level needs as project work is performed, and informing the PM of the need to upgrade/downgrade protection levels as appropriate.

9. Contacting the RHSM to perform personal industrial hygiene monitoring for aromatic hydrocarbons if the second action level is reached (>(*) ppm in the OBZ) as described in the Action Level Table (page 4) and Section 6.1.1.

10. Ensuring that decontamination procedures described in Section 10.0 are followed by URS personnel.

11. Establishing monitoring of URS personnel and recording results of exposure evaluations.

12. Halting URS site operations, if necessary, in the event of an emergency or to correct unsafe work practices.

13. Maintaining the visitor log.

14. Posting OSHA "Safety of the Job" and other required posters at the site.

4.3 REGIONAL HEALTH AND SAFETY MANAGER (URS)

The Regional Health and Safety Manager (RHSM) is responsible for:

1. Determining the need for periodic audits of the operation to evaluate compliance with this plan.

2. Providing health and safety support as requested by the SSO and PM.

4.4 PROJECT PERSONNEL (URS)

Project personnel involved in on-site investigations and operations are responsible for:

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.

2. Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSO or PM.

3. Implementing the procedures set forth in the Health and Safety Plan, and reporting any deviations from the procedures described in the Plan to the SSO or PM for action.

4. Notifying the PM and SSO of any special medical problems (i.e., allergies) and seeing that all on-site URS personnel are aware of such problems.

5. Reviewing project health and safety plan and signing Safety Plan Compliance Agreement.

4.5 SUBCONTRACTOR'S SAFETY REPRESENTATIVE

Each subcontractor is requested to designate a Subcontractor's Safety Representative (SSR) who is the subcontractor supervisor. The SSR is responsible for the safe and healthful performance of work by his work force and subcontractors. During subcontractor activities on-site, the SSR will perform continuing work area inspections, and conduct safety meetings and safety orientations for all new employees. The SSR will attend periodic safety meetings with the SSO. The SSR will also investigate accidents and over-exposures involving subcontractor personnel. The subcontractors will be required to comply with the same level of GE health and safety requirements as URS.

5.0 JOB HAZARD ANALYSIS

5.1 CHEMICAL HAZARDS

There are two categories of chemical hazards associated with site activities:

- Site Constituents
- Chemicals used to conduct the site work

Site constituents are those which exist at the site and are the cause for conducting site activities. The chemicals that are brought on site in order to conduct the work may be hazardous and subject to regulation under OSHA's Hazard Communication Standard (29 CFR 1910.1200).

5.1.1 Site Constituents

Given that any potential exposure to site personnel will be only for a short period of time (intermittent for several days), the levels of contaminants that have been, or could be, encountered during site activities should not represent a significant concern if the provisions of this HSP are appropriately implemented. However, the site is still under investigation, so the potential for exposure to elevated levels of these contaminants may exist. Overviews of the hazards associated with exposure to elevated levels of these contaminants may exist. Overviews of the hazards associated with exposure to the chemicals that may pose a hazard during site activities are presented below in terms of the following types of occupational exposure limits:

PEL - Permissible Exposure Limit (OSHA Standard)
TLV - Threshold Limit Value (ACGIH Guidance)
REL - Recommended Exposure Limit (NIOSH Guidance)
STEL- Short Term Exposure Limit
C - Ceiling

OSHA Permissible Exposure Limits (PELs), ACGIH Threshold Limit Values (TLVs), and NIOSH Recommended Exposure Limits (RELs) are time-weighted averages (TWAs) defined as concentrations for a normal 8-hour work day and 40-hour work week to which almost all workers can be repeatedly exposed without suffering adverse health effects.

Short Term Exposure Limit (STEL) is defined as the concentration to which workers can be exposed for short time periods without irritation, tissue damage, or narcosis sufficient to likely cause impairment of self-rescue or precipitate accidental injury. The STEL is a 15-minute time-weighted average that should not be exceeded at any time during the workday. STELs are used by OSHA, ACGIH and NIOSH for chemical exposure criteria.

A ceiling value (C) is a concentration that should not be exceeded at any time in any workday. Ceiling limits are established by OSHA, ACGIH and NIOSH for chemical exposure criteria.

Summary Of Site Constituents

SUBSTANCE	TOXICITY/CARCINOGENICITY	OCCUPATIONAL EXPOSURE VALUES
Cadmium (Cd)	Can cause acute poisoning w/ severe lung irritation. Highly irritating to stomach lining, eyes and skin.	0.01 mg/m^3 Dust (TLV-TWA)
Chromium (Cr)	May cause respiratory irritation. Poorly absorbed by intestinal tract. Chronic- dermatitis, kidney damage, ulcers and eye damage.	0.5 mg/m^3 Dust (TLV-TWA)
Lead (Pb)	Chronic-may cause reproductive disorders and teratogenic effects. May result in plumbism characterized by lines in gums, headache, weakness and mental changes.	0.5 mg/m^3 Dust (TLV-TWA)
Benzene	Confirmed human carcinogen. Toxic by ingestion, inhalation, and skin adsorption. Irritant to eyes, nose, and throat.	1 ppm (TLV-TWA and PEL) 5 ppm (STEL)
Ethylbenzene	Moderately toxic by ingestion and skin absorption. Irritant to skin and eyes. Confirmed animal carcinogen.	100 ppm (TLV-TWA and PEL) 125 ppm (STEL)
Toluene	Moderately toxic via the oral, inhalation, and intraperitoneal routes, low toxicity via the dermal route.	100 ppm (TLV-TWA and PEL) 200 ppm (STEL) 300 ppm (Ceiling)
Xylene	Moderately toxic via the oral, inhalation, intraperitoneal, and subcutaneous routes.	100 ppm (TLV-TWA and PEL) 150 ppm (STEL)
Polychlorinated Biphenyl (PCB–Aroclor 1254) (54% chlorine)	Toxic via oral, inhalation, ingestion, and skin or eye contact.	1 mg/m3 airborne particulates (TLV-TWA)

Skin contact with potentially contaminated materials will be minimized by the use of personal protective clothing (as described in Sections 1.0 and 7.0). Inhalation of vapors or particulates during the site activities will be minimized by air monitoring and the use of engineering controls, and respiratory protection will be used if Action Levels described in Section 1.0 are exceeded. Ingestion of contaminated materials will be minimized by the use of appropriate personal hygiene procedures during decontamination (i.e., thoroughly washing face and hands with soap and water after leaving the work area and prior to eating or drinking).

5.1.2 Hazard Communication Materials

Materials which are considered hazardous materials under the OSHA Hazard Communication Standard (29 CFR 1910.1200) may be used during this project. In accordance with the URS

Hazard Communication Program, the MSDSs for the hazardous materials listed in Section 1.0 are included in Attachment C. The SSO will make copies of these MSDSs available to any subcontractors (i.e. drillers, excavators) on this project.

URS written Hazard Communication program is located in Safety Management Standard 002, a copy of which shall be maintained on-site.

5.2 PHYSICAL HAZARDS

Physical hazards at this work site include:

- Heat stress and cold stress;
- Noise from the operation of site equipment;
- Slip-Trip-Hazards;
- Back injuries due to improper lifting;
- Being caught in or struck by moving equipment;
- Electrocution or explosion hazards associated with drilling or excavation activities such contact with overhead or underground power lines or pipelines;
- Excavation hazards; and
- Muscle strains from hand auger work.

5.2.1 Heat Stress Recognition and Control

Heat stress monitoring shall commence when personnel are wearing PPE, including Tyvek®-type coveralls, and the ambient temperature exceeds 70°F. If standard work garments (cotton coveralls) are worn, monitoring shall commence at 85°F. Additional information regarding Heat Stress is located Safety Management Standard 018, a copy of which shall be maintained on site.

5.2.2 Cold Stress Recognition and Control

Protection against cold stress should be initiated when temperatures drop below 45°F. Cold stress guidance is provided below. Additional information on cold stress can be found in URS' Safety Management Standard 059 and a copy shall be maintained on-site.

Exposure to cold working conditions can result in cold stress (hypothermia) and/or injury (frostbite) to hands, feet, and head. Hypothermia can result when the core body temperature drops below 36°C (96.8°F). Lower body temperature will likely result in dizziness, drowsiness, disorientation, slurred speech, or loss of consciousness, with possible fatal consequences. Pain in the extremities may be the first warning of danger to cold stress. Shivering develops when the body temperature has fallen to 35°C (95°F).

Hypothermia can be brought on by exposure to cold air, immersion in cold water, or a combination of both. Wind chill factor, the cooling power of moving air, is also a critical factor in cold stress.

Workers must wear adequate insulating clothing if work is performed in temperatures below 4°C (40°F). At temperatures of 2°C (35.6°F or less), workers whose clothing becomes wet should be immediately provided with a change of clothing, and if necessary, treated for hypothermia. Treatment includes warming the victim with skin-to-skin contact, or by providing warm blankets or other coverings, and drinking warm liquids. Skin exposure should not be permitted at temperatures of -32°C (-25°F) or below.

If fine work is to be performed with bare hands for more than 10-20 minutes at temperatures below 16°C (60°F), provisions should be made for keeping the workers' hands warm. If equivalent chill temperatures fall below 40°F and fine manual dexterity is not required, then gloves should be worn. Metal handles of tools should be covered with insulating material at air temperatures below -1°C (30°F).

If work is to be performed continuously in the cold when the wind chill factor is at or below -7°C (19°F), heated warming shelters (tents, trailers, vehicle cabs) should be made available nearby.

5.2.3 Noise Hazards

Previous surveys indicate that heavy equipment such as drilling or excavation equipment may produce continuous and impact noise at or above the action level of 85 dBA. All URS personnel within 25 feet of operating equipment, or near an operation that creates noise levels high enough to impair conversation, shall wear hearing protective devices (either muffs or plugs). URS personnel who are in the Medical Surveillance program are automatically enrolled in the URS Hearing Conservation Program and have had baseline and, where appropriate, annual audiograms. Personnel will wash their hands with soap and water prior to inserting earplugs to avoid initiating ear infections. Additional information regarding the URS Hearing Conservation Program is located in Safety Management Standard 026, a copy of which shall be maintained on-site.

5.2.4 Slip/Trip/Fall Hazards

Workers should exercise caution when walking around the site to avoid fall and trip hazards. If there are holes or uneven terrain in the work area that could cause site personnel to fall or trip, then the hazard must be covered, flagged or marked to warn workers. Workers should exercise caution around open excavations, such as test pits, and avoid getting closer than two feet to the edge of an unsloped excavation unless guardrails or fall protection is provided. If conditions become slippery, workers should take small steps with their feet pointed slightly outward to decrease the probability of slipping. Gravel or sand should be spread in muddy areas to increase traction. Workers should watch where they are walking and walk only in areas of good stability.

It shall be the responsibility of the Project Manager to implement a fall protection procedure when workers are exposed to a fall hazard of 6 feet or greater. Use of guardrails and/or a combination of fall arrest systems shall be used when working above 6 feet. Class 1 body belts are forbidden in the use of a fall protection system. Additional information regarding fall

protection can be found in URS Safety Management System Standard 040, a copy of which shall be maintained on-site.

5.2.5 Lifting Hazards

The following guidelines will be followed whenever lifting equipment such as portable generators, coolers filled with samples, any other objects that are of odd size or shape, or that weigh over 40 pounds. Safe lifting procedures are described in Safety Management Standard 045, a copy of which is to be available on-site.

- Get help when lifting heavy loads. Portable generators will only be lifted using a two-person lift.
- When moving heavy objects such as drums or containers, use a dolly or other means of assistance.
- Plan the lift. If lifting a heavy object, plan the route and where to place the object. In addition, plan communication signals to be used (i.e., "1,2,3, lift," etc.)
- Wear sturdy shoes in good conditions that supply traction when performing lifts.
- Keep your back straight and heads aligned during the lift and use your legs to lift the load – do not twist or bend from the waist. Keep the load in front of you – do not lift or carry objects from the side.
- Keeping the heavy part of the load close to your body will help maintain your balance.

5.2.6 Heavy Equipment

Operation of heavy equipment during site activities presents potential physical hazards to personnel. Issues associated with heavy equipment operations are addressed in Safety Management Standard 019, a copy of which is to be maintained on site.

The following precautions must be observed whenever heavy equipment is in use:

- Personal protective equipment (PPE) such as steel-toed shoes, safety glasses or goggles, and hard hats must be worn whenever such equipment is present.
- Personnel must at all times be aware of the location and operation of heavy equipment, and take precautions to avoid getting the way of its operation. Never assume that the equipment operator sees you; make eye contact and use hand signals to inform the operator of your intent, particularly if you intend to work near or approach the equipment.

- Traffic safety vests are required for URS personnel working near mobile heavy equipment, such as backhoes and other excavators.

- Never walk directly in back of or to the side of, heavy equipment without the operator's acknowledgment.

- When an equipment operator must operate in tight quarters, the equipment subcontractor should provide a person to assist in guiding the operator's movements.

- Keep all non-essential personnel out of the work area.

- Any heavy equipment that is used in the exclusion zone should remain in that zone until its task is completed. The equipment subcontractor should completely decontaminate such equipment in the designated equipment decontamination area as required prior to moving the equipment outside of the EZ/CRC.

5.2.6.1 DRILLING / GEOPROBE SAFETY GUIDELINES

The primary responsibility of drilling safety is with the drilling contractor. However, URS employees are responsible for their own safety, which includes recognizing and avoiding drill rig hazards. URS employees that observe a drill rig condition deemed unsafe shall inform the drill rig operator.

In general, a safety meeting will be conducted with the drilling contractor prior to work. Sample tables and general work areas will be to the side of the rig (not directly behind) and approximately 30 feet away. URS employees shall not, at any time, assist the driller with equipment, supplies or operate drill controls.

Information regarding the movement and placement of the drilling rig can be found in the Section 5.2.6 of this document and URS' Safety Management Standard 056, a copy of which shall be maintained on site.

5.2.7 Underground and Aboveground Utilities

The Site Manager or SSO is responsible locating that underground utilities prior to the commencement of any subsurface (> 0.3 meters (1 ft.) activities. Resources include site plans, utility companies, and regional utility locating services. The proper utility company personnel shall certify in writing to the Site Manager or SSO the deactivation of underground utilities, and the certification retained in the project files. URS will also perform physical clearing (e.g. hand digging, probing, etc.) at boring locations to a minimum of four feet bgs at all locations to confirm absences of subsurface utilities before proceeding with the drill rig.

Procedures for activities proximal to utility locations are located in Safety Management Standard 034, a copy of which is to be maintained on site.

Excavation, drilling, crane, or similar operations adjacent to overhead lines shall not be initiated until operations are coordinated with the utility officials. Operations adjacent to overhead lines are prohibited unless one of the following conditions is satisfied:

- Power has been shut off and positive means (e.g. lockout/tagout) have been taken to prevent lines from being energized. Wherever possible, the URS SSO will observe power shut off and place a lock and tag on the switch. In all cases, utility company personnel shall certify in writing to the Site Manager or SSO the deactivation of overhead utilities, and the certification retained in the project files. The Site Manager or SSO must also attempt to verify power shut off by checking that power is no longer available to the affected building or equipment. Information regarding lock-out/tag-out procedures can be found in URS' Safety Management Standard 023, a copy of which shall be maintained on-site.

- Equipment, or any part of the equipment, cannot come within the following minimum clearance from energized overhead lines:

Power Lines Nominal System (kv)	Minimum Required Clearance
0-50	10 feet
51- 200	15 feet
201-300	20 feet
301-500	25 feet
501-750	35 feet
751-1000	45 feet

5.2.8 Work Area Protection

As the project operations may be undertaken in a roadway or parking lot, motor vehicles may be a hazard. Consideration should be given to parking a work vehicle within the coned area between the work area and oncoming traffic. Procedures for work zone traffic control are located in Safety Management Standard 032, a copy of which is to be maintained on site.

5.2.9 Trenching and Excavation

All URS personnel are prohibited from entering a trench or excavation until it has been inspected by a competent person in accordance with 29 CFR 1926.650-651. If personnel are required to enter a trench or excavation that is deeper than five feet, the contractor who created the excavation must provide the following provisions prior to entry:

- If hazardous atmospheres are suspected, any trench or excavation more than four feet deep must be monitored.

- Adequate shoring, sloping, or benching techniques must be employed.

- Adequate means of employee access and egress must be utilized.

- The contractor's trained, competent person must inspect the trench or excavation on a daily basis, before work commences and on an as-needed basis throughout the day.

A copy of the Fed-OSHA Excavation Standard can be obtained from the Regional Health and Safety Manager. All provisions of this regulation must be complied with when working in a trench or excavation. Additional information regarding URS procedures for excavation activities are located in Safety Management Standard 013, a copy of which is to be maintained on site.

5.2.10 Lead in Construction

It shall be the requirement of the Project Manager to determine if any surface, that is to be disturbed or altered, contains lead. Proper protection measures will be implemented as necessary. All employees will have the required training and participate in medical surveillance. Protective measures may include dust suppression, proper PPE, decon and hygiene facilities.

Known hazardous area will be marked appropriately with boundary tape and signs. Possible color coordination of boundary areas defining soil concentrations for lead may also be established. Additional information regarding URS procedures for Lead are located in URS' Safety Management Standard 022 (see Appendix B).

5.3 AIR MONITORING PLAN

Equipment: Photoionization Detector (PID) (OVM 580B or equivalent) that can record readings every 1 minute and calculate 15-minute running average concentrations. The equipment specifications and calibration procedures for the PID were provided in Appendix D of the Field Sampling Plan.

MIE Data Ram Portable Aerosol Monitor (or equivalent), each equipped with omni-directional sampling inlets, inlet heads that can monitor particulate matter less than 10 micrometers in size (PM-10 inlets), and an alarm amplifier (optional). The equipment specifications for the dust monitor are provided in Attachment G.

Implementation: Air monitoring will be performed in the Operator's Breathing Zone (OBZ), according to the Health and Safety Plan and as described below in Section 1.0. If the lower range of the 1st Action Level for VOCs [5 parts per million (ppm) above background] or PM-10 particulate level of 100 $\mu g/m^3$ above background are exceeded in the OBZ, air monitoring in the OBZ will continue and also be conducted at the perimeters of the exclusion zone (which is 25 feet circumference around the immediate work area) using monitoring equipment. Dust migration will also be assessed visually. The monitoring at the perimeter of the exclusion zone is described in Section 5.3.2.

5.3.1 Monitoring in Operator's Breathing Zone

According to Health and Safety Plan, continuous air monitoring for VOCs will be performed in the OBZ for all ground intrusive activities, which includes the installation of soil borings or monitoring wells. In the future, other potential ground intrusive activities may include soil/waste excavation and handling, test pitting or trenching. Furthermore, dust monitoring using both portable instrument and visual observations will be performed in the OBZ.

For continuous air monitoring, the PID will be programmed to record readings every minute and calculate 15-minute running average concentrations. The portable aerosol monitor (dust monitor) will be outfitted with a PM-10 inlet head and an omni-directional sampling inlet which will enable representative sampling at a variety of wind speeds. The instrument will be capable of measuring particulate matter less than 10 micrometers in size (PM-10). The dust monitor will be programmed for running time average concentrations over 15 minute intervals. All data collected by both portable meters will be downloaded to a PC daily and saved.

Periodic air monitoring for VOCs only will be performed in the OBZ during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from the monitoring wells. Periodic monitoring during sample collection will consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring every 15 minutes during well baling/purging, and taking a reading prior to leaving a sample location.

ACTION LEVELS

The action levels for the VOCs in the OBZ are summarized in Health and Safety Plan, Section 1.0 (Plan-At-A-Glance). The lower range of the 1st Action Level for VOCs in OBZ is 5 ppm above the background reading.

The action levels for the dust monitoring are summarized below:

PM-10 Particulate Level	Action
Less than 100 $\mu g/m^3$ above background	Continue regular work procedures.
Between 100 $\mu g/m^3$ and 150 $\mu g/m^3$ above background Or, visible dust leaving the area	Employ dust control measures.
> 150 $\mu g/m^3$ above background Or, visible dust continues to leave area	Stop work and reevaluate dust control measures and work procedures.

The background (upwind) reading will be established according to procedure described in Section 6.2 of the Health and Safety Plan.

5.3.2 Monitoring at the Perimeter of Exclusion Zone

This section describes the monitoring at the upwind and downwind perimeter of the exclusion zone (if required) and related actions. The exclusion zone will be established according to procedures described in Section 9.2 of the Health and Safety Plan.

5.3.3 VOC Monitoring

If the action level described in Section 1.0 are exceeded (5 ppm above background in OBZ), then VOCs will be monitored at the downwind perimeter of the exclusion zone on a continuous basis. Upwind concentrations will be measured at the start of each workday and periodically thereafter to establish background conditions.

If the ambient air concentration of total organic vapors at the downwind perimeter of the exclusion zone exceeds 5 ppm above background for the 15-minute average, work activities will be temporarily halted and monitoring will be continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities will resume with continued monitoring.

If total organic vapor levels at the downwind perimeter of the exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities will be halted. The source of vapors will be identified, corrective actions will be taken to abate emissions, and monitoring will be continued. Work activities will resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less. However, in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

If the organic vapor level is above 25 ppm at the perimeter of the exclusion zone, activities will be shutdown.

5.3.4 Dust Monitoring

If the action level of 100 $\mu g/m^3$ above background level is exceeded, then dust suppression techniques will be employed and air dust monitoring will be conducted at the perimeters of the exclusion zone using monitoring equipment. Dust migration will also be assessed visually.

The monitors will be set up at the perimeter of the exclusion zone and operated continuously when work is in progress. One monitor will be placed upwind and the other monitor downwind of the work area. At the start of each work day the initial background particulate level at the upwind monitor will be noted. The downwind monitor will be programmed to alarm at the background particulate level plus 150 $\mu g/m^3$. If field observations indicate that transient ambient conditions have produced an elevated background particulate level, the background particulate level will be reassessed and the alarm level may be modified. Response actions as described for the Action Levels in Section 1.0 will be followed.

If the dust suppression techniques are unsuccessful at adequately controlling dust migration and particulate levels are greater than 150 $\mu g/m^3$ above background level then work will be halted and the procedures reevaluated.

6.0 EXPOSURE MONITORING PLAN

Heat stress, noise, and chemical exposures may be encountered at this site. Heat stress monitoring and prevention is addressed in Section 5.2.1. Noise levels will not be monitored; URS personnel will wear hearing protection as described in Section 5.2.3.

6.1 CHEMICAL EXPOSURE MONITORING

The field instrumentation described in this health and safety plan has been specifically selected for the contaminants that may be reasonably anticipated to be encountered during this course of this project. Selection factors include anticipated airborne concentrations, potential interference, ionization potentials, instrument sensitivity, and occupational exposure limits. The Action Levels specified in Section 1.0 were established with the expectation that specific instruments will be used. DO NOT SUBSTITUTE INSTRUMENTS WITHOUT THE CONSENT OF THE HSP PREPARER OR THE REGIONAL HEALTH AND SAFETY MANAGER.

The monitoring equipment specified in Section 1.0 will be used on a regular basis to evaluate the potential for exposure to airborne contaminants, typically every five to ten minutes. Monitoring will be conducted in the immediate vicinity of the contaminant source point or work area (e.g., at the borehole and cuttings adjacent to the borehole). If readings exceed the first Action Level (1 ppm> one minute), monitoring in the operator's breathing zone (OBZ) of the person working nearest the point of operations/contaminant source will start immediately, and site personnel will don protective clothing. Monitoring will be conducted using a Drager pump, with a detection tube specified for Benzene.

A reading in the OBZ above the second Action Level (100 ppm > one minute) will require the use of full-face respirators with appropriate cartridges. An OBZ reading above the third Action Level (150 ppm > one minute) will require work to stop, and workers will move upwind while the airborne contaminants dissipate. If elevated levels remain for more than five minutes, organic vapor engineering controls (such as the use of Biosolve or similar product) will be employed. If elevated levels remain the source of the airborne contamination will be covered with clean soil, plastic sheeting, or foam, (or controlled in an appropriate manner) and the Health and Safety Representative or PM will be contacted for further guidance.

6.1.1 Personal Exposure Monitoring

In accordance with 29 CFR 1910.120(h), a URS industrial hygienist will perform quantitative personal monitoring on personnel at greatest risk of exposure (i.e., those working in the exclusion zone). The industrial hygienist will determine who to sample based upon site conditions at the time of the sampling; monitoring will commence when the Second Action Level is exceeded.

Personnel will be monitored for chemical exposure in accordance with National Institutes for Occupational Safety and Health (NIOSH). A laboratory accredited by the American Industrial

Hygiene Association will perform analyses, and results will be reported and records maintained in accordance with OSHA criteria.

Procedures for personal monitoring are located in Safety Management Standard 043, a copy of which is to be maintained on site.

6.2 BACKGROUND READINGS

All direct-reading instrument readings will be evaluated relative to background reading, not "meter zero". Prior to the start of work at each shift, and whenever there is a significant shift in wind direction, instrument readings will be obtained upwind of the site work zone in order to determine the level of "background" readings from local vehicle traffic, emissions from nearby operations unrelated to the site, etc. Site readings will be evaluated against these background readings (i.e., if an action level is listed as 20 ppm, it is evaluated as 20 ppm above background). The SSO should consult with the industrial hygienist regarding the potential health hazards associated with background readings above 5 ppm.

6.3 DATA LOGGING

All monitoring data, including background readings, will be logged in the field logbook. The results of daily instrument calibrations can either be logged on the form provided in Appendix E or in the field logbook. All monitoring instruments will be calibrated in accordance with the manufacturer's instructions prior to the start of each shift. Calibration should also be performed when inconsistent or erratic readings are obtained. If an instrument cannot be calibrated to specification, or becomes otherwise inoperable, all invasive site work (i.e., drilling, excavating) will cease until the instrument is appropriately repaired or replaced; the PM or Regional Health and Safety Manager should be contacted for further guidance.

6.4 DUST CONTROL

High winds and site operations can cause airborne dust hazards. If site operations generate sustained visible dust, a water mist will be applied to reduce dust generation. If the mist is not effective in reducing dust generation, personnel will don respirators (full-face as appropriate for analyzer readings) with combination organic vapor-HEPA cartridges (such as MSA's GMC-H cartridges).

Sand and Portland cement that may be used in groundwater monitoring well construction may contain free silica (quartz). Airborne exposure to silica dust may occur during handling of these materials. Full-face respirators with HEPA cartridges should be worn for those sand and cement handling operations where there is a reasonable possibility for exposure to sustained airborne dust from the pouring and mixing of dry sand or cement.

6.5 EXPLOSIVE ATMOSPHERES

Due to the presence of elevated concentrations of site constituents that have a low flash point, the potential exists for explosive atmospheres at the site. Therefore, a Combustible Gas Indicator/O_2 (CGI/O_2) meter will be used to monitor ambient conditions. Decisions will be based on the levels measured using a CGI/O_2 meter (measurements are in % of the Lower Explosive Limit) as determined by the Action Level Table located on page 5.

For excavation operations, a CGI with a remote sensing head should be used. The sensing head should be attached to the excavator arm near the bucket, and the cable run back along the arm to the CGI located in the excavator cab. This will permit the operator to be alerted to hazardous situations without requiring monitoring personnel to stand at the working face.

Fire suppression equipment (Two 2A10B:C fire extinguishers) is to be present at all times during site operations in areas where a fire potential exists.

6.6 OXYGEN DEFICIENT ATMOSPHERES

Oxygen deficient atmospheres may be encountered in excavations. An excavation with an oxygen deficient atmosphere is not to be entered unless absolutely necessary and then only after following appropriate confined space entry procedures. These procedures are available by contacting the Regional Health and Safety Manager to obtain a confined space entry permit. Any confined space entry must be approved by the Regional Health and Safety Manager.

Prior to entering any space where an oxygen deficiency may exist, an oxygen meter will be used to test for adequate oxygen levels. Decisions will be based on oxygen concentrations as follows:

>23.5%	Do not enter, ventilate, and contact 550
19.5 – 23.5%	Continue operations and monitoring
<19.5%	Do not enter, ventilate and determine if supplied air equipment is required

Guidelines for confined space entry are located in URS' Safety Management Standard 010, of which a copy is to be maintained at the site (see Appendix B).

7.0 PERSONAL PROTECTIVE EQUIPMENT

The minimum Personal Protective Equipment (PPE) for site personnel includes:

- Hardhat
- Safety glasses with side shields (or impact resistant goggles)
- Steel-toed boots or Chemical-resistant steel-toed boots
- Ear protection in vicinity of noisy equipment
- Work gloves and/or chemical-resistant gloves
- Traffic safety vest in the vicinity of heavy equipment

As the various monitoring Action Levels are reached, additional PPE is required. Section 1.0 provides the description of the incremental PPE requirements relative to specific Action Levels, as well as the specific kinds of PPE to be use. Procedures for use and selection of personal protective equipment are located in Safety Management Standard 029, a copy of which is to be maintained on site (see Appendix B).

7.1 LIMITATIONS OF PROTECTIVE CLOTHING

The protective equipment ensembles selected for this project are anticipated to provide protection against the types and concentrations of hazardous materials that may potentially be encountered during field operations. However, no protective garment, glove or boot is resistant to all chemicals at any concentration; in fact, chemicals may continue to permeate or degrade a garment even after the source of the contamination is removed.

In order to obtain optimum usage from PPE, the following procedures are to be followed by all URS personnel:

- When using disposable coveralls, don a clean, new garment after each rest break or at the beginning of each shift

- Inspect all clothing, gloves and boots both prior to and during use for:
  - Imperfect seams
  - Non-uniform coatings
  - Tears
  - Poorly functioning closures

- Inspect reusable garments, boots and gloves both prior to and during use for:
  - Visible signs of chemical permeation such as swelling, discoloration, stiffness or brittleness
  - Cracks or any signs of puncture or abrasion

Any reusable garments exhibiting any such characteristics will be discarded.

7.2 DURATION OF WORK TASKS

The duration of work tasks in which personnel use PPE ensembles that include chemical protective clothing (including uncoated Tyvek®) will be established by the SSO. Variables to be considered include ambient temperature and other weather conditions, the capacity of individual personnel to work in the required level of PPE in heat and cold, and the limitations of specific PPE ensembles. The recommended rest breaks are as follows:

- Fifteen minutes midway between shift startup and lunch
- Lunch break (30-60 minutes)
- Fifteen minutes midway between lunch and shift end

Rest breaks are to be taken in the support zone or other clean area after personnel have completed the decontamination process, including soap and water wash of hands and face. Additional rest breaks will be scheduled according to heat stress monitoring protocols as described. URS Safety Management Standard 018 (see Appendix B).

8.0 RESPIRATORY PROTECTION

8.1 RESPIRATOR SELECTION

Engineering controls and safe work practices (e.g. elimination of the source of contamination, ventilation equipment, working upwind, limiting exposure time, etc). must always be the primary control for air contaminants. Respirators will be used if engineering or work practice controls are not feasible for controlling airborne exposures below acceptable concentrations and as an interim control measure while engineering or work practice controls are implemented.

Once the need for respirators has been established, the respirators will be selected on the basis of the hazards to which the worker is exposed. Only NIOSH-approved respirators will be issued. Selection criteria established in 29 CFR 1910.134 has been used by the HSP Preparer in determining respirator requirements for this project.

> *CAUTION: Full-face piece or half-face piece air-purifying respirators are not to be used where there is an oxygen deficiency. Only air-supplied respirators with an emergency escape cylinder or self-contained breathing apparatus will be worn when an oxygen deficiency exists.*

> *CAUTION: A respirator does not protect against excessive heat or against hazardous substance that can attack the body through the skin.*

The forms of the airborne contaminants have been evaluated based upon the suspected contaminants of concern. Evaluation of the concentration of the airborne chemical hazard will be performed using direct reading instruments to determine what type respirator will be used. Airborne readings will be compared to Action Levels in the table in Section 1.0. See action level/respirator requirements in Section 6.1.

8.2 MEDICAL SCREENING

Project employees are enrolled in the URS Medical Surveillance Program and are medically evaluated in compliance with the requirements of 29 CFR 1910.120(f). Employees not medically cleared to wear respirators will not be assigned to this project.

The medical status of each employee is reviewed annually and as may be deemed necessary by the examining physician if the physical status of the employee changes.

8.3 FIT TESTING

A person wearing a respirator must be clean-shaven in the area of the face piece seal. Long hair, sideburns, and skullcaps that extend under the seal are not allowed. Glasses with temple pieces extending under the seal are not allowed for full-face respirators. Persons with facial conditions that prevent a proper seal are not allowed to wear a respirator until the condition is corrected.

Facial conditions that may cause a seal problem include missing dentures, scars, severe acne, etc. Contact lenses may be worn with respiratory protection.

No individual will enter an area where the use of respiratory protective equipment is required unless the person has been fit tested within the last year. Fit testing will be performed in accordance with accepted fit test procedures defined in Safety Management Standard 042, a copy of which is maintained at the site (see Appendix B).

Records of fit testing will be maintained on site or by the employee's office and/or corporate medical surveillance program.

Respirator wearers will perform a user seal check each time the respirator is put on. For air purifying respirators, the positive user seal check is performed by first removing the exhalation valve cover, then placing the palm over the respirator exhalation valve and exhaling gently. The respirator mask should puff out without noticeable leakage. The negative user seal check is performed by placing the palms over both of the respirator cartridges, inhaling gently, and holding the breath for 10 seconds. The respirator mask should remain collapsed on the face without noticeable leakage.

8.4 RESPIRATOR USE INSTRUCTIONS

Only those employees who have been properly trained and qualified on the specific type of respirator to be worn may use respirators. No individual will enter an area where the use of respiratory protective equipment is required unless the person has been trained.

All employees whose job assignment requires the use of respirators are given training in accordance with 29 CFR 1910.120 during initial 40-hour and annual Refresher training for hazardous waste operations.

Hands-on training on inspecting and donning a respirator, including user seal checks, was also provided at the time of fit testing. Retraining is performed annually on each type of respirator worn by the individual. In addition, site-specific respirator training is provided during Site Safety Briefings conducted by the SSO. Training records are kept in the employee's training file.

Particulate respirator cartridges should be changed out when the wearer has difficulty breathing through the cartridges. Chemical gas or vapor respirator cartridges will be changed out at least or daily

The fit of a chemical gas or vapor respirator should be rechecked and the cartridges changed if the wearer detects chemical odor or feels chemical irritation on the skin, both indicators of leakage or cartridge breakthrough. Where available, an ESLI will be used on chemical respirator cartridges. Cartridges will be changed as soon as the ESLI indicates that the cartridge is saturated and no longer effective in absorbing airborne chemicals.

8.5 RESPIRATOR INSPECTION

The user will inspect respirators before and after each day's use.

Inspection procedure, air purifying respirators (full-face piece and half-face piece cartridge respirators):

Examine the face piece for:

- Excessive dirt
- Cracks, tears, holes, or distortion from improper storage
- Inflexibility
- Cracked or badly scratched lenses (full-face only)
- Incorrectly mounted eyeglass lenses or broken or missing mounting clips (full-face only)
- Cracked or broken air purifying element holder, badly worn threads, or missing gaskets

Examine the head straps or head harness for:

- Breaks or cracks
- Broken or malfunctioning buckles
- Excessively worn serration on the headstraps, which may permit slippage

Examine the inhalation valves (2) and exhalation valve for:

- Foreign material (e.g. hairs, particles, etc.)
- Improper insertion of the valve body in the face piece
- Cracks, tears, or chips in the valve body, particularly in the sealing surface
- Missing or defective exhalation valve covers

Examine the air-purifying cartridge for:

- Missing or worn cartridge holder gasket
- Incorrect cartridge/canister for the hazard
- Incorrect cartridge installation, loose connections, or cross threading in the holder
- Cracks or dents in the outside case or threads of filter or cartridge/canister

8.6 CLEANING OF RESPIRATORS

Respirators assigned and worn by one individual must be dismantled and thoroughly cleaned and disinfected after each day's use. Visitor's or multi-assigned respirators must be cleaned and disinfected after each use. A disinfectant spray or wipe is approved as a disinfectant between uses during the day but not for cleaning and sanitizing after each day's use. Care must be taken to prevent damage from rough handling during the cleaning procedure. After cleaning, respirators must be reassembled.

RESPIRATOR CLEANING PROCEDURE

Washing: Disassemble and wash with a mild liquid detergent in warm water (not to exceed 110°F). A stiff bristle (not wire) brush may be used.

Rinsing: Rinse in clean water (110°F maximum) to remove all traces of detergent. This is very important to prevent dermatitis.

Disinfecting: Thoroughly rinse or immerse in a sanitizer provided by the manufacturer. Alternatively, a weak chlorine bleach solution (1 milliliter liquid bleach/liter of water) may be used.

Final Rinsing: Rinse thoroughly in clean water (110°F maximum) to remove all traces of disinfectant. This is very important to prevent dermatitis.

Drying: Drain and dry hanging by the straps from racks (take care to prevent damage) or towel drying with clean soft clothes or paper towels.

8.7 MAINTENANCE OF RESPIRATORS

Routine respirator maintenance such as replacing missing valves, gaskets, nosecups etc., must only be performed by trained respirator users or a respirator manufacturer's representative. Only approved replacement parts must be used. Substitution of parts from a different brand or type of respirator is generally not possible, invalidates the technical approval of the respirator, and is not permitted. Any respirator suspected of being defective must be removed from service and replaced.

8.8 STORAGE OF RESPIRATORS

When not in use, respirators must be stored to protect them from dust, sunlight, heat, extreme cold, excessive moisture, damaging chemicals, and physical damage. Respirators must be stored in sealable (e.g. Ziplock® or twist-tie) reusable plastic bags between shifts.

The respirator storage environment must be clean, dry, and away from direct sunlight. Onsite cabinets or cases are suggested. Storing bagged respirators in vehicles is discouraged due to the potential for damage from other material or equipment.

Additional information on the URS Respiratory Protection Program is located in Safety Management Standard 42, a copy of which is to be available on site (see Appendix B).

9.0 SITE CONTROL

9.1 GENERAL

Barricade tape and/or barricades shall be used to delineate a work zone for safety purposes around the work area. The barriers should be set in a 25-foot radius (as practical) around the work area to provide sufficient maneuvering space for personnel and equipment. A short piece of barricade tape can be affixed to a secure upright (e.g., drill rig mast or vehicle antenna) to serve as a wind direction telltale. A five-foot opening in the barricades at the support zone (upwind of the work area) will serve as the personnel and equipment entry and exit point. The personnel decontamination station will be established at this point if formal decontamination procedures are required (see Section 10.0). All entry and exit from the work area will be made at this opening in order to control potential sources of contamination and leave contaminated soil and debris in the work area.

At the end of the shift, all boring/sampling holes and excavations must be covered or otherwise secured. All cuttings and decontamination fluids are to be handled in accordance with relevant regulations and instructions from the PM.

The PM or SSO (with the assistance of the facility representative) will determine an upwind evacuation area prior to each shift, and all personnel will be notified of its location. A horn or other signaling device will be used to signal an evacuation in the event of an emergency. Three blasts of the horn will be the signal to immediately stop work and proceed to the evacuation area.

The SSO will verify that all site visitors sign the visitors' log. In addition, all URS personnel and site visitors entering the work area must present evidence of their participation in a medical surveillance program and completion of health and safety training programs that fulfill the requirements of this plan.

The SSO will provide site hazard and emergency action information to all site visitors before they enter the site. This can be done by providing a copy of this HSP to the visitor.

9.2 WORK ZONES

If monitoring instrument readings exceed the first Action Level (1 ppm > one minute), requiring the use of chemical protective equipment, work zones must be established as described below.

- Exclusion Zone – a 25 foot (as practical) circle around the work area will be defined before work starts. The encircled area will constitute the "Exclusion Zone". This zone is where potentially hazardous contaminants and physical hazards to the workers will be contained. Appropriate personal protection as described in Section 1.0 will be required in this area. Plastic sheeting (visqueen) and/or tarps may be used as necessary to control contaminated materials spilled to the ground during site operations. The size of the Exclusion Zone may be altered to accommodate site conditions and to ensure contaminant containment.

- Contamination Reduction Zone (CRZ) – a corridor leading from the Exclusion Zone will be defined, and will lead from the work area to a break area. All decontamination activities will occur in the CRZ. A waste container will be placed at the end of the corridor so contaminated disposable equipment can be placed inside and covered. Surface/soil contamination in this area should be controlled using plastic sheeting. No one will be permitted into the Contamination Reduction Zone or Exclusion Zone unless they are in full compliance with the requirements of this Plan.

- Support Zone – a Support Zone, the outermost part of the site, must be defined for each field activity. Support equipment is located in this uncontaminated or clean area. Normal work clothes are appropriate within this zone. The location of this zone depends on factors such as accessibility, wind direction (upwind of work area), and resources (i.e., roads, shelter, utilities).

10.0 DECONTAMINATION PROCEDURES

If the monitoring instrument readings indicate respirator use (the Second Action Level [100 ppm > one minute]) in the Operator's Breathing Zone, the following steps will be followed whenever personnel leave the exclusion zone/work area:

1. Remove all equipment, sample containers, and notes to the CRZ. Obtain decontamination solutions and decon tools (shovels, auger flights, etc.) by brushing them under a water rinse. A high-pressure steam cleaner may also be used for decon. All waste and spent decon solutions will be properly contained.

2. Scrub boots with a stiff bristle brush and water. Washtubs and chairs will be provided.

3. Remove outer gloves (and boot covers, if used).

4. Remove Tyvek® coverall; discard in provided container.

5. Remove hardhat and eye protection.

6. Remove respirator.

7. Remove inner gloves.

8. Wash hands and face.

The decontamination area will be covered with plastic sheeting, which will be replaced when torn or heavily soiled, and at the end of each shift.

Each worker will be responsible for cleaning, sanitizing and storing their own respirator in accordance with manufacturer's guidance (i.e., washing in warm water and detergent or sanitizing solution, air drying, and storing in a plastic storage bag; see Sections 8.6 - 8.8). Cartridges will be changed in accordance with the procedures described in Section 8.4.

All spent decontamination fluids (rinse waters, etc.) shall be handled as directed by the PM and in accordance with relevant regulations.

10.1 SANITATION

Potable water will be made available at the site, either from a pressurized source or commercially available bottled water. Drinking cups will be supplied so personnel will neither drink directly from the source of water nor have to share drinking cups. Sources of non-potable water shall be clearly labeled as such.

Unless toilet facilities are available on site or transportation is readily available to transport personnel to nearby (within five minutes) toilet facilities, portable toilet facilities, such as chemical toilets, will be provided on site.

Washing facilities will be provided on site, and will be located in the decontamination area or the support area. Soap, clean water, wash basins and single-use towels will be available for personnel use.

URS procedures for site sanitation are located in Safety Management Standard 030, a copy of which is to be maintained on site (see Appendix B).

10.2 DECONTAMINATION – MEDICAL EMERGENCIES

In the event of physical injury or other serious medical concerns, immediate first aid is to be administered. However, if the injury or emergency is not severe or life threatening, then proper decontamination protocols will be followed.

Severe or life threatening emergencies will require immediately removing the victim to the decontamination corridor. Copious amounts of water will be applied to the victim followed by the removal of the suit. The victim, while being administered aid shall have all clothing removed, and, if possible, continue to rinse with copious amounts of water. Advise incoming medical personnel of the emergency decontamination.

10.3 DECONTAMINATION OF TOOLS

When all work activities have been completed, contaminated tools used by URS personnel will be either appropriately decontaminated or properly disposed of as hazardous waste.

It is expected that all tools will be constructed of non-porous, non-absorbent materials. This will aid the decontamination process. Any tool, or part of a tool, which is made of a porous/absorbent material will be discarded and disposed of as a hazardous waste if it cannot be properly decontaminated.

Tools will be placed on a decontamination pad or into a bucket and thoroughly washed using a soap solution and brushing, followed by a fresh water rinse. All visible particles are to be removed before the tool is considered clean.

11.0 SAFE WORK PRACTICES

11.1 GENERAL

1. Eating, drinking, chewing gum or tobacco, and smoking are prohibited in the contaminated or potentially contaminated area or where the possibility for the transfer of contamination exists.

2. All personnel will enter designated work areas only through the contamination reduction zone (CRZ). All personnel leaving an exclusion/work zone must exit through the CRZ and pass through the decontamination station as described in Section 10.0.

3. Personnel will wash their hands and face thoroughly with soap and water prior to eating, drinking or smoking.

4. Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling, leaning or sitting on contaminated surfaces. Do not place monitoring equipment on potentially contaminated surfaces (i.e., ground, etc.)

5. All field crew members should make use of their senses to alert them to potentially dangerous situations in which they should not become involved (i.e., presence of strong, irritating or nauseating odors).

6. Only those vehicles and equipment required to complete work tasks should be permitted within the exclusion/work zone (drill rigs, excavators, and similar items). All non-essential vehicles should remain within the support zone.

7. Containers, such as drums, will be moved only with the proper equipment and will be secured to prevent dropping or loss of control during transport.

8. Field survey instruments, such as PIDs, should be covered with plastic or similar covering to minimize the potential for contamination.

9. No matches or lighters will be permitted in the work area/exclusion zone or contamination reduction zone.

10. Contaminated protective equipment, such as respirators, hoses, boots, and disposable protective clothing, will not be removed from the work area/exclusion zone or decontamination area until it has been cleaned, or properly packaged and labeled.

11. Prevent, to the extent possible, spills. In the event that a spill occurs, contain liquid if possible.

12. Prevent splashing of the contaminated materials.

13. Field crew members shall be familiar with the physical characteristics of the site operations including:

    - Wind direction in relation to the contaminated area;
    - Accessibility to equipment and vehicles;
    - Areas of known or suspected contamination;
    - Site access; and
    - Nearest water sources.

14. The number of personnel and equipment in the exclusion zone should be minimized but only to the extent consistent with workforce requirements of safe site operations.

15. All wastes generated by URS activities at the site will be disposed of as directed by the PM.

16. All personal protective equipment will be used as specified and required.

17. The buddy system will be used at all times when performing sampling for hazardous material when the first action level criteria has been exceeded or when working in remote areas.

18. Personnel are to immediately notify the SSO or Site Manager if any indications of potential explosions or unusual conditions are observed.

11.2 SAMPLING PRACTICES

For all sampling activities, the following standard safety procedures shall be employed:

1. All sampling equipment should be cleaned before proceeding to the site.

2. At the sampling site, sampling equipment should be cleaned after each use.

3. Work in "cleaner" areas should be conducted first where practical.

4. All unauthorized personnel will remain outside exclusion zones at all times.

11.3 SAMPLE SHIPMENT/HAZARDOUS MATERIALS SHIPMENT

If samples to be collected during the course of this project fall under the criteria that defines them as hazardous materials under DOT regulations 49 CFR Parts 171-177 (see URS guidelines for determination), then they must be shipped in accordance with those regulations by an individual who is certified as having been Function-Specific trained as required under the DOT regulations.

12.0 EMERGENCY RESPONSE PLAN

It is URS policy to evacuate personnel from areas involved in hazardous material emergencies and to summon outside assistance from agencies with personnel trained to respond to the specific emergency. This section outlines the procedures to be followed by URS personnel in the event of a site emergency. These procedures are to be reviewed during the onsite safety briefings conducted by the SSO. Additional information can be found in URS' Safety Management Standard 003 (see Appendix B).

In the event of a fire or medical emergency, the emergency numbers identified in Section 1.0 (page 1) can be called for assistance.

12.1 PLACES OF REFUGE

In the event of a site emergency requiring evacuation, all personnel will evacuate to a pre-designated area located a safe distance from any health or safety hazard (typically the URS field office, unless conditions dictate otherwise). The SSO (in cooperation with a facility representative) will designate a primary assembly area prior to the start of work each day. The daily pre-designated assembly area may have to be re-designated by the SSO in the event of an emergency where the area of influence affects the primary assembly area. Once assembled, the SSO shall take a head count. The SSO will evaluate the assembly area to determine if the area is outside the influence of the situation; if not, the SSO will redirect the group to a new assembly area where a new head count will be taken.

During any site evacuation, all employees shall be instructed to observe wind direction indicators. During evacuation, employees will be instructed to travel upwind or crosswind of the area of influence. The SSO will provide specific evacuation instructions, via the site emergency radio if necessary, to site personnel regarding the actual site conditions.

12.2 FIRE

Fire prevention procedures are described in Safety Management Standard 014, a copy of which is to be maintained on site (see Appendix B). To protect against fires, the following special precautions must be taken:

- Before any flame-producing devices, i.e., cutting torches or welding irons, are used in the exclusion zone, the SSO must be contacted. In some cases, the client may require to be contacted as well to determine if a hot work permit is required. A detailed inspection of the work area will be conducted to determine if potential fire sources exist. The fire sources must be removed to at least 35 feet away before work can commence.

- Two full 2A10B:C fire extinguishers must be located at the work area when cutting/welding is being conducted, and a fire watch will be posted.

- Upon completion of the cutting/welding activities the area will be inspected for hot metal, slag, etc. The fire watch will remain on station for at least 15 minutes after the hot work is completed.

Type ABC fire extinguishers will be available on site to contain and extinguish small fires. The local or facility fire department shall be summoned in the event of any fire on site.

12.3 COMMUNICATION

A communication network must be set up to alert site personnel of emergencies and to summon outside emergency assistance. Where voice communication is not feasible an alarm system (i.e., sirens, horns, etc.) should be set up to alert employees of emergencies. Radio communication may also be used to communicate with personnel in the exclusion zone. Where phone service is not readily available, radios or portable phones should be used to communicate with outside agencies. Site personnel should be trained on the use of the site emergency communication network. Emergency phone numbers shall be posted at the phone or radio used for outside communication. The SSO is responsible for establishing the communication network prior to the start of work, and for explaining it to all site personnel during the site safety briefing.

In the event of an emergency, personnel will use the following hand signals where voice communications are not feasible:

Signal	Definition
Hands clutching throat	Out of air/can't breathe
Hands on top of head	Need assistance
Thumbs up	OK/I'm alright/I understand
Thumbs down	No/negative
Arms waving upright	Send back-up support
Grip partner's wrist	Exit area immediately

12.4 EMERGENCY RESPONSE PROCEDURES

12.4.1 Emergency Response Team

The emergency response team will consist of employees who assume the following roles:

- Emergency Care Provider(s)

  Provide first aid/CPR as needed.

- Communicator

  The role of the communicator is to maintain contact with appropriate emergency services, providing as much information as possible, such as the number injured, the

type and extent of injuries, and the exact location of the accident scene. The communicator should be located as close to the scene as possible in order to transmit to the emergency care providers any additional instructions that may be given by emergency services personnel enroute.

- Site Supervisor

  The site supervisor (usually the SSO) should survey and assess existing and potential hazards, evacuate personnel as needed, and contain the hazard. Follow up responsibilities include replacing or repairing damaged equipment, documenting the incident, and notifying appropriate personnel/agencies described under incident reporting. It also includes reviewing and revising site safety and contingency plans as necessary.

In the event of an emergency, notify site personnel of the situation. Survey the scene to determine if the situation is safe, to determine what happened, and to search for other victims. The Emergency Response Checklist can be used to help remember the things to do in an emergency (Appendix E).

12.5 MEDICAL EMERGENCY RESPONSE PLAN

At least one URS employee on site will hold a current certificate in American Red Cross Standard First Aid. This training provides six and one-half hours of Adult CPR and Basic First Aid. If a medical emergency exists, consult the emergency phone number list and request an ambulance immediately. Perform First Aid/CPR as necessary, stabilize the injured, decontaminate if necessary, and extricate only if the environment they are in is dangerous or unsafe and ONLY if the rescuers are appropriately protected for potential hazards they may encounter during the rescue. When emergency services personnel arrive, communicate all first aid activities that have occurred. Transfer responsibility for care of the injured/ill to the emergency services personnel.

The following items and emergency response equipment will be located within easy access at all times:

- First Aid Kit and Infection Control Kit;
- Eyewash – A 15 minute eyewash (required if corrosives are present) or an appropriate amount of portable sterile eyewash bottles will be available on site for flushing foreign particles or contaminants out of eyes. The SSO will demonstrate the proper operation of the unit(s) prior to the start of work;
- Emergency Phone Numbers List; and
- Portable radios for emergency communications in remote areas.

Drugs, inhalants, or medications shall not be included in the First Aid Kit.

Supplies should be re-ordered as they are used. A monthly inventory must be done on the first aid kit and infection control kit contents and supplies re-ordered that have been used and not reported.

12.6 ALL INCIDENT REPORT

Site injuries and illnesses must be reported to the SSO and PM immediately following first-aid treatment. The SSO will notify the Regional Health and Safety Manager, Phil Jones, at 215-542-3800. Work is to be stopped until the PM or SSO and RSO have determined the cause of the incident and have taken the appropriate action to prevent a reoccurrence. Any injury or illness, regardless of severity, is to be reported. Refer to URS Safety Management Standard 049 (see Appendix B).

12.7 OPERATION SHUTDOWN

Under certain extreme hazardous situations the SSO or SSR may request that site operations be temporarily suspended while the underlying hazard is corrected or controlled. During operation shutdown, all personnel will be required to stand upwind to prevent exposure to fugitive emissions. The SSO, with concurrence from the Regional Health and Safety Manager, will have ultimate authority for operations shutdown and restart.

12.8 SPILL OR HAZARDOUS MATERIALS RELEASE

Small spills are immediately reported to the SSO and are dealt with according to the chemical manufacturer's recommended procedures found on the MSDS. Steps will be taken to contain and/or collect small spills for approved storage and disposal.

In the unlikely event of a larger release of hazardous materials as a result of site activities, site personnel will evacuate to the predesignated assembly area. The local Designated Emergency Response Authority (DERA) will be notified by the SSO immediately and appropriate actions will be taken to protect the public health and mitigate the contaminant release. The DERA can be reached through the local police or fire department. The Site Manager will make the following emergency contacts:

Regional Health and Safety Manager – Phil Jones 215-542-3800

Health and Safety Representative - [redacted]

Project Manager - Mr. Christopher Gaule (518) 688-0015

EPA Response Center (800) 424-8802

13.0 TRAINING, MEDICAL SURVEILLANCE, SITE INSPECTIONS

13.1 TRAINING AND MEDICAL SURVEILLANCE

All URS site personnel will have met the requirements of 29 CFR 1910.120(e), including:

- Forty hours of initial off-site training or its recognized equivalent
- Eight hours of annual refresher training for all personnel (as required);
- Eight hours of supervisor training for personnel serving as Site Safety Officers
- Three days of work activity under the supervision of a trained and experienced supervisor

All URS site personnel are participating in medical surveillance programs that meet the requirements of 29 CFR 1910.120(f). Current copies of training certificates and statements of medical program participation for all URS personnel are maintained by the local office.

In addition, all URS site personnel will review this HSP and sign a copy of the Safety Plan Compliance Agreement, which is found in Appendix A. The PM will maintain these agreements at the site, and place them in the project file at the conclusion of the operation.

Prior to the start of operations at the site, the SSO will conduct a site safety briefing, which will include all personnel involved in site operations. At this meeting, the SSO will discuss:

- Contents of this HSP
- Types of hazards at the site and means for minimizing exposure to them
- The type of monitoring that will be performed
- Action levels for upgrade and downgrade of personal protective equipment
- Personal protective equipment that will be used
- Site-specific respiratory protection requirements
- Decontamination protocol
- Site control measures, including safe operating practices and communication
- Location and use of emergency equipment
- Evacuation signals and procedures

All site personnel, including subcontractor personnel, are to attend the briefings and sign the briefing form.

Subsequent site safety briefings will be conducted at least weekly, or whenever there is a change in task or significant change in task location. Briefings will also be conducted whenever new personnel report to the site.

13.2 SITE INSPECTIONS

The URS Site Manager or Site Safety Officer is to conduct a daily site inspection prior to the start of each shift. It is the responsibility of the Project Manager or Site Manager to resolve discrepancies immediately, contacting the Regional Health and Safety Manager if necessary for assistance. Inspections are to be documented and maintained on site until the completion of the project, at which time they are placed in the project files.

14.0 RECORDKEEPING

The PM and SSO are responsible for site record keeping. Prior to the start of work, they will review this plan; if there are no changes to be made, they will sign the approval form (PM) or acceptance form (SSO) and forward a copy to the Regional Health and Safety Manager.

All URS personnel will review the HSP and sign the Safety Plan Compliance Agreement in Attachment A; copies of these forms will be maintained in the project file as noted in Section 12.

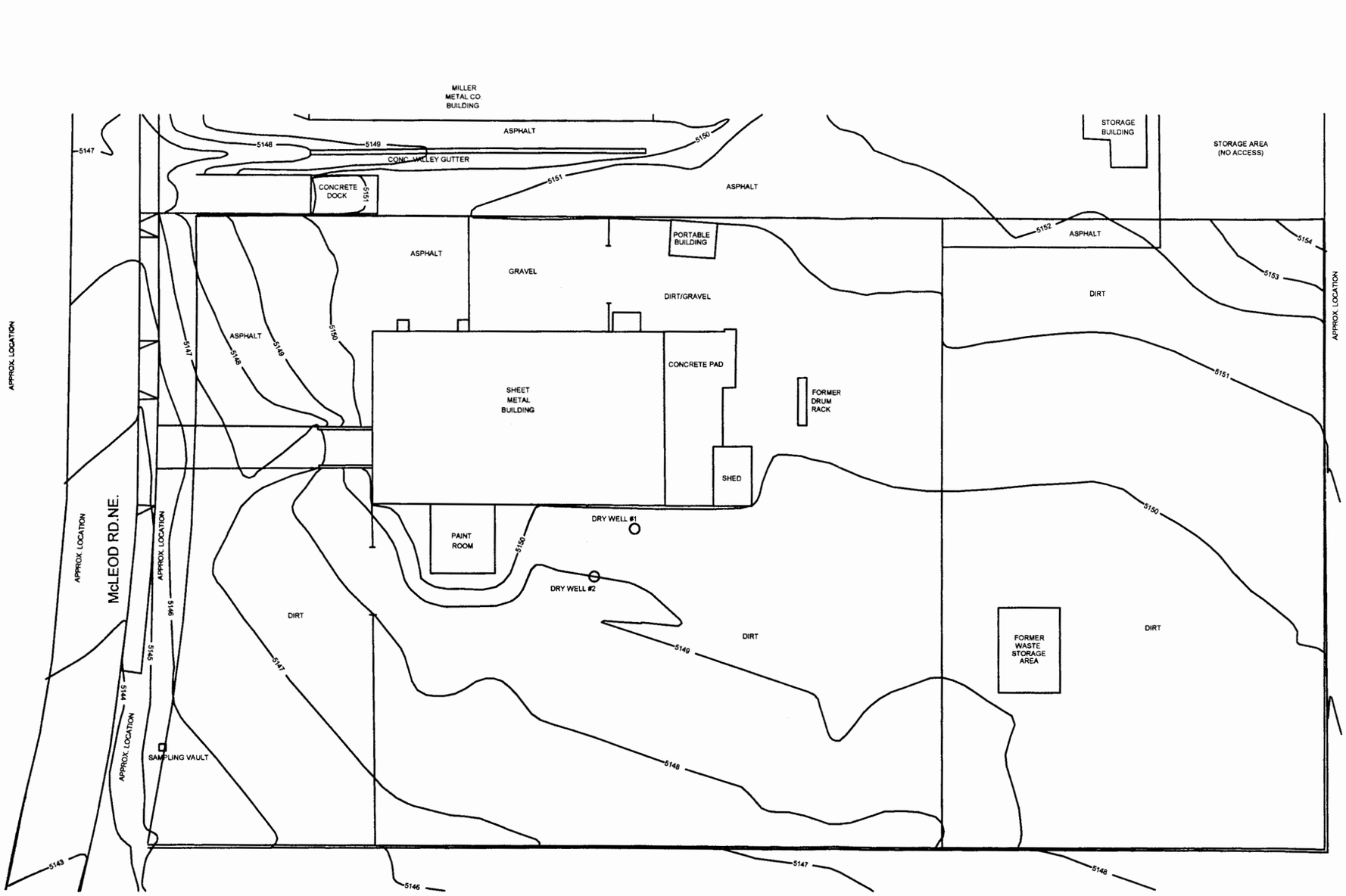
The SSO will conduct a Site Safety Briefing in accordance with Section 13 and have all attendees sign the form in Appendix A; copies will be maintained in the project file.

Any incident or exposure incident will be investigated and the Incident Report form (SMS 049) will be completed and forwarded to the Office Human Resources Representative and the Regional Health and Safety Manager.

All instrument readings and calibrations, PPE use and changes, health and safety-related issues, and deviations from or problems with this HSP will be recorded in the field log.

FIGURE 1

SITE MAP



0 20 40 60 80 Feet

GRAPHIC SCALE

BASEMAP PROVIDED BY LAW ENVIRONMENTAL

91-40133600.00

FIGURE 1

SITE LAYOUT

GENERAL ELECTRIC COMPANY
APPARATUS SERVICE SHOP
ALBUQUERQUE, NEW MEXICO

URS

646 PLANK ROAD SUITE 202
CLIFTON PARK, NEW YORK 12065

FIGURE 2

HOSPITAL ROUTE MAP

YAHOO! Maps

Yahoo! - Yellow Pages

USE AT YOUR OWN DISCRETION!
Tiny Wireless Video Camera
Transmits live video to your TV/VCR/PC!
Never any action

Welcome, Guest User

Create My Locations - S

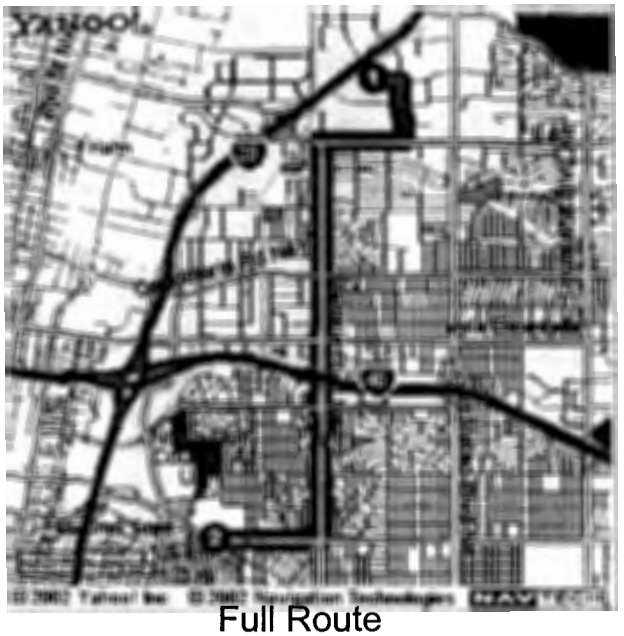
Yahoo! Maps - Driving Directions

Starting from: 4420 McLeod Road, Albuquerque, NM 87109-2218

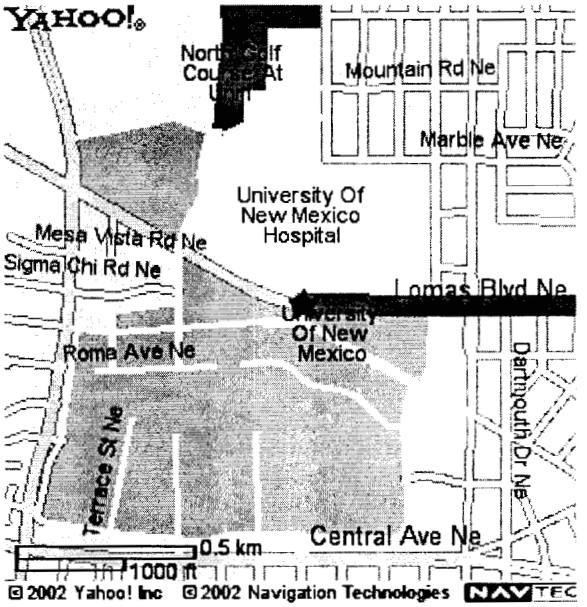
Arriving at: ★ 2211 Lomas Blvd, Albuquerque, NM 87106-2719

Distance: 5.1 miles **Approximate Travel Time:** 11 mins

- Email Directions
- Get Reverse Directions
- Text Only Driving Direct



Full Route



Destination

	Directions	Miles
1.	Start on **MCLEOD RD NE**	0.2
2.	Turn Right on **JEFFERSON ST NE**	0.5
3.	Turn Right on **MONTGOMERY BLVD NE**	0.6
4.	Turn Left on **CARLISLE BLVD NE**	3.0
5.	Turn Right on **LOMAS BLVD NE**	0.8

When using any driving directions or map, it's a good idea to do a reality check and make sure the road exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an in planning.

Driving Directions **New Loca**

1 **Enter a starting address** or select from My Locations

My Locations -- My Locations -- Sign In

(Address, Intersection or Airport Code)

Address 4420 McLeod Road

City, State or Zip Albuquerque, NM 87109-22

Country United States

2 **Enter a destination address** or select from My Locations

My Locations -- My Locations -- Sign In

(Address, Intersection or Airport Code)

Address 2211 Lomas Blvd

City, State or Zip Albuquerque, NM 87106-27

Country United States

Get Directions

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APPENDIX A

SAFETY PLAN COMPLIANCE AGREEMENT AND MEDICAL EMERGENCY CONTACT SHEET

APPENDIX A

SAFETY PLAN COMPLIANCE AGREEMENT AND MEDICAL EMERGENCY CONTACT SHEET

I, _____, have received a copy of the Health and Safety Plan for this Project. I have reviewed the plan, understand it, and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the health and safety requirements specified in the plan.

SIGNED: _____ _____

Signature Date

Firm: URS Corp.

This brief Medical Emergency Contact Sheet will be kept in the Support Zone during site operations. It is in no way a substitute for the Medical Surveillance Program requirements of the URS Health and Safety Program. This data sheet will accompany injured personnel when medical assistance or transport to hospital facilities is necessary.

Emergency Contact: _____ Phone #:_____

Relationship: _____

Do you wear contact lenses? _____

APPENDIX B
(Not included in this version)

URS' SAFETY MANAGEMENT STANDARDS

APPENDIX C
(Not included in this version)

MATERIAL SAFETY DATA SHEETS

APPENDIX D
(Not included in this version)

EQUIPMENT MANUALS

APPENDIX E

FORMS

EMERGENCY RESPONSE CHECKLIST

GENERAL ELECTRIC
ALBUQUERQUE, NEW MEXICO

In an Emergency	**Yes**	**No**
Confirm the reported incident	_____	_____
Evacuate and secure the area	_____	_____
Render first aid / emergency medical care	_____	_____
Notify promptly:		
Project Manager	_____	_____
Fire Department	_____	_____
Police Department	_____	_____
Nearest Hospital / Medical Care Facility	_____	_____
Start Documentation	_____	_____
If spill or leak occurs:		
Don the proper PPE	_____	_____
Stop the source (containment)	_____	_____
Contain the spill (confinement)	_____	_____
Clean up the spill	_____	_____
Upon evacuating, take attendance at the assembly area	_____	_____
Authority given:		
Leave the site	_____	_____
Restart the operations	_____	_____
Debrief and document the incident	_____	_____
A copy of the document submitted to the HSM	_____	_____

GE – ALBUQUERQUE
VISITOR'S LOG

NAME	DATE	IN	OUT	IN	OUT	IN	OUT

DAILY CALIBRATION AND AIR MONITORING LOG

General Electric
Albuquerque, New Mexico

DAILY INSTRUMENT CALIBRATION CHECK SHEET						
Date	Instrument	Battery OK	Zero Adjusted	Cal Gas ppm	Reading ppm	Calibrated by

AIR MONITORING ACTIVITY LOG						
Date	Activity Monitored	Time	Location	Reading ppm	Action Level?	Reading by

APPENDIX E

APPENDIX E

CONTINGENCY PLAN

CONTINGENCY PLAN
CORRECTIVE MEASURE IMPLEMENTATION
GENERAL ELECTRIC COMPANY
ALBUQUERQUE, NEW MEXICO

This *Contingency Plan* is intended to addresses emergencies or unplanned incidents that may arise during implementation of the *Corrective Measure Work Plan* at GE's former apparatus service shop in Albuquerque, New Mexico. 40 CFR 265 Subpart D requires amendment of a facility's contingency plan whenever changes in a facility's circumstance "materially increases the potential for fires, explosions, or releases of hazardous waste or hazardous waste constituents."

The proposed corrective measure includes excavation and off-site disposal of soils at the site which have been impacted by site activities. Very little, if any, of the soil to be removed contains concentrations of contaminants that would qualify the excavated soil as hazardous waste. However, the removed soil will be handled as if it were hazardous until waste characterization sampling confirms that the soil is non-hazardous. The *Corrective Measure Implementation Work Plan* includes these measures to minimize the hazards to human health or the environment:

- Prior to excavation, a utility clearance will be conducted to identify any utilities that may lie within or near the planned excavation areas.
- The corrective measure implementation will be conducted in accordance with site-specific *Health and Safety Plans*.
- An exclusion zone and decontamination areas will be utilized throughout the work.
- Dust monitoring will be conducted during excavation and dust control measures will be implemented, if warranted.
- Remediation waste will be containerized upon generation.

Prior to beginning the corrective measure implementation, the local fire department will be notified and provided with a copy of this *Contingency Plan*.

1.0 RESPONSE PROCEDURES

Upon mobilization to the site to begin the project, GE and each of their subcontractor site health and safety officers will meet and determine an off-site location at which all project personnel (GE or their subcontractors) will meet in the event of an emergency that requires site evacuation. This information will be conveyed to all project personnel during health and safety meetings. Each subcontractor project manager will be responsible for knowing how many of his or her employees are on-site at any given time.

1.1 FIRE

In the event of a fire, personnel (GE or their contractors) at the site will immediately vacate the area and notify the fire department and the emergency coordinator.

1.2 EXPLOSIONS

In the event of an explosion, personnel (GE or their contractors) at the site will immediately vacate the area and notify the fire department and the emergency coordinator.

1.3 HAZARDOUS WASTE RELEASE

In the event that a hazardous waste release poses an imminent hazard to human health, personnel (GE or their contractors) at the site will immediately vacate the area and notify the fire department and the emergency coordinator.

Based on the scope of the project, the most likely types of hazardous waste releases (such as a spill of potentially hazardous soil) would not be imminently hazardous to human health. Therefore, the primary response will be for site personnel to notify the emergency coordinator, gain control of the release, and proceed with cleanup measures.

2.0 EMERGENCY COORIDNATOR

During implementation of the CMS the people listed below will serve as emergency coordinators.

Primary Emergency Coordinator:	Steven Geiger, URS
Office Phone:	(505) 672-2109
Home Phone:	(505) 662-0430
Alternate Emergency Coordinator:	
Office Phone:	(505) 855-7500
Cell Phone:	(505) 301-5345
Home Phone	(505) 281-9773

3.0 EMERGENCY EQUIPMENT

The facility has been inactive for eight years. As such, it will be presumed that any emergency equipment present at the facility is not in good working order. The excavation contractor will be required, upon mobilization to the site, to provide:

Fire Extinguisher: A type ABC fire extinguisher of at least 20 pounds.

Spill Control Equipment: Spill control equipment capable of containing a spill of 100 gallons.

4.0 EVACUATION PLAN

Upon mobilization to the site to begin the project, GE and each of their contractor site health and safety officers will meet and determine an off-site location at which all project personnel (GE or their contractors) will meet in the event of an emergency that requires site evacuation and the primary and secondary evacuation routes. This information will be written out and added to each contractor's *Health and Safety Plan*. In addition, this information will be conveyed to all project personnel during health and safety meetings. Each subcontractor project manager will be responsible for knowing how many of his or her employees are on-site at any given time.

APPENDIX F

APPENDIX F

COMMUNITY RELATIONS PLAN

COMMUNITY RELATIONS PLAN
GENERAL ELECTRIC COMPANY
ALBUQUERQUE, NEW MEXICO

This *Community Relations Plan* describes the community relations activities that will be conducted during the planning and implementation stages of the selected corrective measure for the site. Preparation and submission of this *Community Relations Plan* is a requirement of the 1992 Consent Decree (Civil Action Number 87-1073-jb).

Based on discussions with the United States Environmental Protection Agency (USEPA) and the New Mexico Environment Department (NMED), GE understands that the USEPA will take the lead on disseminating information about the project to the public. Actions that will be taken to inform the community of the project are described below.

Facility Fact Sheet: A facility fact sheet will be generated. The fact sheet will summarize the general information regarding the facility such as location, regulatory status, the plan for addressing the contaminated soil present at the facility, and the points of contact.

Public Access to Facility Documents: All documents generated to date will become part of the administrative record. In addition, all documents generated to date will put on file for public viewing and comment at the Government Information Center and the Zimmerman Library at the University of New Mexico.

Public Notice: Public notice of the project may include publishing the Facility Fact Sheet in local newspapers and/or direct mailing of the Facility Fact Sheet to neighboring landowners. The public notice will include a point of contact that can be contacted by interested parties.

Public Comment Period: The public will be provided with 30 days from public notice to provide their comments on the project.

Revised Facility Fact Sheet: After receipt of public comments on the proposed corrective measure, the engineering design will be finalized and the Facility Fact Sheet will be revised.

The attached table provides contact information for the three people who will be collaborating on the community relations activities.

TABLE 1
PRIMARY CONTACTS - COMMUNITY RELATIONS PLAN
GENERAL ELECTRIC
ALBUQUERQUE, NEW MEXICO

USEPA	NMED	GE
Gary Miller Project Coordinator US Environmental Protection Agency Region 6 1445 Ross Avenue, Suite 1200 Dallas, Texas 75202-2733 Phone: (214) 665-8318	Richard Kilbury Project Leader State of New Mexico Environment Department Hazardous Waste Bureau 2905 Rodeo Park Drive East, Building 20685 Santa Fe, New Mexico 87505-6303 Phone: (505) 845-5932 Fax: (505) 845-5853	Edward Jamison Project Manager General Electric Power Systems 1 River Road, Bldg. 43, Room 237 Schenectady, New York 12345 Phone: (518) 385-7979 Fax: (518) 385 4074

APPENDIX G

APPENDIX G

QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN

for

CORRECTIVE MEASURE STUDY IMPLEMENTATION

GE Power Systems

Albuquerque, New Mexico

August 16, 2002

Prepared for:

GE Power Systems
1 River Road
Building 43, Room 237
Schenectady, New York 12345

Prepared by:

URS Corporation
646 Plank Road, Suite 202
Clifton Park, NY 12065

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1.0 PROJECT AND TASK ORGANIZATION

The project organization and the responsibilities of key personnel are defined below. Figure - 1 presents the program lines of authority and generic project organization.

1.1 RESPONSIBILITIES

1.1.1 General Electric (GE) Project Manager

The GE Project Manager, Mr. Edward Jamison, is responsible for establishing project scope and objectives and for communicating same to the contractor. He is also responsible for identifying internal, regulatory, and procedural requirements pertinent to the work that may differ from accepted industry standards of work.

1.1.2 URS Project Manager

The URS Project Manager, Mr. Christopher Gaule, is responsible for assuring that projects are properly staffed and is ultimately responsible for the technical direction and quality of the work performed by URS personnel. He is responsible for establishing appropriate budgets and schedules, making available appropriate forms of training, and monitoring the performance of the staff. The Project Manager may talk with regulatory agencies regarding methodologies and requirements. He is also responsible for monitoring the implementation of the quality assurance program. Specific responsibilities include:

- Assure the provision of necessary facilities, equipment, and funding;
- Review and approve Project Controlling Documents (PCDs) (i.e., Workplan, Quality Assurance (QA) Project Plan (QAPP), and Corrective Measure Study Implementation (CMSI);
- Support the efforts of the Field Manager, QA Officer (QAO), and Laboratory Manager(s) in all matters concerning the quality of work products; and

- Assure effective response to corrective action requirements identified by any member of the project team.

1.1.3 Field Manager

The URS Field Manager, (to be determined) is responsible for the day to day management of field operations. He schedules and plans the work activities of field staff, provides periodic reports on the progress of work, and reviews the field logs and other forms of field documentation. The Field Manager will work closely with the QAO to plan and schedule audits, if any, assure proper training of field personnel, and immediately communicate any situations that may affect the quality of work. The Field Manager is responsible for assuring that the work proceeds according to schedule, the CSMI, and bears responsibility for guaranteeing the technical quality of the work. Specific responsibilities include:

- Oversee and monitor performance of staff;
- Plan the activities of and coordinate field personnel on specific assignments;
- Provide a liaison between the Project Manager, field, laboratory staff, and any other subcontractors;
- Effectively carry out the URS QA Program and this QAPP; and
- Assure completion of corrective actions, as needed.

1.1.4 Laboratory QA Manager

The Laboratory QA Manager, (to be determined), is responsible for QA/QC in all aspects of laboratory operations. The Laboratory QA Manager ensures that laboratory staff uses recognized procedures and accepted laboratory practices. The Laboratory QA Manager is responsible for ensuring appropriate instrument maintenance and calibrations. The Laboratory QA Manager is responsible for method development and documentation of procedures. The Laboratory QA Manager is responsible for training and designating qualified personnel for laboratory assignments. The Laboratory QA Manager is responsible for assuring compliance with applicable analytical

methodology, strict adherence to Standard Operating Procedures (SOPs) and QA/QC requirements. The Laboratory QA Manager is responsible for ensuring that laboratory analyses proceed according to schedule, and bears responsibility for guaranteeing the technical accuracy and quality of the work. Specific responsibilities include:

- Provide sufficient equipment, space, resources, and personnel to conduct analyses and carry out the laboratory QA programs and this QAPP;
- Ensure appropriate documentation of laboratory methods;
- Ensure that all laboratory records are maintained securely and retrievably;
- Assess the quality of purchased laboratory materials, reagents, and chemicals in relation to their impact on the quality of analytical results; and
- Ensure the implementation of appropriate corrective action for any QA/QC deficiencies identified.

1.1.5 QA Officer

The QA Officer (QAO), (to be determined), is responsible for implementation of both the URS QA Manual (incorporated by reference) and this QAPP in both field and laboratory operations. The Project Manager delegates to the QAO the authority to take any actions necessary to ensure the reliability and validity of work and deliverables according to this QAPP. The QAO has, by definition, a level of authority coequal to that of the Field Manager and Laboratory QA Manager. The QAO is responsible for developing and implementing procedures to appropriately document all project activities, to provide specific means of measuring conformance to specifications, managing the corrective actions program, and providing periodic reports to management. Specific responsibilities include:

- Develop, document, and carry out QA activities to ensure that appropriate QC measures are being carried out and documented;
- Ensure all records related to quality assurance are documented and maintained securely and retrievably;

- Conduct periodic performance audits and/or surveillances to measure conformance to specifications;
- Prepare periodic quality reports and QA sections of final reports;
- Ensure corrective actions are carried out and documented in a way that precludes future occurrences;
- Review and approve SOPs as provided in the CSMI, training records, and purchasing actions; and
- Acquire and maintain required certifications, and manage performance evaluation tests.

1.1.6 Technicians and Analysts

Field staff and analysts are responsible for executing their work assignments in strict conformance to documented procedures and for the immediate identification of any conditions adverse to the quality performance of the work or work products. They are responsible for acquainting themselves with the technical requirements of any work assigned and seeking training or guidance as necessary to comply with those requirements. They are responsible for documenting their activities according to applicable SOPs and reviewing their own work and the work of others presented to them for peer review. They will immediately cause work to cease on any activity that in their judgement does not meet applicable quality and safety standards, will appropriately document and report such conditions to management and will be active in the resolution of any such conditions. Specific responsibilities include the following:

- Ensure that all work is performed according to the applicable specifications;
- Ensure that QC measures are being carried out and documented;
- Ensure the quality of work and work products; and
- Communicate QA and safety concerns to management.

1.2 ORGANIZATION

Figure -1 presents the organization chart for this project.

2.0 PROBLEM DEFINITION/BACKGROUND

Problem definition and background information about the site are provided in Section 8 of the CMSI Workplan.

3.0 PROJECT/TASK DESCRIPTION

Table -1 provides a tabular summary of the sampling and analysis program. Definition of the major tasks and approach to the work are provided in Section 8 of the CMSI Workplan.

Quality assessment provisions are described in detail in Sections 8 and 9 of this document. The schedule for the fieldwork is defined in Section 8 of the CMSI Workplan. Records and reporting are covered in Section 7 of this document and the applicable methods of work and SOPs are presented in the CSMI.

4.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The overall objective is to carry out procedures for sample collection, analysis, evaluation, and reporting that will meet the objectives for the program as established by the client in association with the project team. QA objectives will be achieved through the implementation of specific procedures for sampling, field data collection, chain-of-custody, laboratory analysis, calibration, internal quality control, audits, preventive maintenance and corrective actions as described in this QAPP. Table -2 presents QC criteria for measurement data (Data Quality Indicators [DQIs]). Sampling and analytical methodologies are chosen based on the intended use and data quality requirements of the work. The purpose of this section is to broadly define minimum QA goals for precision, accuracy, representativeness, completeness, comparability, and sensitivity in field and laboratory measurements. More specific information regarding data quality indicators, including matrix

specific QC criteria and detection limits for individual analytes are presented in the CMSI for the methods of analysis specified in Table – 3.

4.1 DATA USE

There are four objectives to the data deliverables:

- To delineate lateral and vertical extent of PCBs in soil to better define soil excavation areas;
- To verify that the CMSI clean-up objectives have been met through pre- and post-excavation verification sampling;
- To document the quality of soil left in place at the former dry wells; and
- To characterize remediate wastes in order to determine proper disposal.

Nonetheless, in general terms, there are two levels of data quality that encompass all of the various measurements.

4.1.1 Definitive Data

Definitive data are quantitative and provide confirmation of analyte identification on an analyte specific basis. They are usually generated using published analytical methods. These data are documented rigorously with detailed QA/QC information provided in addition to detailed sample specific information, allowing for independent review. Soil, sediment, sludge, and waste chemical analysis measurements will be defined as definitive in nature.

4.1.2 Screening Data

Screening level data are generally developed using less rigorous analytical methods. The data may provide indications of contamination, be semi-quantitative, and may not be analyte specific. To be considered data of known quality, screening level measurements must be confirmed by definitive methods

4.1.3 Target Analytes

See Table – 1.

5.0 QA OBJECTIVES FOR MEASUREMENT

5.1.1 Accuracy

Accuracy means agreement between a known value and a measured value. This is normally expressed as percent recovery (%R) of a surrogate, matrix spike, and/or analytical control sample.

$$ACCURACY = \frac{MEASURED\ VALUE}{KNOWN\ VALUE} x100 \qquad EQUATION\,1$$

The accuracy objectives are noted in Table - 2. The Laboratory Manager will be responsible for compliance with accuracy objectives. Should any of the data fail the accuracy criteria, corrective action will be taken as described in the method, the relevant SOPs, or according to the provisions of Section 9. Peer and senior review of work products will be provided as a check on measurement accuracy.

5.1.2 Precision

Precision is agreement among individual measurements of the same property under similar conditions. Precision is tested through the use of field and laboratory duplicate or replicate analyses. It is usually expressed as either relative percent difference (RPD) or percent relative standard deviation (%RSD) between duplicates or replicates.

$$\%RPD = \left(\frac{|\mathrm{Re}\,p1 - \mathrm{Re}\,p2|}{(\mathrm{Re}\,p1 + \mathrm{Re}\,p2)/2} \right) x100 \qquad EQUATION\,2$$

$$\%RSD = \left(\frac{\sigma_{x_1 \cdots x_n}}{\overline{X}_{x_1 \cdots x_n}} \right) x100 \qquad EQUATION\,3$$

The precision objectives are noted in Table - 2. The Laboratory Manager will be responsible for compliance with precision objectives. Should any of the data fail the precision criteria, corrective action will be taken as described in the method, the relevant SOPs, or according to the provisions of Section 9. Peer and senior review of work products will be provided as a check on laboratory precision.

5.1.3 Representativeness

Representativeness is a measure of the degree to which the measured values accurately and precisely reflect the medium being sampled. Representativeness is largely the result of the appropriate selection of sampling locations and sampling methods. It is assessed through the comparison of field duplicate sample data to the original sample data and the review of blanks. Should any of the data fail the representativeness criteria, corrective action will be taken as described in the method, the relevant SOPs, or according to the provisions of Section 9. Peer and senior review of work products will be provided as a check on laboratory representativeness. The QAO is responsible for assessing representativeness of the data and implementing corrective actions according to the provisions of Section 9.

5.1.4 Completeness

Completeness is a measure of the amount of valid data obtained compared to the amount of valid data expected to be obtained under normal conditions.

$$COMPLETENESS = \frac{QUANTITY\ OF\ RELIABLE\ DATA}{TOTAL\ QUANTITY\ OF\ DATA} x100 \qquad EQUATION\ 4$$

The completeness objectives are as noted in Table –2. The QAO will be responsible for monitoring the completeness objectives. Should any of the data fail the completeness criteria, corrective actions will be taken, which may include resampling and/or reanalysis.

5.1.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Following the CMSI developed to standardize the collection of samples and acquisition of measurements will control comparability. Consistent, proper calibration of all equipment throughout the field exercises, as described in this QAPP, will help in maintaining the comparability of measurements. Field documentation and QA audits will be used to establish that protocols for sampling and measurement follow the CMSI.

5.1.6 Sensitivity

Sensitivity is a quantitative statement that conveys the lowest level of measurement that can be distinguished from background with a given level of confidence. Analytical detection limits (sensitivity) should be low enough to confirm the presence or absence of a given analyte at a concentration greater than a predetermined comparison criteria, at specified levels of precision and accuracy. General reporting limits, which are highly matrix dependent, are presented in Table -2. Specific detection limits are presented in the method SOPs.

6.0 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

In addition to health and safety training as required for hazardous site workers by the Occupational Safety and Health Administration, field and laboratory personnel will receive technical training in the techniques they are expected to carry out. Training will consist of, at a minimum, on the job training by a senior staff member in the procedures they are expected to implement in accordance with CMSI, documented by virtue of a signed copy of the cover sheet for the CMSI. Said documentation will be retained on file by the QAO.

Analysts will receive appropriate training in procedures, safety, and waste disposal. The Laboratory QA Manager, or his designee, will train all analysts on analytical methods and operation of laboratory instrumentation. All analysts will be required to prove the ability to execute methods they

perform with acceptable precision and accuracy through analysis of performance evaluation samples in quadruplicate which meet the applicable QC standards of the method. Training completed by the analyst will be documented by the Laboratory QA Manager and maintained on file. These records will serve the additional purpose of providing for validation of non-standard methods of analysis.

7.0 DOCUMENTATION AND RECORDS

Bound logbooks will be used for all record keeping purposes both in the field and laboratory with the exception of certain standard forms, which will be maintained in three ring binders. All logbooks and binders will contain a unique document control number. All pages, including loose-leaf forms, will be numbered.

Field and laboratory personnel will transmit the bound logbooks to the Field Manager or Laboratory QA Manager (or their designees) on a routine basis. Original logbooks will be reviewed at a frequency not to exceed once every week, by the Field or Laboratory QA Manager, who will sign the logbook as proof of said review.

To ease data review, the person making an entry must sign and date the entry. All entries must be recorded in ink or other permanent-marking device. Drawing a line through the incorrect entry, recording the correct information, and initialing and dating the corrected entry will make correction to entries. If the reason for making the change is not immediately evident, an explanation is required. Unused portions of logbook pages must be lined out.

If computerized information is used, a hard copy that has been permanently affixed to the logbook will be acceptable as an original record of sampling and/or laboratory logging

7.1 FIELD RECORDS

Field records, including sample collection records, chain of custody records, etc. will be maintained according to the CMSI. At a minimum, all field personnel will keep a personal log of activities,

noting any conditions that in their judgement may bear on the use or interpretation of the data they acquire.

7.2 LABORATORY RECORDS

7.2.1 Laboratory Log In

Once the laboratory has received samples, they will be logged into the laboratory's Laboratory Information Management System (LIMS) or into a bound laboratory notebook. Minimum information content for log in includes:

- Field sample number;
- Laboratory receipt date;
- Chain of Custody status;
- Condition in which sample arrived (i.e., intact, cracked lids, frozen, etc.);
- Analyses requested; and
- Other pertinent observations including temperature, preservation status, appearance, etc.

7.2.2 Reference Materials

Bound logbooks must be maintained of all reference materials used for analytical purposes. This will include records of all dilutions or other standard preparation steps such that all standards used during analysis will be traceable to purchased certified standards. The record must include the following information:

- Date of receipt;
- Source;
- Purity;
- Unique identification numbers;

- Record of dilutions/preparation referencing original standard ID number; and
- Expiration date.

7.2.3 Sample Preparation

Personnel involved in doing sample extraction, digestion or other sample preparation techniques must maintain a record of those activities in a bound logbook. Although, this logbook must be specific to the operation, it need not be operator specific. The logbook should be signed and dated daily and contain the following information:

- Samples prepared, including date and time, analysis, weights or volumes involved at beginning and end of process;
- Standards and reagents used;
- QC samples prepared with the batch and the reference values of the standards if applicable;
- Procedures used; and
- Relevant calculations and other relevant observations such as color, foaming, gas generation, etc.

7.2.4 Instrument Operation

Each instrument must have a dedicated logbook. Information in the logbook must reflect routine and emergency maintenance activities, tuning, calibration, and all analytical activities conducted on the instrument. A new page must be started daily during equipment operation. Information to be included for each page consists of:

- Date, operator, and project name;
- Description of any instrument maintenance or modification;
- Tuning and calibration activities;
- Instrument settings;

- Instrument operating conditions; and
- Samples analyzed including QA/QC samples and the results of each if separate instrument printouts are not provided. The use of automated data acquisition systems will require recording a reference to the data file for each standard or sample.

Hard copy data output from integrators and chromatograms should have the following information on the printout:

- Analysis date and time;
- Test name and sample number;
- Reference to the calibration curve used for quantitation;
- Logbook reference to recorded analytical activities; and
- Identification of chromatographic peaks.

7.3 LABORATORY DELIVERABLES

For the first round of sampling, a summary data reporting format consisting of analytical results and a QC summary will be provided (see Screening Data, below). For all subsequent rounds of sampling and analysis, the required analytical deliverable for definitive data types from the fixed-base laboratory must include the following at a minimum.

Definitive Data

The following forms are required for all organic analyses using gas chromatography.

- Narrative and sample identification cross reference
- Copies of Chain of Custody documentation
- Organic analysis data summary for field and QC samples
- System monitoring compound/surrogate summary
- QC Check Sample/LCS summary
- Matrix Spike and Duplicate summary

- Method blank summary
- Retention time windows
- Initial Calibration summary
- Continuing calibration summary
- Raw data for field samples including sample prep and run logs
- MDLs and RLs

The following forms are required for all organic analyses using gas chromatography/mass spectroscopy.

- Narrative and sample identification cross reference
- Copies of Chain of Custody documentation
- Organic analysis data summary for field and QC samples
- System monitoring compound/surrogate summary
- QC Check Sample/LCS summary
- Matrix Spike and Duplicate summary
- Method blank summary
- Tune summary
- Initial calibration summary
- Continuing calibration summary
- Raw data for field samples including sample prep and run logs
- MDLs and RLs

The following forms are required for all other analyses.

- Narrative and sample identification cross reference
- Copies of Chain of Custody documentation
- Analysis result summary
- Initial and continuing calibration summary
- LCS summary

- Method blank summary
- Sample spike summary (as applicable)
- Duplicate sample summary
- Instrument raw data
- Sample prep and run logs

Screening Data

Summary reporting only will be provided.

- Narrative and sample cross-reference
- Copies of Chain of Custody documents
- Analytical results
- QA/QC summary

An example of an acceptable QA/QC summary is presented below.

QA/QC SUMMARY

Batch ID:

Matrix: Fraction:

Related Samples:

Parameter	Passed	Failed	Note
Holding time			
Surrogates			
Matrix Spike			
Spike Duplicate			
Blanks			
Calibration			

Check Sample: _____

Narrative Notes:

7.4 RECORD STORAGE AND HANDLING

All records will be designated as "lifetime" or "nonpermanent" before temporary or final storage. Nonpermanent records will be retained for three years after the completion of the fieldwork, or three

years after the date the record was generated, whichever is longer. A lifetime record will be stored until authorized for destruction by either the client or legal order.

Records of either type will be catalogued before shipment to the storage facility. The storage facility will confirm that the received parcels contain all of the catalogued records and convey a receipt for the records to the originating office. The records will be made available to the originating office upon request and according to the procedures of the storage facility.

The QAO will review all records as they are received from various sources (e.g., the client, the laboratory, subcontractors, etc.) and determine whether the records are lifetime or nonpermanent. Lifetime records must meet one or more of the following criteria:

- The record may be of significant value in demonstrating capability for safe operations;
- The record may be of significant value in maintaining, reworking, repairing, replacing or modifying an item, or updating applicable remedial investigation and feasibility studies;
- The record may be of significant value in determining the cause of an accident or malfunction of an item;
- The record provides required baseline data for in-service inspections; or
- Nonpermanent records are those records that do not meet the listed criteria.

8.0 SAMPLING PROCESS DESIGN

The sampling process design and rationale are described in the CMSI. Project staff are responsible for becoming familiar with the details of that document as they pertain to their assigned work. The detailed schedule for project activities is provided in Section 8 of the CMSI Workplan.

8.1 SAMPLING METHODS REQUIREMENTS

Specifications for sampling procedures are contained in the CMSI, including sample location definition, methods of sampling and sub sampling, equipment and decontamination procedures.

Field personnel will be trained to the provisions of the PCDs and are expected to execute the work in strict accordance with those instructions and specifications. In the event that a field change to specifications is required, said changes will be fully documented in accordance with the provisions of Section 9 and subject to technical review including an assessment of the impact of the change on the quality and usability of resulting data (see Section 10). The Field Manager will consult with the Project Manager and receive verbal approval of the change in advance to the fullest extent possible. However, the Field Manager will use his discretion based on professional judgement and experience as required to acquire samples and data suitable to the intended use and objectives of the work.

8.2 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Field personnel will, at all times, be aware of the need to maintain all samples, whether in the field or in the laboratory, under strict chain of custody. A sample is in the custody of a person if it is in his possession, within his view, or secured by him in a location accessible only to authorized personnel. Chain of custody provisions, as defined in Section 8 of the CMSI, is applicable to all off-site shipments of samples. An example of a typical chain-of-custody form is provided as Figure –2.

Samples received in the laboratory will be received under chain of custody and will be defined as in a secure location while within the confines of the laboratory. Laboratory facilities will be locked whenever personnel are not present. Filing manifests and/or shipping documents upon clean disposal will terminate custody.

8.2.1 Sample Receipt

Samples delivered to the fixed-base laboratory will be received and processed in accordance with the provisions of the laboratory.

8.2.2 Laboratory Coordination

The Laboratory Manager or his designee will contact the Field manager each day to verify laboratory receipt of samples sent the previous day and to coordinate sample receipts for the current day. The Laboratory Manager will inform the data user of any problems observed with the previous day's

shipment (e.g., breakage, inconsistencies with chain-of-custody and actual numbers received), at which time corrective action will be carried out by agreement between the parties. Said agreement to be documented in the form of a telephone conversation log entry.

8.2.3 Sample Holding Times

Sample holding time, (the time between sampling and sample preparation and/or analysis), in which a sample can be considered valid and representative of the sample matrix, is specific to the analytes of interest and the method of analysis employed. Although holding times will not generally be at issue in a field measurement where samples are to be analyzed on the day of receipt, the allowable holding times for the analyses performed in the off-site laboratory are presented in Table – 4. The Laboratory Manager or his designee is responsible for sample tracking and to ensure that holding times are not exceeded.

8.3 ANALYTICAL METHOD REQUIREMENTS

8.3.1 Analytical Methods

Analytical methodologies will be based on current USEPA methods, other published sources, or on manufacturer's recommendations in the case of certain semi- or non-quantitative measurements. Table -3 presents a listing of the analytical methods applicable to this work and the source of guidance for that method. All analytical methods are documented in SOPs, reviewed and approved by the Laboratory QA Manager or his designee. Specific QC procedures and corrective action requirements are addressed in Section 8.4.

8.3.2 Sample Preparation

Sub-sampling (i.e., the selection of analytical aliquots) will be performed using standard methods. Except for samples analyzed for VOCs, field submitted samples would be homogenized through gentle agitation (in the case of aqueous samples) prior to selecting the analytical aliquot or through a cone and quartering technique for soils. Care must be taken with VOC samples to minimize losses

through volatilization during aliquot selection (i.e., minimizing agitation, splashing, etc.) and to select solid sample aliquots from previously unexposed surfaces.

Sample preparation will be performed according to SOPs based on standard methods or manufacturer's recommendations. In the field laboratory, preference will be given to methods that require minimum space, provide for rapid processing, and produce minimal amounts of waste. All sample preparations will be performed with appropriate personnel protective devices immediately available. The use of heat sources will be limited to the fullest extent possible and no open flame or sparking apparatus will be employed. Sample preparation will be documented according to the provisions of Section 7 including documentation of all standards and reagents employed, the known values of all standard and spiking mixtures employed with cross references to appropriate dilution log entries, and notation of any pertinent observations by the analyst.

8.3.3 Reference Materials

Reference standards are required to generate certification data, calibrate instruments, spike analytical surrogates or standards, and prepare QC samples. These solutions must be of known concentration and purity to be useful in assessing the quality of analytical data.

Standards used to conduct analyses will be either Standard Analytical Reference Materials (SARMs), Interim Reference Materials (IRMs), or purchased, certified standards. SARMs developed and distributed by the Central QA Laboratory of the National Institute of Standards and Technical (NIST) will be the preferred standard. IRMs are not as rigorously characterized as SARMs. In any case where standards other than those described above are employed, or where the analytical method so specifies, second source verification of standards will be required.

Material safety data sheets (MSDSs) for all standards and reagents will be stored on-site. It is the responsibility of the Laboratory Manager and all personnel to know where MSDSs are stored and to be familiar with the content of the most commonly used chemicals in the laboratory environment.

Reference materials for organic analyses must be stored in a refrigerator at or below 6°C. When purchased standards are used to create stock standards and subsequent dilutions for calibration and

spiking, the standards log must be filled out by the analyst according to the provisions of Section 6. Newly created standards will be labeled with a unique identification number, the analyte(s), concentrations, date created, and an expiration date. Newly created standards will be analyzed against existing standards and are expected to agree to within method accuracy requirements. If this test fails, the analyst must investigate the problem to identify which standard is deficient. If the new standard is deficient, the entry in the standards log will be voided and new standard prepared. If the old standard appears to have degraded, the Laboratory Manager is to be notified to assess the impact to the quality of related analyses. Corrective action will be followed and documented in accordance with the provisions of Section 9.

8.3.4 Waste Disposal

All generated wastes will be properly segregated and stored in properly labeled containers. Field generated waste will be handled according to the provisions of the site specific work plan and CMSI. In the laboratory, analyses will be conducted in a way that keeps wastes to a minimum.

8.3.4.1 Waste Characterization

The majority of the soil to be removed is expected to be non-TSCA, non-hazardous remediation waste. As discussed in the section above, excavated soil will be segregated based on the anticipation waste type (non-TSCA, non hazardous, TSCA waste, potentially hazardous waste.

The exact analysis required for waste characterization and the frequency of sampling will depend on the requirements of the selected disposal facilities. For the purpose of estimating the cost associated with implementing this corrective measure we assumed that one sample would be required for every three roll-off containers of each anticipated waste type. The frequency of waste characterization sampling is expected to decrease after sufficient data has been generated to document contaminant levels.

8.3.5 Decontamination

Decontamination of field equipment will be accomplished according to the site specific CMSI. In general terms, decontamination will be performed on all equipment that will contact the sampled media before the start of work and between sampling locations. Decontamination will generally consist of a non-phosphate detergent and water wash, tap water rinse, distilled/deionized water rinse, hexane rinse, air-drying and a second distilled/deionized water rinse. Equipment will be stored in clean areas, wrapped in plastic or aluminum foil sheeting.

Drilling tools will be steam cleaned between sampling locations. If steam cleaning does not remove the contaminate from the drilling tools or other equipment, then a biodegradable degreaser such as CitruSolv® will be sprayed on the tools and a scrub brush will be used to help breakdown the contaminate. If CitruSolv® alone is ineffective, diesel fuel may be utilized followed by CitruSolv®. Between each CitruSolv® wash, the equipment will be steam cleaned.

Also, at a minimum, the tires of all transport vehicles (i.e., trucks that transport the roll-off containers) will be decontaminated with a non-phosphate detergent water wash before exiting the site. A scrub brush will be used to help remove any residues (contaminant or soil). Following the detergent wash and scrub, the tires will be rinsed via steam cleaning.

Disposable labware will be employed to the fullest extent possible. Laboratory supplies and equipment that are reused will be decontaminated using soap and water washes followed by repetitive rinses with demonstrated analyte free water and appropriate solvents. Using method blanks will show the cleanliness of labware and equipment.

8.4 QUALITY CONTROL REQUIREMENTS

Field programs will include the collection and analysis of appropriate types of quality control samples. For purposes of this program, the following field QC samples will be used: field duplicates, and rinse/equipment blanks. Matrix spike/matrix spike duplicate samples are required by the methods of analysis proposed and additional field sample will be provided to the laboratory

for this purpose as required. This section describes the method of collection and typical frequency of collection for field quality control samples. In addition, laboratory QC samples are also analyzed to establish the precision, accuracy, and representativeness of results. This section also describes the QC samples associated with each type of analysis, the acceptance criteria for each QC check, and the corrective actions taken if criteria are not met.

8.4.1 Field QC Samples

Duplicate samples will generally be taken from areas known or suspected to be contaminated at a frequency equal to 5% of all field samples. When appropriate to this method, matrix spike/matrix spike duplicates will also be collected at a frequency of 5% each. Soil sample duplicates/splits are collected and homogenized before being split. Samples submitted for VOC analyses are not homogenized or split. Soils VOC analyses must be sealed immediately and shipped to the laboratory. The data user must assess field duplicate results. No corrective action is taken in the laboratory based on field duplicate results.

Rinse/equipment blanks will be collected when the sampling equipment is decontaminated and reused in the field or when a sample collection vessel (bailer or beaker) is used. Frequency of sampling blanks will be one per twenty samples (5%) or a minimum of one per day per equipment. The equipment used in sampling will be rinsed with analyte free water and the water running off the equipment will be collected in sample containers.

The data user must assess field duplicate results. No corrective actions are taken by the laboratory based on field submitted blanks.

8.4.2 Laboratory QC Samples

Table - 5 presents the QC samples analyzed with each method, the frequency at which those QC checks are made, the acceptance criteria applied, and the corrective action taken if acceptance criteria are not met.

QC data are maintained for periodic review by the QAO. The QAO, as a part of his periodic report to the Project Manager, will identify any areas of concern for formal corrective action according to the provisions of Section 9.

8.4.3 Audits/Surveillance

This section discusses performance and system audits/surveillances used to monitor the capability and performance of the total measurement system and to evaluate the quality of field and laboratory operations. A performance audit is a planned independent check of the operation of a system to obtain a measure of the quality of data generated. It involves the use of standard reference samples or materials certified as to their chemical composition or physical characteristics. System audits are of a qualitative nature and consist of on-site review of a system's quality assurance system and physical facilities for sampling/analysis, calibration, and measurement. Less formal surveillance may also be executed to assess conformance of field and laboratory staff to work specifications. The QAO will be responsible for auditing field activities and the field analytical laboratories at a frequency agreed upon with the Project or Laboratory Manager.

8.4.3.1 Field System Audits

If authorized by the client, a field QA audit will be conducted during the first few days of each major field activity to learn if the field teams are following protocols delineated in the PCDs. The QAO will assess conformance to the following general provisions using a check list based on site specific PCDs:

- Copies of the Health and Safety Plan, CSMI, and QAPP are on-site and accessible to the sampling and analysis teams;
- The field instruments are of the proper type, have been properly maintained and calibrated;
- Appropriate documentation is maintained according to agreed upon specifications;

- Sample collection and analysis procedures are executed per the QAPP and Workplan or CMSI;
- Sample handling procedures are executed properly;
- Chain-of-custody forms include all information listed in the SOP; and
- Sampling equipment is properly decontaminated per the QAPP and CMSI.

During the audit, appropriate actions will be taken by the QAO to ensure that field sampling is conducted according to this QAPP and the Workplan or CMSI. The QAO will document any deficiencies encountered during the audit and any actions taken in the field to correct potential problems. Results of the audit will be maintained at the URS office in Albany, New York as part of the QA documentation.

Upon completion of the audit, a report of the findings will be given to the Project Manager. Deficiencies encountered will be listed in the report and the corrective action recommended/taken to rectify the problem.

8.4.3.2 Laboratory System Audits

The URS QAO may perform laboratory audits to assess compliance with the provisions of this QAPP. In the event that the client authorizes such an audit, the QA manager will inspect the laboratory's facilities to verify the adequacy and maintenance of instrumentation and the conformance of personnel to SOPs. The items to be checked include, but are not necessarily limited to:

- Size and appearance of the facility;
- Quantity, age, availability, scheduled maintenance and performance of instrumentation;
- Availability, appropriateness, and use of SOPs including QC provisions;
- Staff qualifications, experience, and personnel training programs;
- Reagents, standards, and sample storage facilities;
- Standard preparation logbooks and raw data;
- Bench sheets and analytical logbook maintenance and review;

- Review of the laboratory's sample analysis/data package inspection procedures; and
- Ensuring that all records, logs, SOPs, and analytical results are maintained securely and retrievably.

Upon completion of the laboratory audit, a report of the findings will be given to the Laboratory Manager. Deficiencies encountered will be listed in the report with the corrective action recommended/taken by the laboratory. Deficiencies found during the audit will immediately be relayed to the appropriate laboratory personnel for immediate corrective action.

8.4.3.3 Office Audits

The QAO will also conduct audits of the case files. These audits will determine the completeness of the files and verify that all of the appropriate information is included in the files.

8.5 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

All equipment and supplies purchased in support of these activities will be purchased according to the provisions of this plan, which requires a documented review of the vendor and equipment selection process and receipt inspection and/or testing as appropriate.

In summary, those procedures require that new equipment be tested with an appropriate standard or standards to ensure they function according to their intended use. Quality control sample results from initial field use of all equipment and supplies will be reviewed by the Field Manager, Laboratory Manager or his designee to identify any cause for concern regarding new equipment and supplies received. Corrective actions will be implemented and documented according to the provisions of Section 9 as required.

Instrument maintenance, both routine and preventive, will be performed according to manufacturers' instructions. A preventive maintenance plan allows for periodic instrumentation checks for problems that occur frequently. The objective of a preventive maintenance plan is to rectify equipment problems before they become serious. Preventive maintenance also brings attention to those areas

of the instrument susceptible to degradation from aging, toxic/corrosive attack, and clogging due to environmental factors.

Procedures for preventive maintenance are contained in each instrument's manual under the maintenance/troubleshooting sections. Logbooks, such as those described in Section 7, will be maintained for each instrument used in the laboratory. Maintenance, calibration, and performance data will be entered by the operator and will be periodically reviewed by the Field/Laboratory Manager.

An inventory of critical spare parts will be maintained on-site during all field activities. Critical spare parts are defined as those that would cause a delay in field or laboratory activities of greater than 4 hours upon failure. The specific needs of the program will be determined at the discretion of the Field/Laboratory Manager.

8.6 INSTRUMENT CALIBRATION AND FREQUENCY

An instrument calibration establishes a reproducible reference point to which all sample measurements can be correlated. The analytical method mandates the frequency of instrument calibrations. Laboratory calibration standards will be traceable to their sources. Documentation of all standards used and their preparation will be included in the Standards Log referenced in Section 7.

Routine calibrations are required for most forms of analytical instrumentation. An initial calibration is performed before sample analysis. Where appropriate, retention time windows will be established for each compound of interest. At a minimum, a 3-point calibration curve will be established for quantitative analyses. Single point calibrations will be acceptable for semi-quantitative and qualitative tests. Calibrations will be verified by using independent standards as a QC check sample, calibration verification sample, or fully processed Laboratory Control Samples (LCSs).

For quantitative analyses, a continuing calibration check (midpoint calibration standard) will be analyzed periodically according to the provisions of the applicable SOP. All analytical sequences will end with a calibration verification, although occasionally, where sequential work shifts are employed, the second shift continuing calibration will serve as the end of shift check for the first shift.

All calibrations are documented in the run logs and are stored with the project files after completion of the project. Calibration acceptance criteria and corrective actions can be found in Table -5.

8.7 INSPECTION / ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

The Field/Laboratory Manager or his representative will inspect materials and consumables against the purchase order specifications to verify fitness for use. See Section 8.5 for additional detail. All materials received will be properly labeled and recorded on the inventory log for accuracy. An expiration date will be assigned immediately to all standards, reagents, and solvents.

Documentation concerning the quality of materials used on-site will be retained in the central files.

8.8 DATA MANAGEMENT

The generalized data flow is as follows:

Field data is collected and recorded in bound field notebooks according to the provisions of Section 7 and the PCDs. Sample custody and analysis requests are documented on appropriate forms and forwarded to the laboratory. Custody is accepted at the laboratory and samples are recorded in the receiving log. Sample processing is recorded in sample preparation and run logs. Raw data are either generated by instrumentation or recorded by the analyst in appropriate logs. Data are further reduced according to procedures and formulae defined in relevant SOPs. Data are peer reviewed and a report is produced. The report, including any electronic forms, is further reviewed for accuracy and completeness. Reports are forwarded to the data user with copies to central files.

Electronic data are derived from automated data acquisition systems such as a GC. This instrument is equipped with software that performs various manipulations, identifications, and calculations of analytical data. Software calculations will be verified manually during the data validation process. Other data generated by laboratory personnel may consist of analytical results recorded by the analyst. This data will be documented in a logbook and may subsequently by entered into one or another form of electronic files. The Field and Laboratory Managers or their designees, as a part of their periodic reviews of logbooks and deliverables, will audit transcriptions to ensure accuracy. Any errors encountered will trigger further auditing until no transcriptions errors are encountered in the audit set, up to and including 100% review.

Raw analytical data that require further reduction to produce usable analytical results will be reduced according to procedures defined in the referenced analytical method or SOP for the activity. After the data have been generated, they are subjected to a three tiered review process. This review process includes verifying the electronic identifications and calculations performed by the software and the analyst.

The first level of review is performed by the responsible technician/analyst. The technician/analyst verifies that QC acceptance criteria have been met and that instrument-operating conditions were appropriate to the analysis performed. The second level of review, performed by a peer, consists of a double check of the technician/analyst observations, calculations, and QC criteria. At this point, assuming any anomalies identified by the peer have been reconciled, a preliminary report is assembled. A senior staff member, who performs the same checks on the final report, performs the third level of review. The QAO will also perform reviews of work products as part of his audits.

Data are reported in three forms, two hardcopy forms and one electronic form, depending upon the data user's requirements. Screening level data are generally reported in summary form including sample identification information, results for the sample analyses, and a summary of the QC data including calibrations and verifications of precision, accuracy, and representativeness where

appropriate. Definitive level data reports will include all of the above with hard copies of all supporting information, including copies of instrument printouts and all log pages pertaining to the work. For purposes of this program a laboratory deliverable equivalent to a USEPA Level II will be required of the fixed-base laboratory. Electronic deliverables are required. They will be presented in a flat, fixed field width, ASCI format.

Analytical results will include statements of sensitivity for non-detects whenever applicable. Whether delivered in "Screening" or "Definitive" data packages, all case files will contain copies of or references to all relevant raw and processed data. However, as with bound logbooks, these data may not be replicated in each case file.

If data manipulation or reduction is performed electronically, outside of the raw data produced by purchased instrumentation, the formulae or macros employed for these purposes will be validated by comparing the results of a sample manual calculation to the result produced electronically. This validation will be documented and maintained in central files.

Additional detail regarding data review and validation is provided in Section 10. Data transformations, to the extent that they are applicable to this work, are detailed in the referenced analytical methods and SOPs. Data analysis techniques applicable to the data will be taken from two sources: (1) Guidance for Data Quality Assessment, EPA QA/G-9, July 1996; and, (2) Guidance for Data Usability in Risk Assessment, Final, April 1992. As applies to this program, the laboratory LIMS will perform data tracking. Data storage and retrieval are addressed in Section 7.

9.0 ASSESSMENTS AND RESPONSE ACTIONS

Assessments of work and data quality are provided by several means. First, peer and senior review of work and work products are required by this plan at various stages. Second, individual procedures contain detailed QC requirements, acceptance criteria, and corrective action requirements. Third, periodic, independent auditing is stipulated as a part of this plan. Fourth, formal pre-qualification

of subcontractors is required by this plan. Corrective action will be initiated where indicated based on the above referenced assessment actions.

To enhance the timeliness of corrective action and reduce the generation of unacceptable measurement data, problems identified by assessment procedures will be resolved at the lowest possible management level. Problems that cannot be resolved at this level will be reported to the QA Manager for resolution. The QA Manager will determine at which management level the problem can best be resolved, and will notify the appropriate manager. Periodic progress reports will detail all problems and subsequent resolutions.

The steps comprising this closed-loop corrective action system include:

- Defining the problem;
- Assigning responsibility for problem investigation;
- Investigating and determining the cause of the problem;
- Assigning responsibility for problem resolution; and
- Verifying that the resolution has corrected the problem.

Documentation of the condition requiring corrective action, assignment of responsibility for corrective action, due dates for completion of corrective action, and verification of completion will be maintained. Such documentation will be reviewed during system audits. Figure 3 is a form for use by all project staff to document the identification and resolution of all corrective actions and field changes.

Process changes, including field changes, will be governed by control measures commensurate with those applied to the original sampling design. Field changes will be justified, documented and approved by the Project or Laboratory Manager or his designee. The control of changes to project work plans will be according to this requirement.

9.1 REPORTS TO MANAGEMENT

The QAO will provide periodic reports to the Project Manager including an overview of activities assessed, identifying any conditions adverse to quality, and stipulating corrective actions carried out and/or required. These reports will be provided at a frequency not to exceed once per quarter and will include as attachments, and as appropriate to the reporting period:

- Data validation findings;
- Audit/surveillance reports;
- Monthly status reports of QC activities;
- Corrective Action Requests and Resolutions; and
- Other forms of control measurement documentation.

10.0 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

Upon completion of the data collection activities, the QAO will perform a review of the data collected and produce a report for the Project Manager addressing the following:

- Sampling design - What, if any, deviations were observed from the PCDs in terms of numbers of samples collected, locations of sample collection points, and unexpected events or observations in the field. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

- Sampling procedures - What, if any, deviations were observed from the PCDs in terms of the method of work applied in the collection of the samples. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

- Sample handling - What, if any, deviations were observed from the PCDs in terms of the handling and custody of the samples, including containers, preservation, storage, etc. This will include an assessment of any potential sample alias problems. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

- Analytical procedures - What, if any, deviations were observed from the PCDs in terms of the method of work applied in the analysis of the samples. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.
- Quality control and calibration- What, if any, deviations were observed from the PCDs in terms of conformance to QC and calibration criteria. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.
- Data Reduction and processing - What, if any, deviations were observed from the PCDs in terms of data reduction and processing specifications. An assessment will be provided of the impact of any such deviations on the usability or interpretation of the results.

11.0 REFERENCES

URS Quality Assurance Manual, 2000

Data Quality Objectives Process for Superfund, Interim Final Guidance, EPA 540-R-93-071, September 1993.

EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R5, Final, February 1998.

Guidance for Data Quality Assessment, EPA QA/G-9, July 1996.

Guidance for Data Usability in Risk Assessment, Final, April 1992.

Methods for the Chemical Analysis of Water and Wastes, USEPA 600/4-79-20, March 1993.

Methods for Organic Analysis of Municipal and Industrial Wastewater, USEPA 600/4-82-057, July 1982.

Standard methods for the Examination of Water and Wastewater, 18th Edition, APHA, 1992.

Test Methods for Evaluating Solid Waste, USEPA SW-846, 3rd Edition, Update III, July 1997.

USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA-540/R-94/012, February 1994.

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540/R-94/012, February 1994.

TABLE 1
Summary of the Sampling and Analysis Program for Soils

ACTIVITY	Anticipated Amount of Samples*	Target Analytes	Laboratory Analyses
Pre-Implementation Investigation	29 from 47 Soil Borings	PCBs	EPA 8082
	3 Surface Samples	PCBs	EPA 8082
Post-Excavation Investigation	135 Verification Samples	PCBs	EPA 8082
	4 from Base of Dry Wells	PCBs, VOCs, SVOCs	EPA 8082,8260,8270
Waste Characterization	1 sample per 3 roll-offs per waste stream, total +/- 41 (4,5)	PCBs, TCLP VOCs, TCLP SVOCs, TCLP Metals (potentially – corrosivity, reactivity, igniteabilty, paint filter test)	EPA 8082, 8260, 8270,6010 (9040/9045, 7.3, 1010, 9095)

*Frequency of field QC samples will be as follows:
(1) Rinseate blanks - 1 per 20 samples per matrix or minimum one per day.
(2) MS/MSDs - 1 pair per 20 samples per matrix;
(3) Field duplicates – 1 per 20 samples per matrix.
(4) Upon verification, reduce number of samples for characterization.
(5) Need to characterize decon water for waste characterization (not TCLP).

TABLE 2
QC Criteria for Measurement Data
Definitive Level Data (Soil)

Test Type[1]	Precision[2, 9,11]	Accuracy[3,10,11]	Representativeness[4]	Completeness[5]	Sensitivit (PQL)[6]
TCL VOCs	Refer to Method SOP	Refer to Method SOP	Blank < DL[7]	95%	ppb[8]
TCL SVOCs	Refer to Method SOP	Refer to Method SOP	Blank < DL[7]	95%	ppb[8]
PCBs	Refer to Method SOP	Refer to Method SOP	Blank < DL[7]	95%	ppb[8]

[1]All specifications refer to the minimum data quality goals for the default method of analysis. Defaults are presented in Table -3. Laboratory specific and matrix specific quality control criteria are presented in the method SOP.
[2]Precision as assessed as the RPD of duplicate control samples.
[3]Accuracy as measured by control sample recovery unless otherwise noted.
[4]Representativeness as measured by field duplicates (see precision goals) and method blank analysis.
[5]Completeness assessed on an analyte specific basis.
[6]General sensitivity expectation. Analyte specific PQLs are presented in the method SOP.
[7]Used in this context, DL = PQL.
[8]parts per billion.
[9]The USEPA validation "5X rule" will be applied.
[10]The USEPA validation "4X rule" will be applied.
[11]The method SOP's can be found at www.epa.gov/epaoswer/hazwaste/test/8_series.htm

TABLE 3
Methods of Analysis

Test Type	Sample Preparation/Analysis Method
Laboratory Measurements	
TCL VOCs	SW-846 Method 5030A / EPA 8260B
TCL SVOCs	SW-846 Method 3550B / EPA 8270C
PCBs	SW-846 Method 5350B / EPA 8082
Metals	EPA 6010
Corrosivity	EPA 9040/9045
Reactivity	EPA 7.3
Ignitabilty	EPA 1010
Paint Filter Test	EPA 9095

TABLE 4
Sample Containers, Preservation, and Holding Times

Test Type	Container	Preservation	Holding time
Lab Measurements			
VOCs	4 oz. wide-mouth glass	Cool to 4°C ± 2°C	14 days
SVOCs	500 ml wide-mouth amber glass	Cool to 4°C ± 2°C	14 days for Extract; 40 days after Extract
PCBs	500 ml wide-mouth amber glass	Cool to 4°C ± 2°C	14 days for Extract; 40 days after Extract
Metals	500ml Plastic	HNO3, pH < 2	6 months

TABLE 5
QC Specifications for Analysis
Laboratory Measurements

Test Type	Frequency	Criteria	Corrective Action
GC/MS (VOCs, SVOCs)			
Instrument Tune	Every 12 hours	As specified in reference method	maintenance, repeat
Initial Calibration	Initially and as required by	%RSD < 15%; r > 0.990	maintenance, repeat
Calibration Verification	con cals	%R ± 20% of true	repeat once, new ical
Continuing Calibration	Following ical	%D < 20%	new ical
LCS	Every 12 hours	Within lab limits	maintenance, repeat tests
Duplicate Analysis	5% or per shift	Within lab limits[4]	note in narrative
Surrogates	5%	Within lab limits[5]	repeat, note in narrative
Matrix Spike	every sample (3 per fraction)	Within lab limits	note in narrative
Internal Standards	5%	+100%--50% of concal; within	repeat, note in narrative
Method Blank	every sample	.5 min RT	maintenance, repeat tests
	5% or per shift	< RL[6]	
GC (PCBs)			
Initial Calibration	Initially and as required by	%RSD < 20%; r > 0.995	maintenance, repeat
Calibration Verification	con cals	%R ± 15% of true	repeat once, new ical
Continuing Calibration	Following ical	%D < 15%	new ical
LCS	Every 12 hours	Within lab limits	maintenance, repeat tests
ıplicate Analysis	5% or per shift	Within lab limits[4]	note in narrative
urrogates	5%	Within lab limits	repeat, note in narrative
Matrix Spike	every sample (2 per sample)	Within lab limits[5]	note in narrative
Method Blank	5%	< RL[6]	maintenance, repeat tests
	5% or per shift		

[1]Manufacturer's specifications or instrument operations manual must be present in the field during use.
[2]Mercury - ±20% of true.
[3]An initial calibration blank will immediately follow the Calibration verification and must meet this same specification.
[4]USEPA National Functional Guidelines 5X rule applies.
[5]USEPA National Functional Guidelines 4X rule applies.
[6]RL=PQL.

FIGURE 3
Corrective Action Report Form

CORRECTIVE ACTION REPORT

Number **CAR-** Date ___

RECOMMENDATION

To _____

You are hereby requested to implement the actions indicated below and as otherwise determined by you (A) to improve the noted condition and (B) to monitor the improvements. Your written response is to be returned to the QAO by _____.

Subject:

Reference Documents:

Recommended Action:

_____	___	_____	___	_____	___
Originator	Date	Approval	Date	Approval	Date

RESPONSE

Evaluation:

Action:

Monitoring Steps:

Affected Documents:

_____	___	QA Follow-up on	_____	___
Signature	Date	Corrective Action:	Verified	Date