

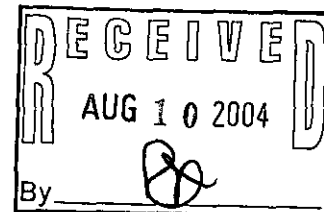


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Date: November 7, 2003
Refer to: ER2003-0667



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ESHID-603357

**SUBJECT: SUBMITTAL OF REVISION 1 TO INVESTIGATION WORK PLAN FOR
MATERIAL DISPOSAL AREA C (MDA C) LOS ALAMOS NATIONAL
LABORATORY (LANL) ENVIRONMENTAL PROTECTION AGENCY
(EPA) ID#NM0890010515**

Dear Ms. Martin:

On October 16, 2003 representatives of the Los Alamos National Laboratory (LANL) Risk Reduction and Environmental Stewardship Remediation Services (RRES-RS) Project and the U.S. Department of Energy (DOE) met with staff from the New Mexico Environment Department's Hazardous Waste Bureau (NMED-HWB) to discuss the Disapproval of the Investigation Work Plan for Material Disposal Area C (disapproval letter) dated September 4, 2003. A second letter from NMED-HWB, also dated September 4, 2003, indicated that the Investigation Work Plan for MDA C was disapproved because it did not follow the format or specific requirements of the Order issued by NMED to the University of California (UC) and DOE on November 26, 2002. That letter required LANL and DOE to address the comments attached to the letter and submit a revised Investigation Work Plan for MDA C within 30 days of receiving the letter.

In response to the above letters, LANL sent a letter to you on September 17, 2003 (ER2003-0591) requesting a meeting with your staff to review the MDA C work plan to reach agreement on the content of this work plan vis-à-vis Order requirements. Mr. David Cobrain of your staff sent us an e-mail agreeing to a meeting on October 16, 2003 and postponing submittal of the revised work plan until a date agreed upon during the October 16, 2003 meeting.

During the October 16, 2003 meeting, NMED requested that LANL and DOE reformat the MDA C work plan as instructed by NMED during the meeting and resubmit the revised work plan as a draft document in November 2003 so that NMED and DOE/LANL could agree on a format for all Investigation Work Plans required by the Order. NMED then sent a letter dated October 17, 2003, requiring submittal of a revised work plan by November 7, 2003. In response to that letter, Revision 1 of the MDA C work plan is enclosed (Enclosure 1).



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November 7, 2003

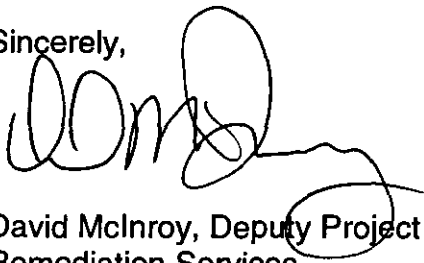
During the October 16, 2003 meeting, it was agreed that a final MDA C work plan would be submitted in the agreed upon format, pending resolution of the technical issues identified in the attachment to the second letter dated September 4, 2003. To facilitate resolution of these technical issues, DOE and LANL request continued working meetings with your staff to initiate the steps leading to approval of the MDA C work plan. In preparation for these discussions, we are providing responses to each NMED-HWB comment included in Attachment 1 to the second letter dated September 4, 2003 (Enclosure 2). The comment responses also serve to explain the basis for changes made to the work plan and to explain why some changes requested by NMED in the attachment to that letter were not made.

NMED stated in the October 16, 2003 meeting that they would not review and formally comment on the MDA C work plan until DOE had approved the Authorization Basis (nuclear safety basis) for characterization of MDA C. It should be noted the location of the proposed boreholes in the attached work plan are technically based and required in order to finalize characterization of MDA C. These locations are independent of any Authorization Basis requirements thus the laboratory believes that the work plan could be reviewed and formally commented on in parallel to the Authorization Basis development. Will not be affected by authorization basis. LANL anticipates completing the draft documented safety analysis (DSA) for the characterization of MDA C in late December 2003, submitting the DSA to the LANL Safety Basis Office (SBO) for peer review the first week in January 2004, formally submitting the DSA to the DOE senior authorization basis team on March 1, 2004 and receiving DOE approval by April 1, 2003.

NMED indicated that the date for submittal of the MDA C Investigation Report would be revised based on the new work plan approval date. According to your staff, the date for submitting the MDA C Investigation Report will be 10 months from the date NMED approves the work plan.

We appreciate the opportunity to work with your staff and believe that continued discussions will help expedite review and approval of the final MDA C work plan.

Sincerely,



David McInroy, Deputy Project Director
Remediation Services
Los Alamos National Laboratory

Sincerely,



David Gregory, Project Manager
Department of Energy
Los Alamos Site Operations

DM/DG/JH/am

Enclosure: (1) Investigation Work Plan for Material Disposal Area C, Revision 1
(2) LANL RRES-RS Project Responses to NMED Comments on the Work Plan for MDA C

Cy:(w/enc)



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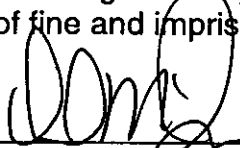
CERTIFICATION

CERTIFICATION BY THE RISK REDUCTION AND ENVIRONMENTAL STEWARDSHIP- REMEDiation SERVICES (RRES-RS) PROJECT TECHNICAL REPRESENTATIVES

Document Title: **SUBMITTAL OF REVISION 1 TO INVESTIGATION WORK PLAN FOR
MATERIAL DISPOSAL AREA C (MDA C) LOS ALAMOS NATIONAL
LABORATORY (LANL) ENVIRONMENTAL PROTECTION AGENCY (EPA)
ID#NM0890010515**

I certify under penalty of law that these documents and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violation.

Name:


David McInroy, Deputy Project Director
Remediation Services
Los Alamos National Laboratory

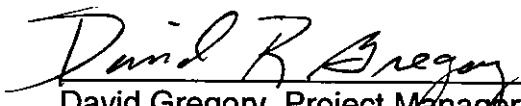
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11/6/03

or

Date: _____

Beverly A. Ramsey, Division Leader
Risk Reduction and Environmental Stewardship Division
Los Alamos National Laboratory



David Gregory, Project Manager
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Department Of Energy/Los Alamos Site Office

Date:

11/6/03

or

Date: _____

Herman LeDoux,
Assistant Area Manager of
Environmental Projects
Department Of Energy/Los Alamos Site Office



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November 2003

ER2003-0696

ERID 87152

Investigation Work Plan for Material Disposal Area C, Solid Waste Management Unit 50-009 at Technical Area 50, Revision 1



Los Alamos NM 87545

Disclaimer

This document contains data regarding radioactive wastes, the management of which is regulated under the Atomic Energy Act and specifically excluded from regulation under the Resource Conservation and Recovery Act and the New Mexico Hazardous Waste Act. These data are provided to the New Mexico Environment Department for information purposes only.

Produced by Risk Reduction and Environmental Stewardship—
Remediation Services

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Investigation Work Plan for Material Disposal Area C, Solid Waste Management Unit 50-009 at Technical Area 50, Revision 1

November 2003

Responsible project leader:

John Hopkins		Project Team Leader	RRES-RS	
Printed Name	Signature	Title	Organization	Date

Responsible UC representative:

David McInroy		Deputy Project Director	RRES-RS	
Printed Name	Signature	Title	Organization	Date

Responsible DOE representative:

David Gregory		Project Manager	DOE-LASO	
Printed Name	Signature	Title	Organization	Date

EXECUTIVE SUMMARY

This investigation work plan presents recommendations for investigation activities required to complete the Resource Conservation and Recovery Act facility investigation (RFI) of Material Disposal Area (MDA) C, Solid Waste Management Unit (SWMU) 50-009, at Technical Area (TA-) 50 at Los Alamos National Laboratory (the Laboratory). The work plan also includes a description of sampling activities and analytical results for historical investigations at MDA C.

The objectives of the investigation activities are designed to complete the determination of the nature and extent of contamination identified during past investigations, including the Phase I RFI fieldwork conducted at MDA C, and to collect additional information on the hydrogeologic properties and other physical characteristics of the vadose zone beneath MDA C. In addition, the objectives of the work plan are to determine the nature and extent of hazardous waste constituent and/or radionuclide releases to the environment identified during the Phase I RFI.

Evaluation of environmental data generated during the Phase I RFI consisted of comparisons of site data with background values (BVs) and/or fallout values (FVs) in environmental media, evaluation of correlations among environmental measurements, and spatial plots of contaminant concentrations in surface and subsurface environmental media. The following contaminant releases were identified at MDA C.

- Americium-241, plutonium-238, and plutonium-239, -240 were elevated with respect to FVs in surface soil on the northeastern and eastern edges of MDA C.
- Limited evidence indicates that Aroclor-1260 and bis(2-ethylhexyl)phthalate may be elevated locally in the surface soil and the fill above Pit 6.
- Numerous metals were detected above BVs in subsurface tuff in one or more samples primarily in borehole 50-09109 beneath Pit 6.
- Numerous radionuclides were detected in the subsurface tuff. With the exception of strontium-90 and tritium, these detections occurred primarily below Pit 6.
- Volatile organic compounds (VOCs) were detected in pore-gas samples collected from two monitoring boreholes (50-09100 and 50-10131).
- VOC surface-flux data indicate airborne releases of trichloroethylene (TCE) and tetrachloroethene (PCE) near the former Chemical Pit, in a location on the southern edge of Pit 5, and in the western regions of Pits 1 through 4.
- Near-surface tritium pore-gas concentrations indicate releases to the atmosphere from locations north of Pit 6 and in the vicinity of the northern portion of Shaft Group 3.

The Phase I RFI data were evaluated to determine if additional data is required to complete the characterization of the nature and extent of contamination. Additional data are required to determine the following:

1. the extent of metals, cyanide and radionuclide contamination in tuff beneath Pit 6;
2. the concentrations and spatial extent of VOCs in the vapor phase in subsurface tuff;
3. the concentrations and spatial extent of tritium in the vapor phase in subsurface tuff;
4. the nature and extent of potential releases of metals, cyanide and radionuclides to tuff beneath Pits 1–5, Shaft Groups 1 and 2, and the strontium-90 disposal shaft;

5. the presence of perchlorate, nitrate, dioxin, and furan contamination in tuff;
6. the presence of perched groundwater beneath MDA C; and
7. information on hydrogeologic properties and fracture characteristics to support contaminant transport modeling of the vadose zone at MDA C.

Ten vertical and four angled boreholes are proposed to be drilled adjacent to or under the disposal units, and samples will be collected to supplement the Phase I RFI data to determine the nature and extent of contamination, determine whether perched groundwater is present, and collect hydrogeologic property data.

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1.0 INTRODUCTION

1.1 General Site Information

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the Department of Energy (DOE) and managed by the University of California (UC). The Laboratory is located in north-central New Mexico approximately 60 miles northeast of Albuquerque and 20 miles northwest of Santa Fe. The Laboratory covers 40 square miles of the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation between 6200 ft and 7800 ft.

The Laboratory's Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) project, formerly the Environmental Restoration (ER) Project, is participating in a national effort by the DOE to clean up sites and facilities formerly involved in weapons research and production. The goal of RRES-RS is to ensure that past operations under the DOE do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, RRES-RS is currently investigating sites potentially contaminated by past Laboratory operations. The sites under investigation are either solid waste management units (SWMUs) or areas of concern (AOCs).

The SWMU addressed in this investigation work plan (SWMU 50-009) contains both hazardous and radioactive components.¹ Depending on the type of contaminant(s) and the history of a site, the New Mexico Environment Department (NMED) or the DOE has administrative authority over work performed by the RRES-RS Program at that site. NMED has authority under the State of New Mexico Hazardous Waste Act (NMHWA) over cleanup of sites with hazardous waste or certain hazardous constituents, including the hazardous waste portion of mixed waste (i.e., waste contaminated with both radioactive and hazardous constituents). The DOE has authority over cleanup of sites with radioactive contamination. Radionuclides are regulated under DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management." DOE is also the administrative authority for sites not under NMED's NMHWA authority.

NMED enforces the Hazardous and Solid Waste Amendments (HSWA) Module of the Laboratory's Hazardous Waste Facility Permit, hereafter referred to as Module VIII. Module VIII specifies conditions and requirements for investigation and cleanup activities at the Laboratory, which are performed by RRES-RS. The Environmental Protection Agency (EPA) issued Module VIII on May 23, 1990, and revised it on May 19, 1994 (EPA 1990, 1585; EPA 1994, 44146). NMED is currently revising the Hazardous Waste Facility Permit.

In accordance with Module VIII, the nature and extent of releases of hazardous waste or hazardous constituents are determined through the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) process. Under RRES-RS, the Laboratory also implements the RFI process for those sites under the administrative authority of DOE.

Material Disposal Area (MDA) C (SWMU 50-009) is located in the east-central portion of the Laboratory on a mesa at the head of Ten Site Canyon (Figure 1). MDA C is an 11.8-acre fenced, radiologically controlled area containing seven subsurface disposal pits and 108 shafts of various dimensions. It is located near the west end of Mesita del Buey, a mesa located primarily between Mortandad and Pajarito

¹ This document contains data on radioactive wastes, including source, special nuclear, and byproduct material. The management of these materials is regulated under the Atomic Energy Act and is specifically excluded from regulation under the Resource Conservation and Recovery Act and the New Mexico Hazardous Waste Act. These data are provided to the New Mexico Environment Department for informational purposes only.

Canyons. Technical Area (TA-) 55 (the plutonium-processing facility); TA-42 (former incinerator site within the boundaries of TA-55); TA-50 (the Radioactive Liquid Waste Treatment Facility [RLWTF]), TA-52 (office and laboratory facilities); TA-62 (maintenance shop and office trailers); and TA-35 (formerly used for radionuclide research, currently the center for laser technology, optics, and nuclear safeguards) are also located on Mesita del Buey. Figures 1 and 2 show the location of MDA C and other TAs on Mesita del Buey. Figure 3 shows the locations of the pits and shafts as well as other site surface features and topographical contours.

MDA C consists of seven pits, with depths ranging from 12 to 25 ft below the original ground surface, and 108 shafts with depths ranging from 10 to 25 ft below the original ground surface, i.e., before a cover was placed over the site in 1984. The pits and shafts are constructed in the Tshirege Member of the Bandelier Tuff, a consolidated tuff unit with relatively numerous fractures. The regional aquifer is estimated to be approximately 1300 ft deep based on data from other wells at the Laboratory and the predictions of the hydrogeologic conceptual model for the Pajarito Plateau (LANL 1998, 59599). The topography of MDA C is relatively flat, although the slope steepens to the north and where the northeast corner of MDA C abuts the south wall of Ten Site Canyon.

Historically, MDA C was used for the disposal of solids and liquids including uncontaminated classified wastes, hazardous chemicals, and radionuclides. Los Alamos Scientific Laboratory Engineering Drawings ENG-R-1264 (LASL 1970, 76047) and ENG-R-4459 (LASL 1974, 38446) were used to locate the pits and shafts. Two geophysical surveys verified the general location and horizontal dimensions of the disposal pits (AGS 2001, 73710; AGS 2002, 73711) and the depth of cover thickness, although the pit boundaries inferred from the geophysical investigation did not exactly match those shown on the engineering drawings. The depth of cover materials across MDA C was investigated using ground-penetrating radar (GPR) in 2001 (AGS 2001, 73710). The cover thickness over Pits 1–6 ranges from approximately 2.5 ft to about 8 ft. However, the cover thickness over Shaft Groups 2 and 3, the western ends of Pits 1–4, and the Chemical Pit was estimated to be less than 1 ft. The current thickness of cover materials at MDA C is illustrated in Figure 4. The depth of the shafts and pits was documented in the approved work plan for operable unit (OU) 1147 (LANL 1992, 07672) and based on historical documents, but elevation data were not documented. Subsequent additions of cover material have increased the elevation across the site. The elevation of the shafts and pits at the time of excavation was estimated from the tuff/soil interface logged in the 1995 Phase I RFI borehole logs.

This work plan presents the results of historical investigations (including the Phase I RFI) of MDA C, SWMU 50-009, at TA-50 and presents recommendations for additional activities required to complete the investigation of MDA C. It includes site background, site conditions, scope of activities to complete the investigation, investigation methods, and the anticipated schedule for completing the field activities. Appendix A includes a list of acronyms, defines terms used in this report, and presents a table with metric-to-US customary conversions. Appendix B describes the historical investigations, including Phase I RFI activities and analytical results for MDA C. Appendix C contains the borehole logs from Phase I RFI drilling activities. Appendix D describes statistical analyses to support data interpretation. Appendix E, on a CD on the inside back cover of this report, provides the Phase I RFI data. Appendix F describes the management of investigation-derived wastes. Appendix G contains a copy of NMED's position paper on the "Determination of Extent of Contamination."

1.2 Investigation Objectives

The objectives of the WP for MDA C are to

- present the current knowledge of the nature and extent of hazardous waste constituents and/or radionuclide releases to the environment based on existing data, including those collected during the Phase I RFI;
- establish the rationale for additional data collection and analysis, including justifications for deviating from the scope of work presented in the November 26, 2002, Order issued by NMED to DOE and UC; and
- identify appropriate methods and protocols for collecting, analyzing, and evaluating data to finalize the characterization of MDA C.

RRES-RS conducted Phase I RFI fieldwork at MDA C from 1993 to 2003. The results of these investigations are summarized in a Historical Investigation Report (HIR) in Appendix B. Based on an evaluation of existing environmental data collected at MDA C, several data requirements were identified that must be addressed to define the nature and extent of contamination in the environment and to evaluate risks to potential human and ecological receptors. These requirements are described in Section 2 of this work plan.

2.0 BACKGROUND

2.1 Operational History

MDA C is a decommissioned material disposal area established to replace MDA B at TA-21 as a disposal area for Laboratory-derived waste. MDA C operated from May 1948 to April 1974 but received waste only intermittently from 1968 until it was decommissioned in 1974. Wastes disposed of at MDA C included liquids, solids, and gases generated from a broad range of nuclear energy research and development activities conducted at the Laboratory, including uncontaminated classified materials, metals, hazardous materials, and radionuclides. Historical reports (Rogers 1977, 0216) indicate it was common practice for chemicals to be burned in the chemical disposal pit at MDA C. A chronology of the major events pertinent to MDA C is presented in Table 2-9, p. 2-49 of the approved RFI Work Plan for OU 1147 (LANL 1992, 07672).

At MDA C, 7 pits and 108 shafts were excavated into the overlying soil and unit 3 of the Tshirege Member of the Bandelier Tuff (Figure 3). The pits and shafts were unlined except for 10 shafts in Shaft Group 3 that were lined with concrete. After each pit or shaft was filled with waste, it was backfilled to ground level with crushed tuff. Once the disposal shafts were filled, they were sealed with concrete. The dimensions and operational dates of the pits and shafts are listed in Table 1.

2.2 Land Use

MDA C is located in an industrial area currently used for Laboratory waste management. The Laboratory does not anticipate that the land use at TA-50 and surrounding TAs will change in the future. Public access to the site is restricted by fencing, locked gates, and restricted access to Pajarito Road. Under present-day conditions, only Laboratory employees or contractors may enter the site for management operations (such as emplacing erosion controls) or collecting environmental samples.

2.3 Relationship to Other SWMUs and AOCs

The only SWMU and/or AOC within close proximity that potentially could have affected MDA C is SWMU 50-006(c). SWMU 50-006(c) refers to surface soil contamination from radioactive contaminants (primarily isotopes of plutonium and americium) deposited by historical stack emissions from operations at TA-50. Based on Phase I RFI data for MDA C and adjacent SWMUs at TA-50 and TA-35, the only areas within close proximity that could potentially have been affected by MDA C is Ten Site Canyon, which is considered an AOC (Figure 5). Eroded surface soils from MDA C, in addition to soils and contaminant releases from other SWMUs and/or AOCs at TA-50 and other TAs, have been deposited in the canyon bottom and stream banks (Nyhan et al. 1978, 5702).

2.4 Contaminant Transport Mechanisms and Potential Receptors

The inventory of wastes disposed of at MDA C includes radionuclides, metals, and organic chemicals. The relevant release and transport processes associated with these wastes are a function of chemical-specific properties, the physical form and/or container associated with a waste, and the nature of the transport process. The transport of tritium and VOCs, for example, occurs primarily in the gas phase and by diffusion or advection in air. Relatively water-soluble contaminants, primarily certain metals and radionuclides, are susceptible to release and transport via infiltration of water through the interred wastes. These contaminants can also be associated with a higher likelihood of transport via root uptake of grasses, shrubs, and trees. Strontium-90 is a good example of such a contaminant. Contaminants with relatively low water solubility, including organic chemicals such as Aroclors, are likely to be released from subsurface wastes only by some physical disturbance such as excavation by burrowing animals. The primary potential release and transport mechanisms for contaminants in subsurface wastes at MDA C include the following.

- *Volatilization, diffusion, and dispersion in air.* Gas or vapor-phase contaminants diffuse from waste and mix with air in the shafts or pits, then diffuse through the air-filled pores in the subsurface rock. Migration of gas- or vapor-phase contaminants from tuff into ambient air may occur by diffusion or by advection driven by barometric pressure changes.
- *Dissolution and advective transport in water.* Rain or melting snow on the surface moves down through the shafts and pits, dissolves contaminants, and slowly transports dissolved contaminants through the subsurface rock. Transport in tuff may be facilitated by the presence of fractures, particularly when fractures have coatings with low conductivity or when sufficient liquid saturates the matrix adjacent to the fracture where flow is occurring.
- *Biotic perturbation and translocation of contaminants in subsurface wastes.* Plants grow into the waste and incorporate contaminants into their surface biomass; contaminants are deposited onto the soil surface as biomass decays. Burrowing animals excavate contaminated wastes and release them onto the soil surface as burrow spoils. Surface contamination may then be transported back into the subsurface by burrow collapse or dissolution in surface water infiltrating the soil or be transported away from the site by suspension in air or surface water runoff.

In addition to the processes described above, which were discussed in the context of buried wastes, contaminants may also have impacted environmental media at MDA C from releases that occurred during its operation. Dissolution of contaminants in infiltrating water, for example, may have been more prevalent during site operations when pits and shafts were open for disposals. Currently, two release mechanisms are inactive at MDA C but may have contributed to existing contamination in environmental media:

- *Operational releases.* Contaminants may have been released to surface soil during the period when wastes were actively disposed at MDA C. Fires in the disposal pits at MDA C have been recorded (LANL 1992, 07672) and may have released contamination to surface soils and air.
- *Erosion prior to installation of existing cover.* The emplacement of a cover over MDA C in 1984 may have been instigated by erosion of the native cover prior to that time. Waste materials were reportedly exposed on the ground surface in the area of Pit 5 prior to the installation of the crushed tuff and fill cover in 1984 (LANL 1992, 07672).

Phase I RFI data collection activities occurred over the past ten years at MDA C. Site conditions have been relatively constant over this period, such that potential temporal changes in the concentrations of contaminants in environmental media are expected to be negligible. One exception may be the presence of locally elevated rates of water infiltration caused by surface depressions related to subsidence within MDA C. Subsidence has been observed above Pit 6 in a location coincident with a surface runoff channel. The subsidence has been repaired.

Receptors potentially exposed to contamination from MDA C include site workers at MDA C and TA-50 and biota at the site. Potentially, site workers may be exposed to contaminants via inadvertent soil ingestion, inhalation of suspended soil (dust), dermal absorption from soil on the skin, and external irradiation. Inhalation of gas-phase contaminants such as tritium and/or volatile organic compounds (VOCs) emanating from the site into the atmosphere is also a possible source of exposure. Ecological receptors may be exposed via these pathways as well as via root uptake and the food web; in addition, these receptors may be exposed to higher concentrations of vapor-phase contaminants in subsurface burrows.

It is possible for plant roots and burrowing animals to penetrate the existing cover and come in contact with subsurface contamination. Site inspections have revealed that rodent and ant burrow spoils contain crushed tuff material that differs from surface soils. Grasses, trees, and shrubs are also present, or have historically been present across MDA C. Results of recent sampling of burrow spoils and small ponderosa pines within MDA C (Appendix B) will be reported in the MDA C Investigation Report.

A perched aquifer was not encountered nor is suspected beneath Mesita del Buey at MDA C (LANL 1998, 59599). No perched water was observed in 316 ft of drilling in the deepest borehole (borehole 50-09100, Appendix C). No perched water was observed in 700 ft of drilling in the nearby borehole SHB-1 or in borehole R-14 (Figure 6). Therefore, the potential for exposure of receptors through a water-mediated pathway is unlikely. Data from other wells at the Laboratory and predictions of the hydrogeologic conceptual model for the Pajarito Plateau place the regional aquifer at a depth of 1300 ft below MDA C (LANL 1998, 59599). Because of the depth to the aquifer and the low moisture content (1%–10% gravimetric moisture content) of the vadose zone, it is unlikely that contamination at MDA C could reach the regional aquifer in the near future. However, contaminants from MDA C have the potential to reach groundwater, and this pathway will be investigated and evaluated in the MDA C Investigation Report for present-day risk.

2.5 MDA C Waste Inventory

Waste disposal records for MDA C are contained in a series of disposal logbooks (LANL 2003, 76035). Radioactive waste disposal records provided sufficient detail to determine the location, type, and volume of waste disposed and to estimate the number of curies present in specific pits and shafts (Appendix B). However, little data exist on the volume of hazardous constituents disposed of at MDA C. The description of waste items disposed of at MDA C is based on information provided in Section 2.3 of the approved RFI

work plan for OU 1147 (pp. 2-51 to 2-57, LANL 1992, 07672) and is summarized in Appendix B of this work plan.

2.6 Historical Releases

Results of historical investigations indicate contaminants have been released to environmental media as a direct consequence of disposal activities. Between 1976 and 1983, analysis of soil and vegetation samples from MDA C "confirmed the presence of pCi/g levels of radionuclides in localized areas" (Section 2.3.2.2.1, LANL 1992, 07672). Wastes in some pits (especially in Pit 5 on the north side of MDA C) were exposed at the ground surface as a result of natural degradation or erosion of the shallow soil covers. Additionally, anecdotal information related in the approved RFI work plan for OU 1147 states, "chemical wastes were responsible for many fires at Areas B and C." It is possible that fires served as a vehicle of contaminant transport from open pits and/or shafts to the surrounding surface soil.

In 1984, additional crushed tuff was placed over contaminated soil on the surface of MDA C. Historical documents report that approximately 1.5 ft of crushed tuff, followed by between 0.5 to 3 ft of topsoil, was placed over existing cover material (LANL 1992, 07672). The 2001 geophysical survey of MDA C (Appendix B) indicates the existing cover thickness across the site ranges from a minimum of 0.0 ft to 8.8 ft with a mean value of 3.4 ft (Figure 4). The only portion of MDA C where additional cover was not placed was the northeast corner of the site where no pits or shafts are located. The isotopic plutonium and americium-241 concentrations detected in surface soils in the northeast portion of the site measured during Phase I RFI resulted in part from windborne deposition of contamination released during waste disposal activities and from deposition of historical stack emissions from operations at TA-50.

2.7 Summary of Historical Investigations

2.7.1 Pre-RFI Field Investigations

Sampling and analysis activities to ascertain the presence and scale of potential environmental contamination at MDA C began following the decommissioning of the facility in 1974. Radiation surveys of site soils and vegetation using field instrumentation were conducted from 1976 through 1984 (p. 2-57, LANL 1992, 07672). Following the placement of crushed tuff and cover material over MDA C in 1984, additional field surveys were conducted and supplemented with off-site contract laboratory analyses of radionuclides in soils and vegetation (p. 2-59, LANL 1992, 07672) in 1985 and 1986. These investigations and the associated findings are described in the HIR (Section B-1 of Appendix B) and in the approved RFI work plan for OU 1147 (LANL 1992, 07672).

2.7.2 Phase I RFI Field Investigations

Phase I RFI activities included sampling of surface soil, subsurface tuff, and pore gas. Surface sampling activities conducted in 1993 included a radiation survey conducted on a 60- by 60-ft grid and the collection of 203 0–6-in. surface samples of soil or tuff. All surface samples were field-screened for radioactivity. One hundred twenty-two samples were submitted to a mobile analytical laboratory for analysis of polychlorinated biphenyls (PCBs). Sixty-eight surface samples were analyzed at an off-site contract laboratory for target analyte list (TAL) metals, radionuclides, and semivolatile organic compounds (SVOCs). Fifty-nine of these samples were also analyzed for PCBs and nine surface samples were analyzed for VOCs. Phase I surface RFI results are reviewed and interpreted in Section 2.7.3 of this work plan; the data are summarized in Appendix B and included on a data CD (Appendix E) attached to the inside back cover of this report.

A total of 390 subsurface samples were collected in 1995 and 1996 from two vertical and nine angled boreholes drilled to depths ranging from 77 to 316 ft below ground surface (bgs). The subsurface samples were field-screened at approximately 5-ft intervals for radioactivity, high explosives (HE) and VOCs and submitted to a mobile radiological analysis laboratory. Samples were collected at approximately 20-ft intervals and submitted for off-site contract laboratory analysis for TAL metals and cyanide, radionuclides, and SVOCs. With the exception of samples from boreholes 50-09100 and 50-09102, 24 subsurface samples were also analyzed for VOCs and PCBs/pesticides.

In 1996, 15 additional samples were collected from curated borehole cores, in response to a request from EPA (Neleigh 1995, 55112). These samples were submitted to an off-site contract laboratory for analysis of inorganic chemicals (excluding cyanide and mercury since the holding times had lapsed) and radionuclides (except tritium). However, based on the core collection dates and the actual dates the samples were analyzed, more than half of the curated core samples missed the 180-day holding time for inorganic chemicals. The inorganic chemical data from these samples is provided only for the purpose of comparison. Because the holding times for PCBs, VOCs, SVOCs, and tritium had been exceeded, curated core samples were not analyzed for these analytes. Phase I RFI subsurface results are reviewed in Section 2.7.3 and presented in Appendix B (Section B-2.0).

Ten of the 11 boreholes were backfilled and abandoned after the 1995 fieldwork. One vertical borehole (50-09100) was capped after the 1995 fieldwork and subsequently completed in 2000 as a vapor monitoring well with ten sampling ports. A second vertical borehole (50-10131) was drilled as a vapor monitoring well in 2001. Pore-gas samples of VOCs were collected quarterly from selected ports in these boreholes in 2000, 2001, 2002, and 2003. Surface-flux measurements of VOCs were conducted in 2000 at 101 locations. Near-surface tritium soil gas concentrations were measured at 15 locations at MDA C in February 2003. Phase I RFI pore-gas and surface-flux results are reviewed in Section 2.7.3 and in Appendix B.

Terrain conductivity (EM31), high-sensitivity metal detector (EM61), and GPR data were gathered during two geophysical surveys at MDA C conducted in 2001 and 2002 (Appendix B, Section B-2.1.1) to confirm the general location of the disposal units, confirm that Pits 1 through 5 do not extend east or south past the MDA C fence line and to map the thickness of cover materials across the site. Sufficient anomalies were detected in the area of Pits 1 through 5 to infer general pit boundaries; however, the anomalies extend over the reported width of the pits making it difficult to distinguish the boundaries between the pits. No clear anomalies were observed to indicate the boundaries of Pit 6 or the Chemical Pit. Cover thickness over the site was determined.

In January 2003, ant mounds and animal burrows were field-screened for radionuclides (gross alpha and gross beta) to select sample locations. Samples of conifer needles from 16 trees and soil from small-mammal burrow spoils and ant mounds (29) were collected in February 2003 and submitted for analysis of gross alpha, beta and gamma radiation. The purpose of this sampling was to determine if plants or animals were transporting contaminants from buried wastes to the ground surface. Results of the February 2003 biota sampling will be presented in the MDA C Investigation Report.

2.7.3 Phase I RFI Results

Conclusions regarding the nature and extent of contamination at MDA C based on the results of Phase I RFI activities are as follows.

1. Releases of radionuclides to historical surface soils were largely covered with crushed tuff in 1984. Elevated concentrations of americium-241 and isotopic plutonium in surface soils in the northeast area of MDA C are likely related to releases from MDA C prior to placement of crushed

tuff on the surface of the site in 1984. The extent of current surface radionuclide contamination is defined.

2. Lead and silver were the only metals detected at concentrations above their respective BVs in surface soil and fill. Statistical analyses in Appendix D indicate that the range of values is almost identical to background. There are sporadic detects of SVOCs and Aroclor-1254 and Aroclor-1260, but no defined pattern and no evidence for a widespread release of organic chemicals from MDA C were found. The extent of current surface inorganic and organic chemical contamination is defined.
3. Concentrations of specific metals (including barium, copper, and lead) and radionuclides (strontium-90 and americium-241) in tuff beneath disposal pits indicate that contamination has migrated from disposal pits into underlying rock. The extent of subsurface contamination has not been defined.
4. Tritium and VOC contamination (primarily trichloroethylene [TCE], tetrachloroethene [PCE], and 1,1,1-trichloroethane [TCA]) exists in subsurface pore gas; however, the vertical and horizontal extent of this contamination has not been defined.
5. Surface flux of VOCs and near-surface tritium soil-gas concentrations indicate localized areas where releases to the atmosphere are occurring.

A detailed review of the Phase I RFI data is presented in Section B-3 of Appendix B. Phase I RFI data are presented in Appendix E (on a CD attached to the inside back cover of this report).

2.7.3.1 Field Screening Results

Screening of Core Samples

Information presented in Section B.2 of the HIR is summarized and interpreted in this section to describe the effectiveness of field screening during the Phase I RFI and its applicability during future investigation activities.

Subsurface samples collected during the Phase I RFI were screened in the field for HE using a spot-test kit, alpha and beta/gamma radioactivity using field survey meters, and VOCs using a photoionization detector (PID). Field screening results for HE, radionuclides and VOCs indicate that concentrations of contaminants in the subsurface at MDA C are sufficiently low such that field screening is ineffective for the purpose of identifying samples for laboratory analysis.

During the Phase I RFI, 332 subsurface core samples were screened in the field for HE using a spot test procedure. No HE was detected in any of these samples.

During the Phase I RFI, 333 subsurface core samples were screened in the field for alpha and beta/gamma radioactivity, and 67 of these samples were submitted for laboratory analysis of radionuclides. Results of the screening analyses are summarized in Table B-18. Forty-three of these 67 samples had detected activities of radionuclides other than tritium within the range of local BVs. The remaining 24 samples had detected activities of radionuclides other than tritium above local BVs. As shown in the Phase I field screening results summarized below, there was no significant difference in field screening results for samples having radionuclides within and above local BVs.

Phase I RFI Field Screening Results	43 Samples Within Background	24 Samples Above Background
Alpha counts per minute		
Range	0–3	0–2
Median	1	1
Average	0.8	0.7
Beta/Gamma counts per minute		
Range	120–220	140–210
Median	180	165
Average	177	170

During the Phase I RFI, 333 subsurface core samples were screened in the field for VOCs by surveying the surface of each core sample with a PID. No VOCs were detected by the PID in any of the samples. Although VOC data were reported for tuff samples, these data are of little value because tuff does not effectively adsorb VOCs and is, therefore, a poor sample matrix for VOCs. VOCs in the subsurface exist primarily in the gas phase because of the low absorptive capacity of the tuff and cannot be detected by a PID in the field. Results of RFIs conducted at other MDAs since 1995 have shown that it is necessary to sample pore gas instead of tuff to determine the nature and extent of VOCs in subsurface tuff.

2.7.3.2 Data Interpretation and Identification of Investigation Objectives

Information presented in Sections B-1.0, B-2.0, and B-3.0 of the HIR is summarized and interpreted in this section to describe the current understanding of the nature and extent of environmental contamination at MDA C. Based on this interpretation, data requirements related to the nature and extent of environmental contamination at MDA C are identified.

Interpretation of Phase I RFI Surface Soil and Fill Data

Metals: Lead and silver were the only metals detected at concentrations above their respective BVs in the surface soil and fill. Silver was detected above the BV of 1.0 mg/kg in two of the 68 samples. Lead, detected above its BV at a frequency of about 13%, has the highest concentrations along the southeast portion of the site. The maximum lead concentration (30 mg/kg) was detected in a sample collected from a location west of Shaft Group 3 and Pits 1 and 2 and south of Pit 6 and the Chemical Pit and is only slightly above the BV (22.3 mg/kg). A box plot of the site surface soil and background soil data for lead (Figure D-15) show that the range of concentrations in the two data sets is almost identical. These findings indicate that the slightly higher site concentrations of lead are most likely related to characteristics of the fill material, natural variability, and the proximity of MDA C to roadways and parking areas. Present-day concentrations of metals in surface soil at MDA C do not indicate that a release of metals from MDA C has occurred to the surface.

Radionuclides: Americium-241, plutonium-238, plutonium-239, -240, thorium-232, tritium, and uranium-238 were detected above their respective BVs in at least one surface sample. The highest concentrations of americium-241, plutonium-238, and plutonium-239, -240 were detected in surface samples collected in the northeast corner of MDA C and along the eastern edge of MDA C. Cover materials placed over the surface of MDA C in 1984 did not extend to this area of the site (Figure B-6). These findings indicate that the elevated concentrations of americium-241 and isotopic plutonium in surface soils are related to releases during historical MDA C site operations and/or from the deposition of

historical airborne emissions from operations at TA-50. Concentrations of americium-241, plutonium-238 and plutonium-239, -240 are comparable to results from surface samples collected near the northeast corner of MDA C during the 1993 RFI of atmospheric releases [SWMU 50-006(c), pp 24–29, LANL 1995, 49925]. The nature and extent of americium-241 and isotopic plutonium in surface soils in the northeast corner of MDA C and along the eastern edge of MDA C is defined. Uranium-238 was detected above the BV in only one of 68 surface samples (2.45 pCi/g), which is slightly higher than its BV (2.29 pCi/g). Thorium-232 was detected above its BV (2.33 pCi/g) in 15 of 68 samples, with the maximum concentrations approximately twice the BV. Spatial patterns do not indicate any release of these isotopes to surface soils at MDA C.

Organic Chemicals: There is no consistent spatial pattern among the detected concentrations of organic chemicals in surface soil and fill at MDA C. Acenaphthene and pentachlorophenol were detected only once in two different samples collected on the south side of MDA C. Bis(2-ethylhexyl)phthalate was detected in two fill samples in the northwest part of MDA C. Like bis(2-ethylhexyl)phthalate, Aroclor-1260 was detected in four of the 43 samples collected in the northwest portion of MDA C, while Aroclor-1254 was detected in two samples from the southeastern portion of the site and in a single sample at the highest concentration, collected from a central location adjacent to Pit 2. Results of mobile laboratory analysis for PCBs showed four detections of Aroclor-1260, all above Pit 6 in the northwest corner of the site and no detections of Aroclor-1254. The detection of Aroclor-1260 in eight samples (four fixed laboratory and four mobile laboratory) and bis(2-ethylhexyl)phthalate in two samples in the same general location may indicate a localized release from Pit 6 to surface soil during historic site operations. The nature and extent of organic chemicals present in surface soils at MDA C is defined.

Nature and Extent of Surface Soil and Fill Contamination

An evaluation of the metal, radionuclide, and organic chemical Phase I RFI data for surface soil and fill at MDA C does not reveal any data needs related to the nature and extent of contamination. A release of radionuclides, including americium-241, plutonium-238, and plutonium-239, -240, was identified in the northeast region of MDA C. This release is most likely associated with historical site operations and/or with the deposition of airborne emissions from historic operations at TA-50 rather than more recent transport of contamination from wastes buried in the disposal units. A release of Aroclor-1260 and bis(2-ethylhexyl)phthalate may have occurred in the area of Pit 6 during operation of the site. The detected concentrations of these chemicals are bounded by other soil and fill samples where they were not detected; therefore, the spatial extent of potential surface releases from MDA C has been established by the Phase I RFI data in accordance with the NMED position paper on the determination of extent (Appendix G). No additional surface sampling is required.

Interpretation of Phase I RFI Subsurface Tuff Data

Metals: A number of metals were detected above their respective BVs in Phase I RFI tuff samples collected at MDA C. Aluminum, beryllium, calcium, chromium, cobalt, magnesium, and nickel were detected above BV in only a single sample. Antimony, arsenic, barium, copper, cyanide, lead, selenium, and thallium were detected in two or more samples above their BVs. Of these metals, cyanide and lead were detected above BVs with the greatest frequency. The greatest depth that metals were detected in the subsurface at MDA C was 83.4 ft bgs in the bottom sample from borehole 50-09106. Metals were detected above BVs in the samples collected from the bottom of two boreholes, vertical borehole 50-09104 adjacent to the southern boundary of Pit 1 and borehole 50-09106, which was angled beneath the north end of Shaft Group 3 and the west end of Pit 4. Plots of the analytical results for metals detected in two or more samples above their BVs are presented in Figures D-10 to D-17.

Phase I RFI boreholes from which samples were collected adjacent to or beneath Pit 5 include 50-09100 and 50-09102, both located north of the pit. Cyanide was detected at a concentration of 0.53 mg/kg in a sample collected from a depth of 43.5 ft bgs in borehole 50-09100; however, there is no BV for cyanide. Cyanide was not detected in any subsequent samples from borehole 50-09100. No other metals were detected above BVs in either borehole (Table 2).

Phase I RFI boreholes from which samples were collected adjacent to Pits 1 through 4 and Shaft Groups 1 through 3 include 50-09103, -09104, -09105 and -09106. Cyanide was detected in the bottom sample from borehole 50-09104 (sample ID 0550-95-0099) at a concentration of 0.26 mg/kg and in samples collected from four of the five previous depth intervals (Table 2). In addition, arsenic, beryllium, copper and thallium were detected in single samples from borehole 50-09104, and lead was detected above background in two consecutive samples from the sample borehole. Thallium was detected in the bottom sample from borehole 50-09106 (sample ID 0550-95-0071) at a concentration of 1.2 mg/kg, and lead was the only other metal detected in this borehole at a concentration of 51.1 mg/kg (BV of 11.2 mg/kg). Lead was the only metal detected in borehole 50-09103, and arsenic was the only metal detected in borehole 50-09105; no metals were detected in subsequent samples collected from either borehole. Collectively, the data for boreholes 50-09103, 50-09104, 50-09105, and 50-09106 indicate releases of metals to tuff have occurred from several of the pits and shafts located in the eastern portion of MDA C; however, the nature and extent of these releases have not been determined, except for the area adjacent to and beneath the northeast area of Pit 5 (Table 2, Table B-16, and Appendix D).

Phase I RFI boreholes from which samples were collected beneath or adjacent to Pit 6 include 50-09101, 50-09107, 50-09108, 50-09109, and 50-09110. With the exception of beryllium, the seven inorganic chemicals listed above detected above BVs were all detected in the same sample, (sample ID 0550-96-0112) collected at a depth of 47 ft bgs in borehole 50-09109 beneath Pit 6. Concentrations of barium, copper, lead, selenium, and thallium were also elevated above BVs in this particular sample. The subsurface sample with the next greatest number of metals detected above BVs (sample ID 0550-95-0231) was also collected from borehole 50-09109 at a depth of 25 ft bgs. Antimony, barium, copper, and lead were detected above BVs in this shallower sample. Of the inorganic chemicals detected above BVs in two or more samples, the highest concentrations of antimony, copper, and thallium were detected in borehole 50-09109 beneath the southwest portion of Pit 6 and the northwest corner of the Chemical Pit.

The highest concentrations of barium, cyanide, and lead were detected in boreholes 50-09107, 50-09101, and 50-09110 adjacent to and beneath Pit 6, respectively. None of these concentrations were detected in the deepest sample from a borehole, and all of the maximum concentrations detected (with the exception of calcium and selenium) were within a factor of 10 of the BV. Detected concentrations of calcium and selenium exceeded BVs by more than a factor of 30 in the sample collected at 47 ft bgs in borehole 50-09109 (sample ID 0550-96-0112). Collectively, the data for boreholes 50-09101, 50-09107, 50-09108, 50-09109, and 50-09110 indicate that releases of metals to tuff below Pit 6 and the Chemical Pit have occurred; however, the nature and extent of these releases has not been determined (Table 2, Table B-16, and Appendix D).

Radionuclides: Radionuclides detected at concentrations above BV, or detected in tuff when there is no tuff BV, include tritium, americium-241, plutonium-238, plutonium-239, uranium-235 and uranium-238, and various fission or activation products including strontium-90, cobalt-60, cesium-134 and cesium-137, europium-152, and sodium-22. The maximum depth of detected radionuclides (other than tritium) was 84.8 ft bgs (Table 2). Radionuclides were detected in samples collected from the bottom of six of the eleven Phase I RFI boreholes. Borehole plots of radionuclides in the subsurface are provided in Appendix D.

Phase I RFI boreholes from which samples were collected beneath or adjacent to Pit 6 include 50-09101, 50-09107, 50-09108, 50-09109, and 50-09110. Americium-241 was detected in the sample collected from the bottom of borehole 50-09101 at a concentration of 0.011 pCi/g at 81 ft bgs (sample ID 0550-95-0309) and in samples from two previous nonconsecutive depth intervals (Table 2). Americium-241 was also detected in the sample collected from the bottom of borehole 50-09107 at a concentration of 0.032 pCi/g at 78.5 ft bgs (sample ID 0550-95-0191) and in samples from three previous depth intervals (Table 2). Sodium-22 was detected in the sample collected from the bottom of borehole 50-09109 at a concentration of 0.056 pCi/g at 81 ft bgs (sample ID 0550-95-0241). Additional radionuclides detected below Pit 6 include cesium-134, strontium-90, and plutonium-238 in borehole 50-09108; strontium-90, uranium-235, and uranium-238 in borehole 50-09109; and strontium-90 in borehole 50-09109. Collectively, the data for boreholes 50-09101, 50-09107, 50-09108, 50-09109, and 50-09110 indicate that releases of radionuclides to tuff below Pit 6 have occurred; however the nature and extent of these releases has not been determined (Table 2, Table B-18, and Appendix D).

Phase I RFI boreholes from which samples were collected adjacent to or beneath Pit 5 include 50-09100 and 50-09102 both located north of the pit. Americium-241 was detected at 0.027 pCi/g, uranium-235 was detected at a concentration of 0.21 pCi/g at a depth of 33.7 ft bgs, and plutonium-239 was detected at a concentration of 0.014 pCi/g at a depth of 43.5 ft bgs in borehole 50-09100; no radionuclides were detected in any subsequent samples from borehole 50-09100. No radionuclides were detected above BVs in borehole 50-09102 (with the exception of tritium; Table 2).

Phase I RFI boreholes from which samples were collected adjacent to Pits 1 through 4 include Shaft Groups 1 through 3 include 50-09103, -09104, -09105 and -09106. Strontium-90 was detected in the sample collected from the bottom of borehole 50-09103 at a concentration of 0.599 pCi/g at 82.6 ft bgs beneath the southeast corners of Pits 2 and 3 (sample ID 0550-95-0129) and in the sample collected from the bottom of borehole 50-09106 at a concentration of 0.767 pCi/g at 83 ft bgs beneath Pit 4 and the north end of Shaft Group 3 (sample ID 0550-95-0071). Plutonium-238 was detected at a concentration of 0.014 pCi/g at 85 ft bgs in borehole 50-09105 beneath Shaft Group 3 and the west end of Pit 3. Plutonium-239 was detected at a concentration of 0.080 pCi/g in the sample collected from the bottom of borehole 50-09105 at 84.5 ft bgs. Americium-241, uranium-235, and various fission or activation products were detected sporadically and at low concentrations in boreholes 50-09103, 50-09104, and 50-09105. The frequent rate of detection of strontium-90 at depth (it was present in four boreholes and below 65 ft in three of the boreholes) may be associated with its greater solubility compared with elements such as americium, uranium, and plutonium.

Collectively, the data for boreholes 50-09103, 50-09104, 50-09105, and 50-09106 showed sporadic detections of radionuclide at low concentrations in tuff adjacent to and beneath several pits and shafts located in the eastern portion of MDA C; however the nature and extent has not been determined, except for the area adjacent to and beneath the northeast area of Pit 5 (Table 2, Table B-18, and Appendix D). Additional sampling is required to determine whether a decreasing trend exists.

Tritium migrates in tuff in the form of water vapor; therefore, its occurrence in the tuff is not necessarily correlated with infiltration of water but is related to diffusion and advection in a gaseous state. Tritium was detected in almost every tuff sample collected at MDA C; borehole profiles for tritium concentrations in tuff are provided in Figure D-18 in Appendix D. Some of the highest tritium concentrations in tuff pore moisture were measured in borehole 50-09107, the same borehole where americium-241 was detected in the bottom borehole sample and three previous sample intervals. However, tritium concentrations were also relatively high in samples collected beneath Pits 4 (borehole 50-09106) and 5 (borehole 50-09102). The tritium tuff data indicate a release of tritium in the subsurface, with concentrations higher in the northern portions of the site below Pits 4, 5, and 6, although subsurface tritium data are lacking from the

central portions of Pits 1 through 5. By contrast, near-surface tritium pore-gas concentrations indicate relatively low concentrations directly above Pits 5 and 6.

Organic Chemicals: The tuff data for SVOCs do not show evidence of a release from the disposal units and are not consistent with the metals and radionuclide data. Bis(2-ethylhexyl)phthalate was the only SVOC detected in tuff samples, and the range of detection limits encompassed the detected concentrations. Thus, the detected concentrations were very close to the limits of detection. PCBs and pesticides were not detected in any tuff samples. Although VOC data were reported for tuff samples, these data are of little value because tuff does not effectively adsorb VOCs and is, therefore, a poor sample matrix for VOCs. VOCs in the subsurface exist primarily in the gas phase because of the low absorptive capacity of the tuff. Also, the low moisture content of the tuff, coupled with the low solubilities of chlorinated hydrocarbons such as PCE and TCE, results in only negligible quantities of VOCs in pore moisture. The distribution of VOCs in pore gas is discussed below (see section entitled "Interpretation of Subsurface Pore-Gas Data" below).

Nature and Extent of Subsurface Contamination

Tuff data for metals (including cyanide), and for radionuclides, indicate that releases to subsurface tuff have occurred below Pit 6 because these contaminants are present at concentrations exceeding BVs and/or fallout values (FVs).

Available data from angled boreholes beneath Pits 3, 4, and 5, and Shaft Group 3 do not provide evidence of infiltration-related releases of metals or radionuclides. However, relatively few tuff samples were collected from beneath these disposal units. No tuff samples were collected from beneath Pits 1 and 3, beneath Shaft Groups 1 and 2, or beneath the strontium-90 disposal shaft. The number and locations of tuff samples are not adequate to support any conclusions regarding the nature and extent of contamination beneath Pits 1 through 5, Shaft Groups 1 and 2, and the strontium-90 disposal shaft.

Tritium pore-gas data in tuff indicate a release of tritium in the subsurface, with higher concentrations measured in the northern portions of the site below Pits 4, 5, and 6. Near-surface tritium pore-gas data indicate that a release of tritium to the atmosphere is occurring in the western regions of Pits 1 through 4, in an area west of Shaft Group 3 and north of Pit 6. One or more shafts on the northern end of Shaft Group 3 may be the source of the high concentration of tritium in pore gas measured in a location west of these shafts, but the Phase I RFI samples are inadequate to confirm this hypothesis.

In addition to the analytical suites applied to the Phase I RFI tuff samples, additional suites may be appropriate given the nature of the wastes disposed at MDA C. Nitrates and perchlorate, which are very soluble and susceptible to migration with infiltrating surface water, were not analyzed in Phase I RFI tuff samples. Nitrates are associated with fertilizers and are also a common breakdown product of most nitrogen-containing organic materials. Perchlorate-containing chemicals have been widely used as oxidizers in a variety of chemical processes, and perchloric acid is a common strong acid used in laboratories. Because of their mobility and potential occurrence in disposed waste at MDA C, analysis of nitrates and perchlorate in tuff samples is appropriate. Therefore, nitrates and perchlorates will be added to analytical suite for subsurface tuff samples to be collected in accordance with this work plan. Dioxins and furans were not reportedly disposed of at MDA C. Historic records indicate that chemicals were burned in the Chemical Pit, however, and may have formed dioxins and furans. Therefore, dioxins and furans will be added to the analytical suite for subsurface tuff samples to be collected beneath Pit 6 and the Chemical Pit in accordance with this work plan.

Information on the hydrogeologic properties and other physical characteristics of the vadose zone at MDA C is generally lacking and is, therefore, needed for evaluating potential future migration of

contaminants from MDA C. Information on the moisture content of tuff was collected from the Phase I RFI samples but only to a depth of approximately 316 ft bgs. Other relevant hydrogeologic information, as well as information on the water content of tuff at greater depths in the vadose zone, must be inferred from data obtained elsewhere at the Laboratory. Hydrogeologic properties such as saturated and unsaturated hydraulic conductivity, porosity, bulk density, chloride-ion concentration, and matric potential are also important parameters for evaluating the migration of liquid- and vapor-phase contaminants in the vadose zone. Such evaluations usually performed using numerical models to simulate field conditions provide support for conclusions regarding the nature and extent of contamination. It also helps in estimating possible future migration of contaminants from the waste disposal units.

The hydrogeologic properties described above pertain primarily to the rock matrices of the geologic strata at MDA C. Some strata, specifically units of the Tshirege Member of the Bandelier Tuff, also contain fractures that can act as conduits for the migration of liquid- and vapor-phase contaminants in the vadose zone. Information from fractured rock that can be used to evaluate the potential role of fractures in contaminant migration includes fracture density, fracture apertures, the strike and dip of fractures, and the presence and characteristics of fracture coating and fill. Where fractures are encountered during coring of boreholes, a comparison of chemical concentration data from tuff immediately adjacent to a fracture and tuff further from the fracture can also provide valuable information on the role of fractures in contaminant transport at MDA C.

Evaluation of Subsurface Pore-Gas and VOC Surface Flux Data

TCE, PCE, and TCA were the most frequently detected VOCs in pore-gas samples collected in 2000 and 2001 from borehole 50-09100 (north of Pit 5) and borehole 50-10131 (adjacent to the Chemical Pit). Data analysis has focused on TCE and PCE because these VOCs were detected at higher concentrations than TCA. TCE concentrations ranging from 10.0 to 15.0 parts per million by volume (ppmv) were measured between 10 to 250 ft bgs in borehole 50-09100, and the concentrations do not decline in samples collected at the bottom of this borehole at 316 ft bgs (Figure D-29). PCE concentrations decreased with depth in borehole 50-09100 (Figure D-28). In borehole 50-10131, maximum TCE concentrations were approximately 5 to 10 times lower (between 1.0 and 2.0 ppmv) than at borehole 50-09100 (Figure D-26). PCE concentrations ranged from 1.0 to 2.0 ppmv at depths above 100 ft bgs in borehole 50-10131 and declined to 0.5 ppmv at the bottom of the borehole at 250 ft bgs (Figure D-25).

In January 2003, pore-gas samples were simultaneously collected in each of the 10 sampling ports in boreholes 50-09100 and 50-10131. Prior to January 2003, sampling of individual ports was sporadic, and the effect of temporal variability on VOC pore-gas concentrations was not known. However, the results from the 2003 sampling were consistent with the previous TCE and PCE data. The highest pore-gas concentrations of TCE in borehole 50-09100 are at 200 to 250 ft bgs, and concentrations of TCE decreased slightly in the two deeper sample intervals. By contrast, the highest concentrations of TCE and PCE in borehole 50-10131 are at 50 ft bgs.

In June and July 2000, 105 EMFLUX[®] samplers were placed across the surface of MDA C to estimate the surface flux of VOCs. PCE, followed by TCE, was the most frequently detected VOC, with measured fluxes ranging up to approximately 200 and 60 ng/m²-min, respectively. PCE flux was highest in the area of the Chemical Pit and at a location on the southern edge of Pit 5 (Figure B-8). There were also frequent measurements of PCE at fluxes of approximately 10 to 30 ng/m²-min between Pits 1 and 3 and in the western regions of Pits 2 and 4.

In February 2003, near-surface pore-gas tritium samples, collected at a depth of 2.5 ft bgs in silica gel columns, were obtained at 15 locations across MDA C. The highest measured tritium concentrations were

north of Pit 6 (2500 pCi/mL), and in an area west of the northern portion of Shaft Group 3 where no subsurface disposal units exist. Tritium pore-gas samples from directly above Pit 6, including a location just south of the high concentration north of Pit 6, do not show such high concentrations. The elevated concentration of tritium west of Shaft Group 3 may be related to a release from these shafts; moreover, concentrations of tritium in pore-gas from borehole 50-09106 near this location are also relatively high. Relatively high tritium pore-gas concentrations were measured on the western areas of Pits 2 and 3 as well. A tritium source at the northern portion of Shaft Group 3 could possibly explain these measurements. Near-surface pore-gas tritium concentrations are shown in Figure D-31.

Nature and Extent of Subsurface Pore Gas Contamination and VOC Surface Flux

With only two vertical boreholes, data are inadequate to define the lateral extent of vapor phase VOCs in subsurface tuff. Based on VOC surface-flux measurements and the pore-gas data from 50-09100 and 50-10131, TCE and PCE are the most prevalent VOCs in the subsurface at MDA C. Surface flux measurements indicate the highest near-surface VOC measurements are in the vicinity of the chemical disposal pit. In fact, VOC concentrations were greatest at shallower intervals at this location (borehole 50-10131) than in borehole 50-09100. The nature and extent of VOCs in the vapor phase has not been determined and will be addressed during the implementation of this work plan.

Phase I RFI data for tritium in subsurface tuff samples indicate a release occurred in the subsurface at MDA C. The highest tritium concentrations were observed in tuff samples from angled boreholes beneath Pit 6, the same area where elevated metals concentrations in tuff were measured. Only a limited number of tritium samples have been collected in tuff samples beneath disposal units, other than beneath Pit 6. A comparison of tritium data from subsurface tuff samples and near-surface pore-gas samples shows a poor correlation of these data. RRES-RS now collects pore-gas samples for tritium, rather than tuff samples, because the pore-gas samples provide a more accurate indication of tritium concentrations in the subsurface. For these reasons, the spatial extent of tritium in the subsurface will be determined during the implementation of this work plan.

3.0 SITE CONDITIONS

This section discusses aspects of the environmental setting at MDA C that are important in assessing the potential impacts posed by contaminated surface and subsurface media, including

- semiarid climate with low precipitation and a high evapotranspiration rate, which limits the amount of moisture percolating into the disposal units and thus limits the amount of moisture available to leach radionuclides or hazardous waste constituents;
- thick, relatively dry unsaturated zone, which greatly restricts or prevents downward migration of contaminants in the liquid phase through the vadose zone to the regional aquifer; and
- canyon-mesa terrain, which affects atmospheric conditions and ecological habitats.

3.1 Surface Conditions

MDA C is located on Mesita del Buey, a 140- to 220-ft-high, finger-shaped mesa that trends southeast (Figure 5). The elevation of Mesita del Buey ranges from 7210 to 7280 ft. The topography at MDA C slopes gently from west to northeast, gradually getting steeper across the northeastern quadrant of the site toward Ten Site Canyon. At MDA C, Mesita del Buey is approximately 2000 ft wide and is bounded by Mortandad Canyon (800 ft to the north) and Two Mile Canyon (750 ft to the south [Figure 2]).

The surface vegetation at MDA C consists of a native grama grass mixture. The vegetation was initially established after the 1984 addition of fill and topsoil. This cover was placed over the tops of the pits and shafts used for disposal at MDA C.

Localized surface subsidence on the north boundary of Pit 6 was observed in 2002. The subsidence may have promoted infiltration of storm water into Pit 6 since it resulted in a hole along an asphalt drainage that carries runoff into Ten Site Canyon. The subsidence has since been mitigated.

3.1.1 Soils

The soils of Mesita del Buey are derived from the weathering of the Tshirege Member tuffs (phenocrysts and phenocryst fragments, devitrified glass, and minor lithic fragments) and from wind-blown sources. Soils on the flanks of the mesa are developed on Tshirege Member tuffs and colluvium with additions from wind-blown and water-transported sources. Native soils have been disturbed by waste management operations over much of the surface of Mesita del Buey, but when present native soils are generally thickest near the center of the mesa and thinner toward the edges.

In general, soils can be considered thin and poorly developed on the mesa surface; they tend to be sandy in texture near the surface and more clay-like beneath the surface. More highly developed soil profiles exist on the north-facing slopes; they tend to be richer in organic matter. Soil profiles on the south-facing slopes tend to be poorly developed. Soil-forming processes have been identified along fractures in the upper part of the mesa, and the translocation of clay minerals from surface soils into fractures has been described at Mesita del Buey. A discussion of the soils in the Los Alamos area can be found in Section 2.5.1.3 of the approved installation work plan (LANL 1998, 62060).

The original soils in the vicinity of MDA C were poorly developed, as is typical of soils derived from Bandelier Tuff and formed under semiarid climate conditions. In general, undisturbed soils on the mesa tops are comprised of the Carjo loam, the Hackroy loam, and the Seaby loam. At MDA C, natural or undisturbed surface soil cover is limited as a result of disposal unit and cover construction. The present-day surface of MDA C is predominantly fill (crushed tuff) and imported topsoil.

Canyon bottoms near MDA C (Cañada del Buey, Two Mile Canyon, Pajarito Canyon, Mortandad Canyon, and Ten Site Canyon) are covered with colluvium and alluvium that has eroded from the tuff and soils on the mesa top and canyon walls. The canyon rims and slopes are composed of soils from the Hackroy-Rock outcrop complex; canyon bottoms are composed of the Tocal, a very fine, sandy loam. Since disposal activities began at MDA C, Ten Site Canyon has experienced a period of accretion, and eroded soils from MDA C, as well as other SWMUs at TA-50, have been deposited on the canyon bottom and stream banks. The canyons are being investigated under separate work plans.

3.1.2 Surface Water

There are no streams on Mesita del Buey; water flows only as storm water and snowmelt runoff on the mesa and in small drainages off the mesa to the northwest and the south. Runoff consists primarily of sheet flow from MDA C into Ten Site Canyon (Figure 5). Sheet erosion appears to be occurring around the east and northeast portions of the site. The RLWTF at TA-50 (SWMU 50-016) discharges treated effluent to NPDES-permitted Outfall 051 in Mortandad Canyon [SWMU 50-006(d), Figure 5]. At the Laboratory, surface water runoff and sediment transport are among the potential migration pathways by which contaminants might be transported to off-site receptors. Surface water may also transport subsurface contaminants exposed by soil erosion. Soil erosion is dependent on several factors, including soil properties, the amount of vegetative cover, the slope of the contaminated area, exposure, the intensity and frequency of precipitation, and seismic activity.

RRES-RS conducted a surface water assessment at MDA C in 2002 following the mitigation of the surface subsidence, which occurred along the northern boundary of MDA C. MDA C received an erosion matrix score of 8.8, indicating low erosion potential. The calculated score includes 8.8 for site setting, an erosion matrix runoff score of 0.0, and a run-on score of 0.0.

3.2 Subsurface Conditions

3.2.1 Stratigraphy

The former ER Project (now RRES-RS) drilled, cored, and sampled eleven boreholes at MDA C during the Phase I RFI to characterize potential contaminant releases and transport in the subsurface. Borehole logs from the site provide detail on the stratigraphy below the ground surface to a depth of approximately 316 ft (borehole 50-09100) and are included in Appendix C. The locations and depths of regional boreholes used to infer the stratigraphy beneath MDA C are shown in Figure 6. Figure 6 also shows east-west cross-sections beneath and in the vicinity of MDA C. The stratigraphy beneath MDA C includes Bandelier Tuff, Cerros del Rio lavas, Puye Formation, Totavi Lentil Deposits, Santa Fe Group, and Santa Fe age basalts (Figures 6 and 7). Descriptions of stratigraphic units beneath MDA C follow.

Bandelier Tuff

In regard to Bandelier Tuff, the term *welding* is used to distinguish between tuffs that are uncompacted and porous (nonwelded) from tuffs that are more compacted and dense (welded). In the field, the degree of welding in tuff is quantified by the degree of flattening of pumice fragments (a higher degree of flattening and elongation equals a higher degree of welding). Petrographically, welded tuffs show adhesion (welding) of grains, while nonwelded tuffs do not. The term *devitrified* is applied to tuffs whose volcanic glass has crystallized. Figure 7 shows the generalized stratigraphy of the Bandelier Tuff.

Tshirege Member

The Tshirege Member of the Bandelier Tuff is a compound cooling unit that resulted from several successive ash-flow deposits separated by periods of inactivity, which allowed for partial cooling of each unit. Properties related to water flow and contaminant migration (e.g., density, porosity, degree of welding, fracture content, and mineralogy) vary both vertically and laterally as a result of localized emplacement temperature, thickness, gas content, and composition.

Tshirege Member Unit 3 (Qbt 3)

Unit 3 of the Tshirege Member of the Bandelier Tuff is poorly welded and nonindurated to slightly indurated. It forms the cliffs of the Pajarito Plateau. Its thickness, as intersected by borehole 50-09100 in the region of MDA C, is 66.5 ft (20 m).

Tshirege Member Unit 2 (Qbt 2)

Unit 2 of the Tshirege Member of the Bandelier Tuff is a competent, resistant unit that forms cliffs where it is exposed on the sides of the mesa. The rock is described as a moderately welded ash-flow tuff composed of crystal-rich, devitrified pumice fragments in a matrix of ash, shards, and phenocrysts (primarily potassium feldspar and quartz). Its thickness in borehole 50-09100 is 78 ft (24 m); the unit thins to the east across Mesita del Buey.

Unit 2 is extensively fractured as a consequence of contraction during post-depositional cooling. The cooling-joint fractures are visible on the mesa edges and on the walls of the pits. In general, the fractures dissipate at the bottom of unit 2. On average, fractures in unit 2 are nearly vertical. Mean spacing between fractures ranges between 1.9 ft and 2.6 ft (0.6 m and 0.8 m), and fracture width ranges between less than 0.03 in and 0.51 in (1 mm and 13 mm), with a median width of 0.12 in (3 mm). The fractures are typically filled with clays to a depth of about 9.9 ft (3 m); smectites are the dominant clay minerals present. Smectites are known for their tendency to swell when water is present and for their ability to strongly bind certain elements, both of which have implications for the transport of radionuclides and inorganic chemicals in fractures. Opal and calcite can occur throughout the fractured length, usually in the presence of tree and plant roots (live and decomposed); the presence of both the minerals and the roots indicates some moisture at depth in fractures.

At the base of unit 2 is a series of thin (less than 3.9-in.-thick [10-cm-thick]), discontinuous, crystal-rich, fine- to coarse-grained surge deposits. Bedding structures are often observed in these deposits. The surge beds mark the base of unit 2.

Tshirege Member Unit 1v (Qbt 1v)

Tshirege Member unit 1v is a vapor-phase-altered cooling unit underlying unit 2. This unit forms sloping outcrops, which contrast with the near-vertical cliffs of unit 2. Unit 1v is further subdivided into units 1vu and 1vc.

Unit 1vu. Unit 1vu is the uppermost portion of unit 1v where u signifies upper. It is devitrified and consists of vapor-phase-altered ash-fall and ash-flow tuff. Unit 1vu is unconsolidated at its base and becomes moderately welded nearer the overlying unit 2. Only the more prominent cooling fractures originating in unit 2 continue into the more welded upper section of unit 1vu but die out in the less-consolidated lower section. More typically, fractures in unit 2 do not extend into unit 1vu. The measured unit thickness in borehole 50-09100 is 73 ft (23 m).

Unit 1vc. Beneath unit 1vu is unit 1vc, where c stands for colonnade, named for the columnar jointing visible in cliffs formed from this unit. Unit 1vc is a poorly welded, devitrified ash-flow tuff at its base and top, becoming more welded in its interior. The measured unit thickness in borehole 50-09100 is 10 ft (3 m).

Tshirege Member Unit 1g (Qbt 1g)

The basal contact of unit 1vc is marked by a rapid change (within 0.7 ft [0.2 m] vertical) from devitrified (crystallized) matrix in unit 1vc to vitric (glassy) matrix in the underlying unit 1g. Vitric pumices in unit 1g stand out in relief on weathered outcrops, while devitrified pumices above this interval are weathered out. In outcrop, this devitrification interval forms a prominent erosional recess termed the *vapor-phase notch*. There is no depositional break associated with the vapor-phase notch; the abrupt transition indicates that this feature is the base of the devitrification that occurred in the hot interior of the cooling ash-flow sheet after emplacement.

Unit 1g is a vitric, pumiceous, nonwelded ash-flow tuff underlying the devitrified unit 1vc. Few fractures are observed in the visible outcrops of this unit, and weathered cliff faces have a distinctive Swiss-cheese appearance because of the softness of the tuff. The uppermost 5 ft to 20 ft (1.5 m to 6.1 m) of unit 1g are iron-stained and slightly welded. This portion of unit 1g is resistant to erosion, helping to preserve the vapor-phase notch in outcrop. A distinctive pumice-poor surge deposit forms the base of unit 1g. Its

thickness measured at borehole 50-09100 is 80 ft (24 m); it thins to 49 ft (15 m) to the east beneath MDA C.

Tsankawi Pumice Bed

The Tsankawi Pumice Bed is the basal air-fall deposit of the Tshirege Member of the Bandelier Tuff. It is a thin bed of gravel-sized vitric pumice. The unit thickness in borehole 50-09100 is about 2–3 ft (0.6–1 m).

Cerro Toledo Interval (Qct)

The Cerro Toledo interval consists of thin beds of tuffaceous sandstones, paleosols, siltstones, ash, and pumice falls; the Cerro Toledo interval separates the Tshirege and Otowi Members of the Bandelier Tuff. The Cerro Toledo interval also includes localized gravel- and cobble-rich fluvial deposits predominantly derived from intermediate composition lavas eroded from the Jemez Mountains west of the Pajarito Plateau. The interval is about 20-ft (6.1-m) thick.

Otowi Member (Qbo)

The Otowi Member tuffs are about 100-ft (30-m) thick in the northwestern portion of Mesita del Buey and become thinner towards the east. The tuffs are a massive, nonwelded, pumice-rich, and mostly vitric ash flow. The pumices are fully inflated, supporting tubular structures that have not collapsed as a result of welding. The matrix is an unsorted mix of glass shards, phenocrysts, perlite clasts, and minute broken pumice fragments.

The Guaje Pumice Bed is the basal air-fall deposit of the Otowi Member of the Bandelier Tuff. The thickness of the unit has been measured as 10 ft (3 m) in the northwestern reaches of Mesita del Buey and as 12 ft (3.7 m) in Pajarito Canyon south of MDA G. The pumice bed is nonwelded and brittle. Pumice tubes are partially filled with silica cement.

Cerros del Rio Basalts (Tb4)

Few data exist to describe the Cerros del Rio lavas directly beneath MDA C; however, dacitic lavas were penetrated to the west (SHB-1) and to the east (R-14). Cerros del Rio basalts were observed to the east in R-15. In R-14, the dacitic lavas are ~150-ft (46-m) thick, extending from 620 to 768 ft below ground surface (bgs). Local borehole cores at MDA L show that the basalts consist of both angular rubble and dense, fractured masses, with zones of moderately to very porous lavas.

Puye Formation (Tpf, Tpp) and Older Fanglomerate

The Puye Formation is a conglomerate deposit derived primarily from volcanic rocks to the west, with varying lithologies including stream channel and overbank deposits, ash and pumice beds, debris flows and lahar deposits. Well tests on the Pajarito Plateau confirm the unit is very heterogeneous with both high and low permeability zones present (Nylander et al. 2003, 76059). The formation is poorly lithified and as such is unlikely to sustain open fractures.

The Puye Formation was encountered to the west (SHB-1) above the Cerros del Rio lavas and to the east (R-14) both above and below the lavas. Two types of Puye rocks were noted at R-14 (Figure 7): an upper layer of fanglomerate rock (Tpf), which may be relatively low in permeability, and a lower layer of pumicious sands and gravels (Tpp), higher in permeability. The water table is found near the bottom of the fanglomerate member beneath MDA C at a depth of 1300 ft.

Totavi Lentil Deposits (Tpt)

The Totavi Lentil is an ancestral Rio Grande deposit composed of coarse gravels and sands with abundant quartzite. The deposit has been alternatively conceptualized as a series of distinct north-south trending ribbons and a continuous thin sheet at the base of the Puye Formation. Like the overlying Puye Formation it has both high permeability and low permeability zones (Nylander et al. 2003, 76059). It was not penetrated by wells near MDA C but may exist at the base of the Puye Formation predicated on evidence from PM-5, about 1 mile to the east (Figure 6).

Santa Fe Group (Tsf, Tf, and Ts) and Santa Fe-Age Basalts (Tb1 and Tb2)

The Santa Fe Group is an alluvial-fan deposit comprised of medium to fine sands and clays. Numerous north-south trending faults are present in the Santa Fe Group. Santa Fe Group rocks are deep below MDA C (1500 ft bgs at PM-5, which is approximately 1 mile east of MDA C) and were not penetrated by R-14 (Figure 6). Most water supply wells on the eastern edge of the Pajarito Plateau and elsewhere in the basin are completed in these rocks. The Santa Fe Group units are characterized with the lowest permeability compared to the other units in the regional aquifer (Nylander et al. 2003, 76059).

Basaltic lava flows occurred during the time the Santa Fe Group was deposited; these basalts are of substantial thickness at PM-5 and may exist within the Santa Fe Group rocks beneath MDA C.

3.2.2 Hydrology

The proposed hydrogeologic conceptual model for the Pajarito Plateau (LANL 1998, 59599) is presented in Figure 8. The model predicts infiltration of water into the subsurface and subsequent transport of water, vapor, and solutes through the upper regions of the vadose zone are heavily influenced by surface conditions such as topography, surface water flow, and microclimate. According to model predictions, movement through deeper layers, including the regional aquifer, is influenced only weakly by surface conditions and is influenced more by hydraulic characteristics of aquifer rocks, regional groundwater flow patterns, and stresses induced by water supply production. The following sections provide an overview of infiltration rates and groundwater occurrence in the vicinity of MDA C.

Infiltration

Surface and near-surface conditions (topography, precipitation, surface runoff) control the infiltration of water into the subsurface and the transport of contaminants in the shallow subsurface. In this respect, the climate behavior of mesas and canyons forming the plateau differ from one another (LANL 1998, 59599). Mesas are generally dry, both on the surface and within the rock that forms the mesa. Canyons range from wet to relatively dry; the wettest canyons contain continuous streams and perennial groundwater in the canyon-bottom alluvium. Dry canyons have only occasional stream flow and may lack alluvial groundwater.

The amount of mesa top recharge along the western portion of the Laboratory where MDA C is located is uncertain. Higher rainfall, increased vegetative cover, and increased welding and jointing of the tuff might lead to different recharge rates than those observed in better-studied portions of the Laboratory such as TA-54 (LANL 1997, 63131). Mesa top recharge can be locally significant under disturbed surface conditions. Such local differences occur when the soil is disturbed, when the vegetation is removed, or when more water is artificially added to the hydrologic system by features such as blacktop, lagoons, or effluent disposal. Fractures within mesas do not enhance the movement of dissolved contaminants

unless saturated conditions develop. Contaminants in the vapor phase generally migrate in a diffusive manner through mesas (Stauffer et al. 2002, 69794; LANL 1997, 63131).

Mesita del Buey is one of the drier mesas found at the Laboratory on the Pajarito Plateau. Infiltration into the mesa appears to be very low, possibly only 0.04 in/yr ([1 mm/yr] LANL 1997, 63131) and occurs during snowmelts or intense summer thunderstorms, which lead to slightly higher moisture contents within the uppermost few meters of the mesa surface. During dry periods, evapotranspiration removes moisture from the surface of the mesa; permeable zones such as fractures and surge beds act as conduits for air and aid in the drying of the mesa.

Groundwater

Groundwater beneath the Laboratory occurs in the regional aquifer (at depths ranging from 1200 to 600 ft bgs) and in perched aquifers (Nylander et al. 2003, 76059). With the exception of TA-16, perched aquifers have been detected only in wells beneath the relatively wet canyons (i.e., Los Alamos Canyon). They exist as two types: (1) shallow alluvial aquifers that occur in some wet canyons (generally at depths less than 100 ft), and (2) deeper "intermediate" perched aquifers that occur in zones separated from both alluvial and regional aquifers by unsaturated rock. To date, data obtained indicate that dry mesas such as Mesita del Buey show no evidence of perched aquifers (Nylander et al. 2003, 76059). However, alluvial and intermediate perched aquifers in adjacent canyons may cause increased moisture contents within the vadose zone at the margins of the mesa.

Perched Intermediate Waters

Observations of perched intermediate water are rare on the Pajarito Plateau. Perched waters are thought to form mainly at horizons where medium properties change dramatically, such as at paleosol horizons containing clay or caliche. It is not known whether perched water bodies are isolated or connected and to what degree they may influence travel times and pathways for contaminants in the vadose zone. Although perched intermediate waters have been observed in some locations elsewhere on the plateau, none have been observed in the regional wells (R-22, R-21, R-20, and R-16) or in R-14, the well closest to MDA C ([Figure 6] LANL 1998, 59599).

Perched intermediate groundwater was not encountered nor is suspected beneath Mesita del Buey at MDA C (LANL 1998, 59599). No perched water was observed in 316 ft of drilling in the deepest borehole drilled to date (borehole 50-09100, Appendix C), although core collected at the depth interval from 71.5 ft to 73.5 ft was described in the borehole log as "wet" (Appendix C). No perched water was observed in 700 ft of drilling in the nearby borehole SHB-1 or in borehole R-14 (Figure 6).

Perched intermediate zones of saturation have been delineated beneath Mortandad Canyon. At borehole MCOBT-4.4, a perched zone was identified in the Puye Formation above Cerros del Rio basalts. The spatial location of perched zones (disconnected, associated with different units) potentially indicates a lack of a continuous perched zone beneath the canyon. However, geochemical data indicate that continuity must have existed at some time in the past and might persist in Mortandad Canyon at present (Longmire 2003, 76050). In addition, when regional aquifer Test Well (TW)-8 was drilled in 1960, the units between the alluvium and the regional aquifer were unsaturated, although possible perched zones were encountered during borehole advancement (Baltz et al. 1963, 8402).

Regional Aquifer

The regional aquifer of the Pajarito Plateau is the only aquifer capable of large-scale municipal water supply (Purtymun 1984, 6513). The regional aquifer extends throughout the Española Basin (an area roughly 6000 km²) and reaches its maximum thickness beneath the Pajarito Plateau (over 9800 ft [3000 m] thick; Cordell 1979, 76049).

Depths to the regional aquifer range between about 1200 ft (366 m) along the western edge of the plateau (1296 ft bgs at R-25, 950 ft at R-19) and about 600 ft (183 m) to the east. Beneath MDA C, the water table elevation is approximately 5884 ft (at R-14) or approximately 1300 ft bgs. Figure 9 depicts water table elevations in the regional aquifer across the Pajarito Plateau.

Spatial variations in water table gradients are caused by a combination of aquifer heterogeneity and the influence of pumping. The horizontal component of the background hydraulic gradient beneath MDA C is approximately 0.02, although gradients locally are steeper (0.03) from pumping at Pajarito Mesa (PM-) 5. At this time, information about the hydrogeological conditions in the vicinity of PM-5 is insufficient to conclusively predict the impact of PM-5 pumping in the deep units on the hydraulic heads and gradients in the shallow aquifer units (Puye Formation and Totavi Lentil). Pore-water velocity is predicted to be approximately 40 ft/yr (12 m/yr) according to a calculation of Darcy's Law that estimates groundwater velocity in the regional aquifer. This velocity assumes hydraulic conductivity of 0.7 ft/day ([0.2 m/day], see Table 5, EPA 1992, 15344), a gradient of 0.03, and a porosity typical of sedimentary rocks (0.2, Freeze and Cherry 1979, 64057). At this velocity, travel time in the regional aquifer between MDA C and PM-5 or R-14 would be approximately 100 yr.

Estimates of groundwater transport velocity will be evaluated more accurately using the existing aquifer model (Nylander et al. 2003, 76059), which takes into account the three-dimensionality of the groundwater flow paths, spatial distribution of recharge along the canyons, time-variation of PM-5 pumping rates, medium heterogeneity, etc. To date, such small-scale model analysis for PM-5 has not been performed.

Vadose Zone

The region beneath the ground surface and above the regional aquifer is called the vadose (unsaturated) zone. This discussion focuses on the vadose zone beneath the mesa at MDA C. The source of moisture in the vadose zone is precipitation, most of which is removed as runoff, evaporation, and transpiration (LANL 1997, 63131). The subsurface movement of the remaining moisture (often referred to as recharge) is predominantly vertical in direction and is influenced by properties and conditions of the vadose zone. Characteristics of infiltration in the vadose zone are described above (see "Perched Intermediate Waters").

The geologic property of the Bandelier Tuff that most influences fluid flow in the unsaturated zone is the degree of welding. Welded tuffs tend to have less matrix porosity and more fractures than nonwelded tuffs. Fractures in welded tuff may include relatively close-spaced cooling joints as well as tectonic fractures. Although welded tuffs also have fractures, they are generally less abundant than in welded tuffs.

Several competing effects determine moisture content and fluid flux in welded, devitrified tuff. While water moves slowly through the unsaturated tuff matrix, it can move relatively rapidly through fractures if nearly saturated conditions exist (LANL 1997, 63131). The saturation levels measured at MDA C are relatively low ([1%–10% gravimetric moisture content] Appendix B). At these saturation levels, most of the fractures beneath the site are expected to be completely dry, and the water will exist in the tuff matrix only. Only in

situations when substantial infiltration occurs from the ground surface will the fractures become wet and conduct water. However, modeling studies predict that when fractures disappear at contacts between stratigraphic subunits, when fracture fills are encountered, or when coatings are interrupted, fracture moisture is absorbed into the tuff matrix (Soll and Birdsell 1998, 70011).

4.0 SCOPE OF ACTIVITIES

This section identifies the specific activities that will be performed during the field investigation of MDA C. These proposed activities differ from those identified in Section IV.C.3.c of the Order issued by NMED to DOE and UC on November 26, 2002, because this work plan considers the requirements of the Order as well as information developed during the Phase I RFI Investigation. Because the proposed scope of work differs from that in the Order, this section also provides a justification for the alternate approach.

Although the scope of activities proposed in this work plan differs from that in the Order, the data obtained from this investigation, combined with the data previously collected in the Phase I RFI, satisfy the investigation objectives identified in the Order, namely determining the nature and extent of contamination and migration pathways to receptors.

4.1 MDA C Investigation Activities

The field investigation of MDA C will be comprised of the following activities. The methods used to conduct each of these activities are identified and discussed in Section 5.

- Ten angled and four vertical boreholes will be installed at the locations shown in Figure 10. Boreholes will be advanced at the angles and to the depths and lengths specified in Table 3.
- Continuous core samples will be collected from each borehole. Core will be visually inspected, field screened for alpha and beta/gamma radioactivity, and geologically logged. Borehole logs will be prepared for each borehole.
- Tuff samples will be collected at approximately 20-ft intervals for laboratory analysis for the parameters shown in Table 3. Collection of samples for laboratory analysis will begin once the borehole is advanced beneath the associated disposal unit. Preliminary sample locations are shown on the cross sections presented in Figures 12 through 24.
- Subsurface vapor samples will be collected from boreholes A through L and N at the approximate depths of 40 to 50 ft bgs and 140 to 150 ft bgs and at 30, 60, 90, 120 and 150 ft bgs in borehole K.
- Subsurface vapor samples will be collected from borehole M at the approximate depths of 100 ft, 200 ft, 300 ft, abandonment of auger drilling (approximately 400 ft), and total depth (800 ft).
- Subsurface vapor samples will be analyzed for VOCs and tritium.
- Groundwater samples will be collected if perched water is encountered.

4.2 Justification for Alternative Scope of Work

The proposed alternate work scopes are summarized in Table 4, along with a brief justification for the alternate approach. The following subsections provide additional details related to the justifications for alternate approaches referenced in Table 4.

4.2.1 Number, Locations, and Depth of Boreholes

The NMED Order prescribes borehole locations that apply to each pit and shaft group at MDA C. This prescriptive approach does not consider the data that were collected during the Phase I RFI. In addition, this prescriptive approach does not consider access limitations and other constraints, such as nuclear safety basis requirements specified in DOE Order 830, associated with drilling activities at MDA C. The borehole locations proposed in this work plan are based on an evaluation of the Phase I RFI data and other relevant information. This evaluation was directed toward identifying specific data requirements that need to be met to satisfy the objectives of the investigation. These objectives are to determine the nature and extent of contamination as identified in NMED's position paper on the determination of extent of contamination (Appendix G) and to characterize migration pathways to receptors to assess the potential present-day and future risk posed by the site. This evaluation of data is presented in Section 2 and yielded the following three data requirements:

1. the nature and extent of contamination in subsurface tuff, including
 - extent of metal and radionuclide contamination in tuff beneath Pit 6,
 - concentrations and spatial extent of VOCs in the vapor phase in subsurface tuff,
 - concentrations and spatial extent of tritium in the vapor phase in subsurface tuff,
 - nature and extent of releases of metals, cyanide, and radionuclides to tuff beneath Pits 1–5, Shaft Groups 1 and 2, and the strontium-90 disposal shaft, and
 - extent of perchlorate, nitrate, dioxin, and furan contamination in tuff beneath MDA C;
2. the potential presence of perched groundwater beneath MDA C; and
3. information on hydrogeologic properties and fracture characteristics of the vadose zone to support contaminant transport modeling in the vadose zone.

These data requirements were considered, along with access constraints and other limitations, to identify the borehole locations and specifications shown in Figure 10 and Table 3, respectively. A comparison of the borehole specifications contained in the NMED Order for each pit and shaft group with the boreholes installed during the Phase I RFI and proposed in this work plan is presented in Table 5. The rationale for installation of each borehole is presented below.

Boreholes A and B: Two angled boreholes (boreholes A and B; Figures 11 and 12) will be advanced beneath Pit 6. Borehole A also will be advanced beneath the Chemical Pit. The boreholes will be advanced from the south side of Pit 6 with a northward strike. Drilling from the south side of Pit 6 is proposed because a review of engineering drawings for Pit 6 and the results of geophysical surveys indicate that its northern boundary is only 10 ft from the fence line. There are numerous subsurface utilities near the fence line and beneath the pavement at TA-50 across the fence, which would compromise the safety of drilling a borehole from the north side of Pit 6.

Boreholes A and B will be advanced at a 45-degree angle from a position 40 ft from the southern boundary of the Chemical Pit (borehole A) and Pit 6 (borehole B). This distance from the disposal units will afford a margin of safety to avoid drilling into the waste, as it is expected that the maximum depth of the disposal units is 25 to 30 ft bgs, and the boreholes should pass below the southern edge of the pits at a depth of 40 ft bgs.

The location and strike of borehole A will allow for collecting tuff samples in the vicinity of (and beneath) Phase I RFI boreholes 50-09109 and 50-09110, where previous tuff samples have indicated metals and

radionuclide contamination (other than tritium) at a depth of 57 and 81 ft, respectively. Additional tuff samples in this area will support an evaluation of the extent of contamination beneath the western end of Pit 6. Additionally, borehole logs from 50-09109 and 50-09110 describe the presence of fractures at several depths (Appendix C). The presence of both fractures and contamination in previous tuff samples makes this an ideal location for evaluating whether contamination in tuff is associated predominantly with fractures, the tuff matrix, or both.

Borehole B is situated for completion beneath the area of surface subsidence where water may have infiltrated Pit 6. Measurements of the moisture content in tuff in this borehole, and analytical data for contamination in tuff will support an evaluation of whether the subsidence of Pit 6 has resulted in the migration of contaminants.

Borehole C: Tuff samples obtained from this angled borehole will provide information on the presence of contaminants beneath the western portion of Pit 5 (Figure 10). No boreholes are presently located in this area to provide information on potential releases.

Borehole D: To date, VOC pore-gas samples have been collected only from boreholes 50-09100 and 50-10131, although EMFLUX® VOC flux data (Figure B-8) indicate that VOCs in the vapor phase may be present in subsurface tuff at other locations at MDA C. The largest VOC flux in an area other than the Chemical Pit occurs on the south edge of Pit 5. Borehole D (Figures 10 and 14) is located such that it will be completed below Pit 5 in the area where the high VOC flux was measured previously. The location of borehole A also serves the purpose of evaluating VOC concentrations beneath the Chemical Pit (where EMFLUX® VOC flux was greatest) to supplement VOC data available from Borehole 50-10131.

Borehole E: The angled borehole extending beneath Shaft Group 1 will provide information on the presence of contaminants beneath this disposal unit (Figure 10). No boreholes are presently located to provide information on potential releases in this area. The orientation of the borehole along the axis of the shafts will maximize the probability of encountering contamination associated with these shafts (Figure 15).

Borehole F: The angled borehole beneath the central areas of Pits 2 and 4 will provide information on the presence of contaminants beneath these disposal units (Figure 10). No boreholes are presently located to provide information on potential releases in this area (Figure 16).

Borehole G: The angled borehole extending beneath the northeast portions of Pits 2 and 4 will provide information on the contaminants beneath these disposal units (Figure 10). With the exception of some samples beneath Pit 2 from the base of borehole 50-09103, no boreholes are presently located in this area to provide information on potential releases. In the event that the floors of Pits 2 and 4 have a slope consistent with surface topography, these boreholes will be sited on the downgradient side of the pits (Figure 17).

Borehole H: The angled borehole that extends beneath the strontium-90 shaft is intended primarily to establish whether a release of strontium-90 has occurred at this location (Figure 10). Strontium-90 is relatively water-soluble and thus is potentially mobilized with infiltrating water. The location of the borehole was sited to the northwest of the strontium-90 shaft to evaluate potential releases of contaminants beneath the southern portion of Shaft Group 3 (Figure 18). Advancing an angled borehole from a position south of the strontium-90 shaft was not feasible because Pajarito Road and its associated utility corridor are located in this area.

Borehole I: The angled borehole extending beneath the eastern portions of Pits 1 and 3 was sited to provide information on the presence of contaminants beneath these disposal units (Figure 10). No

boreholes are presently located in this area to provide information on potential releases (Figure 19). Angled boreholes cannot be advanced from the south at this location because Pajarito Road and utilities are located in this area.

Borehole J: The angled borehole extending beneath the eastern portion of Shaft Group 2 was sited to provide information on the presence of contaminants beneath this disposal unit (Figure 10). No boreholes are presently located to provide information on potential releases in this area. The location of Shaft Group 3 prohibits situating a borehole that extends beneath the western region of Shaft Group 2 (Figure 20). Angled boreholes cannot be advanced from the area south of Shaft Group 2 because Pajarito Road and utilities are located in this area.

Borehole K: The vertical borehole located immediately west of the northern end of Shaft Group 3 was sited to determine whether tritium pore-gas concentrations indicate a release near this location and to provide information on the presence of contaminants adjacent to these disposal units (Figure 10). No vertical boreholes are presently located in this area to provide information on potential releases. Borehole K will be drilled to a depth of 150 ft bgs (Figure 21).

Borehole L: Borehole L is a vertical borehole located to provide information on the presence of contaminants potentially released from Pit 1 (Figure 10). Although an angled borehole extending beneath Pit 1 is preferable to evaluate potential releases of these contaminants from a disposal unit, angled boreholes can be advanced only from the east of Pit 1 because of the presence of other disposal units to the north and west of Pajarito Road and utilities to the south (Figure 22).

Borehole M: A single, vertical borehole will be drilled to a depth of approximately 800 ft in the area north of Pit 5 near the head of Ten Site Canyon (Figures 10 and 23) to determine whether perched groundwater is present below MDA C. The location of the vertical borehole adjacent to the head of Ten Site Canyon will provide the best chance of encountering perched groundwater in the vicinity of MDA C. The borehole is near a storm water runoff channel that is cut into the tuff north of MDA C and that directs storm water collected from parking areas and roadways serving TA-50 into Ten Site Canyon. Therefore, local infiltration rates should be much higher in this area than in other locations near MDA C.

Borehole M provides an opportunity to collect geotechnical data to support transport modeling by characterizing site-specific hydrogeologic properties at MDA C. These properties include saturated and unsaturated hydraulic conductivity, chloride-ion concentration, porosity, bulk density, matrix potential (i.e., suction), and moisture content. A detailed profile of moisture content will ensure an adequate data set to calibrate a neutron probe for moisture logging. Collecting a profile of matrix potential in combination with the moisture content will provide data on the likely direction of moisture movement in the subsurface. Estimates of saturated and unsaturated hydraulic conductivity also support modeling of liquid migration in the vadose zone. Tuff samples for chloride-ion concentration support evaluation of the rates of water infiltration and evaporation.

Borehole N: Vertical borehole N will be drilled to a depth of 150 ft bgs adjacent to the southwest corner of Pit 1, immediately southeast of the strontium-90 shaft (Figure 10). Data from this borehole is intended to establish whether a release of strontium-90 has occurred from the strontium-90 shaft. Strontium-90 is relatively water-soluble and thus is potentially mobilized with infiltrating water. Data from borehole N will also help establish the spatial extent of metals, cyanide, and radionuclide contamination in tuff beneath Pit 1, and from Shaft Group 3. No vertical boreholes are presently located in this area to provide information on potential releases (Figure 24).

Tuff samples will be collected at least every 20 ft in the ten angled boreholes beginning beneath the target disposal unit. Vertical boreholes K, L, and N will be sampled at least every 20 ft beginning at the

same depth as the nearest disposal unit. The frequency of sample collection along the boreholes for submittal to an analytical laboratory is one sample per 20 ft, whereas Section IV.C.3.a.iv of the November 26, 2002, NMED Order states, "A minimum of two samples per 100 feet of drilling depth shall be selected from each boring for laboratory analysis."

Samples will be collected from intervals where visual inspection indicates contamination and/or fractures are present. The maximum depth at which Phase I radionuclides were detected beneath Pit 6 was 80 ft bgs. The proposed borehole depths of 140 to 150 ft (approximately twice the vertical depth of the Phase I RFI boreholes) will be sufficient to establish the vertical extent of contamination beneath Pit 6 with respect to concentrations relative to background or a decreasing concentration gradient (Appendix G). This approach exceeds the requirements in Section IV.C.3.c.iii, Item 6, of the NMED Order for boreholes to extend 25 ft below the depth of contamination detected in previous investigations.

Establishing the "extent" of a liquid-borne release of metals or radionuclides from a disposal unit is difficult because contaminants can migrate with water infiltrating below a pit or shaft via fractures in the tuff rather than in the tuff matrix. Under fracture flow conditions, detection of residual contamination in tuff is largely uncertain and establishing the vertical and horizontal extent of such contamination is inherently subjective, even with respect to concentrations relative to background or a decreasing concentration gradient, criteria noted in NMED's June 17, 1999, position paper "Determination of Extent of Contamination." The sample locations, depths, and sampling design (paired samples of fracture fill and surrounding intact tuff) of proposed Boreholes A and B were specified to supplement existing tuff data beneath Pit 6 and determine whether contamination may have migrated via fractures. The depths for collection of samples beneath the other disposal units is consistent with this approach.

Field documentation of samples collected from fractures will include a detailed physical description of the fracture fill material and rock matrix sampled. The volumes of fracture fill and rock matrix material included in the sample will be estimated from field measurements. An additional sample will be collected from the rock matrix adjacent to the fracture sample material to allow for comparison. The fractures and matrix samples are paired and will be assigned unique identifiers.

4.2.2 Subsurface Vapor Sampling

To establish the extent of VOC contamination in tuff, VOC pore-gas data will be collected immediately after drilling activities are completed for each new borehole at MDA C. For boreholes A through L and N, the first sample will be collected at a depth of approximately 40 to 50 ft bgs, corresponding to a depth of 10 to 30 ft beneath a disposal unit, depending upon the depth of the pit or shafts, where VOC concentrations associated with release from a disposal unit should be evident. The second VOC pore-gas sample will be collected from the bottom (total depth [TD]) of each borehole at 140 to 150 ft bgs to measure VOC concentrations at depth.

Five VOC pore-gas samples will be collected at borehole M immediately after drilling activities are completed to establish the VOC concentration profile with depth at this location. Three samples will be collected at 100, 200, and 300 ft bgs; a fourth sample will be collected at the depth where auger drilling is abandoned in favor of air-rotary drilling methods at an anticipated depth of 400 ft bgs; and a fifth sample will be collected at TD of the borehole following extensive purging of borehole air. Previous experience in drilling boreholes has shown that auger drilling is of limited use in the geologically unstable materials below this approximate depth; thus, the remaining depth of the borehole will be drilled by air-rotary methods (see Section 5).

A second round of VOC pore-gas sampling at the same depths will be conducted approximately one month after drilling activities are completed. The purpose of the second round of sampling is to confirm

the VOC pore-gas data findings for samples collected immediately after drilling. It is possible that the initial VOC pore-gas measurements may be affected by drilling activities; therefore, VOC measurements collected after subsurface pore-gas conditions have stabilized may be more representative of actual conditions. The schedule for VOC pore-gas sampling is discussed in Section 7 of this work plan.

All ten ports in boreholes 50-09100 and 50-10131 were sampled for VOCs in January 2003. The VOC concentrations measured in this sampling were consistent with results from sampling performed in 2000 through 2002, indicating minimal variability in VOC pore-gas concentrations over time. Therefore, no additional VOC sampling in these boreholes is proposed for this investigation. Pore-gas data for VOCs from the first and second phase of VOC sampling in the new boreholes and existing VOC pore-gas data in boreholes 50-09100 and 50-10131 will be used to determine the extent of VOC pore-gas contamination and the need for additional boreholes instrumented for monitoring of VOCs in pore gas. These data will be used to define an interim vapor-monitoring plan for VOCs in the MDA C Investigation Report. Existing monitoring activities are discussed in Section 6 of this work plan. A general diagram for constructing a vapor-monitoring borehole is shown on Figure 25.

To establish the extent of tritium vapor contamination in tuff, tritium pore-gas data will be collected immediately upon completion of drilling activities for each new borehole at MDA C. For boreholes A through J, L and N, two samples will be collected. The first sample will be collected at a depth of approximately 40 to 50 ft bgs. This corresponds to a depth of 10 to 30 ft beneath a disposal unit, depending on the depth of the pit or shafts, where tritium concentrations associated with release from a disposal unit should be evident. The second tritium pore-gas sample will be collected from the bottom 140 to 150 ft bgs (TD) of each borehole to measure tritium concentrations at depth. For borehole K, five tritium samples will be collected every 30 ft bgs.

Five tritium pore-gas samples will be collected immediately drilling activities are completed at borehole M (the 800-ft vertical borehole) to establish the profile of tritium concentrations with depth at this location. A second round of tritium pore-gas samples will be collected approximately one month following the completion of drilling activities for all boreholes. Tritium pore-gas samples will be collected in silica gel samplers for analysis by an off-site contract laboratory.

With respect to boreholes A through L and N, based on the Phase I RFI results, sampling VOCs and tritium at both the sampled depths (40 to 50 ft bgs and 140 to 150 ft bgs) should produce a decreasing trend as required by NMED's position paper on determination of extent (Appendix G).

4.2.3 Field Screening

Section IV.C.3.c.iv, Paragraph 2, of the NMED Order specifies that core samples collected at MDA C be screened using the methods described in Section IX.B of the Order. Section IX.B.2.d of the Order specifies that all core samples be screened by: (1) visual examination; (2) headspace vapor screening for VOCs; and (3) metals screening using x-ray fluorescence (XRF). Additional screening for release-specific characteristics, such as pH and HE, shall be conducted where appropriate. Section IV.C.3.c.iv of the Order indicates that screening results for the samples collected at MDA C shall be used to identify samples to be submitted for laboratory analysis.

Results of Phase I RFI at MDA C indicate that the screening methods specified in the Order, other than visual examination, would be ineffective and would generate no useful information for the purpose of identifying samples to submit for laboratory analysis. The limitations of field screening methods for various classes of analytes are discussed below.

VOCs

The headspace vapor screening procedure given in Section IX.B.2.d of the Order calls for the sample to be sealed in a bag or other container and equilibrated with the ambient air inside the container. The concentration of VOCs in the headspace gas is then measured using a PID. The results of previous investigations at MDA C indicate that this procedure is not appropriate for the core samples to be collected at MDA C.

The above procedure is designed to identify samples having elevated concentrations of VOCs in the solid matrix. This procedure is designed to cause VOCs associated with the solid phase to volatilize into the headspace, where they can be detected using a PID. At MDA C, VOCs are present in subsurface tuff samples in the pore gas and are not associated with the solid matrix. If this screening procedure was applied to samples from MDA C, vapor-phase VOCs would diffuse from the sample pore space into the container headspace and decrease the concentration as the VOCs are diluted into the headspace gas. Based on the results of past subsurface pore-gas monitoring at MDA C, the concentration of VOCs in the headspace gas would be too low to detect using a PID. Past pore gas monitoring has shown maximum concentrations of most VOCs to be less than 1 ppmv, with several VOCs having maximum concentrations in the low ppmv range. The concentration after dilution into the headspace should be less than 1 ppmv, which is the detection limit of many PIDs.

Alternate VOC screening approaches, such as direct surveys of the surface of the core using a PID would also be ineffective. During Phase I RFI, 333 subsurface core samples were screened in the field by direct survey with a PID. No VOCs were detected in any of these samples.

XRF

During Phase I RFI, 82 subsurface tuff samples were submitted for laboratory analysis of metals. Fourteen metals were detected at concentrations above BVs. Only three of these metals (barium, calcium, and lead) were present at concentrations that would have been detectable using XRF. For the other metals detectable using XRF, maximum concentrations were generally less than half the respective XRF detection limit.

HE

During the Phase I RFI, 332 subsurface core samples were screened in the field for HE using a spot-test procedure. No HE was detected in any of these samples.

Radioactivity

The MDA C work plan specifies radiation screening of all samples. This screening is primarily for health and safety purposes rather than for identifying samples for laboratory analysis. The results of the Phase I RFI show that field radiation screening was not effective in identifying samples to submit for laboratory analysis.

During the Phase I RFI, 333 subsurface core samples were screened in the field for alpha and beta/gamma radioactivity, and 67 of these were submitted for laboratory analysis of radionuclides. Forty-three of these 67 samples had detected activities of radionuclides other than tritium within the range of BVs. The remaining 24 samples had detected activities of radionuclides other than tritium above BVs. Table 6 summarizes the results of the field screening for the samples having radionuclide activities within the background range and above background. As shown in Table 6, there was no significant difference in

field screening results for samples having radionuclides within and above background values. Therefore, field screening for radionuclides is not useful for determining which samples should be submitted for laboratory analysis.

4.2.4 Analytical Suites

Subsurface tuff samples will not be submitted for analysis of all analytes specified in the NMED Order. Specific analyses that will not be performed on any VOC, SVOC, pH, HE, and PCB samples. VOCs will not be analyzed in tuff samples because such analyses are not appropriate. As explained in Section 2.7.3 of this work plan, VOCs are primarily present in the subsurface as vapors and are not associated with the solid matrix. As a result, the most accurate method of sampling for VOCs is pore-gas sampling. Pore-gas sampling will be used to determine the extent of subsurface VOC contamination at MDA C.

Subsurface core samples collected during the Phase I RFI were submitted for analysis of SVOCs and PCBs. The results of this sampling indicate that the nature and extent of SVOC and PCB contamination is established at MDA C (Section 2.7.3) and no additional sampling for SVOCs or PCBs is required.

Analysis of tuff samples for pH is not appropriate considering the low moisture content of the tuff and will not be performed.

Subsurface tuff samples will not be analyzed for HE based on the low potential for HE to be present at MDA C. Descriptions of waste sent to MDA C (Appendix B) indicate that the only potential sources of HE-containing wastes were wastes associated with the demolition of Bayo Canyon, which was the location of historic firing sites, and trinitrotoluene (TNT) element samples identified in the waste inventory for Shaft Group 3. Additional details on the wastes associated with Bayo Canyon demolition are contained in the associated RFI work plan and reports and historical reference documents that indicate HE is not present in the wastes sent to MDA C from Bayo Canyon.

When the firing sites in Bayo Canyon were active, residuals and debris from the firing sites were disposed of to a disposal pit, SWMU 10-005. During decontamination and decommissioning of this disposal site in 1957, the wastes in SWMU 10-005 were excavated and burned, and the ash was subsequently disposed of at MDA C (p. 3-63, LANL 1992, 07668). Any HE present in the residuals would have been destroyed by burning. Subsurface samples were collected at the site of SWMU 10-005 during the RFI of this site and were analyzed for HE. No HE was detected in these samples (p. 102, LANL 1996, 54332). The only other wastes from Bayo Canyon identified as potentially having been sent to MDA C was ash from a burn pit used to burn combustible wastes (SWMU 10-006; pp. 4-1–4-3, LANL 1992, 07668.). As at SWMU 10-005, the ash is unlikely to have contained appreciable amounts of HE. The final cleanup of the Bayo Canyon firing sites in 1963 is described in an historical report (LASL 1963, 04771). All remaining firing site debris was removed at this time and no HE was found in this debris (p. 6, LASL 1963, 04771).

TNT is listed in three disposal logbook entries for Shaft Group 3. The origin of this waste is Wing 9 of the Chemical and Metallurgy Building, where significant quantities of HE would not be present for safety reasons. The waste description for some of the TNT refers to "TNT SS center elements," "TNT element samples," or "TNT mounts." There is also accompanying fission product or U with the TNT. The units of disposal are gallon cans, so only a small quantity was disposed of. The results of Phase I RFI SVOC analyses did not identify detectable amounts of 2,4-dinitrotoluene or 2,6-dinitrotoluene, which are associated with TNT, in any tuff samples. Additionally, 233 phase I RFI borehole samples were screened for HE and there were no detects, including those core samples in boreholes 50-09105 and 50-09106 that passed beneath Shaft Group 3.

A review of waste inventory records (see Appendix B) does not indicate the presence dioxins or furans in the disposed wastes. However, dioxin and furans can be generated by the combustion of organic material containing, or in the presence of, chlorine atoms. Therefore, tuff samples collected directly beneath the Chemical Pit will be analyzed for dioxins and furans because of the reported practice of burning chemicals disposed in the Chemical Pit (Rogers 1977, 0216). Tuff samples from other locations will not be analyzed for dioxins or furans.

5.0 INVESTIGATION METHODS

The following RRES-RS standard operating procedures (SOPs), available at <http://erproject.lanl.gov/documents/procedures.html>, are applicable to the investigation methods proposed in this plan:

- LANL-ER-SOP-1.01, Rev. 1 *General Instructions for Field Investigations*
- LANL-ER-SOP-1.02, Rev. 1 *Sample Containers and Preservation*
- LANL-ER-SOP-1.03, Rev. 2 *Handling, Packaging, and Shipping of Samples*
- LANL-ER-SOP-1.04, Rev. 5 *Sample Control and Field Documentation*
- LANL-ER-SOP-1.05, Rev. 1 *Field Quality Control Samples*
- LANL-ER-SOP-1.06, Rev 2 *Management of ER Project Wastes*
- LANL-ER-SOP-1.08, Rev. 1 *Field Documentation of Drilling and Sampling Equipment*
- LANL-ER-SOP-1.10, Rev. 1 *Waste Characterization*
- LANL-ER-SOP-3.11, Rev. 1 *Coordination and Evaluating Geodetic Surveys*
- LANL-ER-SOP-4.01, Rev. 1 *Drilling Methods and Drill-Site Management*
- LANL-ER-SOP-5.03, Rev. 2 *Monitoring Well and RFI Borehole Abandonment*
- LANL-ER-SOP-5.07, Rev. 0 *Operation of LANL Owned Borehole Logging Trailer*
- LANL-ER-SOP-6.26, Rev. 1 *Core Barrel Sampling for Subsurface Earth Materials*
- LANL-ER-SOP-6.31, Rev. 1 *Sampling of Sub-Atmospheric Air*
- LANL-ER-SOP-7.05, Rev. 1 *Subsurface Moisture Measurements Using a Neutron Probe*
- LANL-ER-SOP-12.01, Rev. 4 *Field Logging, Handling and Documentation of Borehole Materials*

Additional procedures may be added as necessary to describe and document quality-affecting activities.

5.1 Methods for Drilling and Sampling Boreholes A through L and N

5.1.1 Drilling Protocol

Vertical boreholes will be drilled using the hollow-stem auger method and angled boreholes will be drilled using either the hollow-stem auger or air-rotary method depending on nuclear safety requirements. A description of these methods is provided below.

Hollow-Stem Auger

The hollow-stem auger consists of a hollow steel shaft with a continuous spiraled steel flight welded onto the exterior side of the stem. The stem is connected to an auger bit and, when rotated, transports cuttings to the surface. The hollow stem of the auger allows drill rods, split-spoon core barrels, Shelby tubes, and other samplers to be inserted through the center of the auger so the samples may be retrieved during the drilling operations. The hollow stem also acts to case the borehole temporarily, so that the casing (riser) may be inserted down through the center of the augers once the desired depth is reached, thus minimizing the risk of possible collapse of the borehole. A bottom plug or pilot bit can be fastened onto the bottom of the augers to keep out most of the soils and/or water that have a tendency to clog the bottom of the augers during drilling. Drilling without a center plug is acceptable provided that the soil plug, formed in the bottom of the auger, is removed before sampling or installing well casings. The soil plug can be removed by washing out the plug using a side discharge rotary bit or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger.

Air Rotary

The air-rotary method uses a drill pipe or drill stem coupled to a drill bit that rotates and cuts through soil and rock. The cuttings produced from the rotation of the drilling bit are transported to the surface by compressed air, which is forced down the borehole through the drill pipe and returns to the surface through the annular space (between the drill pipe and the borehole wall). The circulation of the compressed air not only removes the cuttings from the borehole but also helps to cool the drill bit. The use of air rotary drilling is best suited for hard rock formations. In soft unconsolidated formations, casing is driven to keep the formation from caving. When using air rotary, the air compressor shall have an in-line organic filter system to filter the air coming from the compressor. The organic filter system shall be inspected regularly to ensure that the system is functioning properly. In addition, a cyclone-velocity dissipator or similar air containment/dust-suppression system shall be used to funnel the cuttings to one location instead of allowing the cuttings to discharge uncontrolled from the borehole. Air rotary that employs the dual-tube (reverse circulation) drilling system is acceptable because the cuttings are contained within the drill stem and are discharged through a cyclone-velocity dissipator to the ground surface.

Boreholes A through L and N will be drilled in the approximate locations shown in Figure 10. The subsurface borehole configurations are projected relative to disposal units in Figures 11 through 24. The depth, angle, and sampling protocol for each borehole are described in Table 3. Each borehole will be continuously cored using a split barrel sampler following LANL-ER-SOP-4.01, Rev 1, to TD. Core will be screened for radiological contamination, visually inspected, and geologically logged. If radiological contamination is detected using field screening methods at the proposed TD, the boring will be advanced until contamination is no longer detected.

The exact location of each borehole will be determined after extensive and careful review of the potential risks and access limitations. Pit and shaft boundaries will be mapped via a differential global positioning system survey (± 2 cm X, Y, Z) following LANL-ER-SOP-3.11, Rev 1, to further refine borehole locations. A GPR survey will also be conducted in order to define potentially hazardous utility lines in the work area. Each site will be thoroughly examined to identify potential hazards for subsurface drilling.

5.1.2 Collection of Tuff Samples

Subsurface tuff samples will be collected from the split-spoon core barrel into sealed sleeves or core-protect bags to preserve core moisture following LANL-ER-SOP-6.26, Rev 1. The analytical suites for

each borehole are listed in Table 3. The frequency of sampling and orientation relative to disposal units are shown in Figures 11 through 24.

Tuff samples will be collected at least every 20 ft in the ten angled boreholes (A through J) beginning beneath the target disposal unit. Vertical boreholes K, L, and N will be sampled at least every 20 ft beginning at the same depth as the nearest disposal unit. Samples will be collected from intervals where contamination is suspected because field screening results are elevated and/or visual inspection identifies fractures or staining.

Field documentation of samples collected from fractures will include a detailed physical description of the fracture fill material and rock matrix sampled following LANL-ER-SOP-12.01, Rev 4. The volumes of fracture fill and rock matrix material included in the sample will be estimated from field measurements. An additional sample will be collected from the rock matrix adjacent to the fracture sample material to allow for analytical comparison. The fractures and matrix samples will be assigned unique identifiers.

Tuff samples from boreholes A through L and N will be analyzed for TAL metals, cyanide, nitrates, perchlorate, and radionuclides (americium-241, strontium-90, isotopic uranium, isotopic plutonium, and gamma spectroscopy isotopes). Additionally, tuff samples collected during the first sampling interval below the Chemical Pit from borehole A will be analyzed for dioxins and furans. Analysis of all tuff samples will be conducted using analytical methods specified by contract requirements of the statement of work.

Quality assurance/quality control (QA/QC) samples will include field duplicate samples to evaluate the reproducibility of the sampling technique and rinsate blanks to evaluate decontamination procedures. These samples will be collected following LANL-ER-SOP-1.05, Rev 1, and will be collected at the frequency specified in Section IX.B.2.e of the November 26, 2002, NMED Order.

5.1.3 Collection of Pore-Gas Samples

Subsurface pore-gas samples will be collected from boreholes A through K and N following LANL-ER-SOP-6.31, Rev 1. In each borehole, one sample will be collected at the depth in which the borehole is nearest the targeted disposal unit, and the second sample will be collected at TD. Pore-gas samples will be collected using a straddle packer to isolate discrete depths within the borehole. Each interval will be purged prior to sampling until measurements of carbon dioxide and oxygen are stable and representative of subsurface conditions. Subsurface pore-gas samples will be collected in SUMMA canisters and submitted for analysis of VOCs using EPA Method TO-14 and in silica gel samplers for tritium analysis using EPA Method 906.0.

QA/QC samples for VOCs in pore-gas will consist of an equipment blank and field duplicate for each sampling round. After sampling and purge decontamination, the equipment blank will be collected by pulling zero gas (99.9% ultrahigh-purity nitrogen) through the packer sampling apparatus. This sample will be used to evaluate decontamination procedures. The field duplicate sample will be used to evaluate the reproducibility of the sampling technique. A field duplicate sample will also be collected for tritium. QA/QC samples will be collected in accordance with LANL-ER-SOP-1.05, Rev 1, and will be collected at the frequency specified in Section IX.B.2.e of the November 26, 2002, NMED Order.

5.2 Methods for Drilling and Sampling Borehole M

5.2.1 Drilling Protocol

A single, vertical borehole will be drilled to a depth of 800 ft in the area north of Pit 5 near the head of Ten Site Canyon. The location and depth of the borehole were selected to provide information on the vertical profile of VOC and tritium concentrations in pore-gas and to determine whether perched groundwater is present below MDA C.

Hollow-stem auger drilling will be used until refusal (down to at least 400 ft) because it has proven to be capable of collecting undisturbed samples of core and subsurface vapors within the Tshirege Member of the Bandelier Tuff. Upon refusal, air-rotary drilling will be deployed down the same borehole for completion. A description of the air rotary method is provided in Section 5.1.1. The coupling of these drilling methods is practical and allows the objectives of the sampling for this borehole to be met. The vertical borehole will be cored continuously with a split-barrel sampler to 800 ft following LANL-ER-SOP 4.01, Rev 1. Core will be screened for radiological contamination, visually inspected, and geologically logged. The exact location of this borehole will be determined in the manner and with the same scrutiny described in Section 5.1.1 for boreholes A through L and N.

5.2.2 Collection of Pore-Gas Samples

The sampling depth and analytical suites for borehole M are described in Table 3 and depicted at depth in Figure 24. Subsurface pore-gas samples will be collected every 100 ft down the borehole to the depth where hollow-stem auger drilling cannot be continued (approximately 400 ft or deeper). Pore-gas samples will be collected following LANL-ER-SOP-6.31, Rev 1 using a straddle packer to isolate discrete depths of the borehole. Each interval will be purged prior to sampling until measurements of carbon dioxide and oxygen are stable and representative of subsurface conditions. Subsurface pore-gas samples will be collected in SUMMA canisters and submitted for analysis of VOCs using EPA Method TO-14, and collected in silica gel samplers and submitted for tritium analysis using EPA Method 906.0. An additional sample will be collected at TD (800 ft) with a single packer through the end of the air-rotary drill string; however, the potential instability of the Puye Formation and the effects of air-rotary drilling on subsurface vapors may preclude collecting a sample representative of true subsurface conditions. The subsurface vapor sample at TD will be collected only if the conditions for purge-gas stabilization according to LANL-ER-SOP-6.31 are met.

QA/QC samples for VOCs in pore-gas will consist of an equipment blank and field duplicate for each sampling round. After sampling and purge decontamination, the equipment blank will be collected by pulling zero gas (99.9% ultrahigh-purity nitrogen) through the packer sampling apparatus. This sample will be used to evaluate decontamination procedures. The field duplicate sample will be used to evaluate the reproducibility of the sampling technique. A field duplicate sample will also be collected for tritium. QA/QC samples will be collected in accordance with LANL-ER-SOP-1.05, Rev 1.

5.2.3 Collection of Geotechnical Data

Borehole M will be cored continuously and geologically logged to TD following LANL-ER-SOP-4.01, Rev 1, and LANL-ER-SOP-12.01, Rev 4. Samples will be collected from core provided by a split-barrel sampler throughout the Tshirege Member of the Bandelier Tuff to allow visual inspection. Brass sleeves will then be used in the relatively unconsolidated Cerro Toledo interval, the Otowi Member, and the Puye Formation to improve recovery and maintain structural integrity in the hole for hydrogeologic

characterization. Samples collected from the split-barrel sampler will be preserved in sealed sleeves or core-protect bags to preserve core moisture following LANL-ER-SOP-6.26, Rev 1.

Moisture content and matrix potential samples will be collected every 5 ft from borehole M. Samples for chloride analysis will be collected every 20 ft from this borehole. Samples for saturated and unsaturated hydraulic conductivity, porosity, and bulk density will be collected once in each tuff unit, twice from the Cerro Toledo interval, and five times in the Otowi Member at varying depths. Five samples will also be collected from the Puye Formation. The samples collected from the Cerro Toledo interval, the Otowi Member, and the Puye Formation will be selected from core to be representative of all the textural intervals encountered. Analyses for saturated and unsaturated hydraulic conductivity, porosity, and bulk density will be performed using analytical methods specified by contract requirements of the statement of work. One field duplicate sample will be collected and analyzed to evaluate the reproducibility of the sampling technique.

5.2.4 Collection of Perched Water Samples

During drilling operations there is the potential for encountering zones of elevated moisture content, localized saturation, and groundwater. These zones may not be assignable to either an alluvial or the regional groundwater system and represent a localized phenomenon. The Laboratory's decision process for characterizing these zones is presented in the attached flowchart shown in Figure 26 and described in the following text.

If saturation is encountered as a borehole advances, drilling would be stopped to determine whether sufficient water volume is available to analyze the water quality. These analyses may include metals, anions, perchlorate, alkalinity, carbon organic carbon, total inorganic carbon, and total dissolved solids. Generally the total volume required is approximately 0.5 to one liter. Of this volume, 100 mL is unfiltered and unpreserved; another 100 mL is filtered and preserved with nitric acid. If this minimum volume of groundwater cannot be collected, the borehole would be continued to the planned TD or until saturation is encountered again and the process is repeated. A porous cup lysimeter or absorbent membrane would be installed at the depth of saturation to monitor the zone if the borehole is completed for pore gas monitoring. Insufficient water sample volumes from discreet depths would not be composited to make the required volume for screening analysis.

If sufficient volume exists, a groundwater sample would be collected and analyzed for the screening constituents on a rapid turnaround basis at a geochemistry laboratory at Los Alamos. Typically, results of groundwater screening samples are available in the R-well drilling program within 48 hr. During this time, the borehole will be advanced to the base of saturation, or the perching horizon, and halted. If possible, the perching horizon would be identified and not penetrated. This activity will determine the thickness of the zone of saturation and the characteristics of the perching horizon. Borehole drilling will cease, and a monitoring well will be designed, and the design will be submitted to NMED for approval. Following approval of the design, the well will be installed. A borehole will be drilled adjacent to the well and the saturated zone isolated with a double wall casing advancement drilling method to isolate the known saturated zone. The additional borehole will then be completed to the planned depths and the process repeated.

6.0 MONITORING AND SAMPLING PROGRAM

Pore-gas monitoring of two boreholes at MDA C has occurred on a quarterly basis from 2000 through the third quarter of 2003 to collect data to determine the nature and extent of contamination in the vapor

phase beneath MDA C. In addition, biweekly tritium samples in the breathing zone are being collected over a 52-week period outside the northeast fence line of MDA C.

6.1 Pore-Gas Sampling

Two boreholes at MDA C, equipped with positive pressure membranes for sampling, were monitored at multiple depths on a quarterly basis for 11 quarters. Boreholes 50-9100 and 50-10131 are located in areas of elevated surface flux of VOCs, as determined by the EMFLUX[®] soil-gas surveys and are therefore the likely areas of maximum vertical extent. Measured VOC concentrations are in the low ppmv range near the depth of disposal and diffuse with depth. Subsurface VOC concentrations at MDA C have been monitored from the fourth quarter of 2000 until the third quarter of 2003 when quarterly pore-gas monitoring was discontinued.

Extensive vapor sampling at TA-54, MDA L, has identified that VOCs disposed in Bandelier Tuff are present in the subsurface in the form of organic vapors. The very low organic and moisture content of the Bandelier Tuff greatly limits, or excludes, sorption of VOCs to the matrix. Therefore, traditional fixed analytical laboratory analysis of core samples will not detect VOCs, which are present primarily as vapor in the pore space. Therefore, to characterize the nature and extent of potential vapor-phase contamination at MDA C at TA-50, RRES-RS initiated a pore-gas investigation utilizing technologies successful at MDA L.

In 2002, RFI borehole 50-09100 was completed as a vapor monitoring well using a positive-pressure membrane in 2000. Ten sample ports were installed in the membrane, ranging in depth from 20 to 315 ft bgs. In 2001 a second monitoring well (50-10131) was drilled and completed with a positive-pressure membrane and with ports depths ranging from 25 to 250 ft bgs. Figure 25 is a simplified schematic of the membrane in borehole 50-09100 showing port depths and construction.

Monitoring of subsurface VOCs has been completed at MDA C for a total of eleven quarters beginning in the fourth quarter of 2000, until the third quarter of 2003. Every available port at boreholes 50-09100 and 50-10131 was screened with a Brüel and Kjaer (B&K) multigas analyzer during every quarter of the monitoring period following LANL-ER SOP 06.31. SUMMA canister samples were also collected from one port, of one borehole each quarter. SUMMAs were collected from borehole 50-09100 for 10 quarters, and borehole 50-10131 for 6 quarters. In the second quarter of 2003, all sample ports in both boreholes were sampled simultaneously to assess the potential influence of temporal variability on VOC concentrations measured between 2000 and 2002. All pore gas sampling at MDA C is completed per LANL-ER SOP-6.31, Rev. 1, "Sampling of Subatmospheric Air."

The SUMMA canister sampling method is currently being used with analysis by EPA Method TO-14 (gas chromatography/mass spectrometry; EPA 1999, 70063). SUMMA canister samples are drawn from several sampling ports available at each borehole.

Before the required sampling is performed, boreholes 50-09100 and 50-10131 are screened with the B&K multigas monitor. Each port is purged and monitored with field instruments until carbon dioxide levels have stabilized at values representative of subsurface pore-gas conditions and is then screened for four VOCs (TCE, TCA, perchloroethene, and Freon-11).

Three types of field QA samples are collected in addition to the analytical samples. These three samples include a duplicate sample, an equipment blank of zero grade air (zero-grade air is a common term for air that is certified to be free from VOC contamination) or nitrogen drawn through the sampling apparatus in the working area, and a performance evaluation sample/calibration gas sample taken from a tank of a

certified gas mixture. Laboratory QA for EPA Method TO-14 includes internal standards, surrogates, replicates, blanks, laboratory control samples, and reference standards.

6.2 Tritium in Air Sampling

A RRES-Meteorology and Air Quality (MAQ) air-sampling station was set up outside the northeastern boundary (the predominant wind direction) of MDA C in March 2003 at an elevation of four ft above ground level to monitor tritium in the breathing zone. Continuous air sampling for tritium is being conducted over a one-year duration by RRES-MAQ, the Laboratory Air Quality Group in accordance with Standard Operating Procedure RRES-MAQ-204, R10, "Sampling of Ambient Airborne Tritium." Composite samples are being collected over two-week periods (biweekly) and submitted to an off-site laboratory for tritium analysis. The subsequent interpretation and analysis of these data will be performed by the RRES-MAQ Group in support of worker health and safety following their protocols, and its results will be reported in the MDA C Investigation Report.

7.0 SCHEDULE

Revision 1 of the MDA C work plan will be submitted to NMED on November 7, 2003. Assuming a 60-day NMED review period and 30 days to resolve comments between NMED and the Laboratory, the work plan will be approved in mid-February 2003.

Authorization basis (AB) documentation (a documented safety analysis) is being prepared for DOE review to document that drilling beneath the MDA C inventory can be conducted in a safe manner in accordance with nuclear safety requirements in 10CFR 830. AB approval is expected by April 1, 2004. Fieldwork will not be allowed to start until AB approval is received from DOE, but permitting and readiness review activities will proceed in parallel with the AB process.

Field activities, including drilling and subsurface sampling, will take approximately four to six weeks to complete (barring any weather or other unforeseen delays). The subsurface sampling will include the first round of pore-gas sampling using SUMMA canisters and silica gel samplers. A second round of pore-gas sampling will take place during week 10. Assuming a 6-week turnaround time to receive and analyze data on the pore-gas sampling results, Laboratory and NMED representatives will meet to review the pore-gas data during week 16 and decide whether to instrument any additional boreholes for pore-gas monitoring. If required, pore-gas monitoring boreholes will be instrumented during week 22 and samples collected in week 24.

Deep vertical borehole M will be instrumented between weeks 8 and 10, and pore-gas samples collected between weeks 10 and 12.

The Investigation Report will be finalized 10 months after the work plan is approved.

8.0 REFERENCES

The following list includes all references cited in this document. Parenthetical information following each reference provides the author, publication date, and the ER ID number, when available. This information also is included in the citations in the text. ER ID numbers are assigned by RRES-RS to track records associated with the program. These numbers can be used to locate copies of the actual documents at the RRES-RS Records Processing Facility.

AGS (Advanced Geological Services), September 2001. "Integrated Geophysical Investigation MDA C and MDA H Los Alamos National Laboratory, Los Alamos, New Mexico Contract No. 350256-001-01 86," Report. (AGS 2001, 73710)

AGS (Advanced Geological Services), September 2002. "Integrated Geophysical Investigation Material Disposal Area C, TA-50 Los Alamos National Laboratory, Los Alamos, New Mexico," Report. (AGS 2002, 73711)

Baltz, E. H., J. H. Abrahams, and W. D. Purtymun, March 1963. "Preliminary Report on the Geology and Hydrology of Mortandad Canyon near Los Alamos, New Mexico, with Reference to Disposal of Liquid Low-Level Radioactive Waste," US Geological Survey Open File Report, Albuquerque, New Mexico. (Baltz et al. 1963, 0024)

Cordell, L., 1979. "Gravimetric Expression of Graben Faulting in Santa Fe Country and the Española Basin, New Mexico," *New Mexico Geological Society Guidebook*, 30th Annual Field Conference, Santa Fe, New Mexico, pp. 59–64. (Cordell 1979, 76049)

EPA (US Environmental Protection Agency), April 10, 1990. "Module VIII of RCRA Permit No. NM0890010515, EPA Region VI, Issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990," EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 1585)

EPA (US Environmental Protection Agency), November 1992. "Groundwater Remediation: Extraction and Removal of TCE and CR6+ at an NPL Site," EPA Report, Washington, DC. (EPA 1992, 15344)

EPA (US Environmental Protection Agency), April 1994. "Transmittal of Hazardous Waste Permit for Los Alamos National Laboratory (NM0890010515)," EPA Region VI letter to J. Bellows from A.M. Davis, Dallas, Texas. (EPA 1994, 44146)

EPA (Environmental Protection Agency), January 1999. "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air," Second Edition, EPA Report EPA/625/R-96/010B, Washington, DC. (EPA 1999, 70063)

Freeze, R. A. and J. A. Cherry, January 1979. *Groundwater*, Prentice Hall, Inc., Englewood Cliffs, New Jersey. (Freeze and Cherry 1979, 64057)

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1079 Environmental Restoration Plan," Los Alamos National Laboratory document LA-UR-92-450, Los Alamos, New Mexico. (LANL 1992, 07668)

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1147 Environmental Restoration Program," Los Alamos National Laboratory document, LA-UR-92-969, Los Alamos, New Mexico. (LANL 1992, 07672)

LANL (Los Alamos National Laboratory), September 1995. "RFI Report for Potential Release Sites 50-006(a), 50-006(c), 50-007 (formerly Operable Unit 1147), Field Unit 5," Los Alamos National Laboratory Report LA-UR-95-2738, Los Alamos, New Mexico. (LANL 1995, 49925)

LANL (Los Alamos National Laboratory), April 1996. RFI Report for Potential Release Sites 10-002(a-b), 10-003(a-o), 10-004 (a-b), 10-005, 10-007, TA-10 Subsurface Field Unit 1, LA-UR-96-1284. Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1996, 54332)

LANL (Los Alamos National Laboratory), March 1997. "Voluntary Corrective Action Plan for Potential Release Sites at TA-16 16-005(D), 16-006(G, H), 16-013, 16-017, 16-025(x), 16-026(Q), 16-029(G2, H2, W, X), 16-031 (C, D), 16-034(P), C-16-065, C-16-068, C-16-074 Field Unit 3," Los Alamos National Laboratory document LA-UR-97-640, Los Alamos, New Mexico. (LANL 1997, 55512)

LANL (Los Alamos National Laboratory), March 1997. "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G," Los Alamos National Laboratory document LA-UR-97-85, Los Alamos, New Mexico. (LANL 1997, 63131)

LANL (Los Alamos National Laboratory), May 1998. "Hydrogeologic Workplan Los Alamos National Laboratory," Los Alamos National Laboratory Document, LA-UR-01-6511, Los Alamos, New Mexico. (LANL 1998, 59599)

LANL (Los Alamos National Laboratory), November 1998. "Installation Work Plan for Environmental Restoration Project," Revision 7, Los Alamos National Laboratory document LA-UR-98-4652, Los Alamos, New Mexico. (LANL 1998, 62060)

LANL (Los Alamos National Laboratory), July 2003. "MDA C Waste Disposal Logbooks, 2587, 3478, 4644, 6030, 7277, 9293, 9593, 12442, and 11363, November 1948–September 1959," Los Alamos Scientific Laboratory, Los Alamos, New Mexico. (LANL 2003, 76035)

LASL (Los Alamos Scientific Laboratory), June 1974. Engineering Drawing ENG-R-4459, prepared by University of California, Engineering Department, for Los Alamos Scientific Laboratory, Los Alamos, New Mexico. (LASL 1974, 38446)

LASL (Los Alamos Scientific Laboratory), December 1970. Engineering Drawing ENG-R-1264, sheet number 3, prepared by University of California, Engineering Department, for Los Alamos Scientific Laboratory, Los Alamos, New Mexico. (LASL 1970, 76047)

LASL (Los Alamos Scientific Laboratory), May 1963. TA-10 Bayo Canyon Cleanup, LAMS-2945. Los Alamos Scientific Laboratory, Los Alamos, New Mexico. (LASL 1963, 04771)

Longmire, P., May 2003. Email Communication with E. Keating, Los Alamos National Laboratory, Los Alamos, New Mexico. (Longmire 2003, 76050)

Neleigh, D. W., December 1995. "Modification Request for Operable Unit 1147, Los Alamos National Laboratory (NM0890010515)," Los Alamos National Laboratory Letter to T. J. Taylor, DOE ER Program Manager, from D. W. Neleigh, Section Chief, EPA Region 6 (New Mexico) Federal Facilities, Los Alamos, New Mexico. (Neleigh 1995, 55112)

Nyhan, J. W., June 1978. "Soil Survey of Los Alamos County, New Mexico," Los Alamos National Laboratory report LA-6779-MS, Los Alamos, New Mexico. (Nyhan 1978, 5702)

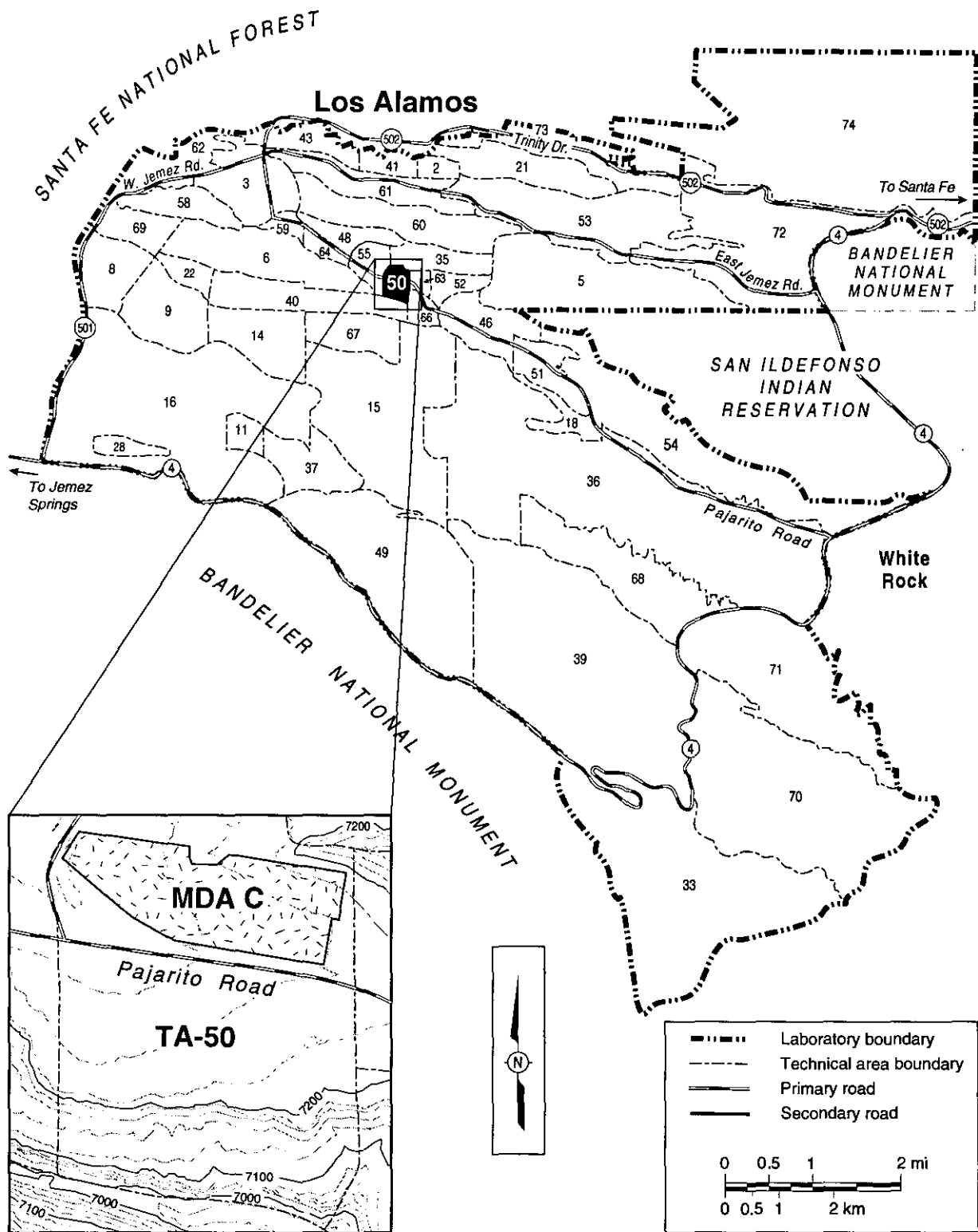
Nylander, C. L., K. A. Bitner, G. Cole, E. H. Keating, S. Kinkead, P. Longmire, B. Robinson, D. B. Rogers, and D. Vaniman, March 2003. "Groundwater Annual Status Report for Fiscal Year 2002," Los Alamos National Laboratory document LA-UR-03-0244, Los Alamos, New Mexico. (Nylander et al. 2003, 76059)

Purtymun, W. D., January 1984. "Hydrologic Characteristics of the Main Aquifer in the Los Alamos Area Development of Ground Water Supplies," Los Alamos National Laboratory report LA-9957-MS, Los Alamos, New Mexico. (Purtymun 1984, 6513)

Rogers, M. A., June 1977. "History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)," Los Alamos Scientific Laboratory report LA-6848-MS, Vols. I and II, Los Alamos, New Mexico. (Rogers 1977, 0216)

Soll, W., and K. Birdsell, February 1998. "The Influence of Coatings and Fills on Flow in Fractured, Unsaturated Tuff Porous Media System," *Water Resources Research*, Vol. 34, No. 2, pp. 193–202. (Soll and Birdsell 1998, 70011)

Stauffer, P. H., K. H. Birdsell, M. Witkowski, T. Cherry, and J. Hopkins, March 2000. "Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions," Los Alamos National Laboratory report LA-UR-00-2080, Los Alamos, New Mexico. (Stauffer et al. 2000, 69794)



F1.0-1, 50-002d RFI RPT, 060200, PTM_Rev. for F1, MDA C IWP, 072403, cf

Figure 1. Location of MDA C with respect to Laboratory technical areas and surrounding land holdings

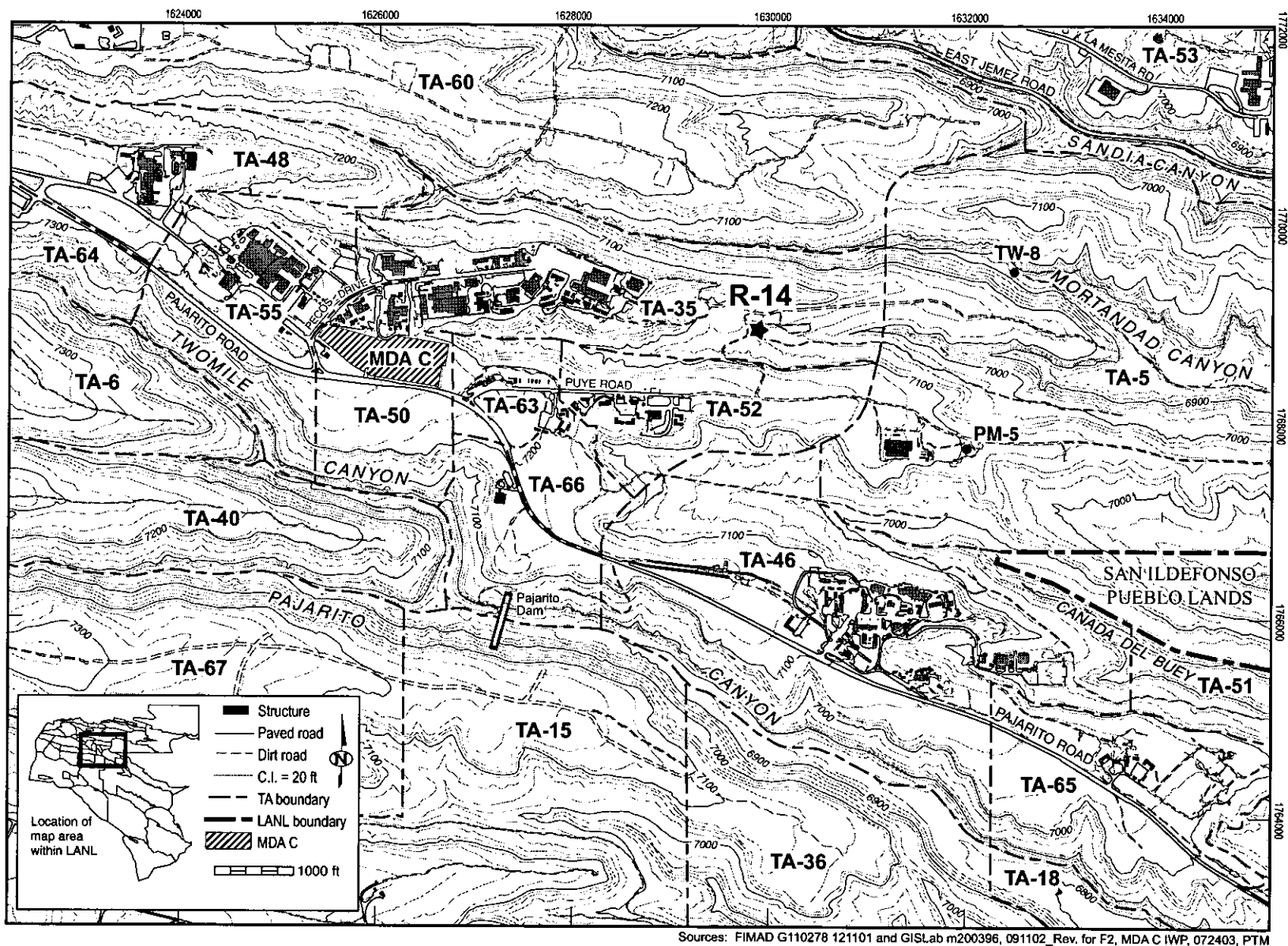


Figure 2. Regional map of MDA C and locations of wells and boreholes for determining stratigraphy at MDA C

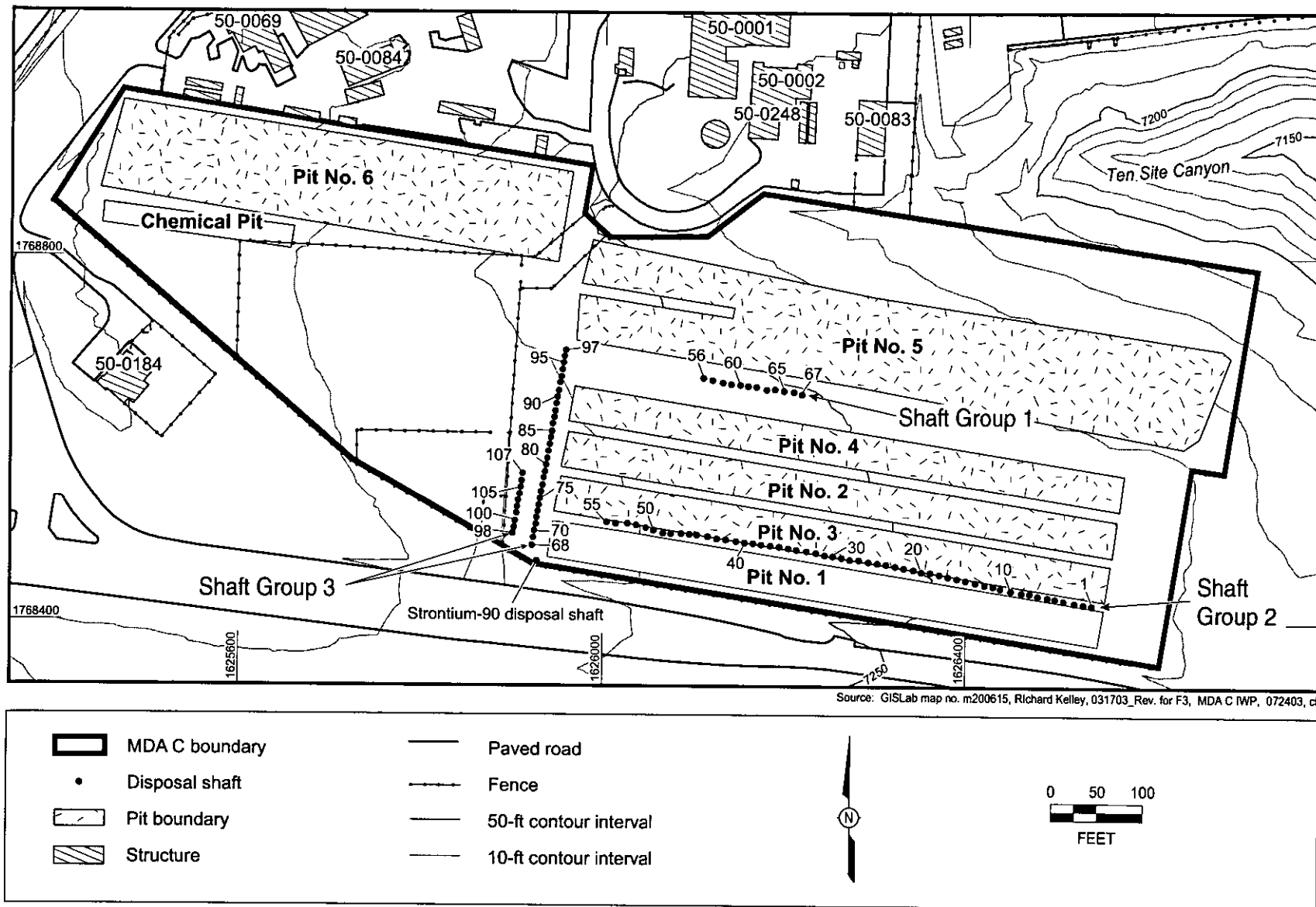


Figure 3. Locations of pits and shafts at MDA C

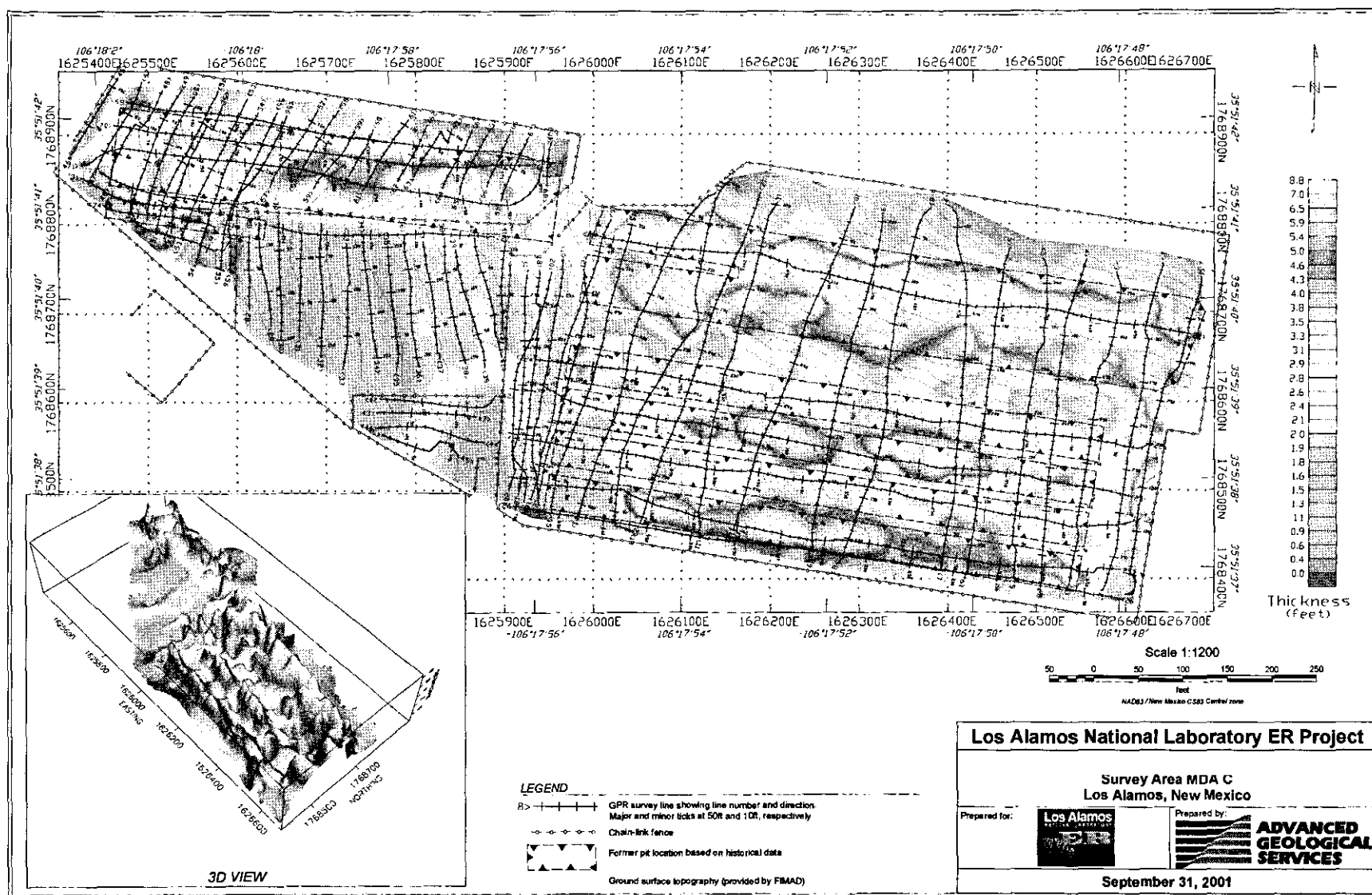
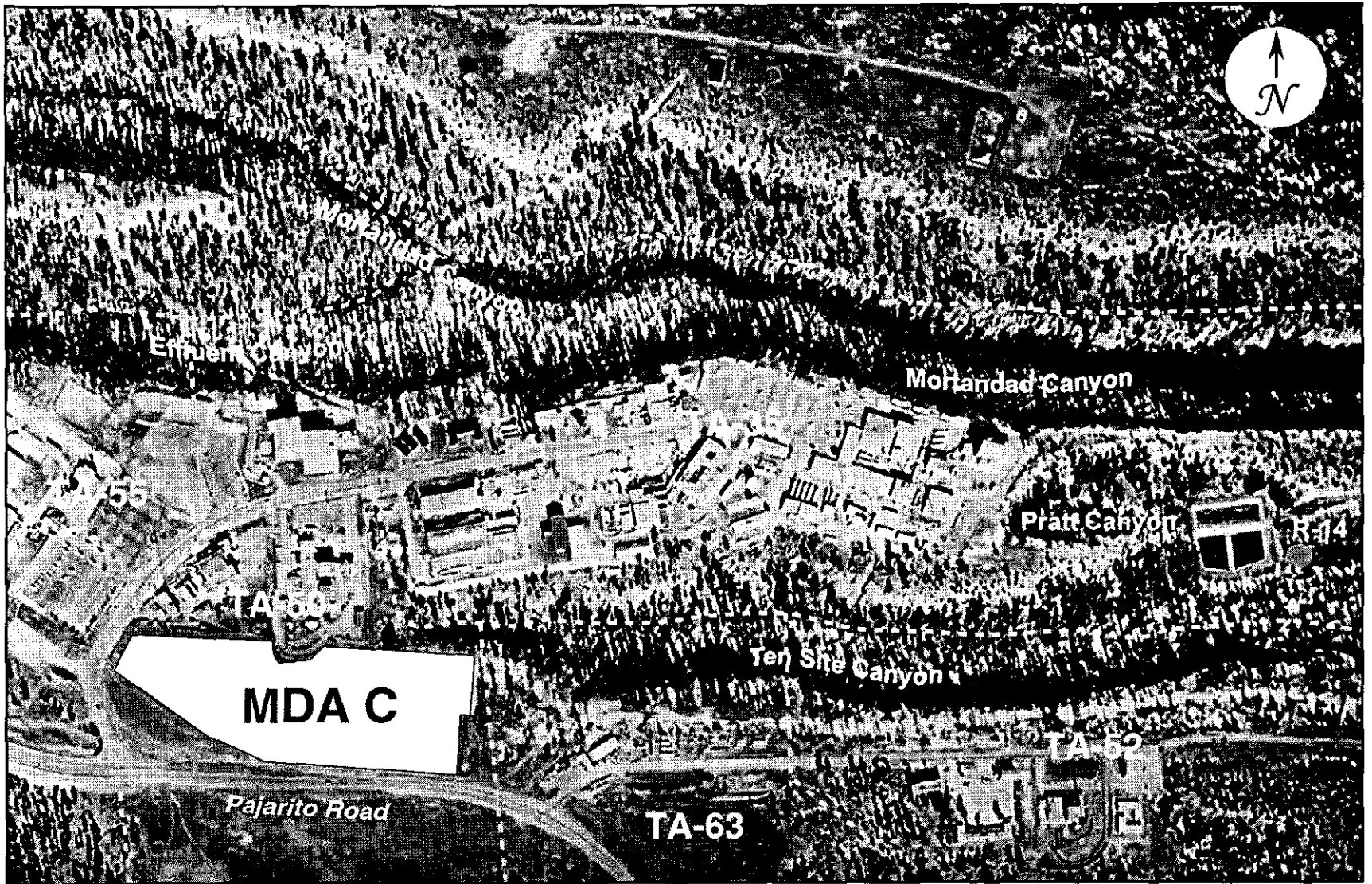


Figure 4. Thickness of fill material at MDA C, estimated by GPR survey



F5, MDA C IWP, 072103, CF

Figure 5. Locations of canyons adjacent to MDA C and regional well R-14

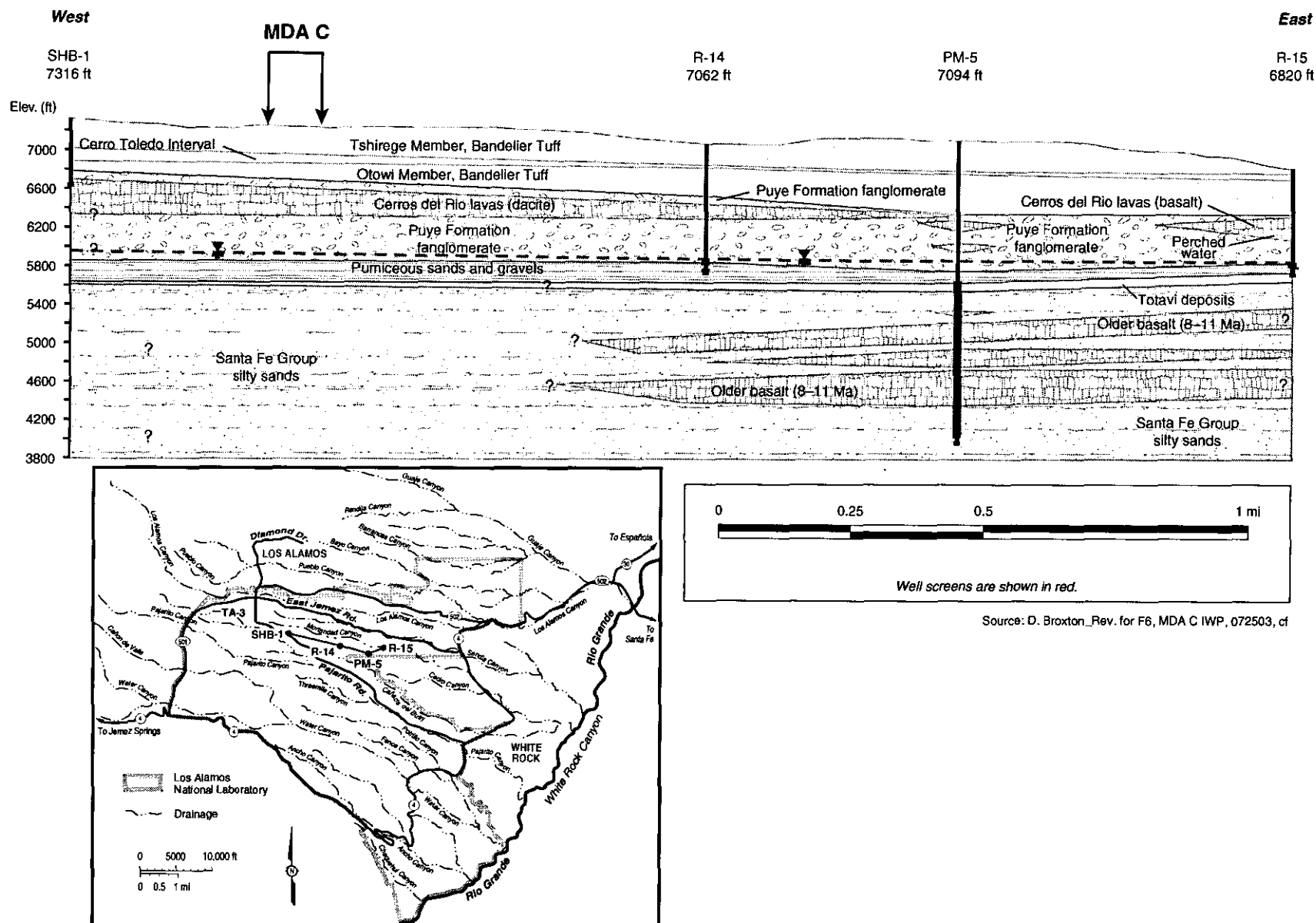
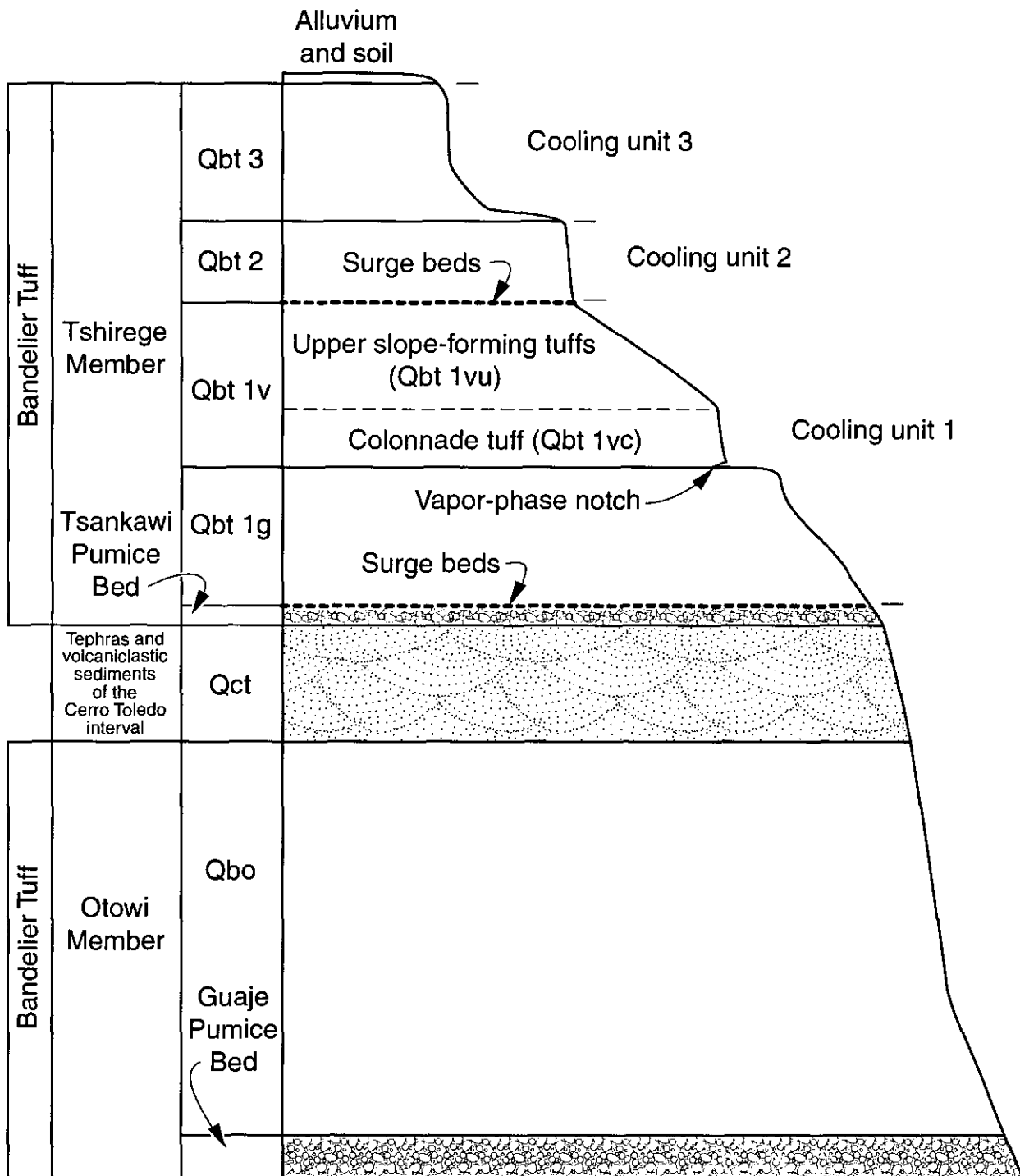


Figure 6. Hydrogeologic cross section through Pajarito Plateau in the vicinity of MDA C along Mortandad Canyon



A. Kron, 083199_FB-4.3-1, 21-005 RFI RPT, 011400, PTM_Rev. for F7, MDA C IWP, 072403, cf

Figure 7. Generalized stratigraphy of Bandelier Tuff at MDA C

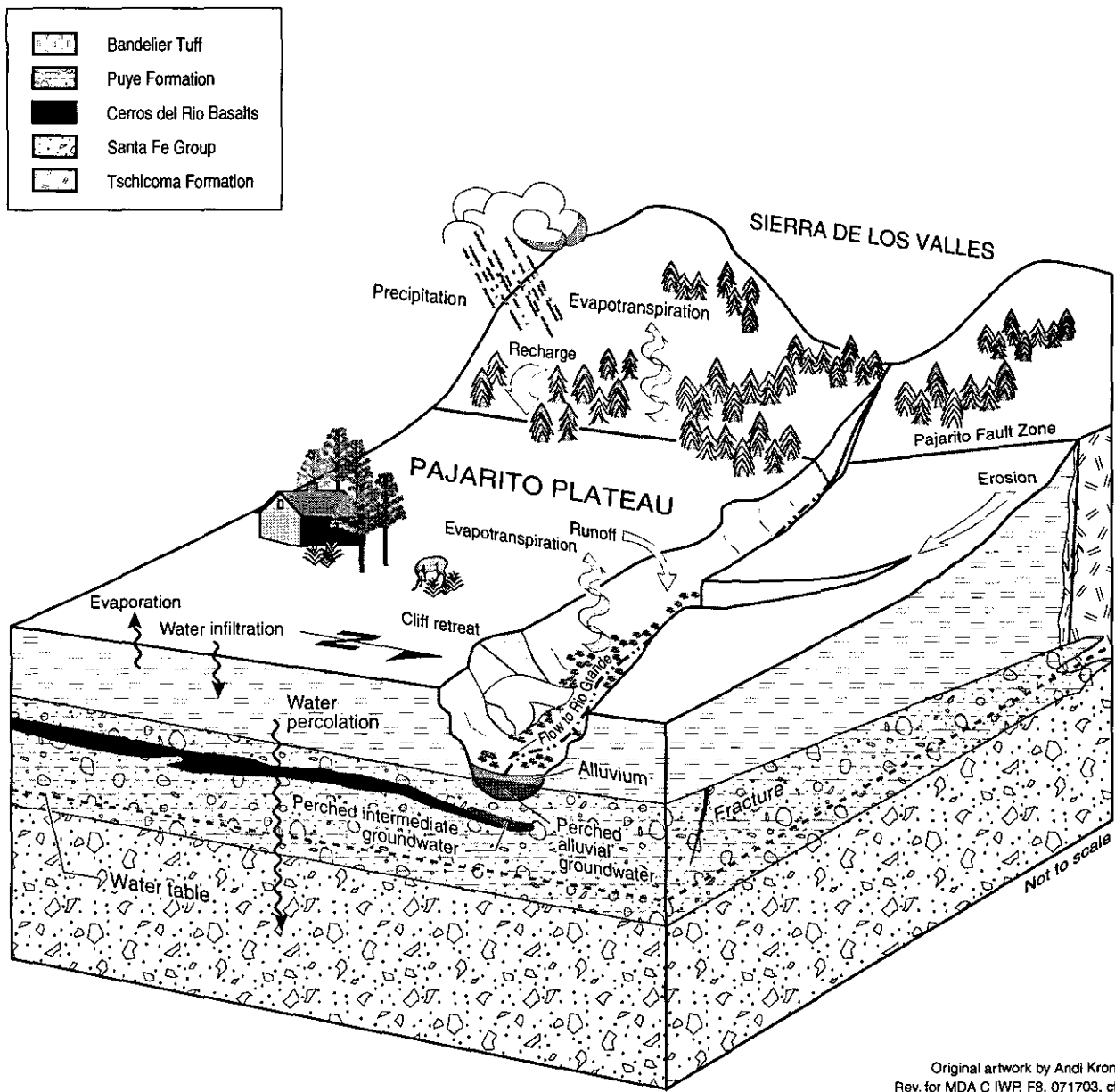
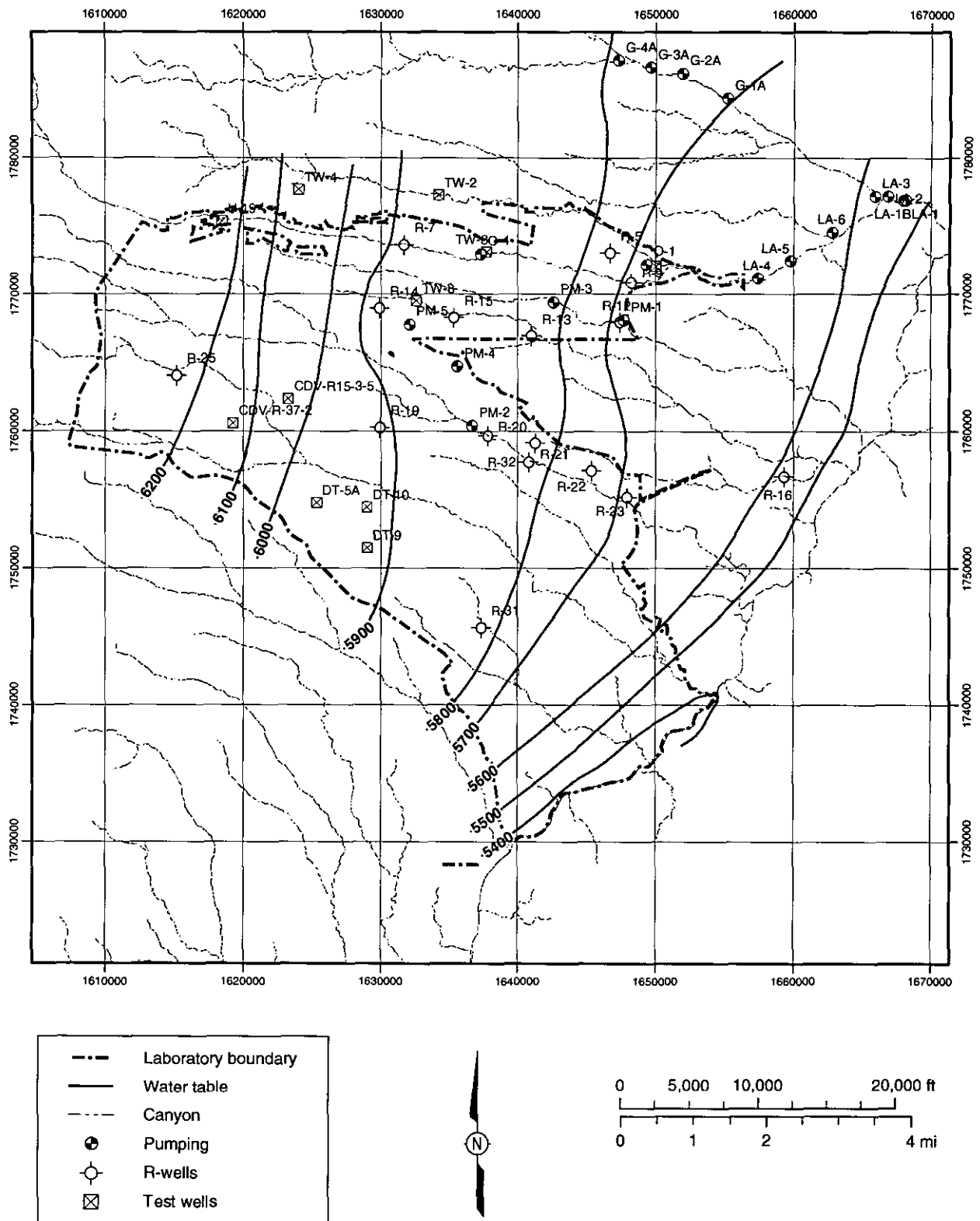


Figure 8. Schematic of the hydrogeologic conceptual model for the Pajarito Plateau (LANL 1998, 59599)



Source: GIS Lab m200714, REK, 061703_Rev. for F9, MDA C IWP, 072403, of

Figure 9. Water table elevations at the Laboratory

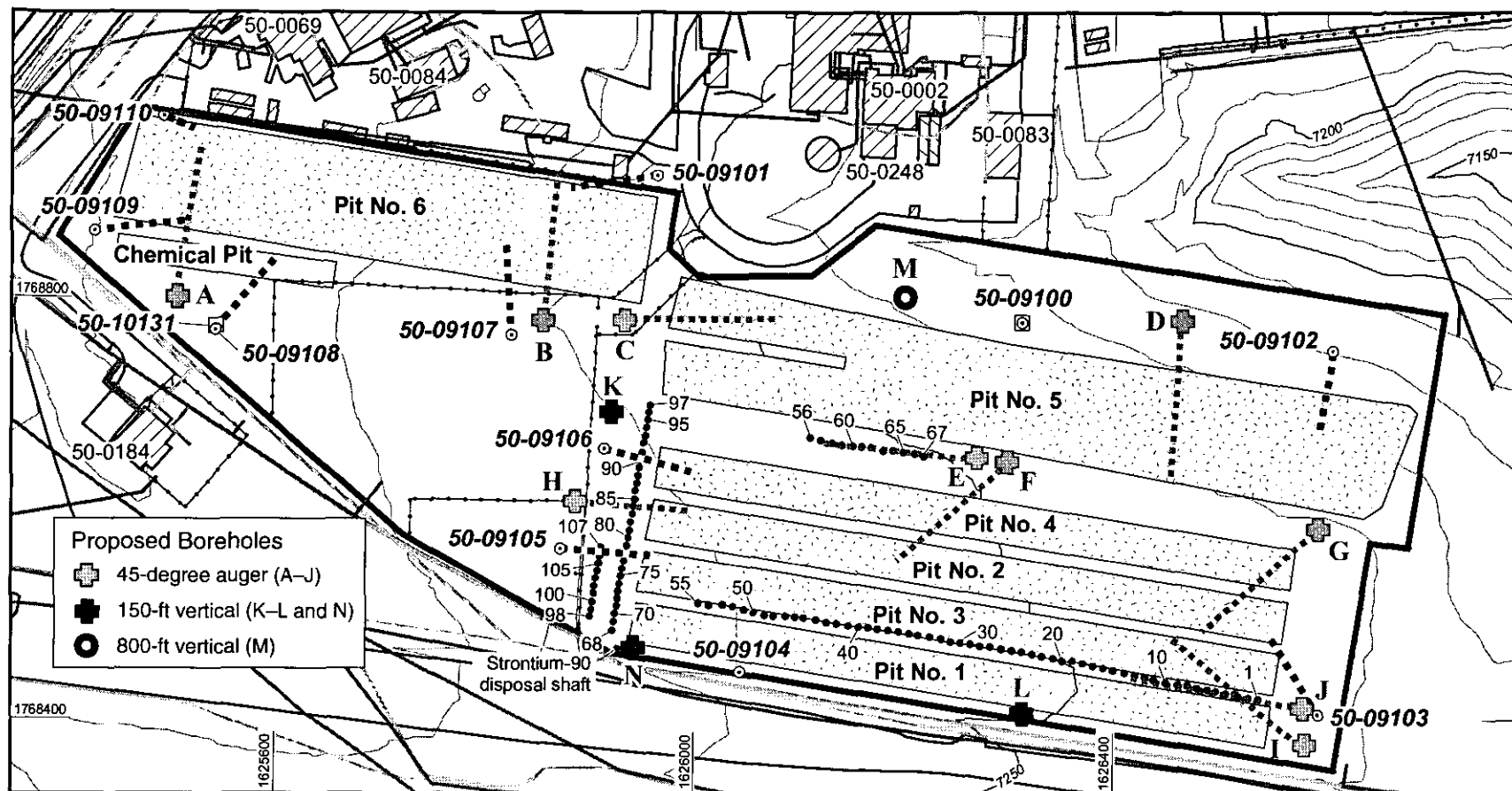


Figure 10. Proposed boreholes at MDA C

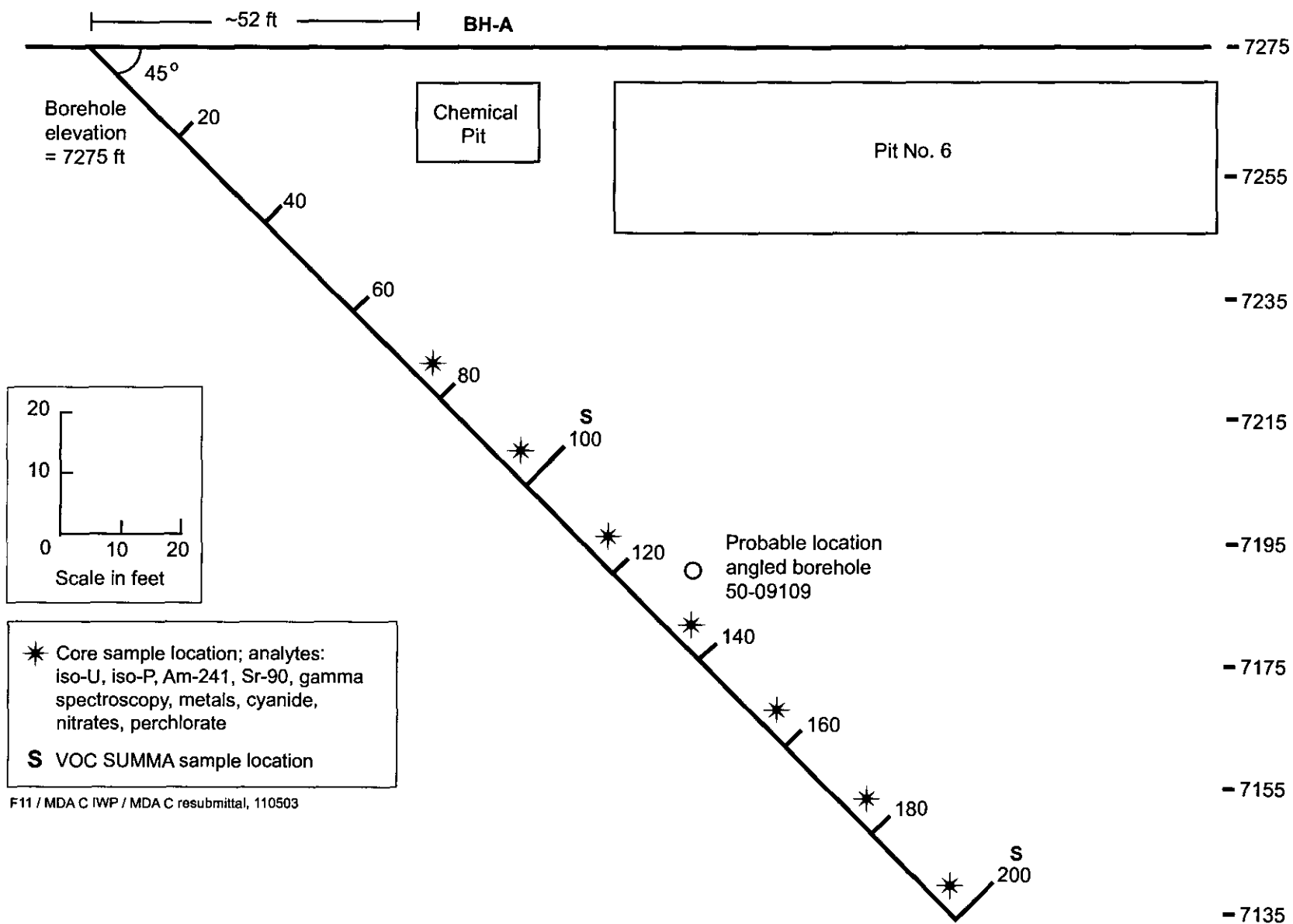


Figure 11. Profile of borehole A at MDA C with planned sample locations

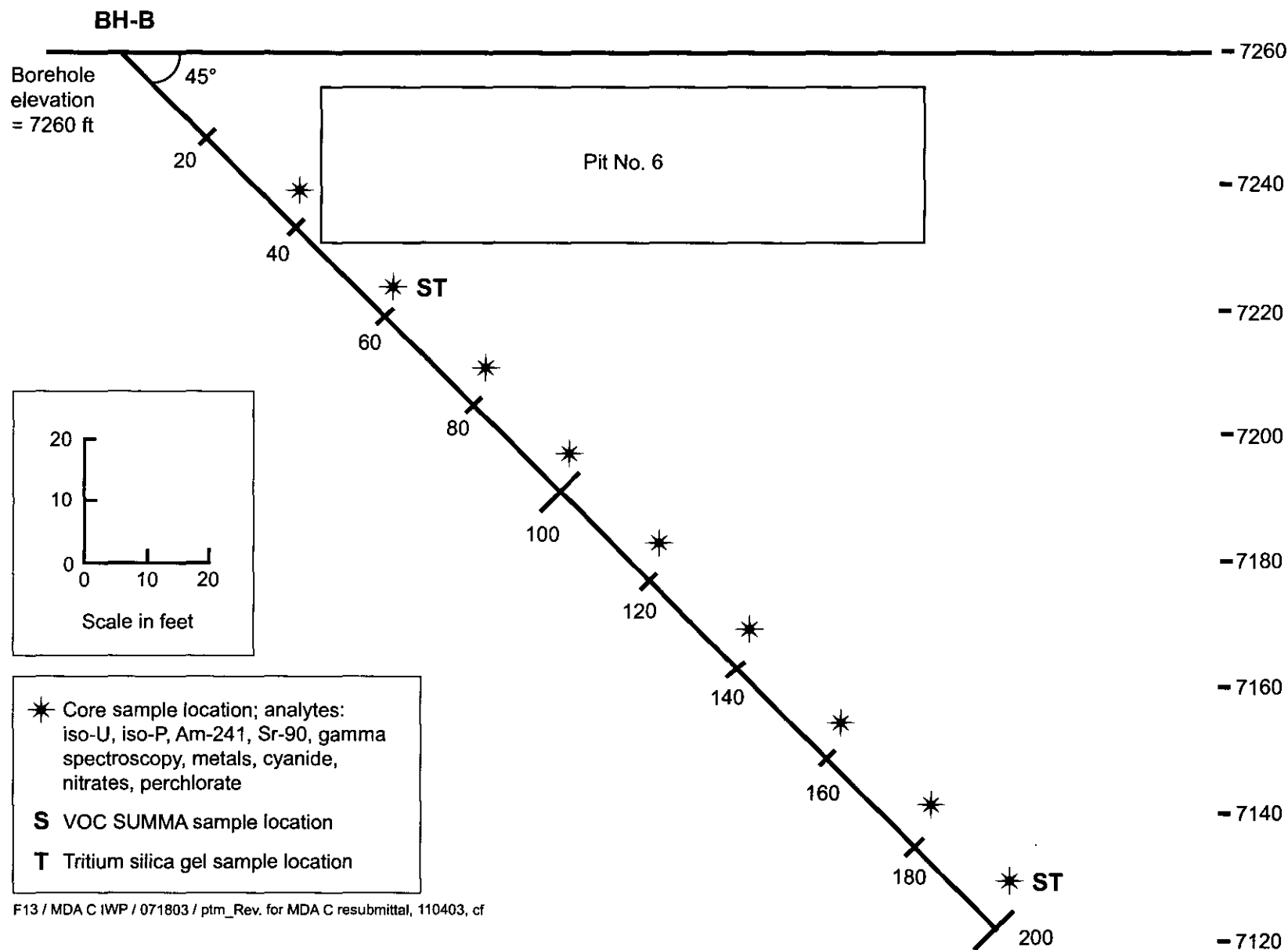


Figure 12. Profile of borehole B at MDA C with planned sample locations

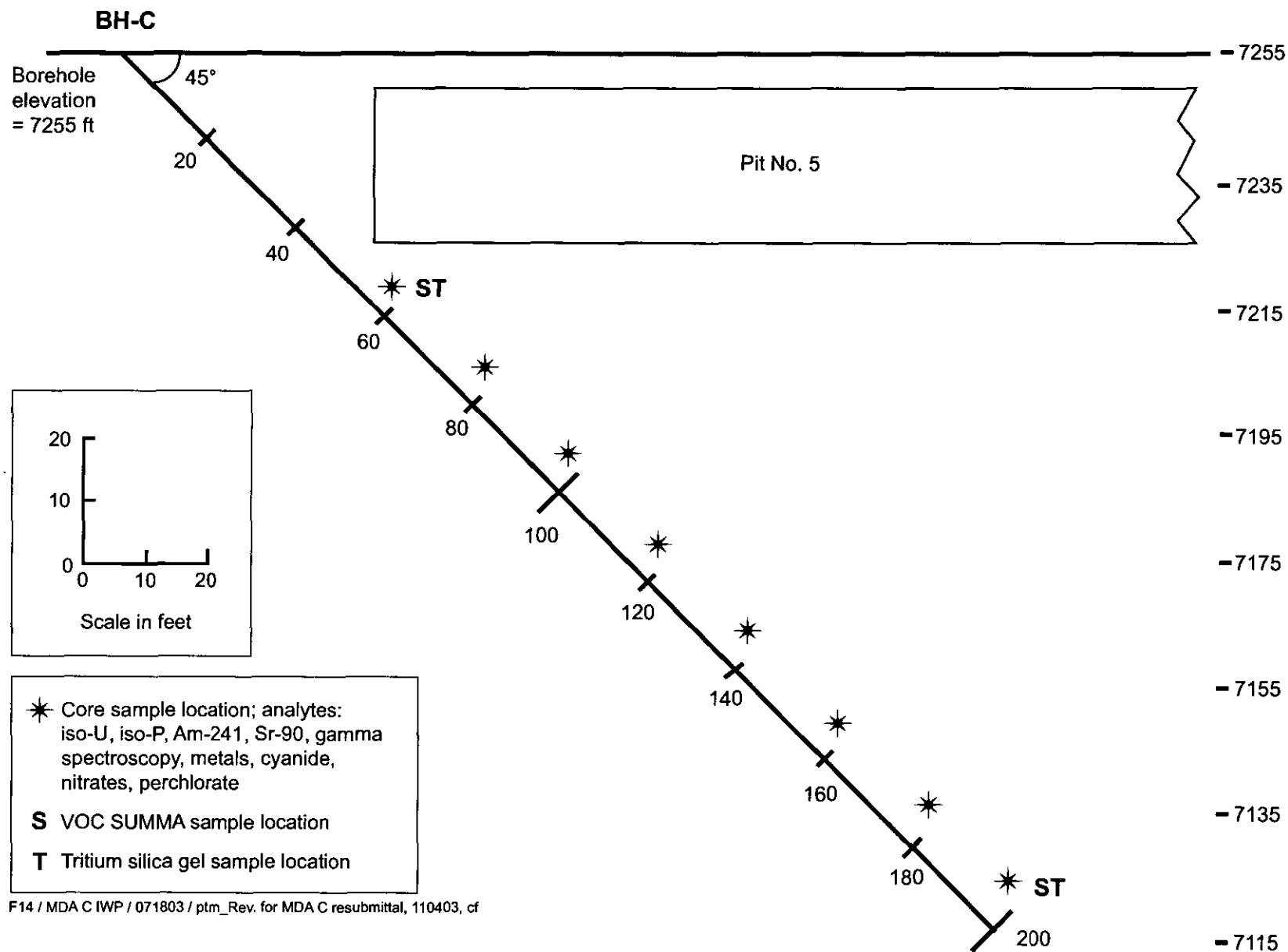


Figure 13. Profile of borehole C at MDA C with planned sample locations

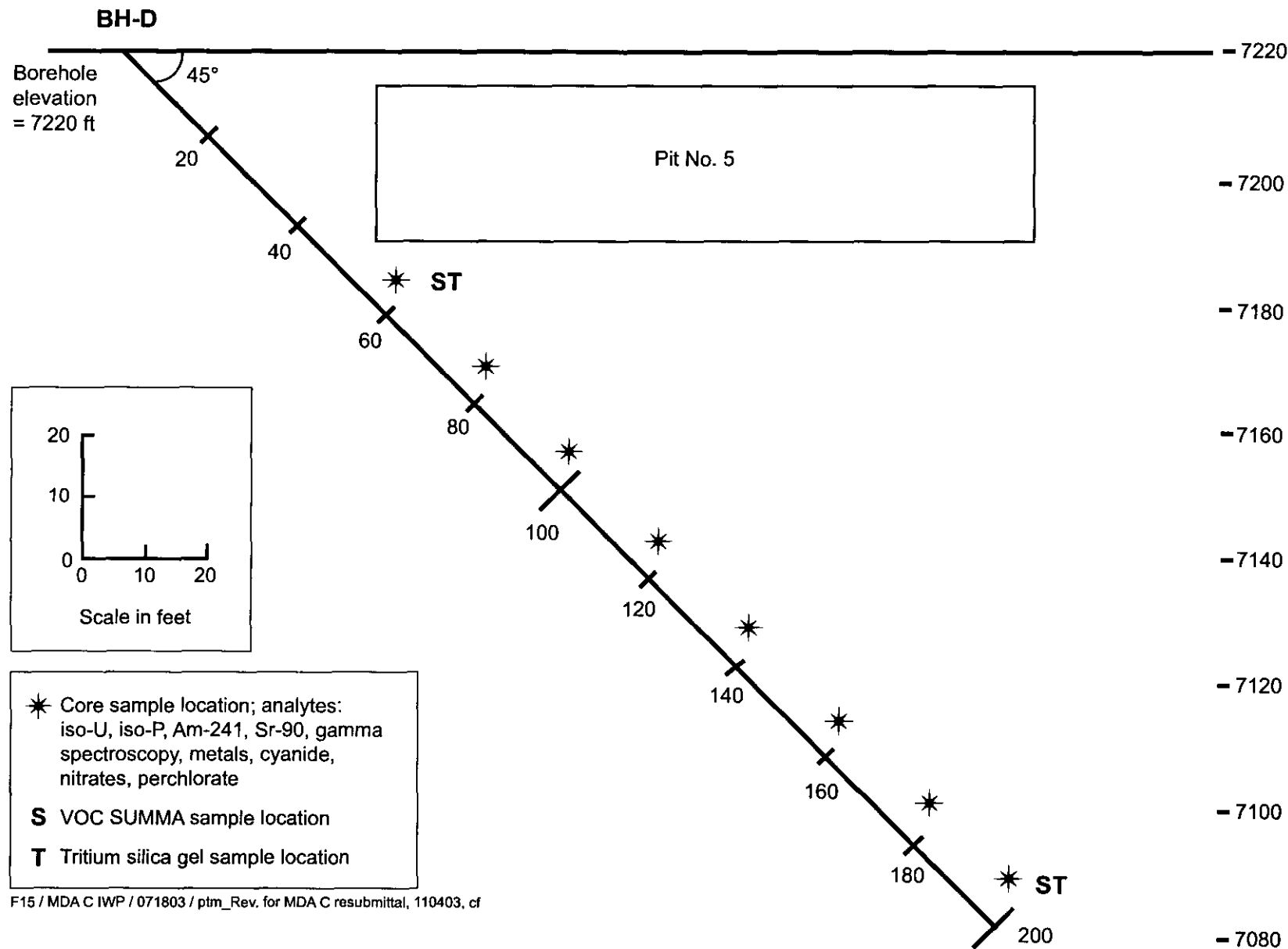


Figure 14. Profile of borehole D at MDA C with planned sample locations



Figure 15. Profile of borehole E at MDA C with planned sample locations

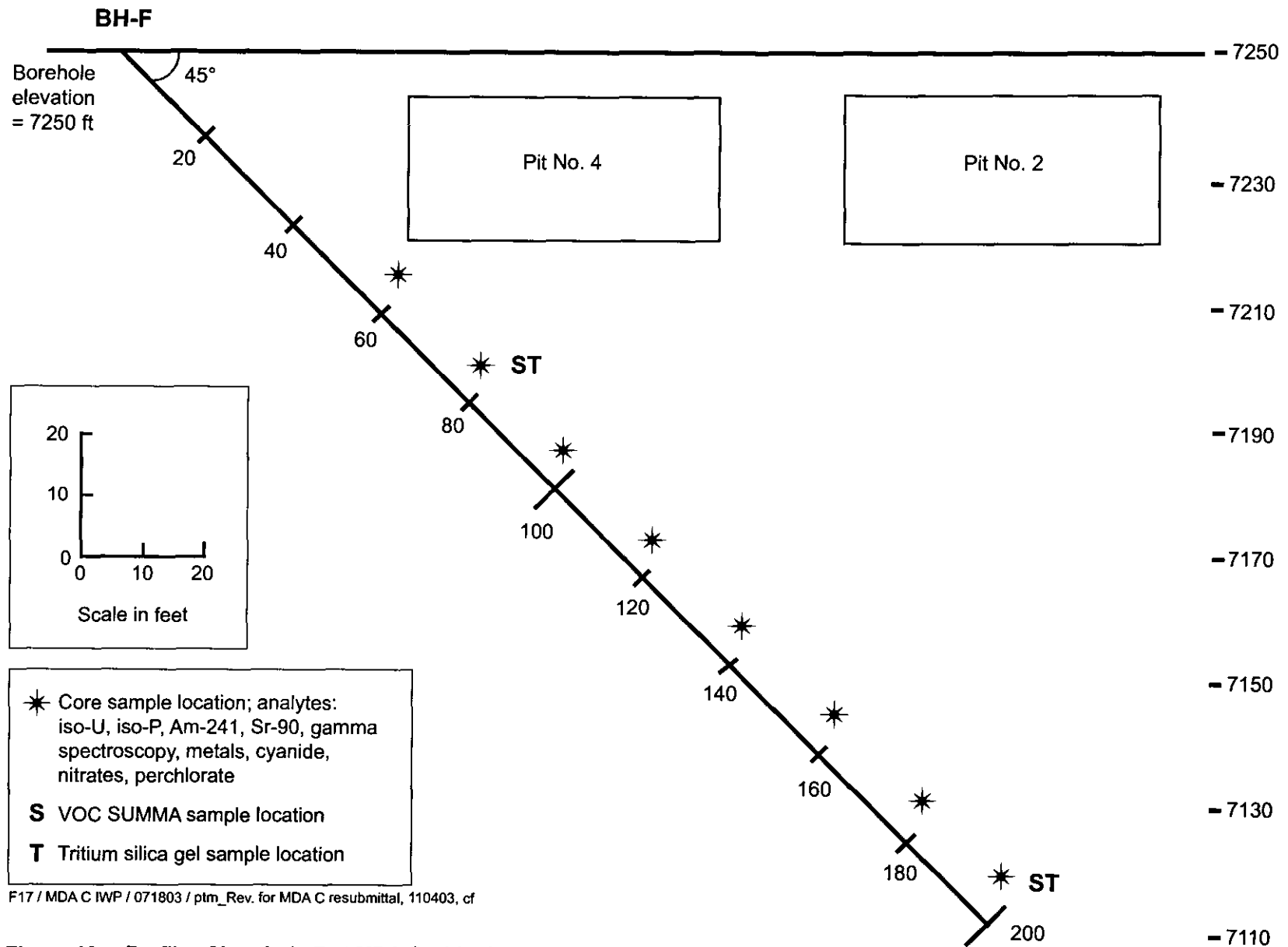


Figure 16. Profile of borehole F at MDA C with planned sample locations

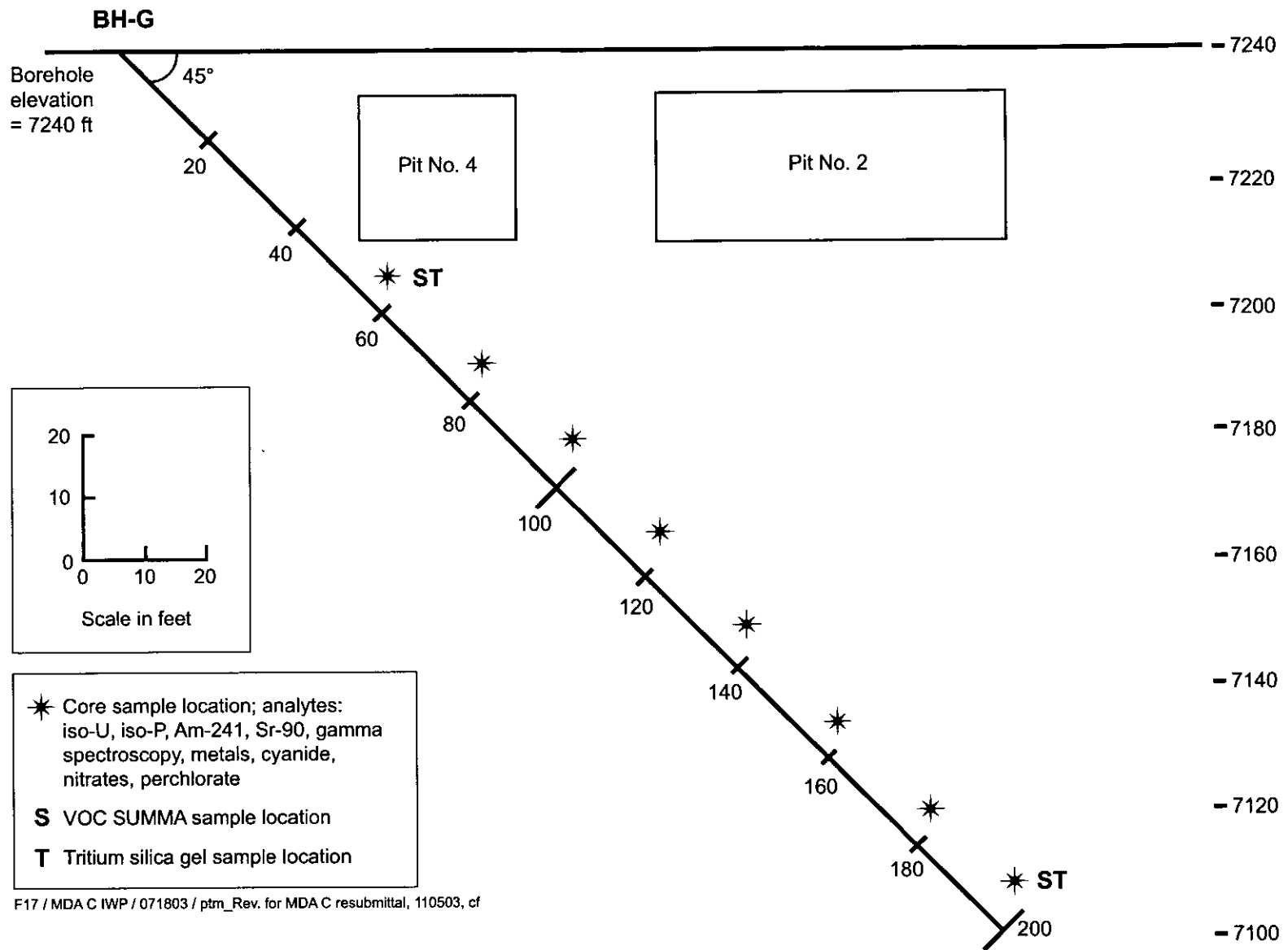


Figure 17. Profile of borehole G at MDA C with planned sample locations

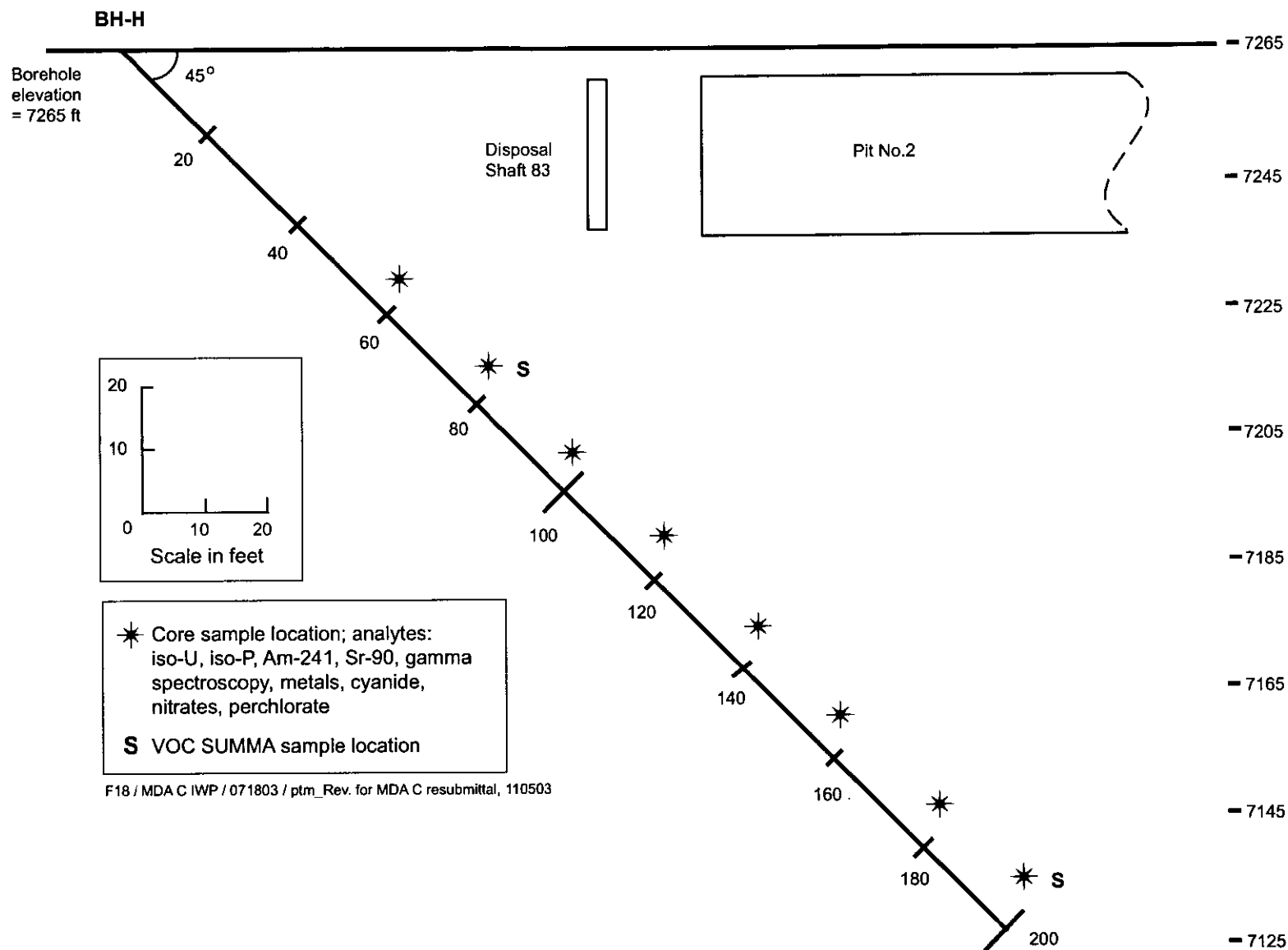


Figure 18. Profile of borehole H at MDA C with planned sample locations

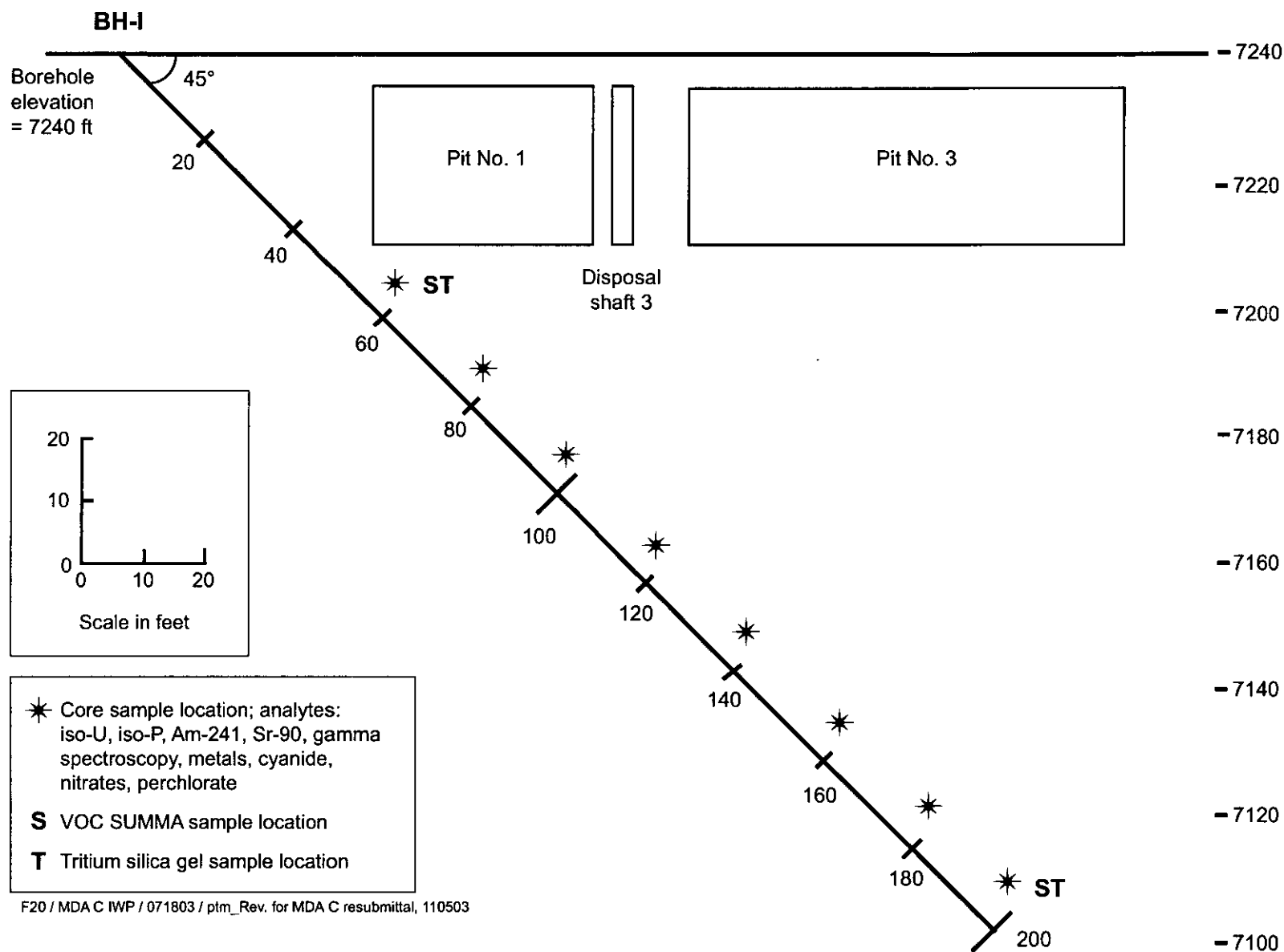


Figure 19. Profile of borehole I at MDA C with planned sample locations



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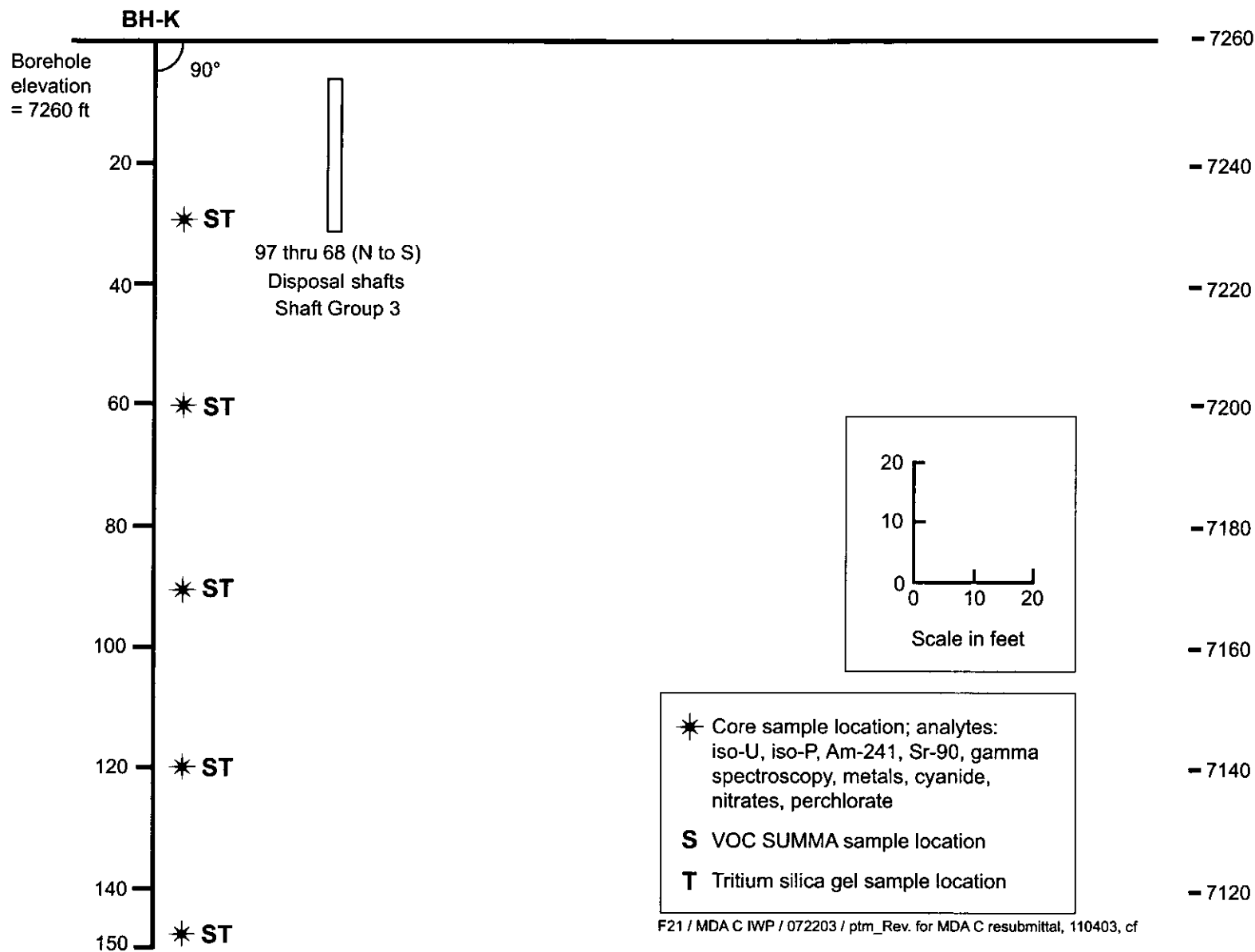


Figure 21. Profile of borehole K at MDA C with planned sample locations

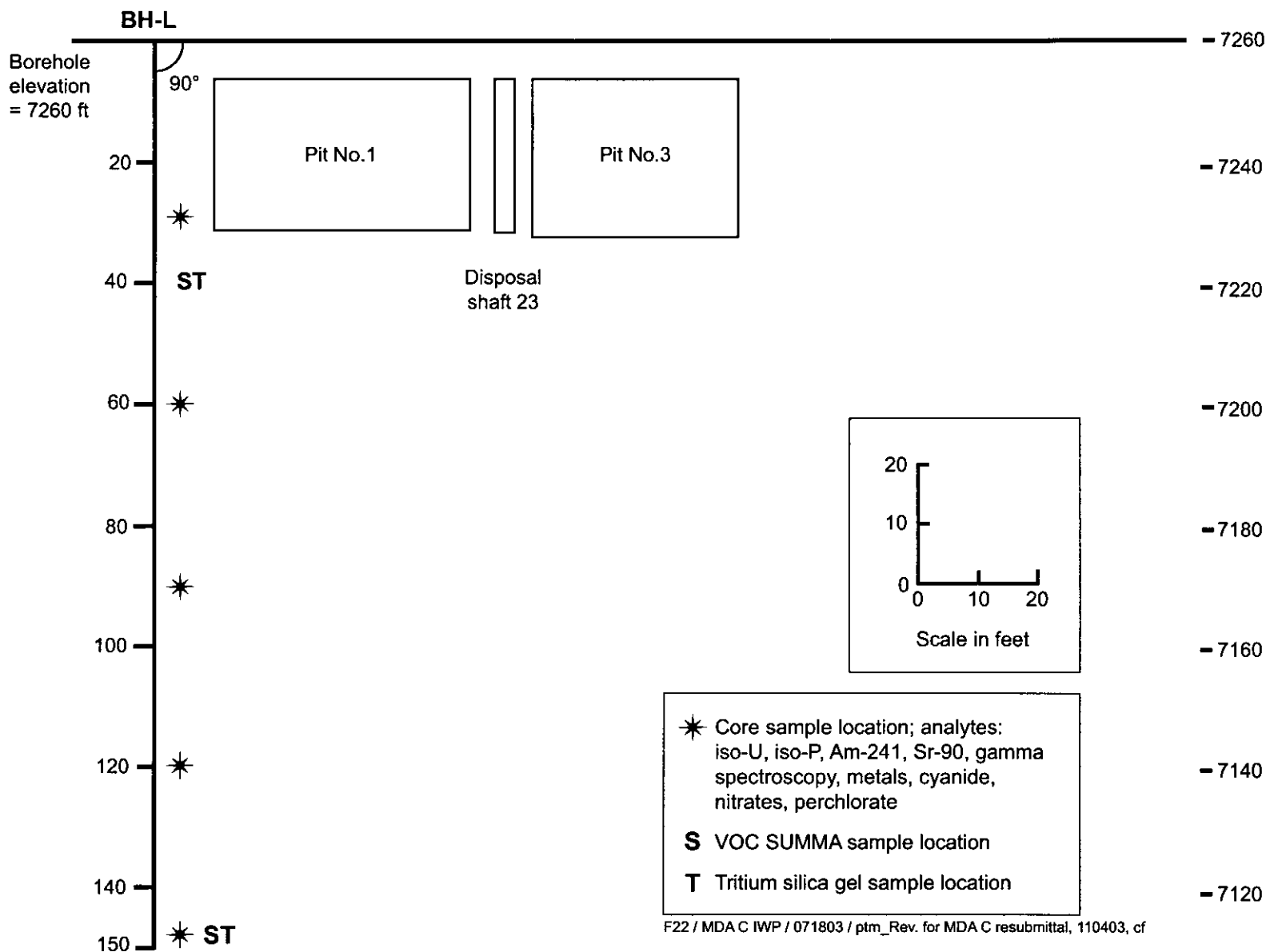


Figure 22. Profile of borehole L at MDA C with planned sample locations



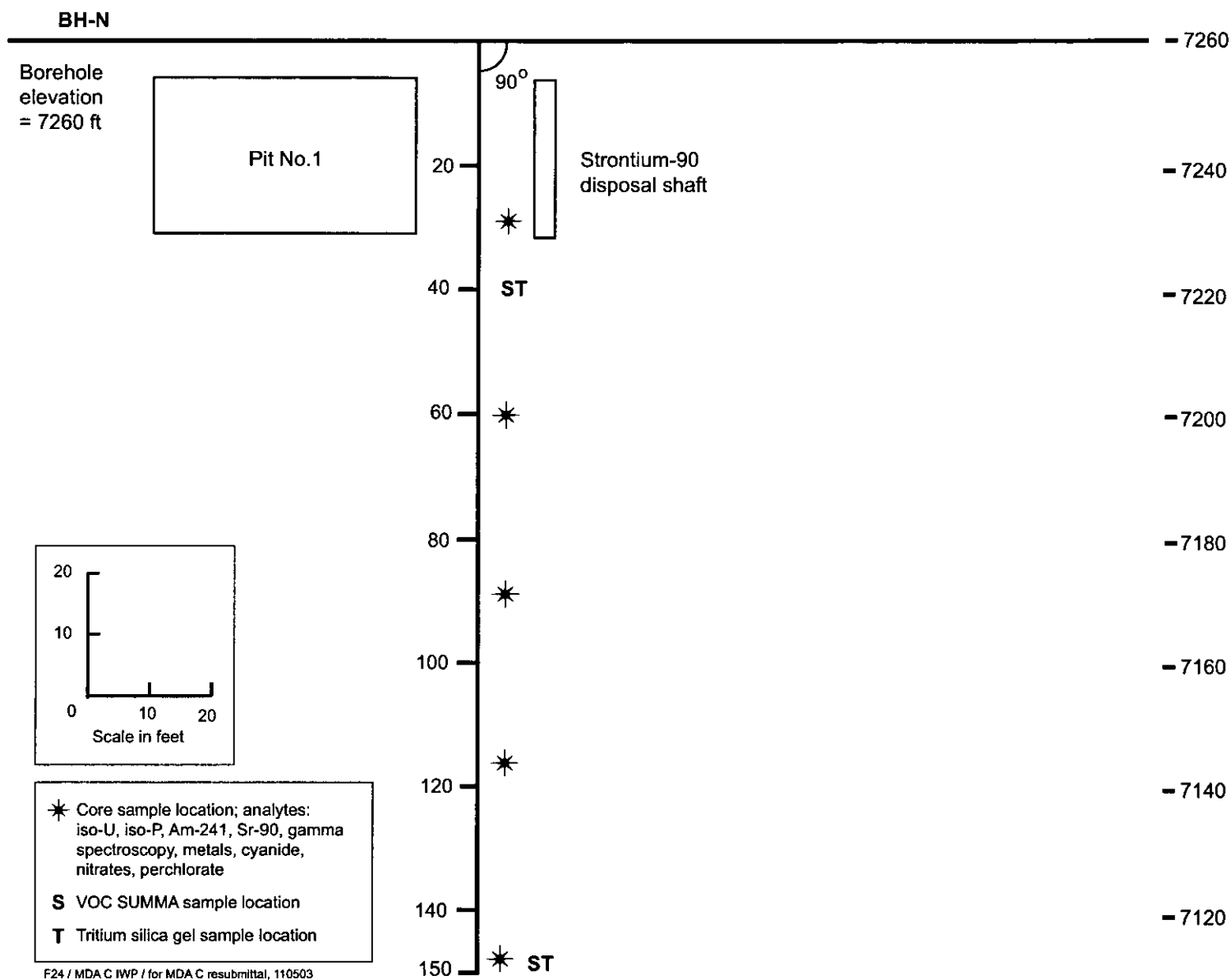


Figure 24. Profile of borehole N at MDA C with planned sample locations

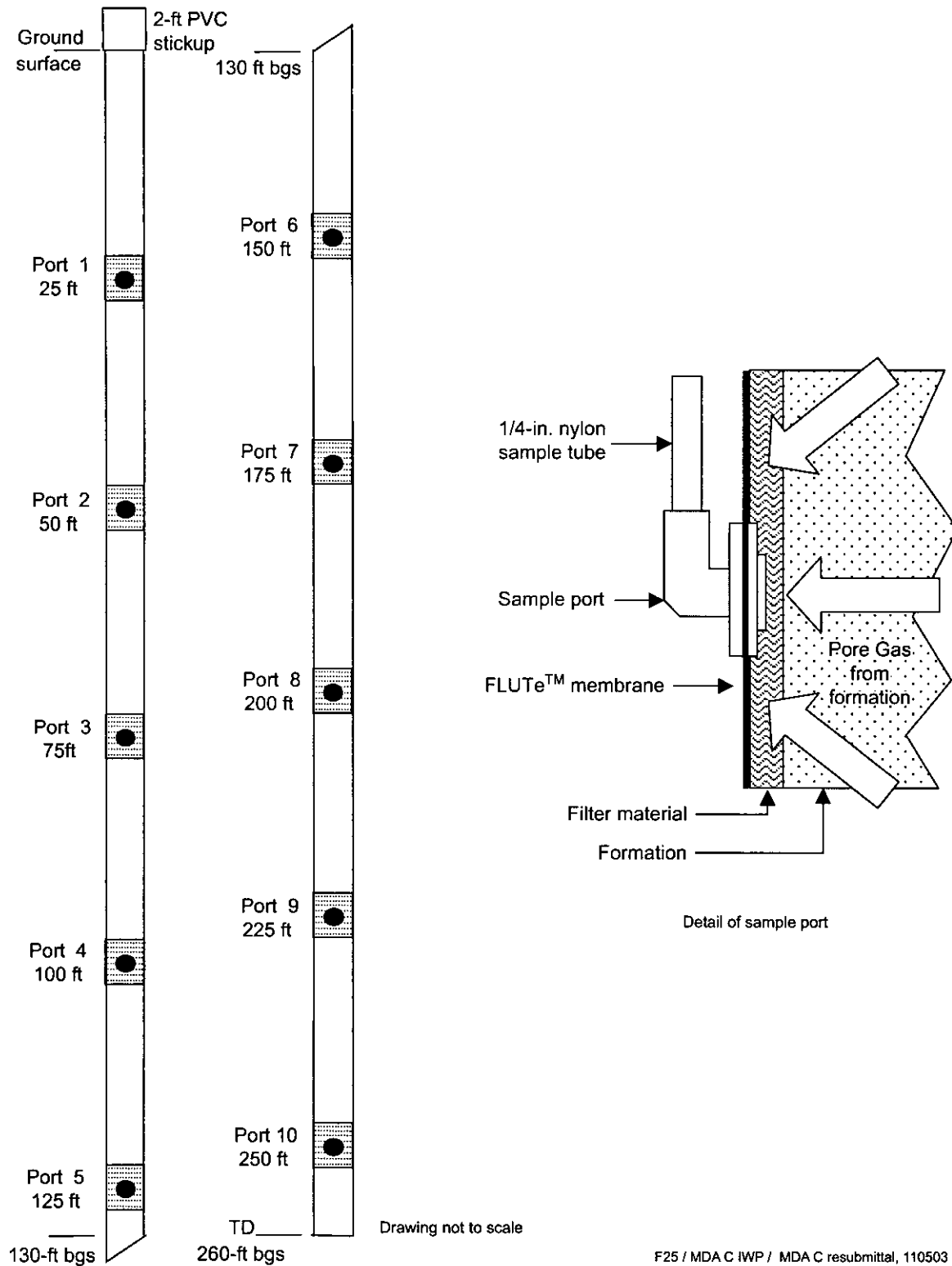
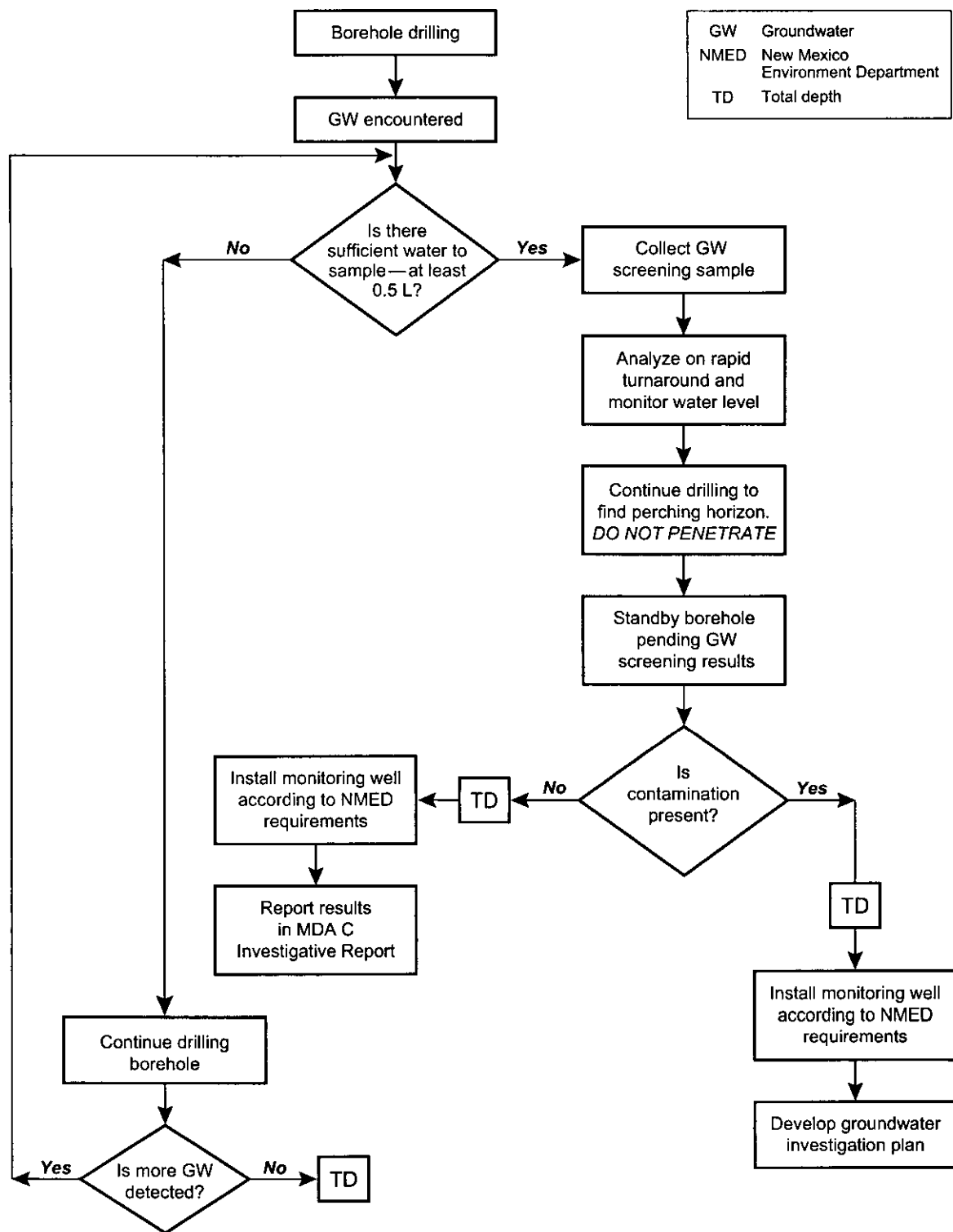


Figure 25. General diagram for construction of a vapor-monitoring borehole



F26, MDA C Rev.1, 110603, cf

Figure 26. MDA C perched groundwater flowchart

Table 1
Dimensions of the Disposal Units at MDA C

Disposal Unit	Dimensions ^a (ft)	Period of Operations
Pit 1	610 x 40 x 25	1948–1951
Pit 2	610 x 40 x 25	1950–1951
Pit 3	610 x 40 x 25	1951–1953
Pit 4	610 x 40 x 25	1951–1955
Pit 5	705 x 110 x 18	1953–1959
Pit 6	505 x 100 x 25	1956–1959
Chemical Pit	180 x 25 x 12	1960–1964
Shaft Group 1 (12 [Shafts 56–67])	2 x 10	1959
Shaft Group 2 (55 [Shafts 1–55])	2 x 15	1959–1967
Shaft Group 3 (40 [Shafts 68–107])	1–2 x 20–25	1962–1966
Shaft 108 (Strontium-90 Disposal Shaft)	Unknown	1950s or 1960s

^a As stated in Table 2-11 of the OU 1147 Work Plan, pit dimensions are length by width by depth; shaft dimensions are diameter by depth (LANL 1992, 07672). Dimensions are approximate.

^b Shafts 98–107 are 1 ft in diameter and lined with 12-in.-thick concrete. Shafts 68–97 are 2 ft in diameter and unlined.

Table 2
Summary of Maximum Depth of Detections for
Inorganic Chemicals and Radionuclides in Phase I RFI Boreholes at MDA C

Inorganic Chemicals				
Borehole	Borehole Depth (ft)	Maximum Sample Depth (ft)	Maximum Depth of Inorganic > BV (ft)	Inorganic Chemicals > BV at Maximum Depth of Inorganic > BV
50-09100	316.0	163.1	43.5	CN @ 0.533 mg/kg
50-09101	82.7	81.0	69.3	Se @ 1.2 x BV
50-09102	77.8	77.8	0.0	None > BV
50-09103	84.9	82.6	43.8	Pb @ 1.4 x BV
50-09104	90.0	87.0	87.0	
50-09105	84.9	84.8	44.6	CN @ 0.26 mg/kg
50-09106	84.9	83.4	83.4	Tl @ 1.1 x BV
50-09107	83.4	78.5	34.3	Se @ 3.7 x BV
50-09108	84.9	81.3	68.9	CN @ 1.0 mg/kg
50-09109	84.9	81.1	47.4	Al @ 1.1 x BV, Ba @ 1.6 x BV, Ca @ 34 x BV, Cr @ 1.8 x BV, Co @ 1.2 x BV, Cu @ 6.6 x BV, Pb @ 1.01 x BV, Mg @ 1.6 x BV, Ni @ 2.0 x BV, Se @ 4.3 x BV, Tl @ 1.3 x BV
50-09110	85.5	84.0	57.1	Pb @ 6.7 x BV
Radionuclides				
Borehole	Borehole Depth (ft)	Maximum Sample Depth (ft)	Maximum Depth of Detected Radionuclide Other Than Tritium (ft)	Detected Radionuclides at Maximum Detected Depth
50-09100	316.0	163.1	43.5	Pu-239 @ 0.014 pCi/g (0.3 x FV)
50-09101	82.7	81.0	81.0	Am-241 @ 0.011 pCi/g (0.8 x FV)
50-09102	77.8	77.8	0.0	None detected
50-09103	84.9	82.6	82.6	Sr-90 @ 0.599 pCi/g (0.5 x FV)
50-09104	90.0	87.0	45.1	U-235 @ 2.6 x BV
50-09105	84.9	84.8	84.8	Pu-239 @ 0.080 pCi/g (1.5 x FV)
50-09106	84.9	83.4	83.4	Sr-90 @ 0.767 pCi/g (0.6 x FV)
50-09107	83.4	78.5	78.5	Am-241 @ 0.032 pCi/g (2.5 x FV)
50-09108	84.9	81.3	68.9	Pu-238 @ 0.014 pCi/g (0.6 x FV)
50-09109	84.9	81.1	81.1	Am-241 @ 0.056 pCi/g (4.3 x FV)
50-09110	85.5	84.0	46.5	U-235 @ 2.3 x BV

Table 3
Summary of Proposed Borehole Sampling

Borehole	Angle	Depth (ft)	Length (ft)	Number of Core Samples	Analytical Suites for Core Samples	Number of Subsurface Vapor Samples	Analytical Suites for Vapor Samples	Rationale for Location
A	45	140	200	9 2	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff. Dioxins, furans	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath Chemical Pit. Support extent of contamination at western end of Pit 6, especially 50-09109.
B	45	140	200	9	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath eastern end of Pit 6 (downgradient), especially beneath area of subsidence.
C	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath western end of Pit 5.
D	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath east-central area of Pit 5 (downgradient). Evaluate VOC tuff pore gas concentrations beneath area of high EMFLUX® surface flux.
E	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath Shaft Group 2.
F	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath central area of Pits 2 and 4.
G	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath eastern area of Pits 2 and 4 (downgradient).
H	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath central area of shaft group 3, and beneath western end of Pit 2.

Table 3 (continued)

Borehole	Angle	Depth (ft)	Length (ft)	Number of Core Samples	Analytical Suites for Core Samples	Number of Subsurface Vapor Samples	Analytical Suites for Vapor Samples	Rationale for Location
I	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath eastern area of Pits 1 and 3 (downgradient).
J	45	140	200	8	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOC, tritium vapor on silica gel	Establish nature and extent of contamination beneath eastern end of Shaft Group 1. No access to other portions of Shaft Group 1 because of Shaft Group 3 position and utilities along Pajarito Road.
K	90	150	150	5	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	5	SUMMA VOCs, tritium vapor on silica gel	Northern portion of Shaft Group 3 is potential source of near-surface tritiated water vapor measured at 50-03-21467; establish nature and extent of contamination at the north end of Shaft Group 3.
L	90	150	150	5	Iso-U, iso-Pu, Am-241, Sr-90, tritium, gamma spectroscopy, metals, cyanide, nitrates, perchlorate.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath central area of Pit 1. Angled drilling from near Pajarito Road prohibited by utilities.
M	90	800	800	—	Geotechnical parameters: <ul style="list-style-type: none"> Moisture and matric potential every 5 ft Chloride analysis every 20 ft Hydraulic conductivity, porosity, and bulk density—2 in Cerro Toledo interval, 5 in the Otowi Member, and 5 in Puye Formation 	5	SUMMA VOCs, tritium vapor on silica gel	Evaluate possible presence of perched water in an area near Ten Site Canyon. Evaluate vertical extent of VOCs and tritium in pore gas near borehole 50-09100. Obtain geotechnical data for modeling vadose-zone transport at MDA C.
N	90	150	150	5	Iso-U, iso-Pu, Am-241, Sr-90, gamma spectroscopy, metals, cyanide, nitrates, perchlorate in tuff.	2	SUMMA VOCs, tritium vapor on silica gel	Establish nature and extent of contamination beneath western end of Pit 1 and beneath Sr-90 disposal shaft.

Table 4
Summary of Proposed Alternatives to NMED Order Specifications and Justifications for Alternative

Item	NMED Order Specification	LANL Proposed Alternative	Justification for Alternative
1	A minimum of one boring shall be advanced at the following locations: 1) directly adjacent to the down-slope end of each pit; 2) at the lowest base elevation point of each disposal pit; 3) at the corners of each disposal pit, at 100-ft intervals along the sides of disposal pits 1 through 6; 4) at 70 ft intervals along the sides of the chemical pit; 5) at the ends of each shaft row; 6) at 50-ft intervals along each shaft row; and 7) adjacent to the location of the strontium-90 disposal shaft. Where practical, boring locations may be combined to address more than one of the requirements listed above. (Order Section IV.C.3.c.iii, Paragraph 1)	10 angled boreholes and 4 vertical boreholes at locations shown in Figure 10 to augment 9 angled and 3 vertical boreholes installed in Phase I RFI.	Proposed and Phase I boreholes are sufficient to meet objectives of investigation and drilling at many locations specified in Order is not possible. See Section 4.2.1 for detailed discussion of proposed boreholes.
2	The borings shall be advanced a minimum of 25 ft below the deepest detected vapor-phase, soil, rock, or groundwater contamination as detected by field screening or previous investigations, whichever is deeper. (Order Section IV.C.3.c.iii, Paragraph 6)	Proposed borehole depths are based on evaluation of Phase I data (Section 2.7.3) and are sufficient to define nature and extent of contamination per the requirements of the NMED Position Paper (Appendix G).	The specification in the Order is inconsistent with the NMED Position Paper and is not necessary to establish nature and extent. See Section 4.2.1 for additional details.
3	Each borehole shall be characterized using geophysical logging techniques approved by the Department. (Order Section IV.C.3.c.iii, Paragraph 7)	Proposed boreholes will not be logged.	Two boreholes installed during Phase I RFI were geophysically logged. Examination and geologic logging of continuous core from proposed boreholes will provide geologic information needed to meet objectives of investigation and geophysical logging is not necessary.
4	Each boring shall be completed as a vapor monitoring well. The screened intervals or sample port locations and methods and materials used to construct each vapor monitoring well shall be based upon information obtained during drilling activities and open-hole vapor sampling field screening results, and shall be approved by the Department prior to well construction. (Order Section IV.C.3.c.iii, Paragraph 9)	Subsurface vapor samples will be collected from each borehole immediately after drilling activities are completed, and approximately one month later. Based on analysis of these results, specific boreholes will be identified for completion as vapor monitoring boreholes.	Design of a vapor monitoring program should be based on evaluation of subsurface vapor data. Completion of all boreholes as vapor monitoring wells is not necessary to implement an effective monitoring program. See Section 4.2.2 for additional details.

Table 4 (continued)

Item	NMED Order Specification	LANL Proposed Alternative	Justification for Alternative
5	At a minimum, two borings shall be advanced at MDA C to evaluate the presence of intermediate perched groundwater and vapor-phase contamination at depth beneath the site. The boring locations, depth of the boring, the drilling and sampling program and the well design shall be approved by the Department prior to the start of drilling activities. (Order Section IV.C.3.c.iii, Paragraph 10)	One 800-ft vertical borehole will be installed to verify absence of perched aquifer. This borehole, and existing Phase I borehole 50-09100, which was installed to a depth of approximately 315 ft, will be used to evaluate vapor phase contamination at depth.	Previous investigations on Mesita del Buey have not encounter perched aquifers and none is expected below MDA C (see Section 3.3.2.3.1). Based on the size of MDA C, one 800-ft boring is sufficient to determine that a perched aquifer is not present below MDA C. Based on evaluation of the Phase I subsurface vapor data (Section 2.7.3), one deep borehole is sufficient to characterize vapor contamination at depth. See Section 4.2.1 for additional details.
6	At a minimum, one TA-50-specific well shall be installed that intersects the regional aquifer at a location approved by the Department. The well shall be located generally east or southeast of MDA C. (Order Section IV.C.3.c.iii, Paragraph 11)	No regional well will be installed as part of the MDA C investigation. Existing regional well R-14 will be used.	Well R-14 was installed downgradient of MDA C (Figure 5) as part of the Hydrogeologic Work Plan for LANL and no additional wells are needed to evaluate potential impacts to the regional aquifer from MDA C.
7	Soil and rock samples shall, at a minimum, be obtained from each boring at ten-ft intervals, from the bedrock directly below the base elevation of each pit or shaft, and from the maximum depth of each boring. (Order Section IV.C.3.c.iv, Paragraph 1)	Continuous core samples will be collected from each borehole.	Collection of continuous core provides better stratigraphic data than collection of samples at discrete intervals.
8	The samples shall be collected and screened in accordance with the methods described in Section IX.B of this Order. (Order Section IV.C.3.c.iv, Paragraph 2)	Samples will be screened by visual inspection and radioactivity.	Based on the low levels of contaminants detected during the Phase I RFI, the screening methods specified in Section IX.B (head space VOC analysis, X-ray fluorescence) would not be effective. See Section 4.2.3 for additional details.

Table 4 (continued)

Item	NMED Order Specification	LANL Proposed Alternative	Justification for Alternative
9	A minimum of two samples per 100 ft of drilling depth shall be selected from each boring for laboratory analysis. The samples submitted for laboratory analyses shall be analyzed for VOCs, SVOCs, pH, HE compounds, PCBs, dioxins, furans, nitrates, perchlorate, TAL metals, total uranium, cyanide, and radionuclides. The selection of the samples shall include those locations outlined in Paragraphs 5 through 9 below. (Order Section IV.C.3.c.iv, Paragraph 4)	Samples will be collected at approximate 20-ft intervals for laboratory analysis as indicated in Table 3. Core samples will not be analyzed for VOCs, SVOCs, pH, HE, and PCBs and limited samples will be analyzed for dioxins and furans.	Based on the Phase I RFI data, the nature and extent of subsurface SVOC and PCB contamination has been established per the requirements of the NMED Position Paper (Section 2.7.3). Pore gas monitoring will be used to determine the nature and extent of subsurface VOC contamination in lieu of VOC analysis of core samples because it produces more representative results (Section 2.7.3). Based on results of Phase I RFI screening results for HE and the operational history analysis for HE is not necessary (see Section 4.2.4 for additional details). Samples collected beneath the Chemical Pit will be analyzed for dioxins and furans as fires at the Chemical Pit are the most likely source of dioxins and furans at MDA C.
10	The samples displaying the greatest field screening evidence of contamination shall be selected for submittal to the analytical laboratory for analysis of the analytes listed in Paragraph 4 above. (Order Section IV.C.3.c.iv, Paragraph 5)	Samples will be collected at approximate 20-ft intervals for laboratory analysis as indicated in Table 3.	As described in Item 8, samples will be screened for radioactivity, but this screening is being performed for health and safety and sample transportation reasons. Based on the results of the Phase I RFI, field screening methods are not sufficiently sensitive to identify samples to be submitted for laboratory analysis. See Section 4.2.3 for additional details. See Item 9 for discussion of analytical suites.
11	If field-screening evidence of contamination is not observed in a boring, the sample obtained from the bedrock directly below the base elevation of each pit or shaft shall be submitted for chemical analysis of the analytes listed in Paragraph 4 above. (Order Section IV.C.3.c.iv, Paragraph 6)	Samples will be collected at approximate 20-ft intervals for laboratory analysis as indicated in Table 3.	The use of 20-ft sample intervals, combined with the existing Phase I RFI data, will be sufficient to establish nature and extent of contamination, as specified by the NMED Position Paper (Appendix G). See Item 9 for discussion of analytical suites.
12	The sample obtained from the maximum depth of each boring also shall be submitted to an analytical laboratory for analysis of the analytes listed in Paragraph 4 above. (Order Section IV.C.3.c.iv, Paragraph 7)	Samples will be collected at approximate 20-ft intervals for laboratory analysis as indicated in Table 3.	See Item 9 for discussion of analytical suites.

Table 4 (continued)

Item	NMED Order Specification	LANL Proposed Alternative	Justification for Alternative
13	The sample obtained from the maximum depth in each boring that displays field screening evidence of contamination shall be submitted to an analytical laboratory for analysis of the analytes listed in Paragraph 4 above. (Order Section IV.C.3.c.iv, Paragraph 8)	Samples will be collected at approximate 20-ft intervals for laboratory analysis as indicated in Table 3.	See Item 8 for discussion of applicability of field screening for identification of samples for analysis. See Item 9 for discussion of analytical suites.
14	Samples obtained from high permeability units such as surge beds, fracture zones, and pumice beds shall be submitted to an analytical laboratory for analysis of the analytes listed in Paragraph 4 above. (Order Section IV.C.3.c.iv, Paragraph 8)	Samples will be collected at approximate 20-ft intervals for laboratory analysis as indicated in Table 3. This frequency should be sufficient to assure that samples are collected in all geologic units. Fracture zones will be sampled as described in Section 5.	See Item 9 for discussion of analytical suites.
15	An investigation vapor monitoring and sampling work plan shall be prepared in accordance with the format described in Section XI.B of this Order and submitted by the Respondents to the Department for approval. (Order Section IV.C.3.c.v, Paragraph 2)	See response to item 4.	See response to item 4.
16	Vapor sampling shall be conducted at MDA C in each existing and newly constructed vapor well and boring. (Order Section IV.C.3.c.v, Paragraph 3)	Vapor sampling will be conducted at each newly constructed boring. Existing vapor wells will not be sampled.	Previous sampling of the two existing vapor wells at MDA C has shown that results do not change appreciably over time (see Appendix B). Therefore, resampling of the existing wells is not necessary.
17	The Respondents shall construct a minimum of one intermediate depth groundwater monitoring well at MDA C if evidence of perched groundwater is observed during the drilling of the two borings drilled to evaluate for the presence of intermediate perched groundwater or during drilling of the regional groundwater monitoring well. (Order Section IV.C.3.c.vi)	One 800-ft borehole will be advanced to investigate the presence/absence of a perched aquifer. If a perched aquifer is determined to be present, this borehole will be completed as a monitoring well.	See Item 5.
18	The Respondents shall, at a minimum, construct one monitoring well associated with MDA C and TA-50 intersecting the regional aquifer in accordance with Section X of this Order. (Order Section IV.C.3.c.vii)	No regional well will be installed as part of the MDA C investigation. Existing regional well R-14 will be used.	See Item 6.

Table 5
Comparison of Borehole Locations Specified in November 26, 2002 NMED Order and Existing and Proposed Boreholes

Pit/Shaft Field	Borehole Locations Specified in Order	Number of Boreholes to Meet Order Specifications	Phase I RFI and Proposed WP Boreholes	Deviations from Order
Pit 1	Downslope end, lowest base elevation, corners, and 100-ft interval along sides.	5 vertical – south side of Pit 1. 4 vertical – each corner of Pit 1. (Length of E and W ends is less than 100 ft. Downslope ends and lowest elevations included with corners. N side included with SG2.)	3 vertical – S side of Pit 1 (boreholes 50-09104 and L) and SW corner (borehole N). 2 angled – SE and NE corners (boreholes I and J, respectively).	2 boreholes vs. 5 on S side based on Phase I RFI results. Angled boreholes vs. vertical boreholes at NE and SE corners to extend sample coverage. No borehole at NW corner due to insufficient drilling space.
SG 2	Each end of shaft row and 50-ft interval along shaft row.	2 vertical – each end of shaft row. 10 vertical – at 50-ft intervals.	1- angled borehole beneath E end of shaft rows extending 200 ft (borehole J).	1 angled borehole at E end vs. 1 vertical borehole at E end and 4 vertical boreholes at 50 ft intervals along E end due to insufficient drilling space for vertical boreholes along shaft row. No vertical borehole at W end or along W and central shaft field due to insufficient drilling space.
Pit 3	Downslope end, lowest base elevation, corners, and 100-ft interval along sides.	5 vertical – N side of Pit 3. 2 vertical – NE and NW corners of Pit 3. (Length of E and W ends is less than 100 ft. SE and SW corners included with Pit 1. Downslope ends and lowest elevations included with corners. S side included with SG2.)	3 angled – NW and NE corners and E end (boreholes 50-09105, 50-09103, and I, respectively).	1 angled borehole beneath E end vs. 5 boreholes along N side due to insufficient drilling space along N side and W end. Angled boreholes vs. vertical boreholes at NE and NW corners to increase sample coverage beneath Pit 3.

Table 5 (continued)

Pit/Shaft Field	Borehole Locations Specified in Order	Number of Boreholes to Meet Order Specifications	Phase I RFI and Proposed WP Boreholes	Deviations from Order
Pit 2	Downslope end, lowest base elevation, corners, and 100-ft interval along sides.	5 vertical – N side of Pit 2. 2 vertical – NE and NW corners of Pit 2. (Length of E and W ends is less than 100 ft. SE and SW corners included with Pit 3. Downslope ends and lowest elevations included with corners.)	2 angled – N side of Pit 2 (boreholes F and G).	2 angled boreholes vs. 5 vertical boreholes on N side due to insufficient drilling space and to extend sample coverage beneath Pit 2. No vertical borehole at NW corner due to insufficient drilling space. No vertical borehole at NE corner due to angled borehole under east end (G).
Pit 4	Downslope end, lowest base elevation, corners, and 100-ft interval along sides.	5 vertical – N side of Pit 4. 2 vertical – NE and NW corners of Pit 4. (Length of E and W ends less than 100 ft. SE and SW corners include with Pit 2. Downslope ends and lowest elevations included with corners.)	3 angled – N side of Pit 4 (borehole F), NE corner (borehole G), and NW corner (borehole 50-09106).	1 angled borehole vs. 5 vertical boreholes on N side based on Phase I RFI results. 1 angled borehole vs. 1 vertical borehole at NE corner to extend sample coverage beneath E ends of Pits 4 and 2. 1 angled borehole vs. 1 vertical borehole at NW corner to extend sample coverage beneath SG3 and W end of Pit 4 and insufficient drilling space adjacent to W end of Pit 4.
SG1	Each end of shaft row and 50-ft intervals along shaft row.	2 vertical – each end of shaft row. 2 vertical – at 50-ft intervals.	1- angled (borehole E)	1 angled borehole under entire length of shaft row vs. 4 vertical boreholes to improve sampling coverage.

Table 5 (continued)

Pit/Shaft Field	Borehole Locations Specified in Order	Number of Boreholes to Meet Order Specifications	Phase I RFI and Proposed WP Boreholes	Deviations from Order
Pit 5	Downslope end, lowest base elevation, corners, and 100-ft interval along sides.	6 vertical – N side of Pit 5 1 vertical – E end of Pit 5. 1 vertical – W end of Pit 5. 2 vertical – NE and NW corners of Pit 5 (S side included with SG2 and Pit 4. SE corner included with Pit 4. SW corner included with N end of SG3. Downslope ends and lowest elevations included with corners and ends.)	3 angled – N side of Pit 5 (boreholes D and 50-09102) and west end of Pit 5 (C). 2 vertical – N side of Pit 5 (boreholes M and 50-09100).	2 angled and 2 vertical boreholes vs. 6 vertical boreholes on N side based on Phase I RFI results and to extend sample coverage under Pit 5. No vertical borehole at E end due to angled borehole beneath E end from N side (50-09102). 1 angled borehole vs. 1 vertical borehole beneath W end to extend sample coverage beneath Pit 5. No vertical boreholes at NE and NW corners due to angled boreholes beneath E and W ends of Pit 5.
SG 3	At ends of each shaft row and at 50-ft intervals along each shaft row.	2 vertical – ends of western shaft rows. 1 vertical – Middle of western shaft row. 1 vertical – N end of eastern shaft row. (Eastern shaft row except N end included with west corners of Pits 1-4.)	1 vertical – N end of eastern shaft row (borehole K). 1 angled – Beneath western shaft row (borehole H).	1 angled borehole beneath western shaft row vs. 3 vertical boreholes at ends and middle of western shaft row to increase sample coverage beneath western shaft row, S end of eastern shaft row, SW corner of Pit 1 and Sr-90 Shaft.

Table 5 (continued)

Pit/Shaft Field	Borehole Locations Specified in Order	Number of Boreholes to Meet Order Specifications	Phase I RFI and Proposed WP Boreholes	Deviations from Order
Pit 6	Downslope end, lowest base elevation, corners, and 100-ft interval along sides.	4 vertical – N side of Pit 6 4 vertical – S side of Pit 6 3 vertical – NE, NW, and SW corners of Pit 6 (Length of E and W ends less than 100 ft. SE corner of Pit 6 included with Pit 5. Downslope ends and lowest elevations included with corners.)	6 angled – NE corner (borehole 50-09101), NW corner (borehole 50-09110), SW corner (borehole 50-09109), and S side (boreholes 50-09107, A, and B).	No vertical boreholes on N side vs. angled boreholes at NE and NW corners that extend under N side and two angled boreholes extending under Pit 6 to N side from S. Insufficient drilling space to drill on N side other than at corners. 3 angled boreholes vs. 4 vertical boreholes on S side to extend sampling coverage beneath Pit 6. Angled boreholes vs. vertical boreholes at NE, NW, and SW corners to extend sampling coverage beneath Pit 6.
Chemical Pit	Downslope end, lowest base elevation, corners, and 70-ft interval along sides.	2 vertical – S side of Chemical Pit. 2 vertical – SE and SW corners of Chemical Pit. (Length of E and W ends less than 70 ft. NE and NW corners of Chemical Pit included with Pit 6. Downslope ends and lowest elevations included with corners.)	2 angled – S side boreholes 50-09108 and A). 1 vertical – S side (borehole 50-10131)	2 angled and 1 vertical vs. 2 vertical boreholes on S side to extend sample coverage beneath Chemical Pit. No vertical boreholes at SE and SW corners because of use of angled boreholes beneath Chemical Pit.
Sr-90 Shaft	Adjacent to Sr-90 shaft	None – Sr-90 Shaft included with SW corner of Pit 1 (borehole N).	Addressed with Pit 1 (borehole N).	None.
TOTAL		75 vertical.	19 angled and 7 vertical (9 angled and 3 vertical in Phase I RFI, 10 angled and 4 vertical in IWP).	

Table 6
Summary of Radiological Field Screening Results for Samples Submitted for Laboratory Analysis of Radionuclides

Radiological Field Screening Results	Samples Within Radionuclides Other Than Tritium Within Background Range	Samples With Radionuclides Other Than Tritium Above Background
Alpha (cpm)		
Range	0–3	0–2
Median	1	1
Average	0.8	0.7
Beta/Gamma (cpm)		
Range	120–220	140–210
Median	180	165
Average	177	170

Appendix A

Acronyms, Glossary, and Metric Conversion Table

APPENDIX A ACRONYMS, GLOSSARY, AND METRIC CONVERSION TABLE

ACRONYMS

AB	authorization basis
ALLH	all-soil horizon
AOC	area of concern
ARS	American Radiation Services of New Mexico
B&K	Brüel and Krajer
bgs	below ground surface
BV	background value
CI	confidence interval
CMS	corrective measure study
COPC	chemical of potential concern
DL	detection limit
DOT	(US) Department of Transportation
dpm	disintegrations per minute
DU	depleted uranium
EM	electromagnetic
EPA	(US) Environmental Protection Agency
ER	Environmental Restoration (Project)
EQL	estimated quantitation limit
FV	fallout value
GPR	ground-penetrating radar
GPS	global-positioning system
HE	high explosive
HIR	historical investigation report
HSWA	Hazardous and Solid Waste Amendments of 1984
ICPMS	inductively coupled plasma/mass spectroscopy
ICPES	inductively coupled plasma emission spectroscopy
IDW	investigation-derived waste
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory (designation of the Laboratory before January 1, 1981)
LIR	Laboratory Implementation Requirement
mb	millibar
MDA	material disposal area
MDA	minimum detectable activity

MTADS	multisensor towed array detection system
NMED	New Mexico Environmental Department
NMHW	New Mexico Hazardous Waste Act
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
ppmv	parts per million by volume
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RLWTF	Radioactive Liquid Waste Treatment Facility
RRES-MAQ	Risk Reduction and Environmental Stewardship—Meteorology and Air Quality
RRES-RS	Risk Reduction and Environmental Stewardship—Remediation Services
SAP	sampling and analysis plan
scfm	standard cubic feet per minute
SOP	standard operating procedure
SVOC	semivolatile organic compound
TA	technical area
TAL	target analyte list (EPA)
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TLD	thermoluminescent dosimeters
TNT	trinitrotoluene
UC	University of California
USGS	United States Geological Survey
UTL	upper tolerance limit
VOC	volatile organic compound
WCSF	Water Characterization Strategy Form
XRF	x-ray fluorescence

GLOSSARY

Background value (BV). The upper tolerance limits (UTLs) of background sample results, calculated as the upper 95% confidence limit for the 95th percentile. When a UTL cannot be calculated, either the detection limit or the maximum reported value is used as a BV; BVs are used as simple threshold numbers to identify potentially contaminated site sample results that are greater than background levels in that geological sample medium (or group of media). Most inorganic chemicals and radionuclides have BVs.

Baseline risk assessment (also known as risk assessment). A site-specific analysis of the potential adverse effects of hazardous substances that are released from a site in the absence of any control or mitigation actions. A baseline risk assessment consists of four steps: data collection and analysis, exposure assessment, toxicity assessment, and risk characterization.

Calibration. Process used to identify the relationship between the true (reference) analyte concentration or other variable and the response of a measurement instrument, chemical analysis method, or other measurement systems.

Chemical of potential concern (COPC). A chemical detected at a site that has the potential to adversely affect human *receptors* because of its concentration, distribution, and mechanism of toxicity. A COPC remains a concern until *exposure* pathways and receptors are evaluated in a site-specific human health risk assessment.

Chemical of potential ecological concern (COPEC). A chemical detected at a site that has the potential to adversely affect ecological *receptors* because of its concentration, distribution, and mechanism of toxicity.

Data validation. Systematic process that applies a defined set of performance-based criteria to a body of data and may result in qualification of the data. The data validation process is performed independently of the analytical laboratory that generates the data set and occurs before conclusions are drawn from the data. The process may comprise a standardized data review (routine data validation) and/or a problem-specific data review (focused data validation).

Department of Energy (DOE). Federal agency that sponsors energy research and regulates nuclear materials for weapons production.

Detection limit (DL). Minimum concentration that can be determined by a single measurement by an instrument; it implies a specified statistical confidence that the analytical concentration is greater than zero.

Dose. Quantity of radiation that is absorbed, per unit of mass, by the body or by any portion of the body.

Ecological screening level (ESL). An organism's exposure-response threshold for a given chemical constituent. The concentration of a substance in a particular medium corresponds to a hazard quotient (HQ) of 1.0 for a given organism below which no risk is indicated.

Environmental Protection Agency (EPA). Federal agency responsible for enforcing environmental laws. While state regulatory agencies may be authorized to administer some of this responsibility, the EPA retains oversight authority to ensure protection of human health and the environment.

Groundwater. Water in a subsurface saturated zone; water beneath the regional water table.

Hazard index (HI). The sum of hazard quotients for multiple contaminants to which a receptor (j) is determined to be exposed, i.e., $HI_j = \sum_i HQ_{ij}$.

Hazard quotient (HQ). The ratio of a calculated exposure (E) to or dose (D) from a given *contaminant* (I) to a given *receptor* (j) over a reference value (TRV) for contaminant (I) determined to be protective of receptor (j), i.e., $HQ_{ij} = E_{ij} \text{ [or } D_{ij}] \text{ TRV}_{ij}$.

Migration. The movement of inorganic and organic species through unsaturated or saturated materials.

Model. A mathematical approximation of a physical, biological, or social system.

National Pollutant Discharge Elimination System (NPDES). The national program for both issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits and imposing requirements under Sections 307, 318, 402, and 405 of the Clean Water Act.

Polychlorinated biphenyls (PCBs). Any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances containing such substances. PCBs are colorless, odorless compounds that are chemically, electrically, and thermally stable and have proven to be toxic to both humans and animals.

Quality assurance (QA). All those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily in service.

Quality control (QC). (1) All those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements. QC is the process through which actual quality performance is measured and compared with standards. (2) All methods and procedures used to obtain accurate and reliable results from environmental sampling and analysis. Includes rules for when, where, and how samples are taken; sample storage, preservation and transport; and the use of blanks, duplicates, and split samples during the analysis.

Radionuclide. A nuclide (species of atom) that exhibits radioactivity.

RCRA facility investigation (RFI). The investigation that determines if a *release* has occurred and the nature and extent of the contamination from such a release at a hazardous waste facility. The RFI is generally equivalent to the remedial investigation portion of the Comprehensive Environment Response, Compensation, and Liability Act (CERCLA) process.

Receptor. A person, plant, animal, or geographical location that is exposed to a chemical or physical agent released to the environment by human activities.

Regional aquifer. Geologic material(s) or unit(s) of regional extent whose saturated portion yields significant quantities of water to wells, contains the regional zone of saturation, and is characterized by the regional water table or potentiometric surface.

Release. Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous waste or hazardous constituents into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles that contain any hazardous wastes or hazardous constituents).

Resource Conservation and Recovery Act (RCRA). The Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976. (40 CFR 270.2)

Sample. A portion of a material (e.g., rock, soil, water, air), which, alone or in combination with other samples, is expected to be representative of the material or area from which it is taken. Samples are typically sent to a laboratory for analysis or inspection or are analyzed in the field. When referring to samples of environmental media, the term "field sample" may be used.

Screening action level (SAL). Medium-specific concentration level for a chemical derived using conservative criteria below which it is generally assumed that there is no potential for unacceptable *risk* to human health. The derivation of a SAL is based on conservative exposure and land-use

assumptions. However, if an applicable regulatory standard exists that is less than the value derived by risk-based computations, it will be used for the SAL.

Screening assessment. A process designed to determine whether contamination detected in a particular medium at a site may present a potentially unacceptable human-health and /or ecological risk. The assessment utilizes screening levels that are either human-health or ecologically based concentrations derived by using chemical-specific toxicity information and standardized exposure assumptions below which no additional actions are generally warranted.

Sediment. (1) A mass of fragmented inorganic solid that comes from the weathering of rock and is carried or dropped by air, water, gravity, or ice; or a mass that is accumulated by any other natural agent and that forms in layers on the earth's surface such as sand, gravel, silt, mud, fill, or loess. (2) A solid material that is not in solution and either is distributed through the liquid or has settled out of the liquid.

Site conceptual model. A qualitative or quantitative description of sources of contamination, environmental transport pathways for contamination, and biota that may be impacted by contamination (called receptors) and whose relationships describe qualitatively or quantitatively the release of contamination from the sources, the movement of contamination along the pathways to the exposure points, and the uptake of contaminant by the receptors.

Standard operating procedure (SOP). A document that details the method for an operation, *analysis*, or action with thoroughly prescribed techniques and steps, and is officially approved as the method for performing certain routine or repetitive tasks.

Target analyte. An element, chemical, or parameter, the concentration, mass, or magnitude of which is designed to be quantified by use of a particular test method.

Technical area (TA). The Laboratory established technical areas as administrative units for all its operations

Topography. The physical configuration of the land surface in an area.

Tuff. A compacted deposit of volcanic ash and dust that contains rock and mineral fragments accumulated during an eruption.

US Department of Energy (DOE). Federal agency that sponsors energy research and regulates nuclear materials for weapons production. [Already listed under DOE]

US Environmental Protection Agency (EPA). Federal agency responsible for enforcing environmental laws. While state regulatory agencies may be authorized to administer some of this responsibility, the EPA retains oversight authority to ensure protection of human health and the environment.[Already listed above]

Vadose zone. The unsaturated zone. Portion of the subsurface above the water table in which pores are not fully saturated.

METRIC CONVERSION TABLES**Metric to English Conversions**

Multiply SI (Metric) Unit	by	To Obtain US Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (μm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram ($\mu\text{g/g}$)	1	parts per million (ppm)
liters (l)	0.26	gallons (gal.)
milligrams per liter (mg/l)	1	parts per million (ppm)
degrees Celsius ($^{\circ}\text{C}$)	$9/5 + 32$	degrees Fahrenheit ($^{\circ}\text{F}$)

Appendix B

Historical Investigation Report

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APPENDIX B HISTORICAL INVESTIGATION REPORT

This historical investigation report (HIR) provides a summary of the field investigations and associated environmental data collected to date for Material Disposal Area (MDA) C. The purpose of the HIR is to provide supporting information for the proposed sampling design necessary to complete the MDA C investigation as presented in Section 4 of this investigation work plan (hereafter, the work plan).

B-1.0 MDA C DISPOSAL UNIT INFORMATION (OPERATIONAL HISTORY)

MDA C operated from May 1948 to April 1974 but received waste only intermittently from 1968 to 1974 before it was decommissioned in 1974. Wastes disposed of at MDA C included liquids, solids, and gases generated from a broad range of nuclear energy research and development activities conducted at the former Los Alamos Scientific Laboratory (LASL), now the Los Alamos National Laboratory (LANL or the Laboratory), including uncontaminated classified materials, metals, hazardous materials, and radionuclides. MDA C consists of seven pits, with depths ranging from 12 to 25 ft below the original ground surface and 108 shafts with depths ranging from 10 to 25 ft below the original ground surface. The dimensions of pits and shafts based on LASL Engineering Drawing ENG-R 1264 (LASL 1970, 76047) are listed in Table B-1. The pits and shafts were excavated into the overlying soil and the Tshirege Member of the Bandelier Tuff and were unlined, except for Shafts 98-107, which were lined with 12-in. thick concrete. In 1959, permanent markers consisting of metal stakes with numbered tags were placed next to each shaft in 1959. The shafts were sealed by filling them with crushed tuff, followed by concrete (p. C-3, Rogers 1977, 0216). The pits were filled with crushed tuff when they were decommissioned.

Fill dirt was used to cover the material disposed in the pits as they were being filled. The dirt acted as a temporary cover. A 1959 memo indicates that Pit 6 received approximately 10,000 yd³ of waste and 24,000 yd³ of fill dirt, an approximate ratio of 2.5 yd³ of fill to 1.0 yd³ of waste material that was typical of MDA C operations (p. C-3, Rogers 1977, 0216). When MDA C was decommissioned in 1974, most of the surface was covered with crushed tuff and fill, and the new surface was recontoured and seeded with a native grama grass mixture.

B-1.1 Waste Inventory and Disposal History

Waste disposal records for MDA C from 1948 to 1974 are found in LASL logbooks 2587, 3478, 4644, 6030, 7277, 8453, 9293, 9593, and 12422 (LANL 2003, 76035). These logbooks were used to record information on the type, date, location, and volume of waste placed in MDA C. Records prior to 1954 are incomplete and most logbook entries contain only brief descriptions of the wastes disposed at MDA C. Historical reports (Rogers, 1977, 0216) indicate that it was common practice for chemicals to be burned in the chemical disposal pit at MDA C. Hazardous constituents and uncontaminated classified material were buried with radioactive contaminated material. Routine radioactive contaminated trash disposed at MDA C consisted of cardboard boxes, 5-mil plastic bags of waste generated in LASL chemistry labs, and 55-gal. barrels of sludge from wastewater treatment plants at Building 35 at TA-21, DP West/TA-21, and TA-45. Nonroutine contaminated waste included debris from the demolition of Bayo site and TA-1, classified materials, and tuballoy chips (p. C-3, Rogers 1977, 0216). Waste inventory information gleaned from the logbooks is summarized in the approved Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) work plan for Operable Unit (OU) 1147 (pp. 2-52–2-56, LANL 1992, 07672). The logbooks are currently being reviewed to estimate the specific quantities of individual contaminants in the MDA C disposal inventory. An updated inventory will be presented in the MDA C Investigation Report.

B-1.1.1 MDA C Disposal Pit Inventory

Disposal pits at MDA C were used to dispose of hazardous wastes, uncontaminated classified materials, and radioactive materials. Operating dates for each disposal pit and a discussion of the waste inventory for each disposal pit compiled from disposal records for MDA C follows.

Pit 1 (Nov 1948–Sept 1951)

From LASL logbooks 2587 and 3478: trichloroethylene (TCE), boron, sulfuric acid, graphite, medical laboratory solutions, contaminated materials and trash, tritium, americium-241, uranium, classified material, plutonium, cyanide, mercury, radium-226, acids, lead, and waste oil.

Pit 2 (Apr 1950–Sept 1951)

From LASL logbooks 2587 and 3478: TCE and contaminated materials and trash, boron, tritium, americium-241, uranium, sulfuric acid, biological waste, graphite, classified material, plutonium, cyanide, mercury, radium-226, acids, lead, and waste oil.

Pit 3 (Oct 1951–Apr 1953)

From LASL logbooks 4644: mercury teplers, tritium-contaminated glassware, cyanide solutions, contaminated materials and trash, TCE, boron, americium-241, uranium, sulfuric acid, biological waste, graphite, classified material, plutonium, radium-226, acids, lead, waste oil, and beryllium.

Pit 4 (Oct 1951–Feb 1955)

From LASL logbooks 4644 and 6030: tritium-contaminated glassware, boxes and urine samples, mercury teplers, actinium-227, vials of radium-226, cyanide and cyanide solutions, a 5-gal. can of actinium waste, empty bottles, contaminated materials and trash, TCE, boron, americium-241, uranium, sulfuric acid, biological waste, graphite, classified material, plutonium, acids, lead, waste oil, silver, and beryllium.

Pit 5 (Apr 1953–Sept 1959)

From LASL logbooks 6030, 7277, and 9593: batteries (acids and lead), a 5-gal. can of actinium-227 waste, lead bricks, vials of radium-226, zirconium shavings, cyanide and cyanide solutions, radionuclide-contaminated waste oil, empty bottles, silver nitrate, beryllium chips, tritium-contaminated boxes and urine samples, contaminated materials and trash, TCE, boron, americium-241, uranium, sulfuric acid, biological waste, graphite, classified material, and plutonium.

Pit 6 (Oct 1956–Sept 1959)

From LASL logbooks 9593, 11363, and 9293: radionuclide-contaminated oil, tritium-contaminated oil, copper sheets, cobalt chips, bottles of cadmium-boron tungstate, tritium-contaminated boxes and cans, a can of oil, approximately 100 curies (Ci) of source-strength cobalt-60, a lanthanum source, 10 bottles of platinum chloride, beryllium chips, carbon-14-contaminated graphite, a plutonium slug, contaminated materials and trash, TCE, boron, americium-241, uranium, sulfuric acid, biological waste, classified material, mercury, actinium-227, radium-226, acids, and lead.

Chemical Pit (early 1960–June 1964)

No logbook entries were made for specific wastes disposed of in the Chemical Pit at MDA C. The following quotes were recorded in the approved RFI Work Plan for OU 1147 (p. 2-54, LANL 1992, 07672): the area "was used for burial of a variety of chemicals, pyrophoric metals, natural uranium powders and hydrides, sealed vessels containing sodium-potassium alloy, compressed gases, and unspecified equipment. . . . Undoubtedly, some plutonium- and uranium-contaminated objects were inadvertently placed in the pit. . . . No high explosives were ever interred in this pit. . . . Low-level radioactive waste placed in the pit may have included cardboard boxes containing materials from the chemistry labs, as well as 55-gal. barrels of sludge from the waste treatment plants at Building 35, DP West, and TA-45."

B-1.1.2 MDA C Disposal Shaft Inventory

The disposal shafts at MDA C were primarily used for disposal of beta- and gamma-contaminated waste from the Chemical Metallurgy Research Building at TA-35; however, other Laboratory groups used the MDA C shafts for waste disposal as well. The activity of solid radioactive wastes disposed in the MDA C shafts between 1959 and 1972, decay-corrected to January 1989, includes 20,000 Ci tritium, 0.58 Ci sodium-22, 2.4 Ci cobalt-60, 21 Ci strontium-90/yttrium-90, 1 Ci radium-226, 5 Ci uranium-233, <0.1 Ci uranium-234, -235, -236, and -238, 50 Ci fission products, and 200 Ci of activation products. All of the shafts were unlined with the exception of Shafts 98–107, which were lined with 12-in. thick concrete. A single disposal shaft was drilled at MDA C solely for disposing of a single strontium-90 source in the 1950s or 1960s. Three groups of shafts were used sequentially over time. The Shaft Group 1 consists of 12 shafts numbered 56–67. These shafts were originally numbered 1–12; however, they were renumbered in 1962 to be sequential with subsequent shafts. Shaft Group 1 is south of Pit 5. Shaft Group 2 consists of Shafts 1–55, which are located between Pits 1 and 3. Shaft Group 3 (Shafts 68–107) is west of Pits 1 through 4.

Operating dates for each shaft group and a discussion of the waste inventory for each group of disposal shafts compiled from disposal records for MDA C follows.

Shaft Group 1 (Shafts 56–67 [Feb 1959–Oct 1959])

From LASL logbook 9593: Barium, tritium, radium, lanthanum-140, strontium-89 and -90, tantalum, cerium waste, two cerium sources, fission products, one lanthanum-140 static source, phosphoric acid, depleted uranium (DU), a charcoal trap, and polonium-beryllium-fluorine compounds.

Shaft Group 2 (Shafts 1–55 [Nov 1959–May 1967])

From LASL logbooks 9593 and 11363: barium-140, lanthanum-140, fission products from the Omega reactor, uranyl phosphate, graphite slugs, a cobalt-60 capsule, radioactive graphite, radioactive tantalum, 1 g of irradiated plutonium, thallium, irradiated uranium graphite, lead-beryllium sources, thorium, cesium, strontium, plasma thermocouples, fuel elements (rods), cobalt-60 slugs and sources, sulfuric acid solution, zirconium carbide, a copper sphere, two "rabbit" tubes of beryllium ("rabbits" are containers placed in a reactor neutron flux to irradiate the contents), reactor seals, alpha emitters in solution, acid solutions, actinium components, various uranium isotopes, depleted uranium, cerium-141, yttrium, silver-110, sodium-22, cesium-137, cesium-144, plutonium waste, or alloy (enriched uranium from Oak Ridge), benzene, isopropyl alcohol, neptunium-237, contaminated materials and trash, americium-241, biological waste, classified material, radium-226, lead, silver, and "induced activity" (activation products, usually from a linear accelerator).

Shaft Group 3 (Shafts 68–107 [Oct 1962–Feb 1966])

From LASL logbooks 11363 and 12442: plutonium-contaminated trash, fission products, aluminum sheets and tubes, acids, cesium-137, sodium, cobalt-60, antimony, lanthanum-140, cobalt-60 sources, polonium, beryllium, vacuum pump oil, empty glass bottles, graphite, plutonium, boron, fuel element end caps, thermocouples, acetone, uranium, zirconium carbide, zinc and aluminum residues, barium, irradiated tantalum, tuballoy (a uranium alloy), shell waste, yttrium-91, radioactive chemicals and organic solutions, hydrochloric acid waste, plutonium in ether solution, zinc and mercury solutions, DU chips, miscellaneous sources, or alloy solution, iridium-192, tantalum, indium-114, animal tissues, solvents, a LAMPRE rod assembly, waste oil, detonator components, NRX (Navy experiment) reactor parts, trinitrotoluene (TNT) element samples, americium-242, aluminum-105, zinc-65, neptunium-237, contaminated materials and trash, americium-241, classified material, actinium-227, radium-226, lead, silver, strontium-90, and "induced activity."

B-1.2 Previous Field Investigations

The following information regarding field investigations conducted at MDA C prior to the Phase I RFI is summarized from Section 2.3.2.2 of the approved RFI Work Plan for OU 1147 (LANL 1992, 07672).

B-1.2.1 USGS Water-Infiltration Tests (1956–1961)

From 1956 through 1961, the United States Geological Society (USGS) conducted water infiltration tests at MDA C using shallow pits approximately one ft deep, which were filled with water. One of the tests conducted during the study involved placing 0.75 ft of standing water in a shallow pit and maintaining this level of water in the pit for 99 days. The USGS found that the water did not percolate from the soil into the unweathered tuff, which was encountered at 6 ft beneath the ground surface. The study concluded that in the presence of a continuous and consistent hydraulic head in the shallow pit, subsurface moisture preferentially moved laterally in the soil profile rather than downward into tuff. The study further concluded that the downward movement through soil and tuff is slow and inefficient, requiring more hydraulic head than is typically present at MDA C (p. 2-57, LANL 1992, 07672).

B-1.2.2 Surface Radiation Surveys and Sampling (1976–1986)

Between 1976 and 1984, radiation surveys were conducted on the surface of MDA C to identify localized areas of elevated radioactivity (p. 2-57 LANL 1992, 07672). Surface soil and vegetation samples were subsequently collected from areas with elevated radiation levels and analyzed for radionuclides. Based on the results of these radiation surveys, MDA C was covered with crushed tuff, except in the northeast corner where no disposal pits or shafts are located.

In 1985, radiation surveys were conducted around the MDA C perimeter (Figure B-1). Thermoluminescent dosimeters (TLDs) were used to estimate external penetrating radiation doses. TLD readings taken at 18 locations were all near local background levels. Thus, perimeter TLD monitoring did not identify a significant penetrating radiation source-area within MDA C. The TLD survey was repeated in 1986 with similar results.

A Phoswich detector was used to perform a second 1985 radiation survey for the low end of the energy spectrum to detect the presence of x-ray and gamma-ray emitters on the soil surface using a 64 ft by 64 ft grid over the entire site. A high-pressure ion chamber was used to measure radiation doses at the high end. Both surveys indicated background conditions over most of the site; however, elevated levels of radioactivity were measured in the northeast corner of MDA C.

Surface soil samples were collected from the surface at 0 to 1 cm and analyzed for tritium, plutonium-238, -239, -240, and uranium. Tritium samples from the eastern half of MDA C were below the local background concentration of 4.0 pCi/mL (LANL 1998, 59730). Isotopic plutonium (up to 10 pCi/g of plutonium-239 and -240 and 30 pCi/g of plutonium-238) was detected on the north and east sides of MDA C. Concentrations of uranium were all less than background value within the MDA C boundary. The areas with elevated radionuclides correspond to the portion of MDA C that was not covered in 1984. Additional soil sampling was performed in 1986 at the radiation survey locations shown in Figure B-1. Surface soil samples were analyzed for americium-241, cesium-137, plutonium-238 and -239, and tritium. Results of these analyses are presented in Table B-2 and are consistent with the 1985 results.

B-1.2.3 Perimeter Pore-Gas Sampling (1989)

In 1989, pore-gas samples collected from a depth of 4 ft at six locations near the Chemical Pit and 12 perimeter locations immediately surrounding MDA C were analyzed for volatile organic compounds (VOCs). Results indicated that no VOCs were present at concentrations greater than method detection limits (DOE 1989, 15364). TCE was detected in four of the eighteen samples at 0.2 to 0.3 mg/m³, carbon disulfide was detected in one sample at 0.4 mg/m³, and 2-butanone was detected in one sample at 4.0 mg/m³.

Three sediment samples were collected at 0- to 12-in. intervals from a drainage channel at the top of Ten Site Canyon and were analyzed for pesticides, polychlorinated biphenyls (PCBs), VOCs, semivolatile organic compounds (SVOCs), inorganic chemicals, and radionuclides. Toluene was detected in one sample at 4.0 µg/kg, eight SVOCs were detected at concentrations ranging from 8.0 to 190.0 µg/kg, and four pesticides were detected at concentrations ranging from 1.0 to 36.0 µg/kg. Inorganic chemicals including barium (28 to 110 mg/kg), chromium (7.0 to 19 mg/kg), nickel (58 mg/kg), and zinc (22 to 47 mg/kg) were detected. Radionuclides including radium-226 (800 to 900 pCi/kg), uranium-235 (64 to 100 pCi/kg), total uranium (4000 to 6000 µg/kg), plutonium-238 (8 to 420 pCi/kg), plutonium-239, -240 (328 to 7840 pCi/kg), cesium-137 (160 to 395 pCi/kg), and americium-241 (790 pCi/kg) were detected (DOE 1989, 15364). The 1989 perimeter pore gas and sediment sample locations are provided in Figure B-2, and the analytical results are listed in Table B-3.

B-2.0 PHASE I RFI FIELD INVESTIGATIONS AND REVIEW OF FIELD SCREENING, SURVEY, AND LABORATORY RESULTS

Field Investigations Summary

Phase I RFI fieldwork was conducted at MDA C from 1993 through 2002. The approved RFI work plan for OU 1147 specified the sampling of surface soil, fill, and subsurface tuff and analyzing samples for inorganic chemicals (target analyte list [TAL] metals), organic chemicals (VOCs, SVOCs, pesticides, and PCBs), and radionuclides (p. 5-35, LANL 1992, 07672). The objectives of the Phase I RFI were to determine if contaminants had been released from MDA C, to define the nature and extent of any contaminant releases, to collect data to support and supplement existing data, and to collect data to be used in a risk assessment. Phase I RFI fieldwork conducted at MDA C included

- collecting and analyzing 68 surface soil and fill samples,
- drilling two vertical boreholes and 9 angled boreholes,
- collecting and analyzing 82 core samples,
- collecting and analyzing 34 subsurface pore-gas samples for VOCs,

- collecting and analyzing 15 near-surface pore-gas samples for tritium, and
- collecting and analyzing 105 EMFLUX[®] soil-gas survey samples.

A summary of OU 1147 work plan specifications, fieldwork performed, and the rationales for deviations from the work plan is provided in Table B-4.

Data Review Summary

The Phase I RFI data for MDA C include analytical data from 68 surface samples (16 surface soil samples and 52 fill samples), 15 tritium probe samples, 82 tuff samples collected from 11 boreholes (79 from Qbt 3, 2 from Qbt 2, and 1 from Qbt 1v), 105 EMFLUX[®] soil-gas survey samples, and 34 pore-gas samples; Figures B-3, B-6, and B-7 show the sample locations. All data used quantitatively to identify chemicals of potential concern (COPCs) at MDA C were subjected to Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) quality assurance/quality control (QA/QC) procedures. The data review process for identifying COPCs begins with a comparison of site data with

- naturally occurring background concentrations for inorganic chemicals,
- naturally occurring background and fallout concentrations for radionuclides, and
- analytical estimated quantitation levels (EQLs) for organic chemicals.

Background comparisons and a variety of statistical and graphical methods were used to compare site inorganic and radionuclide data with Laboratory background data (LANL 1998, 59730). Organic chemical data were evaluated for detection status only. For background comparisons, the first step was to compare the site data with a background value (BV). A BV may be an estimated value for the background data set (upper tolerance limit [95, 95] or the 95% upper confidence bound on the 95th quartile), a detection limit (DL), a fallout value (FV), a minimum detectable activity, or it may be calculated based on secular equilibrium or a total analysis. The term "background value" will be used in this report to represent any of these values.

If a site-specific datum exceeds its BV, additional evaluation of the datum may be performed by comparing the range of values in the site data set for that chemical to the range of values for that chemical in the background data set. Graphical analyses (e.g., box plots) may be used or, if adequate data are available, statistical tests that evaluate differences in distribution may be used. Nonparametric tests commonly used to assess data distributions include the Gehan, quantile, and slippage tests. Together these tests assess complete shifts in distributions, shifts of a subset of the data, and the potential for some of the site data to be greater than the maximum background concentration. Observed significance levels (p-values) are obtained; these values indicate whether a difference does or does not exist between the data sets. A p-value of less than 0.05 indicates that a difference exists between the distributions (i.e., the site data are different from the background data). A p-value greater than 0.05 indicates that no difference exists between distributions (i.e., site and background data are similar). Statistical tests, graphical analyses, and their results are discussed in Appendix D.

Only data that are relevant for identifying COPCs are discussed in this section; this includes measurements above applicable thresholds or DLs that are greater than an applicable threshold.

B-2.1 Survey and Screening Results

B-2.1.1 Geophysical Surveys in 1994, 2001, and 2002

1994 Magnetometry Survey

In August 1994, a magnetometry technique, the Multisensor Towed Array Detection System (MTADS), was demonstrated at MDA C as a pilot test to locate boundaries of subsurface disposal units (McDonald and Robertson 1995, 56357). The survey was conducted to evaluate the MTADS, which incorporates a towed array of seven cesium-vapor total-field magnetometers to detect subsurface disposal unit boundaries. The maximum depth range of this survey technique is 12 ft below ground surface (bgs). If ferrous materials were not present within a depth interval, the survey would not identify a subsurface feature.

2001 Geophysical Survey

A geophysical survey was performed in August and September 2001 (AGS 2001, 73710) to delineate existing disposal pit and shaft locations and map the thickness of cover materials across the surface of MDA C. To achieve these objectives, an integrated geophysical investigation was performed using terrain conductivity (EM31), high-sensitivity metal detector (EM61), and digital ground-penetrating radar (GPR) techniques. In addition, the dipole-dipole electrical resistivity technique was tested at MDA C to assess its effectiveness in determining the thickness of cover materials. Although the survey was deemed successful, interference from the chain-link fence obscured the southern and eastern pit boundaries.

2002 Geophysical Survey

A second geophysical survey was performed at MDA C in September 2002 (AGS 2002, 73711) after the chain-link fence along the southern and eastern boundaries of MDA C had been removed. This geophysical survey was done to confirm the southern and eastern pit boundaries and to determine if the pits extend beyond the southern fence line. The geophysical survey was performed using terrain conductivity (EM31), high-sensitivity metal detector (EM61), and digital GPR techniques. The methodology and instrumentation used during this survey were consistent with the previous survey to allow integrated data processing and interpretation.

B-2.1.2 Geophysical Survey Results

Magnetometry Demonstration (1994)

Results of the August 1994 magnetometry demonstration indicate that all seven pits probably extend beyond the boundaries shown on historical maps. In particular, Pits 1–4 extend farther to the east than indicated on historical maps. The line of Shafts 98–107 (a portion of Shaft Group 3) closely correlates with detected magnetic anomalies. The other two shaft fields were not prominently displayed in the magnetic data. Shaft 108 (the strontium-90 disposal shaft) was not identified by magnetic anomalies at its expected location; however, if any ferrous material contained in the shaft is located beneath the 12-ft range of the instrumentation, its location would not have been obvious (McDonald and Robertson 1995, 56357).

Survey results also indicated that Pit 6 may extend to the fence on the north side of MDA C and possibly beyond the fence at the east end of the pit. However, a photograph confirms the proximity of the northern edge of Pit 6 to the north perimeter fence (p. C-9, Rogers 1977, 0216).

2001 Geophysical Survey

The EM31 results from MDA C show east-west trending conductivity anomalies that generally coincide with the expected pit locations. Lateral variations within the interpreted pit locations indicate changes in fill cover and the heterogeneity of the buried materials. At most of the suspected shaft locations, no consistent anomalies were observed that could be attributed with certainty to the shafts. The absence of anomalies at these locations indicates either that the shafts do not exist at the locations shown or that insufficient contrasts occur in the upper 10 ft of materials.

Similarly, the EM61 data show high-amplitude anomalies at Pit 5. This finding indicates that most of the metal objects buried at the site are contained in the southern portion of the pit. Small and randomly scattered metal objects are observed throughout the remaining pit locations.

The interpreted pit boundaries based on the EM61 and EM31 data show a strong correlation. The GPR survey showed that the minimum and maximum cover thicknesses at MDA C are 0.0 and 8.76 ft, respectively, with a mean value of 3.4 ft. Figure B-4 illustrates the fill thicknesses at MDA C.

2002 Geophysical Survey

The electromagnetic (EM) data acquired in the eastern survey area show low values and laterally homogeneous materials typical of natural sediments and rocks. Similarly, the GPR data indicate the presence of native subsurface conditions over most of this area. EM interference created by utilities was encountered along the southern site boundary, which made delineating the southern boundary of Pit 1 difficult. However, a subtle decrease in values was observed in the terrain conductivity, in-phase, and EM61 data between the interpreted trench location and the apparent location of the utilities. The location of the decrease indicates that the Pit 1 boundary occurs inside the fence line. GPR lines running across this boundary support this conclusion. EM and GPR anomalies observed outside the fence line in the southern portion of the survey area are attributed to buried utilities and excavations unrelated to disposal pits. In conclusion, the geophysical data acquired during this investigation show no evidence of disposal pits outside the fence line in the surveyed areas.

Throughout this work plan, figures are based on the disposal pit boundaries shown on LASL Engineering Drawing ENG-R 4459 (LASL 1974, 38446). The interpretation of the pit boundaries from the geophysical survey differs slightly from the engineering drawing. When the pit boundaries are overlaid on the 2001 geophysical survey (Figure B-5), the anomalies extend to a greater distance than the reported pit boundaries. These differences will be taken into consideration when locating new boreholes during implementation of this work plan.

B-2.1.3 Biota Screening and Sampling

Biota sampling was conducted at MDA C in accordance with the MDA C sampling and analysis plan (SAP) addendum (LANL 2003, 74067) to determine whether any evidence of uptake and transport of contaminants by biota could be found at MDA C. Biota sample locations were selected to ensure broad spatial coverage and located above and around the Chemical Pit, Pits 1–6, and the southwest corner of the area where no materials had been buried.

On February 12, 2003, 14 ant mounds and 63 animal burrows across the site were field screened for gross alpha, beta and gamma activity in the field according to LANL-ER Standard Operating Procedure (SOP) 10.14, "Performing and Documenting Gross Gamma Radiation Scoping Surveys." A Ludlum 139 radiation meter was used to detect alpha radiation. A Ludlum ESP 1 radiation meter with an HP 260 pancake probe and a Ludlum Model 2221 Scaler/Ratemeter with a Ludlum Model 44-10 2x2 gamma

scintillator were used to detect beta/gamma radiation. The screening followed protocols outlined in LANL-ER-SOP-10.14, including ensuring that the meter was source-checked prior to use and taking background readings periodically during the meter's use. Local background was determined to be 300-400 disintegrations per minute (dpm) beta/gamma.

On March 20, 2003, 29 surface soil samples were collected from nine ant mounds and 20 animal burrows and submitted to American Radiation Services (ARS) of New Mexico for gross alpha, beta and gamma analysis. Figure B-6 shows the sample locations of the ant mound and animal burrow samples. Samples of pine needles were collected on March 21, 2003, from all sixteen ponderosa pine trees on the surface of MDA C and submitted to ARS for gross alpha, beta and gamma analysis (Figure B-6). Approximately 500 g of plant material were collected from each tree. Pine needles were rinsed with deionized water in the field. Each location was surveyed by global positioning system (GPS). Table B-5 presents all of the samples that were collected and sent to the analytical laboratory.

The trees were cut down and a wafer of the tree trunk was collected for tree-ring dating. All trees were between 4.5 and 5.5 ft high, but exact tree heights were not recorded. The wafer used for tree-ring dating was collected at the base of the trunk. The approximate age of the trees is presented in Table B-6. The data will be evaluated by spatial plots and compared with background rates to determine whether and where biota may be mobilizing subsurface contamination. This information will be used to evaluate alternatives for remediation during the MDA C corrective measure study (CMS).

B-2.1.4 Biota Sampling

The 2003 radiological field-screening results from ant mounds and burrow spoil material located across the surface of MDA C are presented in Table B-7 and Table B-8. For both ant mound and burrow material, alpha counts were not detected during field screening. Plant material was not screened. Biota sampling data from ARS will be reported in the MDA C Investigation Report.

B-2.2 Surface Investigation

B-2.2.1 Surface Soil and Fill Sampling

The Phase I RFI surface sampling was conducted at MDA C from June 14 to July 14, 1993. A 60- by 60-ft sampling grid was laid out across and beyond the boundary of MDA C, and a radiation survey was conducted using a VIOLINIST field instrument to measure gamma radiation and x-rays at 208 locations at midpoints between the nodes of the sampling grid. However, DLs were not available for the VIOLINIST field instrument; therefore, these data are not included in this report.

A total of 203 soil samples were collected from the 0- to 6-in. interval at nodes of the 60- by 60-ft grid (Figure B-3) and screened for gross alpha, beta, and gamma radiation using hand-held field instruments. Based on radiation screening results, a total of 68 surface samples were submitted to an off-site contract laboratory for analysis of the following: 59 samples were analyzed for PCBs, and 68 samples were analyzed for inorganic chemicals (limited list of antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, potassium, selenium, silver, and thallium) and radionuclides (gamma-emitting radionuclides by gamma spectroscopy, strontium-90, americium-241, total and isotopic uranium, and isotopic plutonium). A summary of surface samples collected and requested analyses is presented in Table B-9.

B-2.2.2 Phase I RFI Surface Soil and Fill Samples

Surface samples were collected from both soil and fill material. Table B-9 summarizes all the surface samples collected during the Phase I RFI and the requested analyses for each sample. The request number is shown in the table for each analysis requested for an individual sample. According to the data validation for inorganic chemicals, radionuclides, and organic chemicals in the surface soil and fill, the results were not qualified and all data are suitable for data assessment.

Inorganic Chemical Comparison with BV

Surface soil and fill samples were analyzed for limited TAL metals (antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, potassium, selenium, silver, and thallium). Sixty-eight samples were analyzed for antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, selenium, silver, and thallium; ten were analyzed for mercury and two for potassium. Because the surface of MDA C has been disturbed and fill has been added, distinct soil horizons are not evident for the surface samples; therefore, the BV for all soil horizon is used for background comparisons for samples identified as soil or fill (LANL 1998, 59730). Table B-10 presents the frequency of detected inorganic chemicals above BVs in surface soil and fill samples.

Lead and silver are the only inorganic chemicals that were detected above their respective BVs. Lead was detected above the BV in 9 samples (7 to 30 mg/kg) at concentrations close to the BV (22.3 mg/kg). The results of the Gehan and quantile tests for lead presented in Appendix D (Table D-1) indicate that lead is elevated above background. Silver was detected in two samples at concentrations of 1.1 and 6.0 mg/kg, which are above the BV of 1.0 mg/kg. No further background tests for silver were performed since there is no background data set for silver. All other inorganic chemicals were similar to Laboratory site-wide soil BVs (LANL 1998, 59730). Table B-11 presents the concentrations of lead and silver above background in surface soil and fill material at MDA C. Lead and silver were identified as COPCs in surface soil and fill.

Radionuclide Comparison with BVs and Fallout Values

Sixty-eight surface soil and fill samples were analyzed for americium-241, isotopic plutonium, isotopic uranium, strontium-90, and gamma-emitting radionuclides. Because the surface of MDA C has been disturbed and fill has been added, distinct soil horizons are not evident for the surface samples; therefore, the BVs for all soil horizons are used for background comparisons (LANL 1998, 59730). FVs apply to americium-241, tritium, isotopic plutonium, strontium-90, and gamma-emitting radionuclides. The term "background value" will be used in the following tables and text to represent both BVs and FVs. Table B-12 presents the frequency of detected radionuclides above BV collected in surface soil and fill samples.

Americium-241, plutonium-238, plutonium-239, thorium-232, and uranium-238 were all detected above the BV in at least one sample. The BVs for thorium-232 and uranium-238 are both surrogates from sediment data, and further statistical tests were not performed for these two analytes. The statistical test results from the three radionuclides with soil background data are presented in Table D-2 (Appendix D). As the statistical tests show, all p-values were less than 0.5, indicating that these three radionuclides are elevated compared to the background data.

Table B-13 presents the concentrations above the BV in surface soil and fill. Americium-241, plutonium-238, plutonium-239, thorium-232, and uranium-238 are identified as COPCs in surface soil and fill at MDA C.

During the Phase I RFI, 59 surface soil/fill samples were analyzed for tritium and soil moisture to evaluate the spatial distribution of tritium concentrations in surface soil. Although tritium related to historical surface releases would long since have dissipated to the atmosphere, locally elevated concentrations of tritium in surface soil may reflect areas where subsurface tritium is diffusing to the atmosphere as tritiated water vapor. The analytical results from these surface samples, with tritium concentrations ranging between 0.17 and 12.82 pCi/mL, showed that the higher tritium concentrations were consistently correlated with low moisture contents in the soil/fill samples. This correlation results from the greater uncertainty in tritium values when a sample available for analysis contains little moisture. Because this correlation may confound interpretation of the tritium soil data, 15 shallow pore-gas vapor probes were installed across MDA C in accordance with the MDA C SAP Addendum (LANL 2003, 74067). Pore-gas samples were collected in February 2003 from each probe using absorbent silica gel columns and analyzed for tritium (Section B-2.3.1). The vapor probe data indicate more reliably the locations where releases of tritium to the atmosphere occur. The surface tritium data, including the sample locations and sample identification numbers, are provided in Appendix E but were not used to support the evaluation of the nature and extent of tritium contamination at MDA C.

Evaluation of Organic Chemicals

Surface soil and fill samples were analyzed for PCBs and SVOCs. Sample concentrations were reviewed for detection status. Table B-14 presents the frequency of detected organic chemicals in surface soil and fill.

Only five organic chemicals were detected in the surface soil and fill samples. The concentrations of these organic chemicals are presented in Table B-15.

Figures D-6 to D-8 show the distribution of the Aroclor-1254, Aroclor-1260, and bis(2-ethylhexyl)phthalate data since these organic chemicals were detected in more than one sample. Acenaphthene, Aroclor-1254, Aroclor-1260, bis(2-ethylhexyl)phthalate, and pentachlorophenol are identified as COPCs in the surface soil and fill at MDA C.

Although the approved RFI work plan for OU 1147 did not call for collecting and analyzing surface soil samples for VOC, ten surface soil/fill samples were collected and analyzed for VOCs during the Phase I RFI to assess whether contaminants are available for transport from the surface of MDA C (LANL 1992, 07672). The analytical results from these samples, which reported no detected VOCs, are not representative of past or current conditions because of the volatility of VOCs, which readily dissipate into the atmosphere. Vapor-phase pore-gas sampling is more appropriate for determining the nature and extent of VOCs. Therefore, VOC surface flux was measured across MDA C in two surveys conducted in June and July 2000, and VOC pore-gas samples have been collected and analyzed from two vapor-monitoring boreholes at MDA C (Section B-2.3). The surface VOC data, including sample locations and sample identification numbers, are provided in Appendix E.

B-2.2.3 VOC Surface-Flux Measurements

VOC surface flux was measured across MDA C in two surveys conducted in June and July 2000 to identify the nature and extent of potential subsurface VOC contamination. EMFLUX[®] collectors, consisting of an adsorbent cartridge suspended on a stake beneath a protective shell for a 72-hr period, were used in the survey. VOC analysis was performed by Maryland Spectral Services using gas chromatography/mass spectrometry techniques following a modified US Environmental Protection Agency (EPA) method TO-1 procedure. Additional information on surface-flux sampling and analysis protocols is provided in the EMFLUX[®] soil gas survey report for MDA C (BES 2000, 76046).

Eighty-four sample locations were identified in the first survey in June 2000; subsequently, an additional 21 locations were selected in the July 2000 survey. The EMFLUX[®] surface flux measurement locations are shown in Figure B-7. Four trip blanks were included among the samples of the first survey and one trip blank for the second survey. Two field duplicate samples were also collected during the first survey, and laboratory method blanks were analyzed daily by the analytical laboratory.

B-2.2.4 VOCs in Soil-Gas Survey Samples

Eighty-four surface flux samples were analyzed for VOCs (Figure B-7). Six VOCs were detected at concentrations above the laboratory quantitation limit: aliphatics hydrocarbons, benzene, carbon tetrachloride, chloroform, tetrachloroethene (PCE), and TCE. The rates of flux for these detected organic chemicals are summarized in Table B-16. PCE was one of the most frequently detected organic chemicals in the surface flux samples. Figure B-8 shows the locations of the highest concentrations of PCE at MDA C.

The aliphatic hydrocarbons, benzene, carbon tetrachloride, chloroform, PCE and TCE are identified as COPCs at MDA C.

B-2.3 Subsurface Investigations

B-2.3.1 Subsurface Sampling

Phase I RFI Core Sampling

From July 17 to September 22, 1995, two vertical and nine angled boreholes were advanced at MDA C as part of the Phase I RFI. From January 29 to February 5, 1996, the borehole 50-09100 cap was removed and borehole 50-09100 was extended from 210 to 316 ft bgs to collect stratigraphic and geohydrologic data. Detailed borehole logs, including lithologies and well construction diagrams, are presented in Appendix C. Borehole locations and trajectories are shown on Figure B-9. The boreholes are described by depth, declination, and adjacent disposal unit in Table B-17. The exterior and ends of each core barrel and each 5-ft. interval of core along the borehole were screened for VOCs using a photoionization detector (PID); hand-held field instruments were used to screen for gross alpha, and beta and gamma radiation. These field screening results are presented in Table B-18. Each 5-ft interval of core along the borehole was inspected for fractures or stains, and the results were noted in borehole logs (Appendix C). The screening samples were collected from fractures or stained tuff if present; if no fractures or staining was present, screening samples were collected from the bottom of each 5-ft. interval along the borehole. Field-screening results were not used to select samples because gross alpha, beta, or gamma activity in the core did not exceed local background levels. Results of core sample field screening using the PID showed no VOCs in the core at concentrations exceeding readings in ambient air (Table B-18). A review of sample collection log results of core samples screened with field spot-test kits indicated no high explosives (HE) detections in any of the 5-ft intervals of core collected at MDA C (Table B-18).

During the 1995 Phase I RFI, 66 core samples were collected from 20-ft intervals along the borehole and were submitted to an off-site contract laboratory for analysis of TAL metals, cyanide, and radionuclides (gamma-emitting radionuclides by gamma spectroscopy, tritium, strontium-90, americium-241, total and isotopic uranium, isotopic plutonium, and isotopic thorium). The 66 core samples also were submitted to an off-site contract laboratory for analysis of SVOCs and tritium, and 54 core samples collected from boreholes 50-09101, 50-09103, 50-09104, 50-09105, 50-09106, 50-09107, 50-09108, 50-09109, and

51-09110 were analyzed at an off-site contract laboratory for VOCs and pesticides/PCBs. Table B-19 lists the core sample locations, sample identification numbers, and requested analyses.

The core was photographed, logged, and curated from July through September 1995. On February 27, 1996, in response to a request from the EPA to collect samples at additional intervals, 15 more tuff samples were collected from curated core from boreholes 50-09100, 50-09101, 50-09103, 50-09104, 50-09105, 50-09106, 50-09107, 50-09108, 50-09109, and 50-09110 (Neleigh 1995, 55112). These samples were submitted to an off-site contract laboratory for analysis of inorganic chemicals (not including cyanide and mercury because the holding times had been missed) and radionuclides (except tritium). However, based on the core collection dates and the actual date the samples were analyzed, more than half of the curated core samples missed the 180-day holding time for inorganic chemicals. The inorganic chemical data from these samples are provided for comparison purposes only. VOCs, SVOCs, and PCBs were not analyzed from the curated samples because holding times for these analytes had been exceeded. In addition, tritium in the curated core was not analyzed at an off-site contract laboratory because tritium is found primarily in vapor phase, and water-vapor levels in core that had been curated for several months would not be representative of moisture levels at the time of core extraction. The curated core samples are given in Table B-19.

In September and October 1995, surface casings were removed, and each borehole (except borehole 50-09100) was grouted closed, ensuring that the borehole would not provide a conduit for surface runoff to enter the subsurface. Borehole 50-09100, maintained as an open borehole vapor-monitoring well, was cased to 10-ft deep and capped at the ground surface.

Results of geologic logging were recorded in the borehole logs (Appendix C). Ten of the eleven boreholes were drilled into unit 3 of the Tshirege Member of the Bandelier Tuff (Qbt 3). Borehole 50-09100 was extended to 316 ft, ending in the Tsankawi Pumice Bed (the basal unit of the Tshirege Member).

Saturation was not encountered in any of the boreholes; however, moist core was recovered from borehole 50-09105 below the asphalt on the ground surface and in borehole 50-09101, angled beneath the surface water drainage channel located along the northern boundary of MDA C. Moist tuff was encountered at a depth of 71.5 to 73.5 ft bgs in borehole 50-09100. Moisture was expected at these locations, because surface water runoff is channeled and asphalt prohibits evapotranspiration.

Borehole Air-Flow Velocity

In 1995 and 1996, air-flow velocity, oxygen content of the air entering or leaving the borehole, and atmospheric pressure were monitored at boreholes 50-09100, 50-09101, 50-09102, 50-09103, 50-09105, and 50-09107 to evaluate passive venting. Monitoring was performed for four days at borehole 50-09100, 14 days at 50-09101, 36 days at 50-09102, 14 days at 50-09103, 19 days at 50-09105, and 6 days at 50-09107. The results of the air-flow monitoring demonstrate that air-flow characteristics of MDA C boreholes are similar to those of other boreholes located on Mesita del Buey within the Bandelier Tuff. Because the Bandelier Tuff has a porosity of 40% to 50%, at times these boreholes exhaust air of lower atmospheric pressure (in the afternoon and evening) and at times inhale air of higher atmospheric pressure (from night to mid-morning). During the air-flow monitoring at MDA C, atmospheric pressure ranged from a minimum of 755 millibar (mb) to a maximum of 790 mb. Atmospheric pressure varied from ± 3 to 5 mb daily. Airflow in MDA C boreholes peaked at approximately 1.0 standard cubic feet per minute (scfm). The total volume of air flowing into and out of each MDA C borehole monitored was approximately 250 ft³/day (SEA 1997, 76055).

Pore-Gas Sampling

In 2001, an additional borehole (50-10131) was advanced in the vicinity of the Chemical Pit where high PCE flux concentrations were detected in June and July 2000 (BES 2000, 76046 [see Figure B-7 for borehole location]). Boreholes 50-09100 and 50-10131 are instrumented with FLUTe™ positive-pressure sampling membranes, which each maintain 10 sampling ports at discrete depths. After purge of each port, a VOC screening measurement from each port was made using a Bruel & Kjaer (B&K) gas analyzer calibrated for measuring TCE and PCE in the sub-ppm concentration range. A SUMMA canister sample was collected from two of the ports in each borehole during quarterly sampling based on B&K screening. The samples for each borehole were screened and sampled for VOCs in accordance with the most recent revision of LANL-ER-SOP-6.31, "Sampling of Subatmospheric Air." These samples were submitted to an off-site contract laboratory for VOC analyses by EPA Method TO-14. QA/QC samples were collected per applicable SOPs, including one field duplicate, one equipment blank, and one performance evaluation sample.

Pore-gas sampling in borehole 50-09100 began in August 2000, and borehole 50-10131 was first sampled in November 2001. These boreholes were sampled continually each quarter since November 2001. However, SUMMA canister samples were collected from only two different ports in each borehole during a sample event, making it difficult to compare and correlate B&K screening data and off-site contract laboratory data as well as to evaluate temporal trends. In January 2003, pore-gas samples were collected from all ten ports in both boreholes and analyzed for VOCs. The sampling of all ports in the same event eliminates the temporal variability that confounded interpretation of the patterns of existing VOC concentrations in these boreholes.

Tritium Probe Sampling

Fifteen shallow pore-gas vapor probes were installed across MDA C in accordance with the MDA C SAP addendum (LANL 2003, 74067). Two vapor probes were installed within the boundary of each disposal pit (except the Chemical Pit) and five discretionary locations were selected on the perimeter of the site (Figure B-6). Vapor probes consist of a disposable-screened port bit driven down approximately 3 ft and connected to the surface with Teflon tubing. The disposable-screened bit was left at 2.5 ft, and the holes were backfilled and sealed.

Tritium samples were collected in February 2003 from each probe using absorbent silica gel columns in accordance with LANL-ER SOP 6.31 Rev 1. A single trip blank sample was also collected in accordance with RRES-RS QA/QC requirements.

B-2.3.2 Subsurface Tuff Samples

Eighty-two tuff samples were collected from nine angled boreholes and two vertical boreholes. Seventy-nine samples were collected from Qbt 3 of the Tshirege Member of the Bandelier Tuff, two samples were collected from Qbt 2, and one sample was collected from Qbt 1v. Table B-19 summarizes the subsurface tuff samples collected during the Phase I RFI and the requested analyses for each sample. It should be noted that 15 of the tuff samples were collected from curated core in 1996 from boreholes 50-09100, 50-09101, 50-09103, 50-09104, 50-09105, 50-09106, 50-09107, 50-09108, 50-09109, and 50-09110.

Inorganic Chemical Comparison with BV

Eighty-two subsurface tuff samples were analyzed for TAL metals (except antimony in 76 samples and 61 cyanide in 61 samples). The data validation results for the subsurface inorganic chemicals data at MDA C

indicate some of the data were qualified. A summary of the qualifications and their affect on data review is presented in this section.

Based on the core collection dates and the actual date the samples were analyzed, more than half of the curated core samples missed the 180-day holding time for inorganic chemicals; therefore, the inorganic chemical data from these samples are provided for comparison purposes only. The curated core samples were not analyzed for VOCs, SVOCs, PCBs, tritium, cyanide, or mercury because the holding times for these analytes had been exceeded by several months.

Antimony, selenium, and thallium results were qualified UJ (indicating that the reported DL is estimated) for some samples because of a low recovery in the matrix spike sample. Some results for manganese, lead, zinc, antimony, and cyanide were qualified J- (indicating that the result is estimated and biased low) because of a low recovery in the matrix spike sample. Seven inorganic chemicals (aluminum, beryllium, iron, manganese, lead, thallium, and zinc) had some results qualified J (result is estimated) because the relative percent difference between the sample and the laboratory duplicate was greater than the advisory limit. Some inorganic chemicals also had results qualified J (result is estimated) because the result was less than the estimated DL but above the method detection limit. Results for potassium and sodium were qualified J+ (result is estimated and biased high) in six samples because the interference check sample was high. Many inorganic chemicals had results that were qualified U (not detected) because the concentration was less than five times the concentration in the method blank.

Antimony data were rejected for six samples and cyanide data were rejected for sixteen samples because the matrix spike recovery was less than 30%. All the rejected antimony data were collected in 1995 from borehole 50-09104. Only the sample collected from curated core in 1996 from borehole 50-09104 did not have rejected antimony data. Cyanide was rejected in sixteen samples, a maximum of two samples from nine different boreholes. Fifteen of these samples were collected from the curated core in 1996, and the holding time for cyanide had been exceeded by several months.

The estimated detection limits (UJ) as well as the estimated results (J) will be evaluated in the data review the same as all other reported detection limits and detected results based on EPA guidance (EPA 1992, 54947.1). Because the J- and J+ qualifiers are only an indication of a low bias or high bias based on one type of QC sample and the amount of the bias is not known, the results are compared to the BVs as they were reported. Antimony data that were not rejected were reported with a detection limit above the BV. Because only some of the results were qualified U or UJ (not detected), few results were rejected. The data are of good quality and can be used for data assessment. Table B-20 summarizes the detection limits above the BV.

Analytical results for inorganic chemicals in samples collected from Qbt 2 and Qbt 3 were compared with the appropriate BVs for Qbts 2, 3, and 4, and results for inorganic chemicals in samples collected from Qbt 1v were compared with BVs for that unit (LANL 1998, 59730). Table B-20 presents the frequency of inorganic chemicals detected in the subsurface tuff at MDA C. Analytical results for all inorganic chemicals are presented in box plots in Figure D-9 in Appendix D. The box plots show that the concentrations for most inorganic chemicals are similar to the distribution of background concentrations. Seven inorganic chemicals (aluminum, beryllium, calcium, chromium, cobalt, magnesium, and nickel) were detected above the BV only once. Eight inorganic chemicals (antimony, arsenic, barium, copper, cyanide, lead, selenium, and thallium) had at least two detected concentrations above their respective BVs. DLs for mercury and silver were above BVs. Analytical results for inorganic chemicals with at least two detected concentrations above the BV were plotted by depth bgs in each borehole to identify patterns that might be associated with a release and migration through a fractured medium (see Appendix D, Figures D-10 to D-17). Lead and cyanide were detected most frequently in the subsurface. Boreholes 50-09101 and 50-09104 had the highest number of detects for cyanide. Table B-21 presents the

concentrations of inorganic chemicals detected above BVs in the subsurface tuff at MDA C (tuff samples collected from curated core are noted).

Antimony, arsenic, barium, copper, cyanide, lead, selenium, thallium are identified as COPCs because they were detected above their respective tuff BVs in more than one sample. Mercury and silver are also identified as COPCs because more than one DL was above the tuff BV.

Radionuclide Comparison with Background and Fallout Values

Eighty-two subsurface tuff samples were analyzed for americium-241 (by alpha spectroscopy), gamma-emitting radionuclides, isotopic plutonium, isotopic thorium, isotopic uranium, strontium-90, and tritium. The full-suite analyte list in the analytical services statement of work (LANL 1995, 49738) includes the decay series of the naturally occurring radionuclides, uranium-235, uranium-238, and thorium-232, as well as fission and activation products and their progeny. The primary radionuclides reliably measured by gamma spectroscopy include activation products (americium-241, cobalt-60, and sodium-22); fission products (cesium-134, cesium-137, europium-152, and ruthenium-106); and uranium-235.

Data validation results for the subsurface radionuclide data for tuff at MDA C indicate that some of the data were qualified. Three samples analyzed for thorium-232 and one sample analyzed for uranium-234 and uranium-238 had results qualified J (result is estimated) because the relative percent difference between the sample and the laboratory duplicate was greater than the advisory limit. These estimated results (J) will be evaluated in the data review along with other detected results. In addition, thirty-one samples that were analyzed for uranium-235 by inductively coupled plasma mass spectrometry (ICPMS) instead of alpha spectroscopy. The analytical results from these two methods are not comparable, and the samples analyzed using ICPMS generally have higher results than those analyzed by alpha spectroscopy. Therefore, the uranium-235 data analyzed by ICPMS were evaluated by detection status rather than against the BV. Radionuclide concentrations were compared with the appropriate Laboratory tuff BVs set or evaluated based on detection status (LANL 1998, 59730). Overall, the subsurface radionuclide data are of good quality and suitable for data assessment. Table B-22 presents the frequency of radionuclides detected above BV in subsurface tuff samples collected at MDA C.

As with the surface soil samples, americium-241, plutonium-238, plutonium-239, tritium, and uranium-235 were detected in the subsurface tuff. Since there are no BVs/FVs to compare with these radionuclides, they are evaluated according to detection status. Strontium-90 was also detected in subsurface tuff samples; the highest detected concentration of strontium-90 was at a depth of approximately 18 ft in angled borehole 50-09109 (13 ft bgs). Tritium was detected in all boreholes at concentrations ranging between 1.5 and approximately 650,000 pCi/mL.¹ Figure D-18 in Appendix D presents a borehole profile plot of the tritium data. The highest concentrations of tritium in pCi/mL were measured in borehole 50-09107 in the sampling intervals beneath Pit 6. Table B-23 presents the concentrations of radionuclides above the BVs in subsurface tuff samples (tuff samples collected from curated core are noted).

¹ The accuracy of the tritium values is questionable. Tritium in core is measured by EPA Method 906.0, which is performed on the water extracted from the core sample. At gravimetric moisture content less than 10%, a 3-in. length of 2-in. diameter core will yield less water than the minimum required volume of 5 ml. To reach the necessary volume, de-ionized water is added to the extracted water. The reported activity and uncertainty are corrected for the dilution. Therefore, any moisture loss from a core sample prior to analysis at low moisture contents may substantially increase the uncertainty of the measurement. Moreover, the EPA method requires the core material be ground to a fine mesh before the water is extracted, such that significant moisture loss is inevitable. Given these issues, RRES-RS concluded that tritium contamination is best characterized in low moisture content environments by using sorbent materials to extract and retain in situ subsurface water samples from pore gas.

Americium-241, cesium-134, cesium-137, cobalt-60, europium-152, plutonium-238, plutonium-239, sodium-22, strontium-90, tritium, uranium-235, and uranium-238 were identified as COPCs because the concentrations of these radionuclides were detected above BVs or detected (if no BV is available) in the subsurface tuff.

Evaluation of Organic Chemicals

Subsurface tuff samples were analyzed for PCBs, pesticides, VOCs, and SVOCs. Results for several organic chemicals (i.e., acetone, bis[2-ethylhexyl]phthalate, and methylene chloride) were qualified U (not detected) because the detected concentrations were attributed to laboratory contamination. Some organic chemical results were also qualified J (result is estimated) because the result was less than the EQL but above the method detection limit. All of these estimated results (J) are evaluated in the data review in the same way as the other detected results. Organic chemical concentrations were reviewed for detection status. Overall, the subsurface organic chemical data for MDA C are of good quality and suitable for data assessment. Table B-24 presents the frequency of detected organic chemicals in subsurface tuff samples.

Six organic chemicals were detected in the Phase I RFI subsurface tuff samples at MDA C. Methylene chloride, 2-methylphenol, and toluene were detected once. Acetone, bis(2-ethylhexyl)phthalate, and 1,1-dichloroethene were detected in four to eight samples. The VOC 1,1-dichloroethene was detected in four samples in borehole 50-09104. The detected concentrations of the other organic chemicals were reported in multiple boreholes with no apparent pattern. All of the bis(2-ethylhexyl)phthalate detected concentrations were below the EQL (i.e., J qualified). No PCBs or pesticides were detected in the subsurface samples. Table B-25 presents the detected concentrations in the subsurface tuff samples.

Acetone, bis(2-ethylhexyl)phthalate, 1,1-dichloroethene, methylene chloride, 2-methylphenol, and toluene are identified as COPCs in the subsurface tuff at MDA C.

VOCs in Pore-Gas Samples

Pore-gas samples were collected between August 2000 and November 2001 and in January 2003 and analyzed for VOCs by EPA Method TO-14. Twenty-four VOCs were reported as detected, these VOC results are summarized in Table D-4.

PCE and TCE were detected most frequently and at the highest concentrations in pore-gas samples. PCE was detected at a maximum concentration of 2.1 ppmv at 50 ft in borehole 50-1013, and the concentrations decrease to 0.45 ppmv at a depth of 250 ft at the bottom of the borehole. Figure D-25 in Appendix D shows the concentrations of PCE in borehole 50-10131. This borehole is located in the same area as the high PCE-flux results. TCE was detected at a maximum concentration of 2.3 parts per million by volume (ppmv) also at a depth of 50 ft in borehole 50-10131. Concentrations of TCE ranged between 1.1 and 2.3 ppmv along the entire borehole. Figure D-26 shows the concentrations of TCE in borehole 50-10131.

The maximum concentration of PCE in borehole 50-09100 was 1.2 ppmv at a depth of 20 ft. Samples were collected from this depth four times during the six quarters of sampling, and the results were 0.033, 0.051, 0.070 and 1.2 ppmv. The second highest result reported for PCE in borehole 50-09100 was at 260 ft with a concentration of 0.51 ppmv. With the exception of these two results, the range of PCE concentrations in borehole 50-09100 was 0.033 ppmv to 0.32 ppmv for other sampling events as shown on Figure D-27. PCE concentrations decrease with depth.

TCE was detected over a large range of concentrations in borehole 50-09100 at the ports sampled more than once. At 20 ft, the concentration of TCE ranged from 0.76 to 1.6 ppmv, at 90 ft it ranged from 3.3 to 9.4 ppmv, and at 200 ft it ranged from 8.8 to 12 ppmv. However, the maximum TCE concentration detected in all of the pore-gas sampling events to date was at the bottom of borehole 50-09100 at 13 ppmv at a depth of 316 ft. Figure D-28 illustrates the trend of increasing concentration with increasing depth. Although the maximum concentration was not detected at the bottom of the borehole each year, the maximum concentration was always below a depth of 200 ft.

As stated in section B-2.3.2, pore-gas samples were collected at every port in boreholes 50-09100 and 50-10131 in January 2003. Each sample was screened by the B&K instrument before being submitted to an off-site contract laboratory for analysis. Figures D-29 and D-30 show a plot of the B&K data versus the SUMMA data from the laboratory for TCE and PCE in borehole 50-09100. These figures show that the values of the B&K and SUMMA measurements do not correlate well all the way down the borehole. Therefore, the B&K screening may not be useful for predicting pore-gas concentrations in the low ppmv range. The twenty-four VOCs listed in Table D-4 are identified as COPCs in subsurface pore gas at MDA C.

Tritium in Pore-Gas Samples

Tritium was collected at 15 locations across MDA C in February 2003 (Figure B-6). Of the fifteen results, two results were a factor of ten higher than the rest of the results. The maximum tritium concentration detected was 2500 pCi/mL in a sample collected on the western side of MDA C at location 50-21467. Although no pits or shafts are located directly beneath this area, it is possible that the tritium is coming from Shaft Group 3 to the east. The second highest tritium concentration detected was 1400 pCi/mL at probe location 50-21472, north of Pit 6 near the west end of the pit at location 50-21472. The remainder of the detected tritium concentrations range between 8.87 and 246 pCi/mL. Tritium concentrations detected in the 15 near-surface pore-gas samples are presented in Table D-5. Figure D-31 presents a bubble plot of the concentrations of tritium probe data.

Gravimetric Moisture

Gravimetric moisture content was measured concurrently with tritium sample collection during the Phase I RFI. The gravimetric moisture content ranged from 1% to 11% (Table B-26).

B-3.0 REFERENCES

The following list includes all references cited in this document. Parenthetical information following each reference provides the author, publication date, and the ER ID number, when available. This information also is included in the citations in the text. ER ID numbers are assigned by RRES-RS to track records associated with the program. These numbers can be used to locate copies of the actual documents at the RRES-RS Records Processing Facility.

AGS (Advanced Geological Services), September 2001. "Integrated Geophysical Investigation, MDA C and MDA H, Los Alamos National Laboratory, Los Alamos New Mexico, Contract No. 350256-001-01 86," Report, Los Alamos, New Mexico. (AGS 2001, 73710)

AGS (Advanced Geological Services), September 2002. "Integrated Geophysical Investigation, Material Disposal Area C, TA-50, Los Alamos National Laboratory, Los Alamos, New Mexico," Report, Los Alamos, New Mexico. (AGS 2001, 73711)

BES (BEACON Environmental Services), August 2003. "EMFLUX® Passive, Non-Invasive Soil-Gas Investigation, MDA C, Technical Area 50, Los Alamos National Laboratory, NM," BEACON Report No. EM1044," Forest Hill, Maryland. (BES 2000, 76046)

DOE (Department of Energy), November 1989. "LANL Sampling and Analysis Data Document," Vol. 1, DOE Report EGG-ES-8204, Washington, D.C. (DOE 1989, 15364)

EPA (Environmental Protection Agency), April 1992. "EPA Guidance for Data Usability in Risk Assessment (Part A) Final Dated: April 1992," EPA Publication 9285.7-09A, Washington, D.C. (EPA 1992, 54947)

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1147 Environmental Restoration Program," Los Alamos National Laboratory document, LA-UR-92-969, Los Alamos, New Mexico. (LANL 1992, 07672)

LANL (Los Alamos National Laboratory), July 1995. "Statement of Work—Analytical Support," Revision 2, Los Alamos, New Mexico. (LANL 1995, 49738)

LANL (Los Alamos National Laboratory), July 1998. "Inorganic and Radionuclide Background Data for Soils, Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-98-4847, Los Alamos, New Mexico. (LANL 1998, 59730)

LANL (Los Alamos National Laboratory), January 2003. "Sampling and Analysis Plan Addendum to the Operable Unit 1147 Work Plan for Material Disposal Area C (SWMU 50-009) at Technical Area 50, January 2003," Los Alamos National Laboratory document LA-UR-03-0119, Los Alamos, New Mexico. (LANL 2003, 74067)

LANL (Los Alamos National Laboratory), July 2003. "MDA C Waste Disposal Logbooks, 2587, 3478, 4644, 6030, 7277, 9293, 9593, 12442, and 11363, November 1948–September 1959," Los Alamos Scientific Laboratory, Los Alamos, New Mexico. (LANL 2003, 76035)

LASL (Los Alamos Scientific Laboratory), December 1970. Engineering Drawing ENG-R-1264, sheet number 3, prepared by University of California, Engineering Department, for Los Alamos Scientific Laboratory, Los Alamos, New Mexico. (LASL 1970, 76047)

LASL (Los Alamos Scientific Laboratory), June 1974. Engineering Drawing ENG-R-4459, prepared by University of California, Engineering Department, for Los Alamos Scientific Laboratory, Los Alamos, New Mexico. (LASL 1974, 38446)

McDonald, J. R., and D. N. Robertson, 1995. "Results of a Magnetometry Survey at TA-50, MDA C, Los Alamos National Laboratory," Naval Research Laboratory document NRL/PU/6110-95-278, Washington, D.C. (McDonald and Robertson 1995, 56357)

Neleigh, D. W., December 1995. "Modification Request for Operable Unit 1147, Los Alamos National Laboratory (NM0890010515)," Los Alamos National Laboratory letter to T. J. Taylor, DOE ER Program Manager, from D. W. Neleigh, Section Chief, EPA Region 6 (New Mexico) Federal Facilities, Los Alamos, New Mexico. (Neleigh 1995, 55112)

Rogers, M. A., June 1977. "History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)," Los Alamos Scientific Laboratory report LA-6848-MS, Vols. I and II, Los Alamos, New Mexico. (Rogers 1977, 0216)

SEA (Scientific Engineering Associates, Inc.), October 1997. "Brief Tests of Passively Vented Boreholes at TA-54, MDA H, MDA J, and TA-50, MDA C during 1995 and 1996," SEA-SF-TR-97-171," Santa Fe, New Mexico. (SEA 1997, 76055)

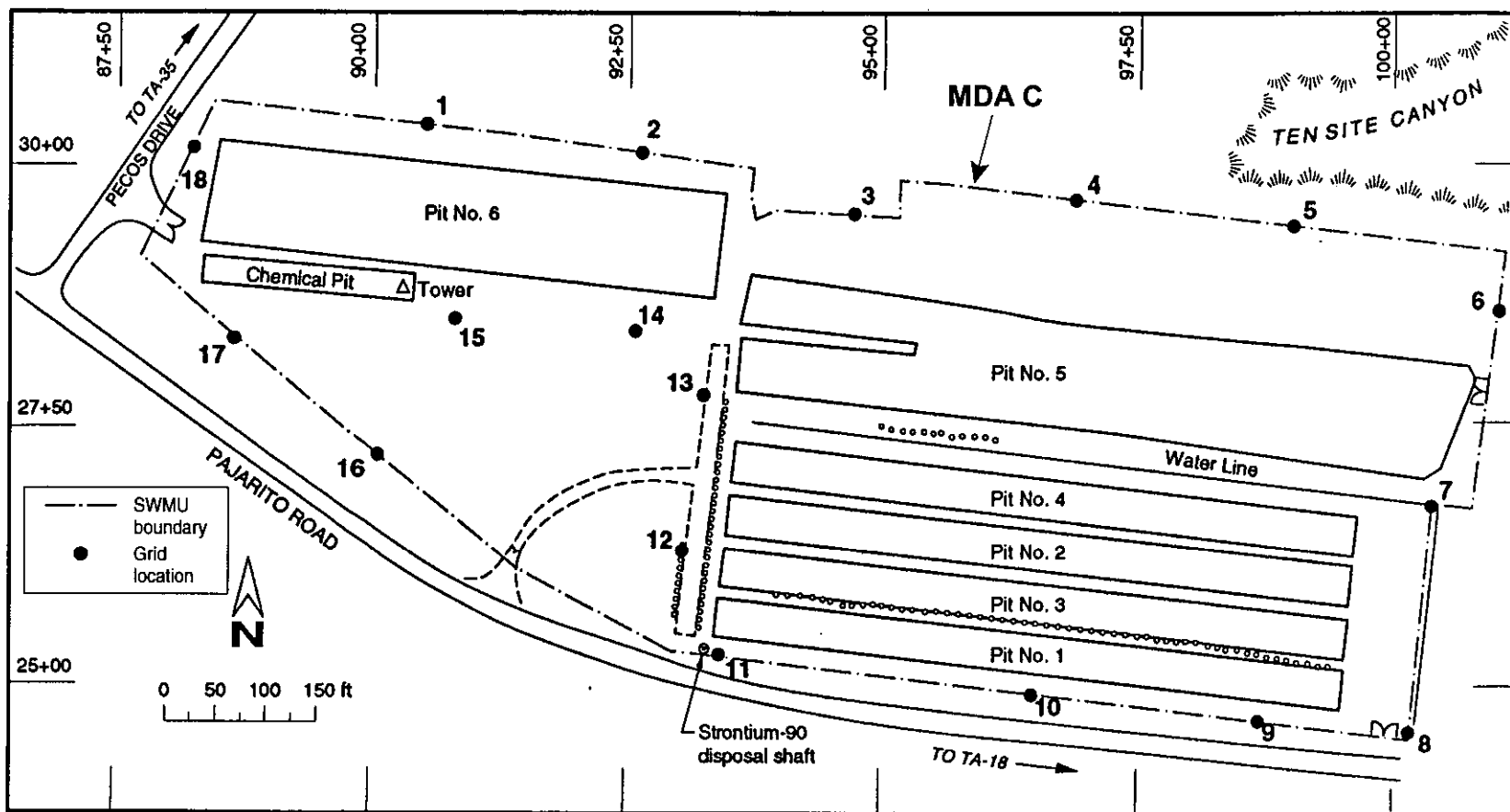
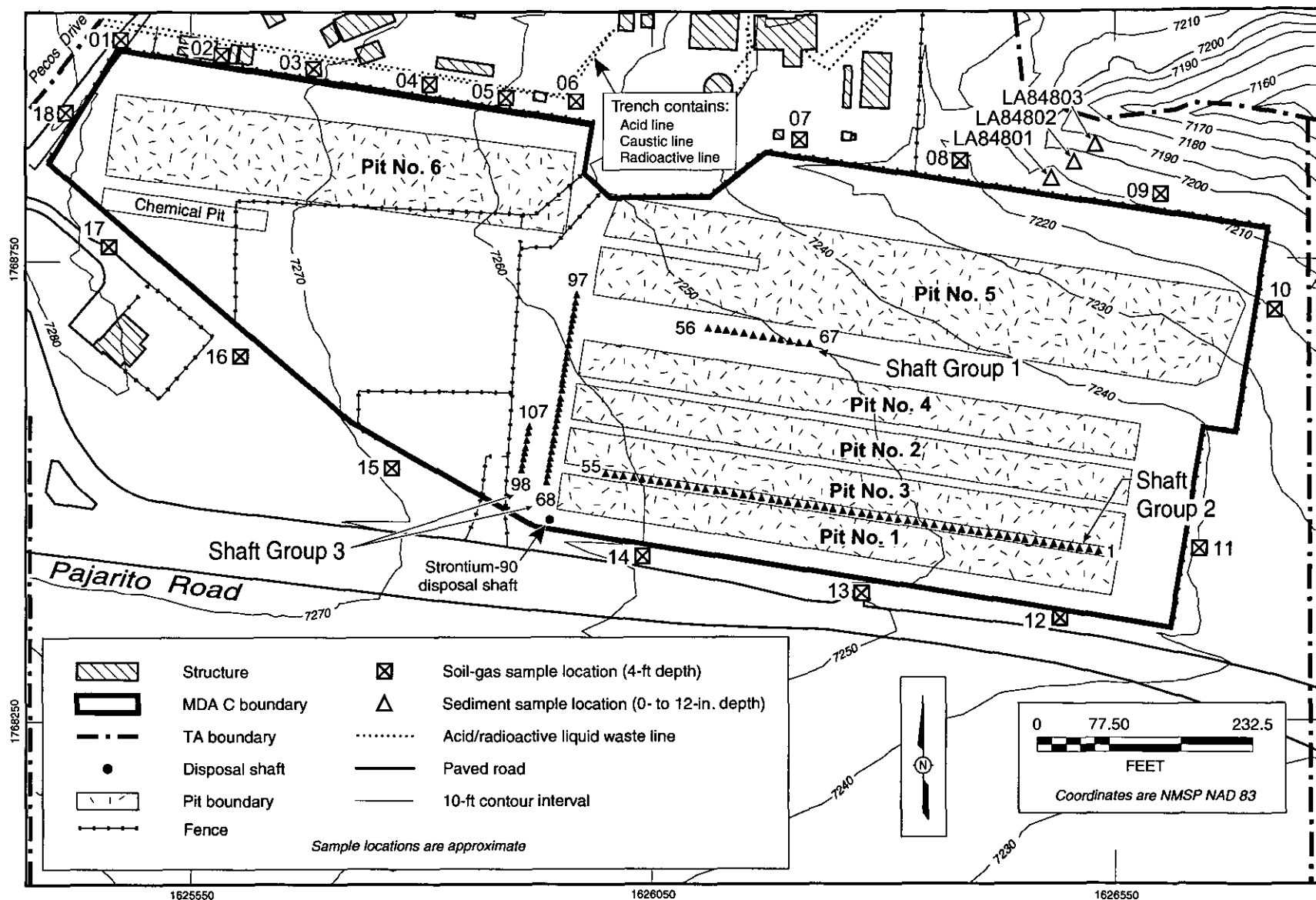


Figure B-1. Thermoluminescent dosimeter perimeter sampling locations at MDA C



Source: GISLab map no. m200615, Richard Kelley, 031703_Rev. for FB2, MDA C IWP, 110603, ptm/cf

Figure B-2. Pre-RFI characterization sample locations—1989

November 2003

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Figure B-3. Phase I RFI surface sample locations at MDA C—1995

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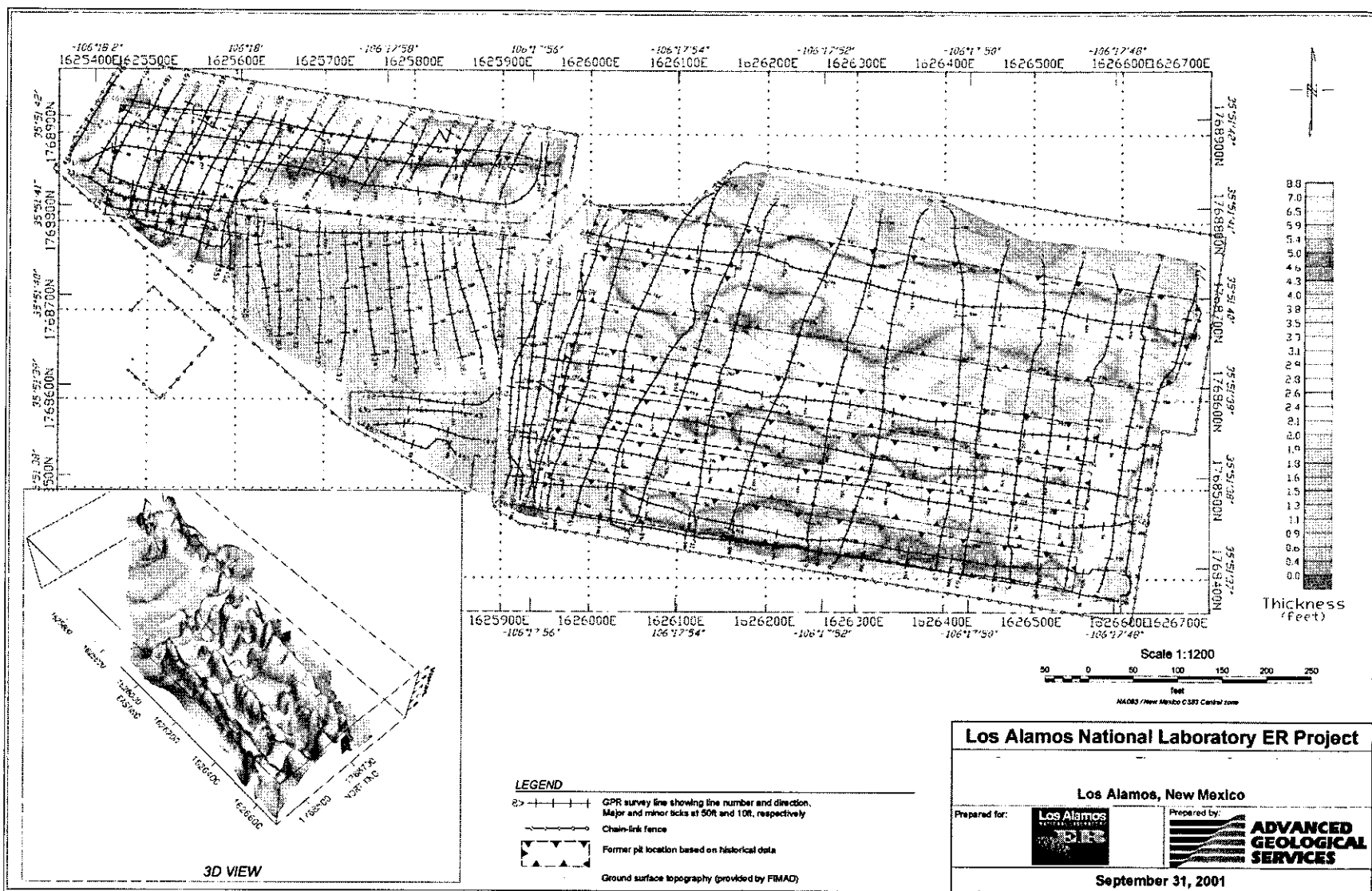


Figure B-4. Thickness of fill material at MDA C based on 2001 geophysical survey

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11x17

Figure B-5. Overlay of 2001/2002 geophysical surveys versus 1974 LASL engineering drawing to identify pit and shaft locations

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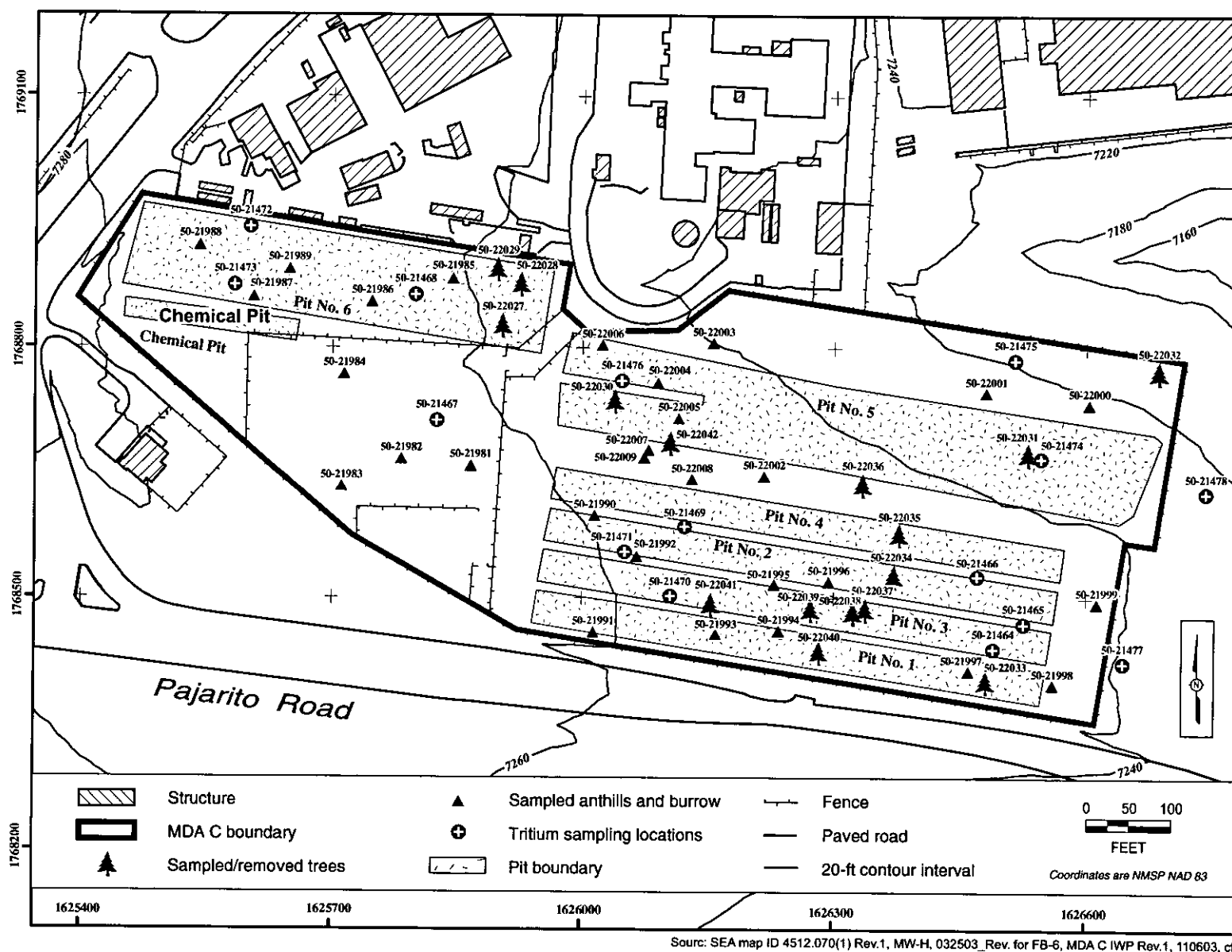


Figure B-6. Locations of tritium probe and biota samples (submitted to ARS) collected in 2003 at MDA C

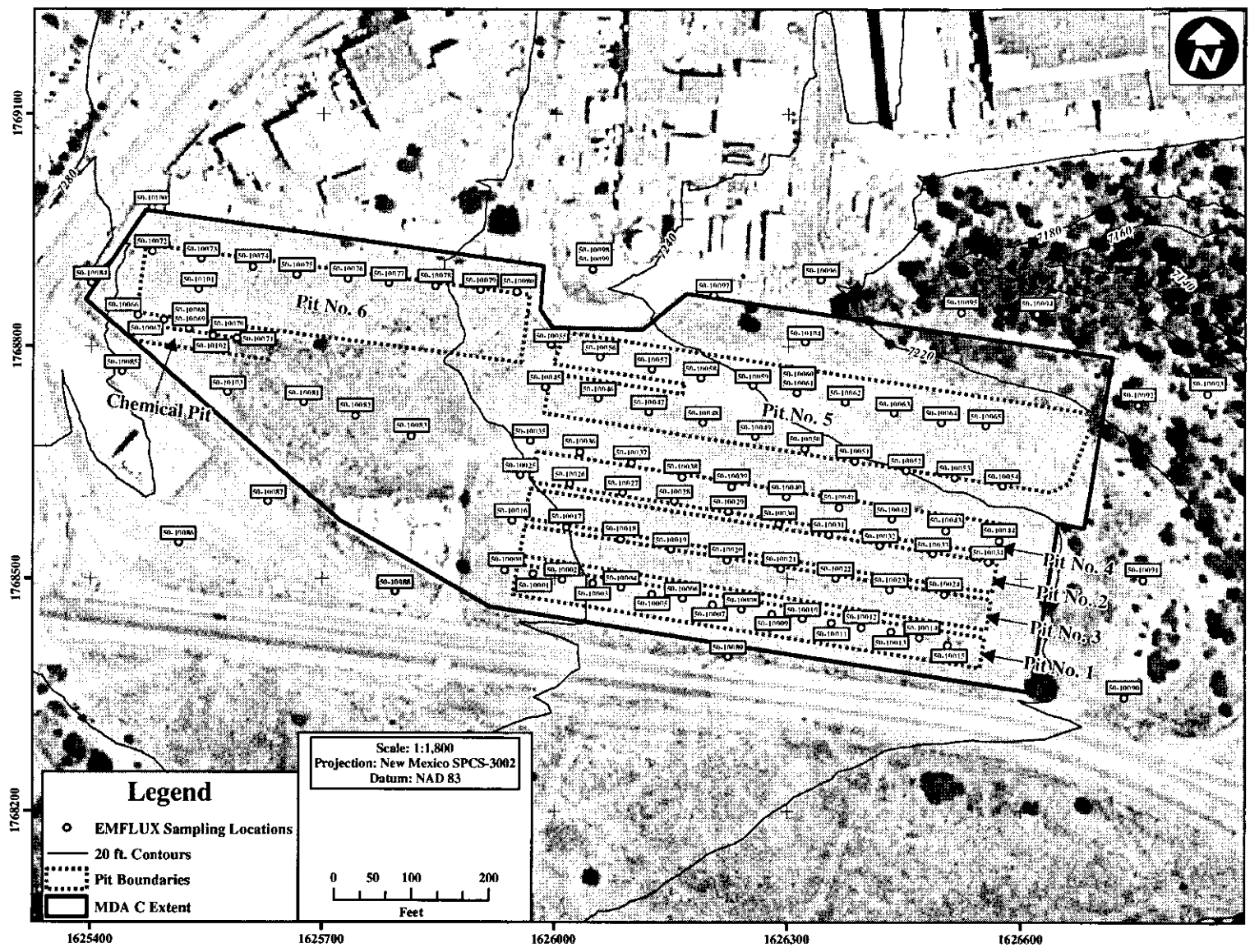


Figure B-7. Locations of surface flux samples at MDA C

Source: SEA, MW-H, 11/03_Rev. for FB-7, MDAC Rev.1, 110603, of

November 2003

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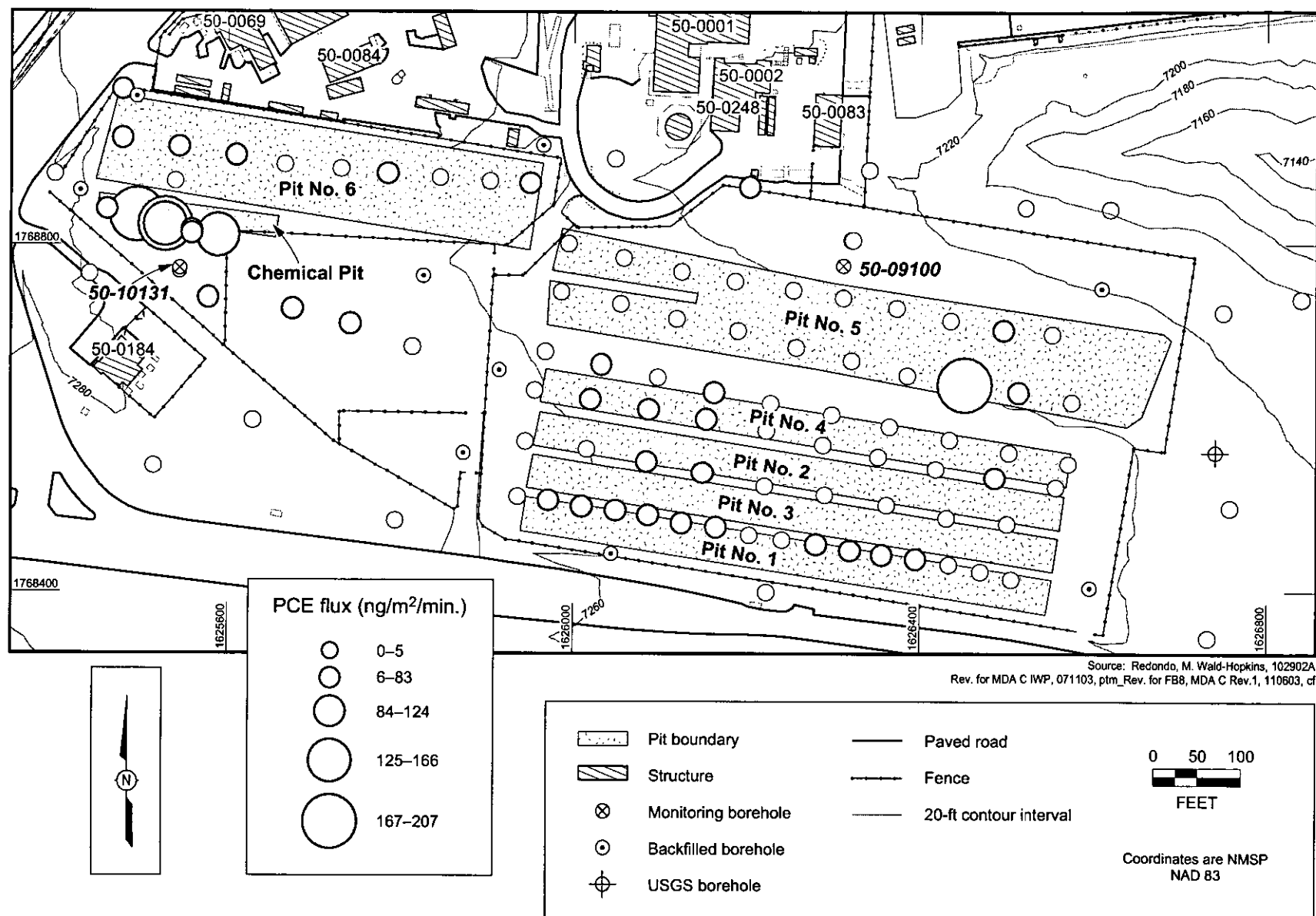
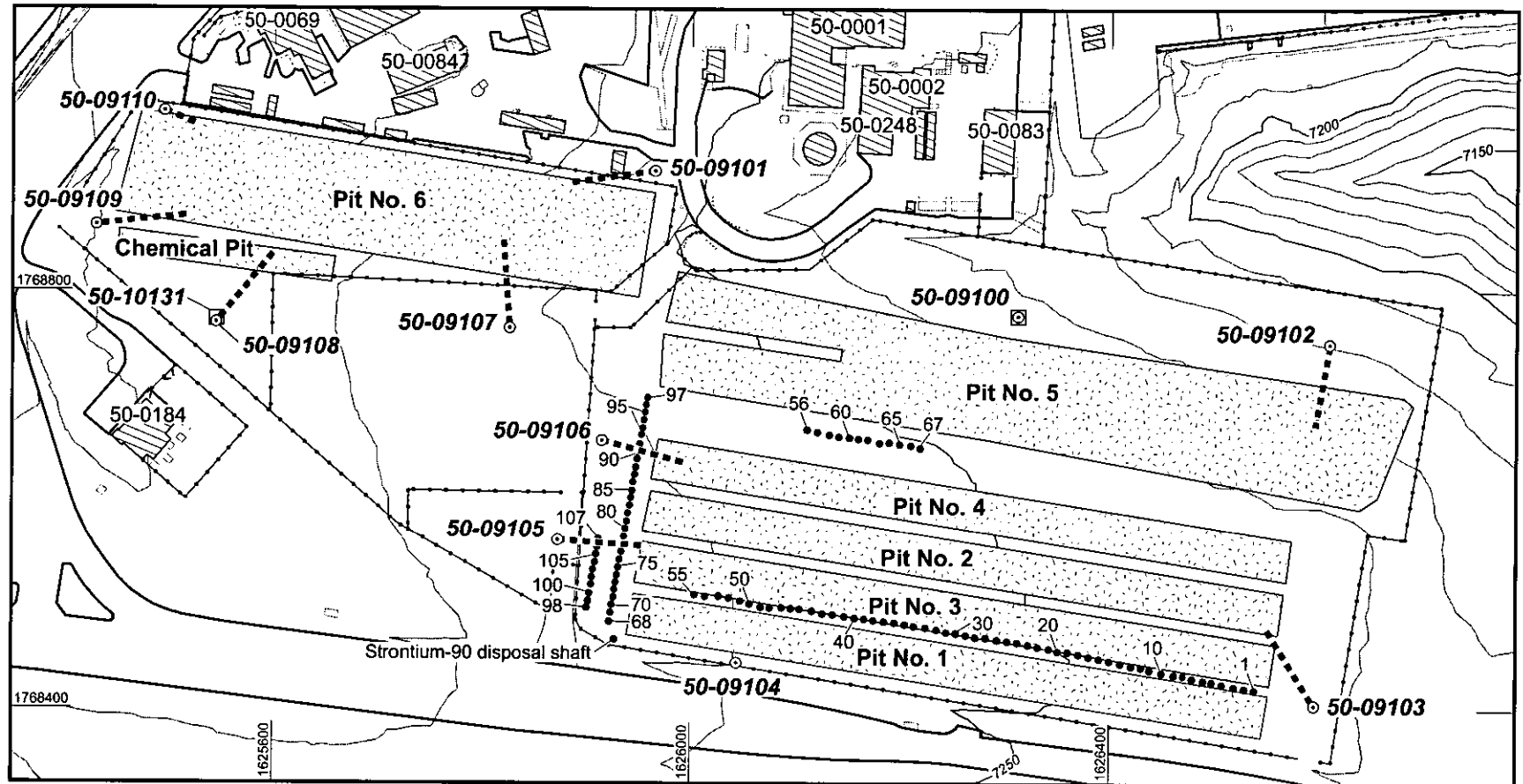


Figure B-8. Concentrations of PCE from the surface flux data at MDA C



Source: GISLab map no. m200615, Richard Kelley, 031703_Rev. for MDA C IWP Rev.1, 110603, plm/cf

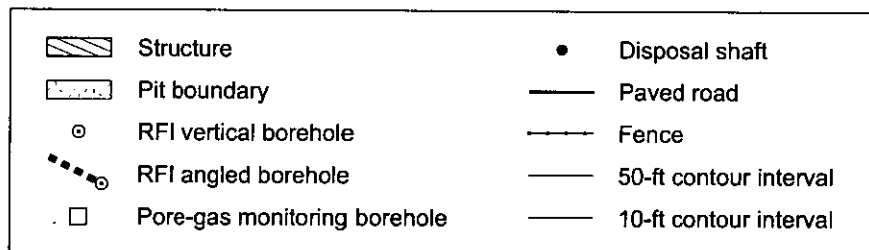
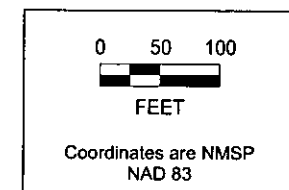


Figure B-9. Phase I RFI borehole locations at MDA C

Table B-1
Dimensions of the Disposal Units at MDA C

Disposal Unit	Dimensions ^a (ft)	Period of Operations
Pit 1	610 x 40 x 25	1948–1951
Pit 2	610 x 40 x 25	1950–1951
Pit 3	610 x 40 x 25	1951–1953
Pit 4	610 x 40 x 25	1951–1955
Pit 5	705 x 110 x 18	1953–1959
Pit 6	505 x 100 x 25	1956–1959
Chemical Pit	180 x 25 x 12	1960–1964
Shaft Group 1 (12 [Shafts 56–67])	2 x 10	1959
Shaft Group 2 (55 [Shafts 1–55])	2 x 15	1959–1967
Shaft Group 3 (40 [Shafts 68–107])	1–2 x 20–25	1962–1966
Shaft 108 (Strontium-90 Disposal Shaft)	Unknown	1950s or 1960s

^a As stated in Table 2-11 of the OU 1147 Work Plan, pit dimensions are length by width by depth; shaft dimensions are diameter by depth (LANL 1992, 07672). Dimensions are approximate.

^b Shafts 98–107 are 1 ft in diameter and lined with 12-in.-thick concrete. Shafts 68–97 are 2 ft in diameter and unlined.

Table B-2
Summary of 1986 Field Instrument and Radiochemical Surveys at MDA C

Grid Loc.	Media Code	H-3 (pCi/L)	Am-241 (pCi/g)	Cs-137 (pCi/g)	Pu-238 (pCi/g)	Pu-239 (pCi/g)	Phoswich (c/100 sec)	RASCAL (c/120 sec)
1	Soil	11000.0	0.72	0.12	0.007	0.34	5319	1656
2	Soil	13000.0	0.78	0.21	0.006	0.60	6070	1649
3	Soil	3200.0	1.18	0.05	0.007	0.20	5986	1902
4	Soil	3400.0	0.29	0.07	0.030	0.80	6141	1755
5	Soil	7000.0	1.48	0.38	0.004	0.60	6736	2202
6	Soil	4000.0	1.07	0.28	0.096	7.30	6856	2139
7	Soil	7700.0	0.08	0.55	0.091	10.40	6333	1755
8	Soil	29000.0	1.60	ND	0.022	2.35	6458	1510
9	Soil	21000.0	0.39	0.09	0.005	0.36	5508	1625
10	Soil	41000.0	1.12	0.30	0.032	2.26	6169	1923
11	Soil	39000.0	1.10	0.13	0.070	15.10	5698	1474
12	Soil	21000.0	0.11	0.22	0.084	1.62	5488	1945
13	Soil	50000.0	1.21	0.03	0.0004	0.01	5887	1853
14	Soil	3000.0	0.22	0.03	0.003	0.06	4544	1208
15	Soil	23000.0	1.11	0.14	0.008	0.15	4391	1324
16	Soil	33000.0	0.19	0.30	0.011	0.13	5361	1440
17	Soil	44000.0	1.22	0.26	0.014	0.60	5272	1512
18	Soil	43000.0	1.31	0.07	0.013	0.78	4877	1554
1	Vegetation	400.0	Samples lost	ND ^a	0.002	0.012	NA ^b	NA
2	Vegetation	ND	Samples lost	ND	0.005	0.069	NA	NA
3	Vegetation	ND	Samples lost	0.35	0.014	0.203	NA	NA
4	Vegetation	ND	Samples lost	0.25	0.012	0.078	NA	NA
5	Vegetation	ND	Samples lost	1.97	0.004	0.040	NA	NA
6	Vegetation	ND	Samples lost	1.87	0.002	0.333	NA	NA
7	Vegetation	ND	Samples lost	1.83	0.005	0.450	NA	NA
8	Vegetation	1000.0	Samples lost	0.20	0.006	0.259	NA	NA
9	Vegetation	1800.0	Samples lost	ND	0.018	0.187	NA	NA
10	Vegetation	2100.0	Samples lost	ND	0.003	0.057	NA	NA
11	Vegetation	ND	Samples lost	0.02	0.014	0.174	NA	NA
12	Vegetation	ND	Samples lost	0.69	0.007	0.059	NA	NA
13	Vegetation	3400.0	Samples lost	3.73	0.002	0.011	NA	NA
14	Vegetation	ND	Samples lost	0.08	0.022	0.121	NA	NA
15	Vegetation	500.0	Samples lost	1.06	0.004	0.028	NA	NA
16	Vegetation	300.0	Samples lost	1.75	0.003	0.026	NA	NA
17	Vegetation	ND	Samples lost	0.83	0.006	0.248	NA	NA
18	Vegetation	ND	Samples lost	0.45	0.005	0.022	NA	NA

^a ND = Nondetect.^b NA = Not analyzed.

Table B-3
Summary of 1989 Perimeter Pore-Gas Sampling at MDA C

Sample Reference on Figure			1	2	3	4	5	6	7
Sample Number			LA80801	LA80802	LA80803	LA80804	LA80805	LA80806	LA80807
Media			Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
Units			mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
VOC	Target Compounds	Acetone	— ^a	—	—	—	—	—	—
VOC	Target Compounds	Carbon Disulfide	—	—	—	—	—	—	—
VOC	Target Compounds	1,2-Dichloroethene_(total)	—	—	—	—	—	—	—
VOC	Target Compounds	2-Butanone	—	4 BQ	—	—	—	—	—
VOC	Target Compounds	Trichlorethene	—	—	—	—	—	—	—
VOC	Target Compounds	Tetrachloroethene	—	—	—	—	—	—	—
VOC	Target Compounds	Toluene	—	—	—	—	—	—	—
VOC	Target Compounds	Styrene	—	—	—	—	—	—	—
VOC		Total (Allowed) Hold Time	16(ns)d	16(ns)d	16(ns)d	16(ns)d	16(ns)d	16(ns)d	16(ns)d
VOC		ELEVated/DECREased CRQL	DECR	DECR	DECR	DECR	DECR	DECR	DECR
VOC		Dilution Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SVOC	Target Compounds	Isophorone	NA ^b	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Benzoic acid	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Phenanthrene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Fluoranthene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Pyrene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Benz(a)anthracene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Chrysene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
SVOC		Total (Allowed) Hold Time	NA	NA	NA	NA	NA	NA	NA
SVOC		ELEVated/DECREased CRQL	NA	NA	NA	NA	NA	NA	NA
SVOC		Dilution Factor	NA	NA	NA	NA	NA	NA	NA

Table B-3 (continued)

Sample Reference on Figure			1	2	3	4	5	6	7
Sample Number			LA80801	LA80802	LA80803	LA80804	LA80805	LA80806	LA80807
Media			Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
Units			mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
PEST/PCB	Target Compounds	alpha-BHC	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	beta-BHC	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	delta-BHC	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Endosulfan I	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Dieldrin	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	4,4'-DDE	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Endosulfan II	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	4,4'-DDD	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	4,4'-DDT	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	alpha-chlordane	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	gamma-chlordane	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Arclor-1254	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Arclor-1260	NA	NA	NA	NA	NA	NA	NA
PEST/PCB		Total (Allowed) Hold Time	NA	NA	NA	NA	NA	NA	NA
PEST/PCB		ELEVated/DECReased CRQL	NA	NA	NA	NA	NA	NA	NA
PEST/PCB		Dilution Factor	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Antimony	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Arsenic	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Barium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Beryllium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Cadmium	NA	NA	NA	NA	NA	NA	NA

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Table B-3 (continued)

		Sample Reference on Figure	1	2	3	4	5	6	7
		Sample Number	LA80801	LA80802	LA80803	LA80804	LA80805	LA80806	LA80807
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
		Units	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
INORGANIC	Analytes	Chromium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Copper ^c	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Lead	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Mercury ^d	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Nickel	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Selenium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Silver	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Thallium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Zinc	NA	NA	NA	NA	NA	NA	NA
INORGANIC		% Solids	NA	NA	NA	NA	NA	NA	NA
INORGANIC		Total (Allowed) Hold Time ^e	NA	NA	NA	NA	NA	NA	NA
INORGANIC		Total (Allowed) Hold Time ^d	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Radium-226	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Thorium-230	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Thorium 232 ^f	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium-235	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium-238 ^f	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium-238 ^g	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium (all isotopes)	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Plutonium-238	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Plutonium-239, 240	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Americium-241	NA	NA	NA	NA	NA	NA	NA
RAD	Beta Emitters	Strontium-90	NA	NA	NA	NA	NA	NA	NA

Table B-3 (continued)

		Sample Reference on Figure	1	2	3	4	5	6	7
		Sample Number	LA80801	LA80802	LA80803	LA80804	LA80805	LA80806	LA80807
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
		Units	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
RAD	Gamma Emitters	Beryllium-7	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Potassium-40	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cobalt-60	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cadmium-109	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cesium-137	NA	NA	NA	NA	NA	NA	NA

Table B-3 (continued)

		Sample Reference on Figure	8	9	10	11	12	13	14
		Sample Number	LA80808	LA80809	LA80810	LA80811	LA80812	LA80813	LA80814
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
		Units	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
VOC	Target Compounds	Acetone	—	—	—	—	—	—	—
VOC	Target Compounds	Carbon Disulfide	—	0.4 J	—	—	—	—	—
VOC	Target Compounds	1,2-Dichloroethene_(total)	—	—	—	—	—	—	—
VOC	Target Compounds	2-Butanone	—	—	—	—	—	—	—
VOC	Target Compounds	Trichlorethene	—	0.3 J	—	—	0.3 J	—	—
VOC	Target Compounds	Tetrachloroethene	—	—	—	—	—	—	—
VOC	Target Compounds	Toluene	—	—	—	—	—	—	—
VOC	Target Compounds	Styrene	—	—	—	—	—	—	—
VOC		Total (Allowed) Hold Time	17(ns)d	17(ns)d	16(ns)d	16(ns)d	16(ns)d	16(ns)d	16(ns)d
VOC		ELEVated/DECReased CRQL	DECR	DECR	DECR	DECR	DECR	DECR	DECR
VOC		Dilution Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000

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Table B-3 (continued)

		Sample Reference on Figure	8	9	10	11	12	13	14
		Sample Number	LA80808	LA80809	LA80810	LA80811	LA80812	LA80813	LA80814
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
		Units	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
SVOC	Target Compounds	Isophorone	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Benzoic acid	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Phenanthrene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Fluoranthene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Pyrene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Benz(a)anthracene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Chrysene	NA	NA	NA	NA	NA	NA	NA
SVOC	Target Compounds	Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
SVOC		Total (Allowed) Hold Time	NA	NA	NA	NA	NA	NA	NA
SVOC		ELEVated/DECReased CRQL	NA	NA	NA	NA	NA	NA	NA
SVOC		Dilution Factor	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	alpha-BHC	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	beta-BHC	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	delta-BHC	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Endosulfan I	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Dieldrin	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	4,4'-DDE	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Endosulfan II	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	4,4'-DDD	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	4,4'-DDT	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	alpha-chlordane	NA	NA	NA	NA	NA	NA	NA

Table B-3 (continued)

		Sample Reference on Figure	8	9	10	11	12	13	14
		Sample Number	LA80808	LA80809	LA80810	LA80811	LA80812	LA80813	LA80814
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
		Units	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
PEST/PCB	Target Compounds	gamma-chlordane	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Arlor-1254	NA	NA	NA	NA	NA	NA	NA
PEST/PCB	Target Compounds	Arlor-1260	NA	NA	NA	NA	NA	NA	NA
PEST/PCB		Total (Allowed) Hold Time	NA	NA	NA	NA	NA	NA	NA
PEST/PCB		ELEVated/DECREased CRQL	NA	NA	NA	NA	NA	NA	NA
PEST/PCB		Dilution Factor	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Antimony	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Arsenic	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Barium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Beryllium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Cadmium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Chromium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Copper ^c	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Lead	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Mercury ^d	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Nickel	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Selenium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Silver	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Thallium	NA	NA	NA	NA	NA	NA	NA
INORGANIC	Analytes	Zinc	NA	NA	NA	NA	NA	NA	NA
INORGANIC		% Solids	NA	NA	NA	NA	NA	NA	NA
INORGANIC		Total (Allowed) Hold Time ^e	NA	NA	NA	NA	NA	NA	NA
INORGANIC		Total (Allowed) Hold Time ^d	NA	NA	NA	NA	NA	NA	NA

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Table B-3 (continued)

		Sample Reference on Figure	8	9	10	11	12	13	14
		Sample Number	LA80808	LA80809	LA80810	LA80811	LA80812	LA80813	LA80814
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas	Soilgas
		Units	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3	mg/m3
Suite	Field Measurements	Depth (ft)	4	4	4	4	4	4	4
RAD	Alpha Emitters	Radium-226	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Thorium-230	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Thorium 232 ^f	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium-235	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium-238 ^f	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium-238 ^g	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium (all isotopes)	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Plutonium-238	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Plutonium-239, 240	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Americium-241	NA	NA	NA	NA	NA	NA	NA
RAD	Beta Emitters	Strontium-90	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Beryllium-7	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Potassium-40	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cobalt-60	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cadmium-109	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cesium-137	NA	NA	NA	NA	NA	NA	NA

Table B-3 (continued)

		Sample Reference on Figure	15	16	17	18	LA84801	LA84802	LA84803
		Sample Number	LA80815	LA80816	LA80817	LA80818	LA84801	LA84802	LA84803
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soil	Soil	Soil
		Units	mg/m3	mg/m3	mg/m3	mg/m3	ug/kg	ug/kg	ug/kg
Suite	Field Measurements	Depth (ft)	4	4	4	4	0-1	0-1	0-1
VOC	Target Compounds	Acetone	—	—	—	—	—	180 B	—
VOC	Target Compounds	Carbon Disulfide	—	—	—	—	—	—	—
VOC	Target Compounds	1,2-Dichloroethene_(total)	—	—	—	—	—	—	—
VOC	Target Compounds	2-Butanone	—	—	—	—	—	—	—
VOC	Target Compounds	Trichlorethene	0.2 J	—	0.3 J	—	—	—	—
VOC	Target Compounds	Tetrachloroethene	—	—	—	—	—	—	—
VOC	Target Compounds	Toluene	—	—	—	—	—	4 J	—
VOC	Target Compounds	Styrene	—	—	—	—	—	—	—
VOC		Total (Allowed) Hold Time	18(ns)d	18(ns)d	18(ns)d	18(ns)d	—	19(14)d	13(14)d
VOC		ELEVated/DECReased CRQL	DECR	DECR	DECR	DECR	—	ELEV	ELEV
VOC		Dilution Factor	1.000	1.000	1.000	1.000	—	1.000	1.000
SVOC	Target Compounds	Isophorone	NA	NA	NA	NA	NA	—	13 J
SVOC	Target Compounds	Benzoic acid	NA	NA	NA	NA	NA	—	190 J
SVOC	Target Compounds	Phenanthrene	NA	NA	NA	NA	NA	51 J	8 J
SVOC	Target Compounds	Fluoranthene	NA	NA	NA	NA	NA	100 J	17 J
SVOC	Target Compounds	Pyrene	NA	NA	NA	NA	NA	81 J	14 J
SVOC	Target Compounds	Benz(a)anthracene	NA	NA	NA	NA	NA	47 J	—
SVOC	Target Compounds	Chrysene	NA	NA	NA	NA	NA	48 J	—
SVOC	Target Compounds	Benzo(b)fluoranthene	NA	NA	NA	NA	NA	33 J	—
SVOC		Total (Allowed) Hold Time	NA	NA	NA	NA	NA	12(14)d	12(14)d
SVOC		ELEVated/DECReased CRQL	NA	NA	NA	NA	NA	ELEV	ELEV
SVOC		Dilution Factor	NA	NA	NA	NA	NA	1.000	1.000
PEST/PCB	Target Compounds	alpha-BHC	NA	NA	NA	NA	NA	—	—

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Table B-3 (continued)

			Sample Reference on Figure	15	16	17	18	LA84801	LA84802	LA84803
			Sample Number	LA80815	LA80816	LA80817	LA80818	LA84801	LA84802	LA84803
			Media	Soilgas	Soilgas	Soilgas	Soilgas	Soil	Soil	Soil
			Units	mg/m3	mg/m3	mg/m3	mg/m3	ug/kg	ug/kg	ug/kg
Suite	Field Measurements	Depth (ft)	4	4	4	4	0-1	0-1	0-1	0-1
PEST/PCB	Target Compounds	beta-BHC	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	delta-BHC	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	Heptachlor epoxide	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	Endosulfan I	NA	NA	NA	NA	NA	NA	36	—
PEST/PCB	Target Compounds	Dieldrin	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	4,4'-DDE	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	Endosulfan II	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	4,4'-DDD	NA	NA	NA	NA	NA	NA	4.50 J	6 J
PEST/PCB	Target Compounds	4,4'-DDT	NA	NA	NA	NA	NA	NA	11 J	16 J
PEST/PCB	Target Compounds	alpha-chlordane	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	gamma-chlordane	NA	NA	NA	NA	NA	NA	0.83 J	—
PEST/PCB	Target Compounds	Arclor-1254	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB	Target Compounds	Arclor-1260	NA	NA	NA	NA	NA	NA	—	—
PEST/PCB		Total (Allowed) Hold Time	NA	NA	NA	NA	NA	NA	12(14)d	12(14)d
PEST/PCB		ELEVated/DECREased CRQL	NA	NA	NA	NA	NA	NA	ELEV	ELEV
PEST/PCB		Dilution Factor	NA	NA	NA	NA	NA	NA	1.000	1.000
INORGANIC	Analytes	Antimony	NA	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Arsenic	NA	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Barium	NA	NA	NA	NA	NA	NA	89.0	106
INORGANIC	Analytes	Beryllium	NA	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Cadmium	NA	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Chromium	NA	NA	NA	NA	NA	NA	7.4	19.2

Table B-3 (continued)

		Sample Reference on Figure	15	16	17	18	LA84801	LA84802	LA84803
		Sample Number	LA80815	LA80816	LA80817	LA80818	LA84801	LA84802	LA84803
		Media	Soilgas	Soilgas	Soilgas	Soilgas	Soil	Soil	Soil
		Units	mg/m3	mg/m3	mg/m3	mg/m3	ug/kg	ug/kg	ug/kg
Suite	Field Measurements	Depth (ft)	4	4	4	4	0-1	0-1	0-1
INORGANIC	Analytes	Copper ^c	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Lead	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Mercury ^d	NA	NA	NA	NA	NA	NR	NR
INORGANIC	Analytes	Nickel	NA	NA	NA	NA	NA	—	58.0
INORGANIC	Analytes	Selenium	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Silver	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Thallium	NA	NA	NA	NA	NA	—	—
INORGANIC	Analytes	Zinc	NA	NA	NA	NA	NA	47.1	46.6
INORGANIC		% Solids	NA	NA	NA	NA	NA	79.0	76.6
INORGANIC		Total (Allowed) Hold Time ^e	NA	NA	NA	NA	NA	7(182)d	11(182)d
INORGANIC		Total (Allowed) Hold Time ^d	NA	NA	NA	NA	NA	—	—
RAD	Alpha Emitters	Radium-226	NA	NA	NA	NA	NA	900 ^h	900 ^h
RAD	Alpha Emitters	Thorium-230	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Thorium 232 ^f	NA	NA	NA	NA	NA	<12890 ⁱ	<12700 ⁱ
RAD	Alpha Emitters	Uranium-235	NA	NA	NA	NA	NA	79 ⁱ	100 ⁱ
RAD	Alpha Emitters	Uranium-238 ^f	NA	NA	NA	NA	NA	<12800 ⁱ	<12200 ⁱ
RAD	Alpha Emitters	Uranium-238 ^g	NA	NA	NA	NA	NA	NA	NA
RAD	Alpha Emitters	Uranium (all isotopes)	NA	NA	NA	NA	NA	5000 ^h	6000 ^h
RAD	Alpha Emitters	Plutonium-238	NA	NA	NA	NA	NA	190 ^h	420 ^h
RAD	Alpha Emitters	Plutonium-239, 240	NA	NA	NA	NA	NA	7840 ^h	5280 ^h
RAD	Alpha Emitters	Americium-241	NA	NA	NA	NA	NA	790 ⁱ	310 ⁱ
RAD	Beta Emitters	Strontium-90	NA	NA	NA	NA	NA	<720 ^h	<900 ^h
RAD	Gamma Emitters	Beryllium-7	NA	NA	NA	NA	NA	NA	NA

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Table B-3 (continued)

Sample Reference on Figure			15	16	17	18	LA84801	LA84802	LA84803
Sample Number			LA80815	LA80816	LA80817	LA80818	LA84801	LA84802	LA84803
Media			Soilgas	Soilgas	Soilgas	Soilgas	Soil	Soil	Soil
Units			mg/m3	mg/m3	mg/m3	mg/m3	ug/kg	ug/kg	ug/kg
Suite	Field Measurements	Depth (ft)	4	4	4	4	0-1	0-1	0-1
RAD	Gamma Emitters	Potassium-40	NA	NA	NA	NA	NA	24100 ⁱ	21200 ⁱ
RAD	Gamma Emitters	Cobalt-60	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cadmium-109	NA	NA	NA	NA	NA	NA	NA
RAD	Gamma Emitters	Cesium-137	NA	NA	NA	NA	NA	395 ⁱ	291 ⁱ

^a — = Not detected.

^b NA = Not analyzed.

^c Copper not quantitated due to suspected interference and/or external contamination.

^d CVAAS

^e ICP.

^f Total unbroken chain activity in equilibrium.

^g Activity in excess of U-238 natural chain.

^h Units are pCi/kgD.

ⁱ Units are pCi/kgW.

Table B-4

Summary of Work Plan Specifications, Actual Fieldwork, and Rationale for Deviations

Media	Work Plan Specification ^a		Actual Fieldwork Performed		Rationale for Deviation
	Sample Number	Analytes Measured	Sample Number	Analytes Measured	
Surface soil and fill	223	Semivolatile organic compounds (SVOCs), inorganic chemicals, gamma spec, tritium, isotopic Pu, Sr-90, total uranium, Am-241.	203 samples were collected and screened for gross alpha, beta, and gamma 68 samples submitted to an off-site contract laboratory.	59 samples analyzed for PCBs/pesticides. 68 samples analyzed for SVOCs, inorganic chemicals (limited list of metals), gamma spec, Sr-90, Am-241, isotopic Pu, isotopic U. 10 samples analyzed for Hg. 59 samples analyzed for tritium but data were not used.	20 of the originally planned samples were not collected because the locations were covered by asphalt.
Tuff	See proposed drilling modifications (LANL 1995, 49969) called for 20-ft sampling interval, all samples to be analyzed by mobile labs, only 2 samples per borehole for fixed lab analysis.	SVOCs, VOCs, inorganic chemicals, gamma spec, tritium, isotopic Pu, Sr-90, total uranium	82 total: 67 in 1995 15 in 1996 from curated core	SVOCs, VOCs, pesticides and PCBs, inorganic chemicals, cyanide, gamma spec, tritium, Am-241, isotopic Pu, isotopic U, isotopic Th, Sr-90 82 TAL metals except Sb (76), Cn (61) 82 radionuclides 67 tritium, SVOCs 54 VOCs, PCBs, and pesticides.	The 6 vertical boreholes specified in the Work Plan were to be 80 ft deep and the 4 angled holes were to range in length from 483 to 706 ft bgs; the 2 vertical boreholes drilled were 90 and 316 ft deep and the 9 angled boreholes drilled ranged in length from 91 to 120 ft bgs. Samples were collected for field screening every 5 feet; one sample per 20 feet was submitted to a fixed contract laboratory based on the proposed OU 1147 Work Plan modifications. EPA's response to LANL's proposed drilling modifications maintained the 10-ft sampling interval requirement in all boreholes (Neleigh 1995, 55112). Phase I RFI fieldwork was already completed so additional core samples (15 of the 82) were collected from curated core and submitted to an offsite contract laboratory for analysis in 1996. The RFI work plan specified locations for boreholes. Actual borehole locations were selected to maximize the area sampled and avoid obstacles such as buried utilities and waste.

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Table B-4 (continued)

Media	Work Plan Specification ^a		Actual Fieldwork Performed		Rationale for Deviation
	Sample Number	Analytes Measured	Sample Number	Analytes Measured	
Pore gas	n/a ^b	n/a	34	VOCs	VOCs don't adsorb to the tuff matrix; gas phase analysis provides information about the nature and extent of VOCs in the subsurface
Near-surface pore gas	n/a	n/a	15	Tritium	15 shallow pore-gas vapor probes were installed across MDA C to identify potential locations of tritium releases to the atmosphere
VOC surface flux	n/a	n/a	105	VOCs	Surface flux data can help identify lateral extent of subsurface VOC contamination
Biota – ant mounds and burrow spoils	Not specified	n/a	29	Gross alpha, beta and gamma radiation	Biota samples were collected and analyzed to determine if there has been any uptake of contaminants at MDA C.
Biota – Ponderosa pine needles	Not specified	n/a	16	Gross alpha, beta and gamma radiation	Biota samples were collected and analyzed to determine if there has been any uptake of contaminants at MDA C.
Air-flow monitoring	Not specified	scfm ^c	6 boreholes	scfm of air	Air-flow monitoring was performed at six boreholes to provide additional data to assess potential contaminant transport at MDA C

^a Based on proposed modifications to the RFI Work Plan for OU 1147 for drilling and core sampling at MDA C to EPA based on a July 7, 1995 meeting with EPA (LANL 1995, 49969)

^b n/a = Not applicable.

^c scfm = Standard cubic feet per minute.

Table B-5
2003 Biota Samples Submitted to ARS

Sample ID	Location ID	Depth (ft)	Media	Sample Description
MD50-03-50891	50-21981	0-0.5	Soil	Ant mounds and burrows
MD50-03-50892	50-21982	0-0.5	Soil	Ant mounds and burrows
MD50-03-50893	50-21983	0-0.5	Soil	Ant mounds and burrows
MD50-03-50894	50-21984	0-0.5	Soil	Ant mounds and burrows
MD50-03-50895	50-21985	0-0.5	Soil	Ant mounds and burrows
MD50-03-50896	50-21986	0-0.5	Soil	Ant mounds and burrows
MD50-03-50897	50-21987	0-0.5	Soil	Ant mounds and burrows
MD50-03-50898	50-21988	0-0.5	Soil	Ant mounds and burrows
MD50-03-50899	50-21989	0-0.5	Soil	Ant mounds and burrows
MD50-03-50900	50-21990	0-0.5	Soil	Ant mounds and burrows
MD50-03-50901	50-21991	0-0.5	Soil	Ant mounds and burrows
MD50-03-50902	50-21992	0-0.5	Soil	Ant mounds and burrows
MD50-03-50903	50-21993	0-0.5	Soil	Ant mounds and burrows
MD50-03-50904	50-21994	0-0.5	Soil	Ant mounds and burrows
MD50-03-50905	50-21995	0-0.5	Soil	Ant mounds and burrows
MD50-03-50906	50-21996	0-0.5	Soil	Ant mounds and burrows
MD50-03-50907	50-21997	0-0.5	Soil	Ant mounds and burrows
MD50-03-50908	50-21998	0-0.5	Soil	Ant mounds and burrows
MD50-03-50909	50-21999	0-0.5	Soil	Ant mounds and burrows
MD50-03-50910	50-22000	0-0.5	Soil	Ant mounds and burrows
MD50-03-50911	50-22001	0-0.5	Soil	Ant mounds and burrows
MD50-03-50912	50-22002	0-0.5	Soil	Ant mounds and burrows
MD50-03-50913	50-22003	0-0.5	Soil	Ant mounds and burrows
MD50-03-50914	50-22004	0-0.5	Soil	Ant mounds and burrows
MD50-03-50915	50-22005	0-0.5	Soil	Ant mounds and burrows
MD50-03-50916	50-22006	0-0.5	Soil	Ant mounds and burrows
MD50-03-50917	50-22007	0-0.5	Soil	Ant mounds and burrows
MD50-03-50918	50-22008	0-0.5	Soil	Ant mounds and burrows
MD50-03-50919	50-22009	0-0.5	Soil	Ant mounds and burrows
MD50-03-51115	50-22027	0-0	n/a*	Pine needles
MD50-03-51116	50-22028	0-0	n/a	Pine needles
MD50-03-51117	50-22029	0-0	n/a	Pine needles
MD50-03-51118	50-22030	0-0	n/a	Pine needles
MD50-03-51119	50-22031	0-0	n/a	Pine needles
MD50-03-51120	50-22032	0-0	n/a	Pine needles
MD50-03-51121	50-22033	0-0	n/a	Pine needles
MD50-03-51122	50-22034	0-0	n/a	Pine needles

Table B-5 (continued)

Sample ID	Location ID	Depth (ft)	Media	Sample Description
MD50-03-51123	50-22035	0-0	n/a	Pine needles
MD50-03-51124	50-22036	0-0	n/a	Pine needles
MD50-03-51125	50-22037	0-0	n/a	Pine needles
MD50-03-51126	50-22038	0-0	n/a	Pine needles
MD50-03-51127	50-22039	0-0	n/a	Pine needles
MD50-03-51128	50-22040	0-0	n/a	Pine needles
MD50-03-51129	50-22041	0-0	n/a	Pine needles
MD50-03-51130	50-22042	0-0	n/a	Pine needles

*n/a = Not applicable.

Table B-6
Tree Sampling Information from MDA C

Tree Sample ID	Location ID	Approximate Age (Years)	Pine Needle Analysis
T-1	50-22027	8	Gross alpha, beta, and gamma
T-2	50-22028	17	Gross alpha, beta, and gamma
T-3	50-22029	10	Gross alpha, beta, and gamma
T-4	50-22030	18	Gross alpha, beta, and gamma
T-5	50-22042	14	Gross alpha, beta, and gamma
T-6	50-22036	9	Gross alpha, beta, and gamma
T-7	50-22035	12	Gross alpha, beta, and gamma
T-8	50-22031	15	Gross alpha, beta, and gamma
T-9	50-22032	17	Gross alpha, beta, and gamma
T-10	50-22034	11	Gross alpha, beta, and gamma
T-11	50-22038	9	Gross alpha, beta, and gamma
T-12	50-22037	11	Gross alpha, beta, and gamma
T-13	50-22033	10	Gross alpha, beta, and gamma
T-14	50-22040	18	Gross alpha, beta, and gamma
T-15	50-22039	9	Gross alpha, beta, and gamma
T-16	50-22041	No sample*	Gross alpha, beta, and gamma

*Sample not delivered for tree ring dating.

Table B-7
Results of Field Radioactivity Screening on Ant Mound Material

Ant Mound	Field Screening Beta-Gamma Disintegrations per Minute
6R*	414
10R*	447
15R	459
2R*	459
8R	459
5R	488
1R*	509
14R*	515
3R	530
4R*	538
11R	550
7R*	550
9R*	567
13R*	612

* Sample submitted to American Radiological Services of NM (ARS) for gross alpha, beta, and gamma radiation analysis.

Table B-8
Results of Field Radioactivity Screening on Mammal Burrow Spoil Material

Burrow Spoil	Field Screening Beta-Gamma Disintegrations per Minute	Burrow Spoil	Field Screening Beta-Gamma Disintegrations per Minute	Burrow Spoil	Field Screening Beta-Gamma Disintegrations per Minute
3B ^a	418	33B	534	41B ^a	608
15B ^a	423	7B	534	51B	612
25B ^a	476	18B	538	43B	621
20B	480	6B	542	23B ^a	625
46B	480	44B	546	26B ^a	625
19B ^a	484	11B	554	4B	625
1B	488	37B	554	39B ^a	629
42B ^a	488	54B	554	49B	633
9B	488	13B	558	56B	654
14B	496	44B ^b	563	50B	658
40B	496	12B ^a	567	52B	660
22B	509	28B	567	31B	662
53B	509	58B	567	55B ^a	769
5B ^a	509	27B	571		
10B	513	2B	575		
30B	513	57B	579		
60B	513	8B ^a	579		
59B	521	16B	583		
32B	525	21B	583		
34B ^a	525	48B	583		
36B	525	35B	587		
17B	530	38B	587		
45B	530	24B	592		
47B	530	29B	596		
61B	530	24B ^b	600		

^a Sample submitted to ARS for gross alpha, gross beta, and gross gamma analysis.

^b Sample mistakenly assigned same number in field as existing marked location.

Table B-9
Summary of Phase I RFI Surface Soil and Fill Samples at MDA C

Sample ID	Location ID	Depth (ft)	Media	Limited List TAL Metals ^a	PCBs	SVOCs	Am-241	Gamma Spectroscopy	Isotopic Plutonium	Isotopic Uranium	Sr-90
AAA3153	50-08010	0–0.5	Fill	14924 ^b	14927	14927	14925	14925	14925	14925	14925
AAA3154	50-08062	0–0.5	Fill	14924	14927	14927	14925	14925	14925	14925	14925
AAA3155	50-08064	0–0.5	Fill	14924	14927	14927	14925	14925	14925	14925	14925
AAA3156	50-08106	0–0.5	Fill	14924	14927	14927	14925	14925	14925	14925	14925
AAA3157	50-08110	0–0.5	Fill	14924	14927	14927	14925	14925	14925	14925	14925
AAA3158	50-08116	0–0.5	Fill	14924	14927	14927	14925	14925	14925	14925	14925
AAA2797	50-08126	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA3242	50-08131	0–0.5	Fill	15092	— ^c	15089	15093	15093	15093	15093	15093
AAA2798	50-08134	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA3243	50-08137	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA3244	50-08139	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA3159	50-08156	0–0.5	Fill	14924	14927	14927	14925	14925	14925	14925	14925
AAA3160	50-08162	0–0.5	Fill	14924	14927	14927	14925	14925	14925	14925	14925
AAA3189	50-08168	0–0.5	Fill	14952	14949	14949	14948	14948	14948	14948	14948
AAA2799	50-08176	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA2800	50-08180	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA3245	50-08185	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA3246	50-08189	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA3247	50-08193	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA2801	50-08194	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA3248	50-08195	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA3190	50-08214	0–0.5	Fill	14952	14949	14949	14948	14948	14948	14948	14948
AAA3191	50-08216	0–0.5	Fill	14952	14949	14949	14948	14948	14948	14948	14948
AAA2802	50-08222	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA2803	50-08224	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA2804	50-08226	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA2805	50-08228	0–0.5	Fill	14867	14865	14865	14866	14866	14866	14866	14866
AAA3249	50-08231	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA3092	50-08240	0–0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869
AAA3093	50-08244	0–0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869
AAA3250	50-08245	0–0.5	Fill	15092	—	15089	15093	15093	15093	15093	15093
AAA3192	50-08266	0–0.5	Fill	14952	14949	14949	14948	14948	14948	14948	14948
AAA3094	50-08274	0–0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869
AAA3095	50-08286	0–0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869
AAA3096	50-08290	0–0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869

Table B-9 (continued)

Sample ID	Location ID	Depth (ft)	Media	Limited List TAL Metals ^a	PCBs	SVOCs	Am-241	Gamma Spectroscopy	Isotopic Plutonium	Isotopic Uranium	Sr-90
AAA3193	50-08312	0-0.5	Fill	14952	14949	14949	14948	14948	14948	14948	14948
AAA3097	50-08324	0-0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869
AAA3098	50-08326	0-0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869
AAA3099	50-08328	0-0.5	Fill	14873	14870	14870	14869	14869	14869	14869	14869
AAA3118	50-08336	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3119	50-08340	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3120	50-08342	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3121	50-08370	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3122	50-08374	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3123	50-08386	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3124	50-08428	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3125	50-08432	0-0.5	Fill	14887	14889	14889	14890	14890	14890	14890	14890
AAA3147	50-08436	0-0.5	Fill	14914	14880	14880	14916	14916	14916	14916	14916
AAA3148	50-08438	0-0.5	Fill	14914	14880	14880	14916	14916	14916	14916	14916
AAA3149	50-08440	0-0.5	Fill	14914	14880	14880	14916	14916	14916	14916	14916
AAA3151	50-08486	0-0.5	Fill	14914	14880	14880	14916	14916	14916	14916	14916
AAA3152	50-08492	0-0.5	Fill	14914	14880	14880	14916	14916	14916	14916	14916
AAA2768	50-08086	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA2769	50-08088	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA3143	50-08102	0-0.5	Soil	14914	14880	14880	14916	14916	14916	14916	14916
AAA2770	50-08136	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA2771	50-08138	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA2772	50-08140	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA2773	50-08142	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA2774	50-08144	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA3144	50-08154	0-0.5	Soil	14914	14880	14880	14916	14916	14916	14916	14916
AAA2775	50-08346	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA3145	50-08364	0-0.5	Soil	14914	14880	14880	14916	14916	14916	14916	14916
AAA2776	50-08396	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA3146	50-08418	0-0.5	Soil	14914	14880	14880	14916	14916	14916	14916	14916
AAA2777	50-08446	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA2778	50-08474	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845
AAA2779	50-08494	0-0.5	Soil	14841	14840	14840	14845	14845	14845	14845	14845

^a Limited list metals include antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, potassium, selenium, silver, and thallium.

^b Sample request number.

^c Dash means sample not requested for the suite.

Table B-10
Frequency of Detected Inorganic Chemicals
Above BV in Phase I RFI Surface Soil and Fill Samples at MDA C

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range ^a (mg/kg)	Background Value ^b (mg/kg)	Frequency of Detects Above Background Value	Frequency of Non-detects Above Background Value
Antimony	Fill	52	1	[0.04] to 0.21	0.83	0/52	0/52
Antimony	Soil	16	5	[0.04] to 0.25	0.83	0/16	0/16
Arsenic	Fill	52	49	[0.2] to 5.2	8.17	0/52	0/52
Arsenic	Soil	16	16	0.9 to 8	8.17	0/16	0/16
Barium	Fill	52	52	36 to 250	295	0/52	0/52
Barium	Soil	16	16	26 to 190	295	0/16	0/16
Beryllium	Fill	52	52	0.41 to 1.4	1.83	0/52	0/52
Beryllium	Soil	16	16	0.32 to 1.2	1.83	0/16	0/16
Cadmium	Fill	52	0	[0.4]	0.4	0/52	0/52
Cadmium	Soil	16	0	[0.4]	0.4	0/16	0/16
Chromium, Total	Fill	52	52	2.4 to 18	19.3	0/52	0/52
Chromium, Total	Soil	16	16	1.3 to 12	19.3	0/16	0/16
Lead	Fill	52	52	7 to 30	22.3	6/52	0/52
Lead	Soil	16	16	10 to 27	22.3	3/16	0/16
Mercury	Fill	9	0	[0.1]	0.1	0/9	0/9
Mercury	Soil	1	0	[0.1]	0.1	0/1	0/1
Nickel	Fill	52	52	2.3 to 14	15.4	0/52	0/52
Nickel	Soil	16	12	[2] to 8.2	15.4	0/16	0/16
Potassium	Fill	1	1	1800	3460	0/1	0/1
Potassium	Soil	1	1	1300	3460	0/1	0/1
Selenium	Fill	52	28	[0.2] to 1	1.52	0/52	0/52
Selenium	Soil	16	3	[0.2] to 0.5	1.52	0/16	0/16
Silver	Fill	52	1	[1] to 1.1	1	1/52	0/52
Silver	Soil	16	1	[1] to 6	1	1/16	0/16
Thallium	Fill	52	51	[0.04] to 0.21	0.73	0/52	0/52
Thallium	Soil	16	16	0.04 to 0.18	0.73	0/16	0/16

^a Values in square brackets indicate nondetects.

^b BVs obtained from LANL 1998, 59730.

Table B-11
Inorganic Chemicals Detected Above BV in Phase I RFI Surface Soil and Fill Samples at MDA C

Sample ID	Location ID	Depth (ft)	Media	Lead (mg/kg)	Silver (mg/kg)
Soil Background Value^a				22.3	1
AAA3143	50-08102	0.00–0.50	Soil	27	— ^b
AAA3144	50-08154	0.00–0.50	Soil	27	—
AAA3093	50-08244	0.00–0.50	Fill	—	1.1
AAA3096	50-08290	0.00–0.50	Fill	23	—
AAA3193	50-08312	0.00–0.50	Fill	30	—
AAA3098	50-08326	0.00–0.50	Fill	26	—
AAA3099	50-08328	0.00–0.50	Fill	24	—
AAA3119	50-08340	0.00–0.50	Fill	23	—
AAA3145	50-08364	0.00–0.50	Soil	24	—
AAA3146	50-08418	0.00–0.50	Soil	—	6
AAA3151	50-08486	0.00–0.50	Fill	23	—

^a Soil background value is used for both fill and soil.

^b Dash indicates not above the BV.

Table B-12
Frequency of Detected Radionuclides
Above BVs/FVs in Phase I RFI Surface Soil and Fill Samples at MDA C

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range ^a (pCi/g)	Background/ Fallout Value ^b (pCi/g)	Frequency of Detects Above Background Value
Americium-241	Soil	16	13	[0.005] to 1.017	0.013	11/16
Americium-241	Fill	52	37	[0.003] to 0.292	0.013	24/52
Cesium-137	Soil	16	1	[0.24] to 1.22	1.65	0/16
Cesium-137	Fill	52	1	[0.269 to 0.915]	1.65	0/52
Cobalt-60	Soil	16	0	[0.165 to 0.814]	na ^c	0/16
Cobalt-60	Fill	52	0	[0.128 to 0.761]	na	0/52
Plutonium-238	Soil	16	12	[0.004 to 0.219]	0.023	6/16
Plutonium-238	Fill	52	20	[0.002] to 0.071	0.023	11/52
Plutonium-239	Soil	16	16	0.01 to 10.687	0.054	15/16
Plutonium-239	Fill	52	46	[0.003] to 2.91	0.054	29/52
Strontium-90	Soil	16	0	[-0.54 to 0.32]	1.31	0/16
Strontium-90	Fill	52	0	[-0.62 to 0.3]	1.31	0/52
Thorium-232	Soil	16	4	[2.09] to 4.01	2.33	4/16
Thorium-232	Fill	52	11	[1.83] to 4.8	2.33	11/52
Uranium-234	Soil	16	16	1.07 to 1.89	2.59	0/16
Uranium-234	Fill	52	52	0.91 to 1.83	2.59	0/52
Uranium-235	Soil	16	0	[0.036 to 0.13]	0.2	0/16
Uranium-235	Fill	52	0	[0.023 to 0.165]	0.2	0/52
Uranium-238	Soil	16	16	1.07 to 1.99	2.29	0/16
Uranium-238	Fill	52	52	1.08 to 2.45	2.29	1/52

^a Values in square brackets indicate nondetects.

^b Tuff BVs obtained from LANL 1998, 59730.

^c na = Not available.

Table B-13
Radionuclides Detected Above the BV/FV in Phase I RFI Surface Soil and Fill Samples at MDA C

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Plutonium-238	Plutonium-239	Thorium-232	Uranium-238
Soil and Fill Background Value^a (pCi/g)				0.013	0.023	0.054	2.33	2.29
AAA3153	50-08010	0.00–0.50	Fill	— ^b	—	—	3.97	—
AAA2768	50-08086	0.00–0.50	Soil	—	—	10.687	—	—
AAA2769	50-08088	0.00–0.50	Soil	—	0.052	0.441	—	—
AAA3143	50-08102	0.00–0.50	Soil	0.094	—	0.446	—	—
AAA3157	50-08110	0.00–0.50	Fill	—	—	—	3.49	—
AAA2798	50-08134	0.00–0.50	Fill	—	—	—	3.732	—
AAA2770	50-08136	0.00–0.50	Soil	0.048	—	1.427	3.74	—
AAA3243	50-08137	0.00–0.50	Fill	—	—	—	3.32	—
AAA2771	50-08138	0.00–0.50	Soil	1.017	—	0.46	3.27	—
AAA2772	50-08140	0.00–0.50	Soil	0.03	—	0.347	4.01	—
AAA2773	50-08142	0.00–0.50	Soil	0.032	—	0.342	—	—
AAA2774	50-08144	0.00–0.50	Soil	0.036	—	0.276	—	—
AAA3144	50-08154	0.00–0.50	Soil	0.257	0.035	1.5	—	—
AAA2801	50-08194	0.00–0.50	Fill	—	—	—	—	2.45
AAA3191	50-08216	0.00–0.50	Fill	—	—	—	3.46	—
AAA2802	50-08222	0.00–0.50	Fill	—	—	—	3.07	—
AAA2804	50-08226	0.00–0.50	Fill	—	—	—	3.73	—
AAA3093	50-08244	0.00–0.50	Fill	—	—	—	3.34	—
AAA3250	50-08245	0.00–0.50	Fill	—	—	—	—	—
AAA3098	50-08326	0.00–0.50	Fill	—	—	—	4.8	—
AAA2775	50-08346	0.00–0.50	Soil	0.357	0.032	2.082	—	—
AAA3145	50-08364	0.00–0.50	Soil	—	—	0.103	—	—
AAA3121	50-08370	0.00–0.50	Fill	—	—	—	2.96	—
AAA2776	50-08396	0.00–0.50	Soil	0.361	0.033	2.499	—	—
AAA3147	50-08436	0.00–0.50	Fill	—	—	—	3.56	—
AAA2777	50-08446	0.00–0.50	Soil	0.192	0.027	2.13	2.75	—
AAA2778	50-08474	0.00–0.50	Soil	—	—	0.562	—	—
AAA2779	50-08494	0.00–0.50	Soil	0.454	0.068	8.69	—	—

^a Soil background value is used for both fill and soil (LANL 1998, 59730).

^b Dash indicates that the concentration was not above the BV.

Table B-14

Frequency of Detected Organic Chemicals in Phase I RFI Surface Soil and Fill Samples at MDA C

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range* (mg/kg)	Frequency of Detects
Acenaphthene	Fill	52	1	[0.00018] to 0.96	1/52
Aroclor-1254	Fill	43	3	[0.03] to 1	3/43
Aroclor-1260	Fill	43	4	[0.03 to 0.15]	4/43
Bis(2-ethylhexyl)phthalate	Fill	52	2	[0.00018] to 1.4	2/52
Pentachlorophenol	Soil	16	1	[0.85] to 1.9	1/16

*Values in square brackets indicate nondetects.

Table B-15

Detected Organic Chemicals Analyses in Phase I RFI Surface Soil and Fill Samples at MDA C

Sample ID	Location ID	Depth (ft)	Media	Acenaphthene	Aroclor-1254	Aroclor-1260	Bis(2-ethylhexyl)phthalate	Pentachlorophenol
AAA3153	50-08010	0.00–0.50	Fill	—*	—	—	1.4	—
AAA3155	50-08064	0.00–0.50	Fill	—	—	0.04	1.4	—
AAA3156	50-08106	0.00–0.50	Fill	—	—	0.03	—	—
AAA3157	50-08110	0.00–0.50	Fill	—	—	0.07	—	—
AAA3158	50-08116	0.00–0.50	Fill	—	—	0.04	—	—
AAA3193	50-08312	0.00–0.50	Fill	0.96	—	—	—	—
AAA3098	50-08326	0.00–0.50	Fill	—	1	—	—	—
AAA3146	50-08418	0.00–0.50	Soil	—	—	—	—	1.9
AAA3151	50-08486	0.00–0.50	Fill	—	0.07	—	—	—
AAA3152	50-08492	0.00–0.50	Fill	—	0.17	—	—	—

Note: Units are mg/kg.

*Dash indicates that the analyte was not detected.

Table B-16
Detected Organic Chemicals in EMFLUX® Samples at MDA C

Location ID	Sample ID	Aliphatics HCs	Benzene	Carbon Tetrachloride	Chloroform	Tetrachloroethene	Trichloroethene
50-10000	MD50-00-0011	0.00	0.00	0.00	0.00	2.08	1.17
50-10001	MD50-00-0012	0.00	0.00	0.00	0.00	10.94	7.31
50-10002	MD50-00-0013	0.00	0.00	0.00	0.00	8.58	1.57
50-10003	MD50-00-0014	0.00	0.00	0.00	3.66	11.56	2.77
50-10004	MD50-00-0015	0.00	0.00	0.00	6.68	10.16	2.27
50-10005	MD50-00-0016	0.00	0.00	0.00	2.80	6.84	1.50
50-10006	MD50-00-0017	0.00	0.00	9.26	1.94	27.82	4.44
50-10007	MD50-00-0018	20.85	0.00	0.00	0.00	3.82	0.84
50-10008	MD50-00-0019	0.00	0.00	0.00	0.00	2.86	0.00
50-10009	MD50-00-0020	0.00	0.00	1.50	0.00	15.86	2.01
50-10010	MD50-00-0021	0.00	0.00	2.67	0.00	15.21	1.17
50-10011	MD50-00-0022	0.00	0.00	6.71	1.16	16.95	2.94
50-10012	MD50-00-0023	86.40	0.00	4.58	0.00	9.30	4.15
50-10013	MD50-00-0024	0.00	0.00	0.00	0.00	2.18	1.20
50-10014	MD50-00-0025	0.00	0.00	0.00	0.00	2.77	3.18
50-10015	MD50-00-0026	0.00	0.00	2.38	0.00	3.27	8.83
50-10016	MD50-00-0027	0.00	0.00	0.00	0.00	2.09	0.94
50-10017	MD50-00-0028	0.00	0.00	0.00	0.00	5.39	0.00
50-10018	MD50-00-0029	0.00	0.00	0.00	0.00	9.22	0.00
50-10019	MD50-00-0030	0.00	0.00	0.00	0.00	7.23	2.58
50-10020	MD50-00-0031	0.00	0.00	0.00	0.00	4.21	2.65
50-10021	MD50-00-0032	0.00	0.00	2.31	0.00	5.08	6.96
50-10022	MD50-00-0033	0.00	0.00	36.15	4.67	2.52	3.52
50-10023	MD50-00-0034	0.00	0.00	1.65	0.00	2.52	4.15
50-10024	MD50-00-0035	0.00	0.00	0.00	0.00	1.28	3.82
50-10025	MD50-00-0036	0.00	0.00	0.00	0.00	1.59	1.34
50-10026	MD50-00-0037	0.00	0.00	0.00	0.00	7.54	0.90
50-10027	MD50-00-0038	0.00	0.00	0.00	0.00	28.06	0.00
50-10028	MD50-00-0039	0.00	0.00	0.00	0.00	9.23	0.00
50-10029	MD50-00-0040	0.00	0.00	0.00	0.00	3.15	2.82
50-10030	MD50-00-0041	0.00	0.00	0.00	0.00	2.53	1.58
50-10031	MD50-00-0042	0.00	0.00	4.85	0.00	4.68	4.79
50-10032	MD50-00-0043	0.00	0.00	2.87	0.00	4.77	3.65
50-10033	MD50-00-0044	0.00	0.00	1.73	0.00	28.38	12.47
50-10034	MD50-00-0045	0.00	0.00	0.00	0.00	1.25	3.85
50-10035	MD50-00-0046	0.00	0.00	0.00	0.00	5.30	1.11

Table B-16

Location ID	Sample ID	Aliphatics HCs	Benzene	Carbon Tetrachloride	Chloroform	Tetrachloroethene	Trichloroethene
50-10036	MD50-00-0047	0.00	0.00	0.00	0.00	13.32	0.00
50-10037	MD50-00-0048	12.60	0.00	0.00	0.00	5.30	0.00
50-10038	MD50-00-0049	0.00	0.00	0.00	0.00	6.92	1.58
50-10039	MD50-00-0050	0.00	0.00	0.00	0.00	3.18	58.03
50-10040	MD50-00-0051	0.00	0.00	0.00	0.00	5.43	3.19
50-10041	MD50-00-0052	0.00	0.00	0.00	0.00	2.84	2.05
50-10042	MD50-00-0053	0.00	0.00	0.00	0.00	4.96	0.97
50-10043	MD50-00-0054	0.00	0.00	0.00	0.00	2.15	1.48
50-10044	MD50-00-0055	0.00	0.00	0.00	0.00	0.87	1.98
50-10045	MD50-00-0056	0.00	0.00	0.00	0.00	3.51	0.00
50-10046	MD50-00-0057	0.00	0.00	0.00	0.00	2.20	0.00
50-10047	MD50-00-0058	170.25	0.00	0.00	0.00	2.82	0.00
50-10048	MD50-00-0059	0.00	0.00	0.00	0.00	0.00	0.00
50-10049	MD50-00-0060	95.56	0.00	0.00	0.00	1.66	0.00
50-10050	MD50-00-0061	0.00	0.00	0.00	0.00	2.92	0.00
50-10051	MD50-00-0062	0.00	0.00	0.00	0.00	2.32	1.48
50-10052	MD50-00-0063	0.00	0.00	0.00	0.00	200.92	0.00
50-10053	MD50-00-0064	0.00	0.00	0.00	0.00	69.71	1.08
50-10054	MD50-00-0065	0.00	0.00	0.00	0.00	4.38	4.27
50-10055	MD50-00-0066	0.00	0.00	0.00	0.00	4.87	0.00
50-10056	MD50-00-0067	0.00	0.00	0.00	0.00	1.92	0.00
50-10057	MD50-00-0068	0.00	0.00	0.00	0.00	1.79	0.00
50-10058	MD50-00-0069	0.00	0.00	0.00	0.00	1.10	0.00
50-10059	MD50-00-0070	13.52	0.00	0.00	0.00	1.89	0.00
50-10060	MD50-00-0071	0.00	0.00	0.00	0.00	1.32	0.00
50-10061	MD50-00-0072	0.00	0.00	0.00	0.00	1.54	0.00
50-10062	MD50-00-0073	0.00	0.00	0.00	0.00	1.19	0.00
50-10063	MD50-00-0074	0.00	0.00	0.00	0.00	4.21	0.00
50-10064	MD50-00-0075	0.00	0.85	0.00	0.00	8.39	0.00
50-10065	MD50-00-0076	0.00	0.00	0.00	0.00	1.51	0.00
50-10066	MD50-00-0077	0.00	0.00	0.00	0.00	27.80	0.00
50-10067	MD50-00-0078	0.00	0.00	0.00	1.52	207.30	10.37
50-10068	MD50-00-0079	13.78	0.00	0.00	0.00	169.70	8.11
50-10069	MD50-00-0080	54.59	0.00	0.00	0.00	140.79	5.78
50-10070	MD50-00-0081	0.00	0.00	0.00	0.00	56.58	6.22
50-10071	MD50-00-0082	0.00	0.00	0.00	0.00	150.02	29.58
50-10072	MD50-00-0083	0.00	0.00	0.00	0.00	16.67	0.00
50-10073	MD50-00-0084	0.00	0.00	0.00	0.00	58.84	0.00

Table B-16

Location ID	Sample ID	Aliphatics HCs	Benzene	Carbon Tetrachloride	Chloroform	Tetrachloroethene	Trichloroethene
50-10074	MD50-00-0085	0.00	0.00	0.00	0.00	10.04	0.00
50-10075	MD50-00-0086	0.00	0.00	0.00	0.00	3.05	0.00
50-10076	MD50-00-0087	0.00	0.00	0.00	0.00	0.94	0.00
50-10077	MD50-00-0088	0.00	0.00	0.00	0.00	7.40	0.00
50-10078	MD50-00-0089	0.00	0.00	0.00	0.00	1.39	0.00
50-10079	MD50-00-0090	0.00	0.00	0.00	0.00	1.42	0.00
50-10080	MD50-00-0091	0.00	0.00	0.00	0.00	13.90	0.98
50-10081	MD50-00-0092	0.00	0.91	0.00	0.00	8.26	1.36
50-10082	MD50-00-0093	0.00	0.00	0.00	0.00	5.74	1.93
50-10083	MD50-00-0094	0.00	0.00	0.00	0.00	3.41	2.14

Note: Results are in ng/m²/min.

Table B-17
Summary of Phase I RFI Boreholes at MDA C

Borehole ID	Declination (°)	Azimuth (°)	Surface Elevation (ft)	Borehole Length (ft)	Vertical Depth (ft)	Total Depth Elevation (ft)	Surface Projection (ft)	Total Depth Formation	NAD83 ^a		Drilling Dates	Borehole Completion	Adjacent Disposal Unit
									Northing	Easting			
50-09100	90.0	n/a ^b	7233.0	316.0	316.0	6917.0	0.0	Qct	1768776	1626312	7/17–31/95	Vapor Monitoring	Pit 5
50-09101	45.0	S 82 W	7253.0	117.0	82.7	7170.3	82.7	Qbt 3	1768915	1625964	9/20–22/95	Backfilled	Pit 6
50-09102	45.0	S 10 W	7219.0	110.0	77.8	7141.2	77.8	Qbt 3	1768750	1626610	8/2–8/95	Backfilled	Pit 5
50-09103	45.0	N 32 W	7242.0	120.0	84.9	7157.1	84.9	Qbt 3	1768404	1626596	8/17–22/95	Backfilled	Pits 1 and 3
50-09104	90.0	n/a	7260.0	90.0	90.0	7170.0	0.0	Qbt 3	1768444	1626044	8/15–17/95	Backfilled	Pit 1
50-09105	45.0	S 86 E	7265.0	120.0	84.9	7180.1	84.9	Qbt 3	1768561	1625873	8/23–28/95	Backfilled	Shaft Group 3
50-09106	45.0	S 75 E	7261.0	120.0	84.9	7176.1	84.9	Qbt 3	1768656	1625915	8/9–15/95	Backfilled	Shaft Group 3/ Pit 4
50-09107	45.0	N 4 W	7262.0	118.0	83.4	7178.6	83.4	Qbt 3	1768764	1625826	8/28–30/95	Backfilled	Pit 6
50-09108	45.0	N 40 E	7275.0	120.0	84.9	7190.1	84.9	Qbt 3	1768770	1625544	8/30–9/11/95	Backfilled	Chemical Pit/ Pit 6
50-09109	45.0	N 84 E	7279.0	120.0	84.9	7194.1	84.9	Qbt 3	1768863	1625429	9/11–14/95	Backfilled	Pit 6
50-09110	70.0	S 67 E	7278.0	91.0	85.5	7192.5	31.1	Qbt 3	1768971	1625494	9/15–19/95	Backfilled	Pit 6
50-10131 ^c	90.0	n/a	7275.6	250	250	7025.6	0.0	Qct	1768774	1625545	6/21-6/25/01	Vapor Monitoring	Chemical Pit

^a North American Datum of 1983.

^b n/a = Not applicable.

^c This borehole was not part of the Phase I RFI boreholes.

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Table B-18
Field Screening Results from Phase I Borehole Sampling

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09100	0550-95-0360	2.0–2.2	Negative	1	180	0
50-09100	0550-95-0361	9.0–9.2	Negative	0	210	0
50-09100	0550-95-0362	10.6–12.6	Negative	3	220	0
50-09100	0550-95-0363	16.5–17.5	Negative	0	220	0
50-09100	0550-95-0394	18.6–19.2	Negative	0	220	0
50-09100	0550-95-0364	21.5–22.3	Negative	0	210	0
50-09100	0550-95-0365	26.5–28.5	Negative	1	180	0
50-09100	0550-95-0366	31.5–32.5	Negative	3	170	0
50-09100	0550-96-0100 ^a	32.7–33.7	— ^b	—	—	—
50-09100	0550-95-0367	38.7–39.5	Negative	1	140	0
50-09100	0550-95-0368	41.5–43.5	Negative	1	160	0
50-09100	0550-95-0369	46.5–47.3	Negative	0	150	0
50-09100	0550-95-0370	52.5–53.3	Negative	0	160	0
50-09100	0550-95-0371	58.2–60.0	Negative	1	170	0
50-09100	0550-95-0372	61.0–62.0	Negative	1	180	0
50-09100	0550-95-0373	66.0–67.0	Negative	0	190	0
50-09100	0550-95-0374	71.5–73.5	Negative	0	220	0
50-09100	0550-95-0375	76.0–76.8	Negative	2	180	0
50-09100	0550-95-0376	86.0–86.8	Negative	0	170	0
50-09100	0550-95-0377	92.2–93.0	Negative	0	180	0
50-09100	0550-95-0378	96.0–96.8	Negative	0	210	0
50-09100	0550-95-0379	102.2–103.0	Negative	0	210	0
50-09100	0550-95-0380	107.0–107.8	Negative	1	220	0
50-09100	0550-95-0381	113.2–114.0	Negative	1	220	0
50-09100	0550-95-0383	115.1–116.9	Negative	1	220	0
50-09100	0550-95-0384	120.0–120.8	Negative	0	210	0
50-09100	0550-95-0385	125.0–125.8	Negative	0	200	0
50-09100	0550-95-0386	130.0–130.8	Negative	2	200	0
50-09100	0550-95-0387	135.0–135.9	Negative	0	180	0
50-09100	0550-95-0388	140.0–140.8	Negative	2	200	0
50-09100	0550-95-0389	145.0–145.8	Negative	0	200	0
50-09100	0550-95-0390	150.0–150.8	Negative	0	180	0
50-09100	0550-95-0391	157.0–157.8	Negative	0	200	0
50-09100	0550-95-0392	161.3–163.1	Negative	0	220	0
50-09100	0550-95-0396	165.0–166.0	Negative	3	170	0
50-09100	0550-95-0397	171.0–171.8	Negative	0	160	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09100	0550-95-0398	177.0–177.8	Negative	0	170	0
50-09100	0550-95-0399	182.2–183.0	Negative	0	180	0
50-09100	0550-95-0400	185.0–185.8	Negative	1	160	0
50-09100	0550-95-0401	191.5–192.5	Negative	0	170	0
50-09100	0550-95-0402	197.3–198.0	Negative	1	200	0
50-09100	0550-95-0403	202.5–203.2	Negative	0	120	0
50-09100	0550-95-0404	206.4–207.2	Negative	0	140	0
50-09100	0550-96-0001	210.8–211.0	—	—	—	—
50-09100	0550-96-0002	213.0–214.0	—	—	—	—
50-09100	0550-96-0003	215.8–216.0	—	—	—	—
50-09100	0550-96-0004	220.7–221.0	—	—	—	—
50-09100	0550-96-0006	222.7–223.0	—	—	—	—
50-09100	0550-96-0007	225.7–226.0	—	—	—	—
50-09100	0550-96-0008	228.1–228.4	—	—	—	—
50-09100	0550-96-0009	230.7–231.0	—	—	—	—
50-09100	0550-96-0010	233.0–233.3	—	—	—	—
50-09100	0550-96-0011	235.7–236.0	—	—	—	—
50-09100	0550-96-0012	238.1–238.4	—	—	—	—
50-09100	0550-96-0013	240.7–241.0	—	—	—	—
50-09100	0550-96-0014	243.7–244.0	—	—	—	—
50-09100	0550-96-0015	245.7–246.0	—	—	—	—
50-09100	0550-96-0016	247.3–248.0	—	—	—	—
50-09100	0550-96-0017	250.7–251.0	—	—	—	—
50-09100	0550-96-0018	253.0–253.3	—	—	—	—
50-09100	0550-96-0019	255.2–255.5	—	—	—	—
50-09100	0550-96-0020	257.2–257.5	—	—	—	—
50-09100	0550-96-0021	260.2–260.5	—	—	—	—
50-09100	0550-96-0022	262.7–263.0	—	—	—	—
50-09100	0550-96-0023	265.2–265.5	—	—	—	—
50-09100	0550-96-0025	267.2–267.5	—	—	—	—
50-09100	0550-96-0024	270.2–270.5	—	—	—	—
50-09100	0550-96-0026	273.2–273.5	—	—	—	—
50-09100	0550-96-0027	275.7–276.0	—	—	—	—
50-09100	0550-96-0028	278.2–278.5	—	—	—	—
50-09100	0550-96-0029	280.7–281.0	—	—	—	—
50-09100	0550-96-0030	283.2–283.5	—	—	—	—
50-09100	0550-96-0031	285.7–286.0	—	—	—	—
50-09100	0550-96-0032	288.3–288.5	—	—	—	—

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09100	0550-96-0033	290.7–291.0	—	—	—	—
50-09100	0550-96-0034	293.2–293.5	—	—	—	—
50-09100	0550-96-0035	295.7–296.0	—	—	—	—
50-09100	0550-96-0036	298.3–298.5	—	—	—	—
50-09100	0550-96-0037	299.7–300.0	—	—	—	—
50-09100	0550-96-0038	303.2–303.5	—	—	—	—
50-09100	0550-96-0039	305.7–306.0	—	—	—	—
50-09100	0550-96-0040	308.2–308.5	—	—	—	—
50-09100	0550-96-0041	310.7–311.0	—	—	—	—
50-09100	0550-96-0042	312.5–313.0	—	—	—	—
50-09100	0550-96-0043	315.2–315.5	—	—	—	—
50-09101	0550-95-0281	2.5–2.6	Negative	0	170	0
50-09101	0550-95-0282	5.7–6.0	Negative	2	180	0
50-09101	0550-95-0283	7.6–7.9	Negative	1	160	0
50-09101	0550-95-0284	10.6–12.0	Negative	1	180	0
50-09101	0550-95-0285	10.6–12.0	Negative	1	180	0
50-09101	0550-95-0286	14.1–14.5	Negative	1	180	0
50-09101	0550-95-0287	17.7–18.0	Negative	1	150	0
50-09101	0550-96-0101 ^a	19.0–19.7	—	—	—	—
50-09101	0550-95-0288	21.2–21.5	Negative	0	170	0
50-09101	0550-95-0289	24.7–25.6	Negative	0	140	0
50-09101	0550-95-0290	26.5–26.8	Negative	0	140	0
50-09101	0550-95-0291	28.6–29.0	Negative	0	180	0
50-09101	0550-96-0102 ^a	31.1–31.9	—	—	—	—
50-09101	0550-95-0292	32.0–32.3	Negative	1	160	0
50-09101	0550-95-0293	37.0–37.4	Negative	0	200	0
50-09101	0550-95-0294	38.9–40.3	Negative	0	180	0
50-09101	0550-95-0295	38.9–40.3	Negative	0	180	0
50-09101	0550-95-0296	43.8–44.2	Negative	1	140	0
50-09101	0550-96-0103 ^a	44.2–44.7	—	—	—	—
50-09101	0550-95-0297	47.4–48.8	Negative	0	140	0
50-09101	0550-95-0298	49.7–50.0	Negative	0	150	0
50-09101	0550-95-0299	53.0–54.4	Negative	0	210	0
50-09101	0550-95-0300	53.0–54.4	Negative	0	210	0
50-09101	0550-95-0301	58.3–58.7	Negative	2	140	0
50-09101	0550-95-0302	61.5–61.9	Negative	0	180	0
50-09101	0550-95-0303	64.1–64.3	Negative	0	180	0
50-09101	0550-95-0304	67.9–69.3	Negative	2	160	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09101	0550-95-0305	67.9–69.3	Negative	2	160	0
50-09101	0550-95-0306	72.5–72.8	Negative	1	150	0
50-09101	0550-95-0307	75.7–76.0	Negative	0	160	0
50-09101	0550-95-0308	78.2–78.5	Negative	1	160	0
50-09101	0550-95-0309	79.2–81.0	Negative	0	180	0
50-09101	0550-95-0310	79.2–81.0	Negative	0	180	0
50-09102	0550-95-0001	2.5–2.6	Negative	0	200	0
50-09102	0550-95-0002	4.2–4.5	Negative	0	210	0
50-09102	0550-95-0003	9.9–10.6	Negative	0	120	0
50-09102	0550-95-0004	11.3–13.4	Negative	0	130	0
50-09102	0550-95-0005	11.3–13.4	Negative	0	130	0
50-09102	0550-95-0006	16.3–17.0	Negative	0	180	0
50-09102	0550-95-0007	18.4–19.0	Negative	0	160	0
50-09102	0550-95-0008	23.3–23.9	Negative	0	110	0
50-09102	0550-95-0009	26.2–28.9	Negative	0	220	0
50-09102	0550-95-0010	26.2–28.9	Negative	0	220	0
50-09102	0550-95-0011	32.4–33.0	Negative	0	190	0
50-09102	0550-95-0012	34.9–35.4	Negative	2	250	0
50-09102	0550-95-0013	36.8–37.4	Negative	0	210	0
50-09102	0550-95-0014	40.3–42.4	Negative	0	180	0
50-09102	0550-95-0015	40.3–42.4	Negative	0	180	0
50-09102	0550-95-0016	43.8–44.5	Negative	0	200	0
50-09102	0550-95-0017	47.6–48.4	Negative	1	210	0
50-09102	0550-95-0018	50.9–51.6	Negative	0	170	0
50-09102	0550-95-0019	51.8–53.7	Negative	2	210	0
50-09102	0550-95-0020	51.8–53.7	Negative	2	210	0
50-09102	0550-95-0021	58.0–58.7	Negative	2	210	0
50-09102	0550-95-0022	60.5–61.2	Negative	0	200	0
50-09102	0550-95-0039	62.2–62.6	Negative	0	180	0
50-09102	0550-95-0023	62.6–62.9	Negative	0	180	0
50-09102	0550-95-0025	66.5–67.2	Negative	0	200	0
50-09102	0550-95-0024	67.2–68.6	Negative	1	200	0
50-09102	0550-95-0026	67.2–68.6	Negative	1	200	0
50-09102	0550-95-0027	72.1–72.8	Negative	1	170	0
50-09102	0550-95-0028	75.0–75.7	Negative	2	200	0
50-09102	0550-95-0029	76.4–77.8	Negative	0	200	0
50-09102	0550-95-0030	76.4–77.8	Negative	0	200	0
50-09103	0550-95-0101	3.5–3.6	Negative	0	180	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09103	0550-95-0102	4.9–5.0	Negative	1	150	0
50-09103	0550-95-0103	8.0–8.4	Negative	2	180	0
50-09103	0550-95-0104	13.1–14.7	Negative	1	150	0
50-09103	0550-95-0105	13.1–14.7	Negative	1	150	0
50-09103	0550-95-0106	16.0–16.3	Negative	2	130	0
50-09103	0550-95-0107	19.2–19.6	Negative	2	160	0
50-09103	0550-95-0108	22.6–23.3	Negative	2	170	0
50-09103	0550-95-0109	25.5–27.4	Negative	0	150	0
50-09103	0550-95-0110	25.5–27.4	Negative	0	150	0
50-09103	0550-95-0111	29.0–29.6	Negative	1	150	0
50-09103	0550-95-0112	32.2–32.9	Negative	0	130	0
50-09103	0550-96-0104 ^a	32.9–33.8	—	—	—	—
50-09103	0550-95-0113	36.6–37.1	Negative	1	150	0
50-09103	0550-95-0114	39.6–41.6	Negative	1	150	0
50-09103	0550-95-0115	39.6–41.6	Negative	1	150	0
50-09103	0550-95-0116	44.8–45.3	Negative	2	130	0
50-09103	0550-95-0117	48.1–48.6	Negative	0	180	0
50-09103	0550-95-0118	49.8–50.3	Negative	2	180	0
50-09103	0550-95-0119	55.2–56.6	Negative	1	158	0
50-09103	0550-95-0120	55.2–56.6	Negative	1	158	0
50-09103	0550-95-0121	56.6–57.3	Negative	1	170	0
50-09103	0550-95-0122	60.8–61.4	Negative	0	160	0
50-09103	0550-95-0123	64.9–65.5	Negative	0	150	0
50-09103	0550-95-0124	67.0–69.3	Negative	0	180	0
50-09103	0550-95-0125	67.0–69.3	Negative	0	180	0
50-09103	0550-95-0126	71.6–72.1	Negative	2	190	0
50-09103	0550-95-0127	74.4–75.0	Negative	2	160	0
50-09103	0550-95-0128	78.7–79.3	Negative	1	190	0
50-09103	0550-95-0129	81.2–82.6	Negative	0	200	0
50-09103	0550-95-0130	81.2–82.6	Negative	1	200	0
50-09103	0550-95-0131	84.3–84.9	Negative	0	190	0
50-09104	0550-95-0073	4.0–4.1	Negative	1	170	0
50-09104	0550-95-0074	9.0–9.1	Negative	1	190	0
50-09104	0550-95-0075	10.9–12.9	Negative	2	190	0
50-09104	0550-95-0076	10.9–12.9	Negative	2	190	0
50-09104	0550-95-0077	15.1–16.0	Negative	1	160	0
50-09104	0550-95-0078	22.1–23.0	Negative	3	180	0
50-09104	0550-95-0079	26.3–28.0	Negative	1	156	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09104	0550-95-0080	26.3–28.0	Negative	1	156	0
50-09104	0550-95-0081	31.8–32.3	Negative	3	140	0
50-09104	0550-95-0082	34.3–35.0	Negative	2	150	0
50-09104	0550-95-0083	36.6–38.6	Negative	2	180	0
50-09104	0550-95-0084	36.6–38.6	Negative	2	180	0
50-09104	0550-96-0105 ^a	44.1–45.1	—	—	—	—
50-09104	0550-95-0085	45.1–46.0	Negative	1	150	0
50-09104	0550-95-0086	50.4–51.3	Negative	1	160	0
50-09104	0550-95-0087	58.0–60.0	Negative	0	170	0
50-09104	0550-95-0088	58.0–60.0	Negative	0	170	0
50-09104	0550-95-0089	62.5–63.0	Negative	0	170	0
50-09104	0550-95-0090	69.2–70.0	Negative	0	170	0
50-09104	0550-95-0092	71.0–73.0	Negative	2	150	0
50-09104	0550-95-0091	71.7–73.0	Negative	2	150	0
50-09104	0550-95-0093	77.8–78.6	Negative	1	190	0
50-09104	0550-95-0095	79.0–81.0	Negative	0	180	0
50-09104	0550-95-0094	82.2–83.0	Negative	2	170	0
50-09104	0550-95-0099	85.0–87.0	Negative	2	130	0
50-09104	0550-95-0100	85.0–87.0	Negative	2	130	0
50-09105	0550-95-0132	2.8–2.9	Negative	1	170	0
50-09105	0550-95-0133	5.4–5.9	Negative	1	150	0
50-09105	0550-95-0134	8.5–9.1	Negative	1	150	0
50-09105	0550-95-0135	11.4–13.1	Negative	1	190	0
50-09105	0550-95-0136	11.4–13.1	Negative	1	190	0
50-09105	0550-95-0137	15.8–16.3	Negative	1	160	0
50-09105	0550-95-0138	19.9–20.6	Negative	2	210	0
50-09105	0550-95-0139	24.2–24.7	Negative	1	180	0
50-09105	0550-95-0140	24.7–26.9	Negative	1	180	0
50-09105	0550-95-0141	24.7–25.2	Negative	1	180	0
50-09105	0550-95-0142	30.5–31.1	Negative	0	170	0
50-09105	0550-95-0143	32.5–33.1	Negative	0	190	0
50-09105	0550-95-0144	36.1–36.8	Negative	1	190	0
50-09105	0550-95-0145	40.3–41.7	Negative	0	180	0
50-09105	0550-95-0146	40.3–40.7	Negative	0	180	0
50-09105	0550-95-0147	43.3–43.8	Negative	0	180	0
50-09105	0550-96-0106 ^a	43.9–44.5	—	—	—	—
50-09105	0550-95-0148	46.7–47.4	Negative	1	150	0
50-09105	0550-95-0149	50.2–50.9	Negative	2	190	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09105	0550-95-0150	54.4–56.4	Negative	0	180	0
50-09105	0550-95-0151	54.4–56.4	Negative	0	180	0
50-09105	0550-95-0152	58.0–58.6	Negative	0	180	0
50-09105	0550-95-0153	61.5–62.1	Negative	0	180	0
50-09105	0550-95-0154	65.1–65.6	Negative	0	180	0
50-09105	0550-95-0155	68.6–70.6	Negative	0	180	0
50-09105	0550-95-0156	68.6–69.0	Negative	0	180	0
50-09105	0550-95-0157	71.6–72.1	Negative	0	180	0
50-09105	0550-95-0159	75.1–75.7	Negative	0	160	0
50-09105	0550-95-0162	80.0–80.6	Negative	2	180	0
50-09105	0550-95-0160	83.2–84.9	Negative	1	160	0
50-09105	0550-95-0161	83.2–84.9	Negative	1	160	0
50-09106	0550-95-0040	2.8–2.9	Negative	2	220	0
50-09106	0550-95-0041	4.6–5.2	Negative	1	210	0
50-09106	0550-95-0042	7.8–8.6	Negative	0	170	0
50-09106	0550-95-0043	7.8–8.6	Negative	0	170	0
50-09106	0550-95-0044	14.5–16.8	Negative	0	200	0
50-09106	0550-95-0046	19.4–21.6	Negative	2	180	0
50-09106	0550-95-0047	19.4–21.6	Negative	2	180	0
50-09106	0550-95-0048	22.5–23.7	Negative	2	160	0
50-09106	0550-95-0049	25.1–25.8	Negative	0	190	0
50-09106	0550-95-0050	29.0–31.1	Negative	0	140	0
50-09106	0550-95-0051	29.0–31.1	Negative	0	140	0
50-09106	0550-95-0052	34.2–34.6	Negative	0	170	0
50-09106	0550-95-0053	37.3–37.8	Negative	1	180	0
50-09106	0550-95-0054	40.0–41.4	Negative	0	190	0
50-09106	0550-95-0055	40.0–41.4	Negative	0	190	0
50-09106	0550-95-0056	45.1–45.7	Negative	0	200	0
50-09106	0550-95-0057	47.9–48.2	Negative	1	180	0
50-09106	0550-95-0058	49.9–51.6	Negative	0	140	0
50-09106	0550-95-0060	49.9–51.6	Negative	0	140	0
50-09106	0550-95-0061	53.7–54.4	Negative	0	170	0
50-09106	0550-95-0062	56.8–57.6	Negative	0	180	0
50-09106	0550-95-0063	60.8–62.6	Negative	1	170	0
50-09106	0550-95-0064	60.8–62.6	Negative	1	170	0
50-09106	0550-95-0065	65.6–66.3	Negative	1	150	0
50-09106	0550-95-0066	71.5–72.1	Negative	2	160	0
50-09106	0550-95-0067	72.1–73.5	Negative	2	150	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09106	0550-95-0068	72.1–73.5	Negative	2	150	0
50-09106	0550-95-0069	74.4–75.0	Negative	2	150	0
50-09106	0550-95-0070	79.7–80.3	Negative	0	150	0
50-09106	0550-95-0071	81.7–83.4	Negative	0	150	0
50-09106	0550-95-0072	81.7–83.4	Negative	0	150	0
50-09107	0550-95-0163	2.8–2.9	Negative	0	130	0
50-09107	0550-95-0164	7.8–8.1	Negative	1	160	0
50-09107	0550-95-0166	9.9–11.2	Negative	0	170	0
50-09107	0550-95-0167	13.4–13.9	Negative	2	180	0
50-09107	0550-95-0165	17.0–17.4	Negative	0	150	0
50-09107	0550-95-0168	21.9–22.1	Negative	2	170	0
50-09107	0550-95-0171	25.5–27.6	Negative	1	160	0
50-09107	0550-95-0172	25.5–27.6	Negative	1	160	0
50-09107	0550-95-0169	30.8–31.3	Negative	0	160	0
50-09107	0550-95-0170	32.5–32.9	Negative	0	140	0
50-09107	0550-96-0107 ^a	33.2–34.3	—	—	—	—
50-09107	0550-95-0173	38.4–39.0	Negative	0	140	0
50-09107	0550-95-0176	40.3–41.7	Negative	1	150	0
50-09107	0550-95-0177	40.3–41.7	Negative	1	150	0
50-09107	0550-95-0174	44.8–45.3	Negative	1	150	0
50-09107	0550-95-0175	46.3–46.8	—	2	160	0
50-09107	0550-96-0108 ^a	46.8–47.4	—	—	—	—
50-09107	0550-95-0178	50.4–50.9	Negative	0	140	0
50-09107	0550-95-0181	53.0–55.6	Negative	0	160	0
50-09107	0550-95-0182	53.0–55.6	Negative	0	160	0
50-09107	0550-95-0179	58.7–59.0	Negative	1	170	0
50-09107	0550-95-0180	60.1–60.6	Negative	0	140	0
50-09107	0550-95-0183	65.8–66.1	Negative	1	150	0
50-09107	0550-95-0186	67.2–68.6	Negative	1	150	0
50-09107	0550-95-0187	67.2–68.6	Negative	1	150	0
50-09107	0550-95-0184	72.1–72.5	Negative	1	120	0
50-09107	0550-95-0185	75.5–76.0	Negative	1	150	0
50-09107	0550-95-0191	76.4–78.5	Negative	0	150	0
50-09107	0550-95-0188	78.1–78.5	Negative	1	150	0
50-09108	0550-95-0192	2.8–2.9	Negative	1	140	0
50-09108	0550-95-0193	5.7–6.2	Negative	0	160	0
50-09108	0550-95-0194	9.9–10.3	Negative	1	230	0
50-09108	0550-95-0195	10.6–11.9	Negative	0	190	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09108	0550-95-0196	10.6–11.9	Negative	0	190	0
50-09108	0550-95-0197	17.0–17.5	Negative	1	190	0
50-09108	0550-96-0109 ^a	17.3–18.0	—	—	—	—
50-09108	0550-95-0198	20.5–20.9	Negative	1	210	0
50-09108	0550-95-0199	21.9–22.3	Negative	1	210	0
50-09108	0550-95-0200	26.2–27.3	Negative	1	210	0
50-09108	0550-95-0201	26.2–27.3	Negative	1	210	0
50-09108	0550-95-0202	30.4–30.7	Negative	2	200	0
50-09108	0550-96-0110 ^a	31.7–32.5	—	—	—	—
50-09108	0550-95-0203	36.1–36.3	Negative	2	250	0
50-09108	0550-95-0204	40.0–40.3	Negative	1	200	0
50-09108	0550-95-0205	40.3–41.7	Negative	1	210	0
50-09108	0550-95-0206	40.3–41.7	Negative	1	200	0
50-09108	0550-95-0207	43.8–44.2	Negative	1	200	0
50-09108	0550-95-0208	47.4–47.9	Negative	0	190	0
50-09108	0550-95-0209	51.1–51.6	Negative	2	210	0
50-09108	0550-95-0210	54.2–55.6	Negative	1	200	0
50-09108	0550-95-0211	54.2–55.6	Negative	1	200	0
50-09108	0550-95-0212	58.1–58.5	Negative	1	180	0
50-09108	0550-95-0213	61.5–61.9	Negative	0	250	0
50-09108	0550-95-0214	66.2–66.6	Negative	1	170	0
50-09108	0550-95-0215	67.5–68.9	Negative	2	190	0
50-09108	0550-95-0216	67.5–67.9	Negative	1	140	0
50-09108	0550-95-0217	70.7–71.1	Negative	1	180	0
50-09108	0550-95-0218	74.2–74.6	Negative	1	140	0
50-09108	0550-95-0219	77.9–78.3	Negative	0	130	0
50-09108	0550-95-0220	79.2–81.3	Negative	2	150	0
50-09108	0550-95-0221	79.2–81.3	Negative	0	180	0
50-09108	0550-95-0222	84.1–84.4	Negative	0	160	0
50-09109	0550-95-0223	2.8–2.9	Negative	0	170	0
50-09109	0550-95-0224	6.0–6.4	Negative	1	170	0
50-09109	0550-95-0225	8.0–8.3	Negative	0	140	0
50-09109	0550-95-0226	12.9–14.3	Negative	0	180	0
50-09109	0550-95-0227	12.9–13.6	Negative	1	170	0
50-09109	0550-95-0228	16.8–17.1	Negative	1	200	0
50-09109	0550-95-0229	18.0–18.4	Negative	1	180	0
50-09109	0550-95-0230	21.6–21.9	Negative	0	210	0
50-09109	0550-95-0231	24.1–25.5	Negative	1	180	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09109	0550-95-0232	24.1–24.5	Negative	1	180	0
50-09109	0550-95-0233	26.0–26.4	Negative	0	140	0
50-09109	0550-95-0234	30.3–30.6	Negative	1	130	0
50-09109	0550-96-0111 ^a	32.5–33.2	—	—	—	—
50-09109	0550-95-0235	33.2–33.5	Negative	2	180	0
50-09109	0550-95-0238	37.5–37.9	Negative	0	150	0
50-09109	0550-95-0236	40.9–42.4	Negative	2	120	0
50-09109	0550-95-0237	40.9–41.2	Negative	2	120	0
50-09109	0550-95-0239	43.1–43.5	Negative	0	230	0
50-09109	0550-95-0240	43.8–44.2	Negative	0	220	0
50-09109	0550-95-0243	46.0–46.3	Negative	1	130	0
50-09109	0550-96-0112 ^a	46.7–47.4	—	—	—	—
50-09109	0550-95-0244	48.6–49.0	Negative	0	200	0
50-09109	0550-95-0245	52.7–53.0	Negative	0	180	0
50-09109	0550-95-0246	54.7–56.4	Negative	2	150	0
50-09109	0550-95-0247	54.7–56.4	Negative	2	150	0
50-09109	0550-95-0248	59.8–60.1	Negative	1	200	0
50-09109	0550-95-0249	62.2–62.5	Negative	2	160	0
50-09109	0550-95-0250	64.3–64.7	Negative	1	190	0
50-09109	0550-95-0251	68.3–69.9	Negative	2	160	0
50-09109	0550-95-0252	73.1–73.5	Negative	1	150	0
50-09109	0550-95-0253	76.4–76.7	Negative	0	190	0
50-09109	0550-95-0254	78.1–78.5	Negative	1	180	0
50-09109	0550-95-0241	79.9–81.1	Negative	1	150	0
50-09109	0550-95-0242	82.9–83.2	Negative	0	170	0
50-09110	0550-95-0256	3.8–3.9	Negative	0	120	0
50-09110	0550-95-0257	8.5–8.9	Negative	1	160	0
50-09110	0550-95-0258	11.3–11.7	Negative	0	220	0
50-09110	0550-95-0259	16.0–17.9	Negative	2	200	0
50-09110	0550-95-0260	16.0–17.9	Negative	2	200	0
50-09110	0550-95-0261	20.7–21.1	Negative	0	200	0
50-09110	0550-96-0113 ^a	22.6–23.3	—	—	—	—
50-09110	0550-95-0262	30.1–30.5	Negative	0	220	0
50-09110	0550-95-0263	32.9–33.4	Negative	1	160	0
50-09110	0550-95-0264	35.7–37.6	Negative	1	200	0
50-09110	0550-95-0265	35.7–37.6	Negative	1	200	0
50-09110	0550-95-0266	41.6–42.1	Negative	1	180	0
50-09110	0550-95-0267	45.1–45.6	Negative	1	200	0

Table B-18 (continued)

Location ID	Sample ID	Depth (ft bgs)	HE Screen	Alpha (cpm)	Beta/Gamma (cpm)	PID (ppm)
50-09110	0550-96-0114 ^a	45.6–46.5	—	—	—	—
50-09110	0550-95-0268	49.3–49.8	Negative	1	200	0
50-09110	0550-95-0269	55.4–57.1	Negative	0	180	0
50-09110	0550-95-0270	55.4–57.1	Negative	0	180	0
50-09110	0550-95-0271	60.1–60.6	Negative	1	200	0
50-09110	0550-95-0272	62.0–62.5	Negative	2	180	0
50-09110	0550-95-0273	66.7–67.2	Negative	0	180	0
50-09110	0550-95-0274	69.5–72.0	Negative	0	180	0
50-09110	0550-95-0275	69.5–72.0	Negative	0	180	0
50-09110	0550-95-0276	74.2–74.5	Negative	0	130	0
50-09110	0550-95-0277	78.9–79.4	Negative	0	180	0
50-09110	0550-95-0279	82.7–84.0	Negative	0	140	0

^a Sample collected from curated core.^b — = Screening was not performed.

Table B-19
Summary of Phase I RFI Subsurface Tuff Samples Collected at MDA C

Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Cyanide	TAL Metals	Pesticides/PCBs	SVOCs	VOCs	Am-241	Gamma Spectroscopy	H-3	Isotopic Plutonium	Isotopic Thorium	Isotopic Uranium	Sr-90
0550-95-0362	50-09100	10.6–12.6	Qbt 3	699	699	— ^a	698	—	700	700	700	700	700	700	700
0550-95-0365	50-09100	26.5–28.5	Qbt 3	722	722	—	721	—	723	723	723	723	723	723	723
0550-96-0100 ^b	50-09100	32.7–33.7	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0368	50-09100	41.5–43.5	Qbt 3	722	722	—	721	—	723	723	723	723	723	723	723
0550-95-0371	50-09100	58.2–60	Qbt 3	722	722	—	721	—	723	723	723	723	723	723	723
0550-95-0374	50-09100	71.5–73.5	Qbt 2	735	735	—	734	—	736	736	736	736	736	736	736
0550-95-0383	50-09100	115.1–116.9	Qbt 2	761	761	—	760	—	762	762	762	762	762	762	762
0550-95-0392	50-09100	161.3–163.1	Qbt 1v	761	761	—	760	—	762	762	762	762	762	762	762
0550-95-0284	50-09101	10.6–12	Qbt 3	1187	1187	1185	1185	1185	1189	1189	1189	1189	1189	1189	1189
0550-96-0101 ^b	50-09101	19–19.7	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0289	50-09101	24.7–25.6	Qbt 3	1187	1187	1185	1185	1185	1189	1189	1189	1189	1189	1189	1189
0550-96-0102 ^b	50-09101	31.1–31.9	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0294	50-09101	38.9–39.4	Qbt 3	1187	1187	1185	1185	1185	1189	1189	1189	1189	1189	1189	1189
0550-96-0103 ^b	50-09101	44.2–44.7	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0299	50-09101	53–54.4	Qbt 3	1187	1187	1185	1185	1185	1189	1189	1189	1189	1189	1189	1189
0550-95-0304	50-09101	67.9–69.3	Qbt 3	1187	1187	1185	1185	1185	1189	1189	1189	1189	1189	1189	1189
0550-95-0309	50-09101	79.2–81	Qbt 3	1187	1187	1185	1185	1185	1189	1189	1189	1189	1189	1189	1189
0550-95-0004	50-09102	11.3–13.4	Qbt 3	820	820	—	800	—	821	821	821	821	821	821	821
0550-95-0009	50-09102	26.2–28.9	Qbt 3	820	820	—	800	—	821	821	821	821	821	821	821
0550-95-0014	50-09102	40.3–42.4	Qbt 3	820	820	—	800	—	821	821	821	821	821	821	821
0550-95-0019	50-09102	51.8–53.7	Qbt 3	877	877	—	—	—	878	878	878	878	878	878	878

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Table B-19 (continued)

Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Cyanide	TAL Metals	Pesticides/PCBs	SVOCs	VOCs	Am-241	Gamma Spectroscopy	H-3	Isotopic Plutonium	Isotopic Thorium	Isotopic Uranium	Sr-90
0550-95-0024	50-09102	67.2–68.6	Qbt 3	877	877	—	876	—	878	878	878	878	878	878	878
0550-95-0029	50-09102	76.4–77.8	Qbt 3	877	877	—	876	—	878	878	878	878	878	878	878
0550-95-0104	50-09103	13.1–14.7	Qbt 3	987	987	986	986	986	988	988	988	988	988	988	988
0550-95-0109	50-09103	25.5–27.4	Qbt 3	987	987	986	986	986	988	988	988	988	988	988	988
0550-96-0104 ^b	50-09103	32.88–33.81	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0114	50-09103	39.6–41.6	Qbt 3	987	987	986	986	986	988	988	988	988	988	988	988
0550-95-0119	50-09103	55.2–56.6	Qbt 3	987	987	986	986	986	988	988	988	988	988	988	988
0550-95-0124	50-09103	67–69.3	Qbt 3	987	987	986	986	986	988	988	988	988	988	988	988
0550-95-0129	50-09103	81.2–82.6	Qbt 3	987	987	986	986	986	988	988	988	988	988	988	988
0550-95-0075	50-09104	10.9–12.9	Qbt 3	946	946	945	945	945	947	947	947	947	947	947	947
0550-95-0079	50-09104	26.3–28	Qbt 3	946	946	945	945	945	947	947	947	947	947	947	947
0550-95-0083	50-09104	36.6–38.6	Qbt 3	—	946	945	945	945	947	947	947	947	947	947	947
0550-96-0105 ^b	50-09104	44.1–45.1	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0087	50-09104	58–60	Qbt 3	946	946	945	945	945	947	947	947	947	947	947	947
0550-95-0095	50-09104	79–81	Qbt 3	946	946	945	945	945	947	947	947	947	947	947	947
0550-95-0099	50-09104	85–87	Qbt 3	946	946	945	945	945	947	947	947	947	947	947	947
0550-95-0135	50-09105	11.4–13.1	Qbt 3	—	1014	1013	1013	1013	1015	1015	1015	1015	1015	1015	1015
0550-95-0140	50-09105	24.7–26.9	Qbt 3	—	1014	1013	1013	1013	1015	1015	1015	1015	1015	1015	1015
0550-95-0145	50-09105	40.3–41.7	Qbt 3	—	1014	1013	1013	1013	1015	1015	1015	1015	1015	1015	1015
0550-96-0106 ^b	50-09105	43.9–44.5	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0150	50-09105	54.4–56.4	Qbt 3	—	1014	1013	1013	1013	1015	1015	1015	1015	1015	1015	1015
0550-95-0155	50-09105	68.6–70.6	Qbt 3	—	1014	1013	1013	1013	1015	1015	1015	1015	1015	1015	1015
0550-95-0160	50-09105	83.2–84.9	Qbt 3	1018	1018	1017	1017	1017	1024	1024	1024	1024	1024	1024	1024
0550-95-0046	50-09106	19.4–21.6	Qbt 3	864	864	863	863	863	867	867	867	867	867	867	867

Table B-19 (continued)

Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Cyanide	TAL Metals	Pesticides/ PCBs	SVOCs	VOCs	Am-241	Gamma Spectroscopy	H-3	Isotopic Plutonium	Isotopic Thorium	Isotopic Uranium	Sr-90
0550-95-0050	50-09106	29–31.1	Qbt 3	908	908	907	907	907	922	922	922	922	922	922	922
0550-95-0054	50-09106	40–41.4	Qbt 3	908	908	907	907	907	922	922	922	922	922	922	922
0550-95-0058	50-09106	49.9–51.6	Qbt 3	908	908	907	907	907	922	922	922	922	922	922	922
0550-95-0063	50-09106	60.8–62.6	Qbt 3	908	908	907	907	907	922	922	922	922	922	922	922
0550-95-0067	50-09106	72.1–73.5	Qbt 3	908	908	907	907	907	922	922	922	922	922	922	922
0550-95-0071	50-09106	81.7–83.4	Qbt 3	908	908	907	907	907	922	922	922	922	922	922	922
0550-95-0166	50-09107	9.9–11.2	Qbt 3	1047	1047	1046	1046	1046	1048	1048	1048	1048	1048	1048	1048
0550-95-0171	50-09107	25.5–27.6	Qbt 3	1047	1047	1046	1046	1046	1048	1048	1048	1048	1048	1048	1048
0550-96-0107 ^b	50-09107	33.2–34.3	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0176	50-09107	40.3–41.7	Qbt 3	1047	1047	1046	1046	1046	1048	1048	1048	1048	1048	1048	1048
0550-96-0108 ^b	50-09107	46.8–47.4	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0181	50-09107	53–55.6	Qbt 3	1047	1047	1046	1046	1046	1048	1048	1048	1048	1048	1048	1048
0550-95-0186	50-09107	67.2–68.6	Qbt 3	1047	1047	1046	1046	1046	1048	1048	1048	1048	1048	1048	1048
0550-95-0191	50-09107	76.4–78.5	Qbt 3	1047	1047	1046	1046	1046	1048	1048	1048	1048	1048	1048	1048
0550-95-0195	50-09108	10.6–11.9	Qbt 3	1090	1090	1089	1089	1089	1091	1091	1091	1091	1091	1091	1091
0550-96-0109 ^b	50-09108	17.3–18	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0200	50-09108	26.2–27.3	Qbt 3	1090	1090	1089	1089	1089	1091	1091	1091	1091	1091	1091	1091
0550-96-0110 ^b	50-09108	31.7–32.5	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0205	50-09108	40.3–41.7	Qbt 3	1090	1090	1089	1089	1089	1091	1091	1091	1091	1091	1091	1091
0550-95-0210	50-09108	54.2–55.6	Qbt 3	1090	1090	1089	1089	1089	1091	1091	1091	1091	1091	1091	1091
0550-95-0215	50-09108	67.5–68.9	Qbt 3	1126	1126	1125	1125	1125	1128	1128	1128	1128	1128	1128	1128
0550-95-0220	50-09108	79.2–81.3	Qbt 3	1126	1126	1125	1125	1125	1128	1128	1128	1128	1128	1128	1128
0550-95-0226	50-09109	12.9–14.3	Qbt 3	1150	1150	1149	1149	1149	1148	1148	1148	1148	1148	1148	1148
0550-95-0231	50-09109	24.1–25.5	Qbt 3	1150	1150	1149	1149	1149	1148	1148	1148	1148	1148	1148	1148

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Table B-19 (continued)

Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Cyanide	TAL Metals	Pesticides/ PCBs	SVOCs	VOCs	Am-241	Gamma Spectroscopy	H-3	Isotopic Plutonium	Isotopic Thorium	Isotopic Uranium	Sr-90
0550-96-0111 ^b	50-09109	32.5–33.2	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0236	50-09109	40.9–42.4	Qbt 3	1150	1150	1149	1149	1149	1148	1148	1148	1148	1148	1148	1148
0550-96-0112 ^b	50-09109	46.7–47.4	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0246	50-09109	54.7–56.4	Qbt 3	1163	1163	1162	1162	1162	1164	1164	1164	1164	1164	1164	1164
0550-95-0251	50-09109	62.6–62.8	Qbt 3	1163	1163	1162	1162	1162	1164	1164	1164	1164	1164	1164	1164
0550-95-0241	50-09109	79.9–81.1	Qbt 3	1163	1163	1162	1162	1162	1164	1164	1164	1164	1164	1164	1164
0550-95-0259	50-09110	16–17.9	Qbt 3	1177	1177	1176	1176	1176	1178	1178	1178	1178	1178	1178	1178
0550-96-0113 ^b	50-09110	22.6–23.3	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0264	50-09110	35.7–37.6	Qbt 3	1177	1177	1176	1176	1176	1178	1178	1178	1178	1178	1178	1178
0550-96-0114 ^b	50-09110	45.6–46.5	Qbt 3	—	1834	—	—	—	1835	1835	—	1835	1835	1835	1835
0550-95-0269	50-09110	55.4–57.1	Qbt 3	1177	1177	1176	1176	1176	1178	1178	1178	1178	1178	1178	1178
0550-95-0274	50-09110	69.5–72	Qbt 3	1177	1177	1176	1176	1176	1178	1178	1178	1178	1178	1178	1178
0550-95-0279	50-09110	82.7–84	Qbt 3	1177	1177	1176	1176	1176	1178	1178	1178	1178	1178	1178	1178

^a Dash indicates sample not analyzed for this suite.^b Tuff sample collected from curated core.

Table B-20
Frequency of Detected Inorganic Chemicals
Above BV in Phase I RFI Subsurface Tuff Samples at MDA C

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range ^a (mg/kg)	Background Value ^b (mg/kg)	Frequency of Detects Above Background Value	Frequency of Nondetects Above Background Value
Aluminum	Qbt 3	79	79	180 to 7900	7340	1/79	0/79
Aluminum	Qbt 2	2	2	254 to 3260	7340	0/2	0/2
Aluminum	Qbt 1v	1	1	272	8170	0/1	0/1
Antimony	Qbt 3	73	3	[0.1 to 11]	0.5	3/73	60/73
Antimony	Qbt 2	2	1	[0.38] to 0.41	0.5	0/2	0/2
Antimony	Qbt 1v	1	0	[0.39]	0.5	0/1	0/1
Arsenic	Qbt 3	79	36	[0.19] to 9.8	2.79	4/79	0/79
Arsenic	Qbt 2	2	2	0.94 to 1.5	2.79	0/2	0/2
Arsenic	Qbt 1v	1	1	0.72	1.81	0/1	0/1
Barium	Qbt 3	79	79	2.8 to 100	46	2/79	0/79
Barium	Qbt 2	2	2	11.5 to 34	46	0/2	0/2
Barium	Qbt 1v	1	1	10.3	26.5	0/1	0/1
Beryllium	Qbt 3	79	51	[0.02] to 1.3	1.21	1/79	0/79
Beryllium	Qbt 2	2	2	0.3 to 0.65	1.21	0/2	0/2
Beryllium	Qbt 1v	1	1	0.43	1.7	0/1	0/1
Cadmium	Qbt 3	79	28	[0.02] to 0.82	1.63	0/79	0/79
Cadmium	Qbt 2	2	0	[0.02 to 0.04]	1.63	0/2	0/2
Cadmium	Qbt 1v	1	0	[0.04]	0.4	0/1	0/1
Calcium	Qbt 3	79	79	160 to 73900	2200	1/79	0/79
Calcium	Qbt 2	2	2	174 to 703	2200	0/2	0/2
Calcium	Qbt 1v	1	1	167	3700	0/1	0/1
Chromium, Total	Qbt 3	79	26	[0.16] to 12.7	7.14	1/79	0/79
Chromium, Total	Qbt 2	2	2	0.2 to 2.2	7.14	0/2	0/2
Chromium, Total	Qbt 1v	1	1	0.19	2.24	0/1	0/1
Cobalt	Qbt 3	79	27	[0.18] to 3.8	3.14	1/79	0/79
Cobalt	Qbt 2	2	2	0.37 to 1.1	3.14	0/2	0/2
Cobalt	Qbt 1v	1	1	0.42	1.78	0/1	0/1
Copper	Qbt 3	79	39	[0.42] to 30.7	4.66	3/79	0/79
Copper	Qbt 2	2	2	0.98 to 4.4	4.66	0/2	0/2
Copper	Qbt 1v	1	1	1	3.26	0/1	0/1
Cyanide, Total	Qbt 3	58	11	[0.00053] to 10.2	na ^c	11/58	na
Cyanide, Total	Qbt 2	2	0	[0.19 to 0.38]	na	0/2	na
Cyanide, Total	Qbt 1v	1	0	[0.19]	na	0/1	na
Iron	Qbt 3	79	79	517 to 8670	14500	0/79	0/79
Iron	Qbt 2	2	2	3560 to 8370	14500	0/2	0/2
Iron	Qbt 1v	1	1	3320	9900	0/1	0/1

Table B-20 (continued)

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range ^a (mg/kg)	Background Value ^b (mg/kg)	Frequency of Detects Above Background Value	Frequency of Nondetects Above Background Value
Lead	Qbt 3	79	79	0.68 to 75.2	11.2	9/79	0/79
Lead	Qbt 2	2	2	3.8 to 6.4	11.2	0/2	0/2
Lead	Qbt 1v	1	1	5.1	18.4	0/1	0/1
Magnesium	Qbt 3	79	74	60.8 to 2690	1690	1/79	0/79
Magnesium	Qbt 2	2	2	93.1 to 478	1690	0/2	0/2
Magnesium	Qbt 1v	1	1	80.3	780	0/1	0/1
Manganese	Qbt 3	79	79	70 to 272	482	0/79	0/79
Manganese	Qbt 2	2	2	286 to 319	482	0/2	0/2
Manganese	Qbt 1v	1	1	358	408	0/1	0/1
Mercury	Qbt 3	79	0	[0.02 to 0.11]	0.1	0/79	11/79
Mercury	Qbt 2	2	0	[0.05]	0.1	0/2	0/2
Mercury	Qbt 1v	1	0	[0.05]	0.1	0/1	0/1
Nickel	Qbt 3	79	20	[0.2] to 13.2	6.58	1/79	0/79
Nickel	Qbt 2	2	2	0.26 to 2.9	6.58	0/2	0/2
Nickel	Qbt 1v	1	1	0.32	2	0/1	0/1
Potassium	Qbt 3	79	57	[55] to 1000	3500	0/79	0/79
Potassium	Qbt 2	2	1	[93.1] to 410	3500	0/2	0/2
Potassium	Qbt 1v	1	0	[96.9]	6670	0/1	0/1
Selenium	Qbt 3	79	5	[0.11] to 10.5	0.3	4/79	48/79
Selenium	Qbt 2	2	0	[0.44]	0.3	0/2	2/2
Selenium	Qbt 1v	1	0	[0.45]	0.3	0/1	1/1
Silver	Qbt 3	79	2	[0.1 to 2.2]	1	0/79	10/79
Silver	Qbt 2	2	0	[0.1 to 0.11]	1	0/2	0/2
Silver	Qbt 1v	1	0	[0.1 to 1]	1	0/1	0/1
Sodium	Qbt 3	79	68	59.5 to 387	2770	0/79	0/79
Sodium	Qbt 2	2	0	[60.4 to 79]	2770	0/2	0/2
Sodium	Qbt 1v	1	0	[49.8]	6330	0/1	0/1
Thallium	Qbt 3	79	17	[0.1] to 1.4	1.1	3/79	21/79
Thallium	Qbt 2	2	1	[0.48] to 0.49	1.1	0/2	0/2
Thallium	Qbt 1v	1	1	0.69	1.24	0/1	0/1
Vanadium	Qbt 3	79	70	0.42 to 10.5	17	0/79	0/79
Vanadium	Qbt 2	2	2	0.73 to 3.1	17	0/2	0/2
Vanadium	Qbt 1v	1	1	0.49	4.48	0/1	0/1
Zinc	Qbt 3	79	79	12.4 to 54	63.5	0/79	0/79
Zinc	Qbt 2	2	2	29.6 to 50.5	63.5	0/2	0/2
Zinc	Qbt 1v	1	1	28.9	84.6	0/1	0/1

^a Value in square brackets indicate nondetects.^b BVs obtained from LANL 1998, 59730.^c na = Not available.

Table B-21
Inorganic Chemicals Detected Above the BV in Phase I RFI Subsurface Tuff Samples at MDA C

Part 1									
Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Calcium
Qbt 2,3,4 Background Value^a				7340	0.5	2.79	46	1.21	2200
Qbt 1v Background Value^a				8170-	6.5	1.81	26.5	1.7	3700
0550-95-0083	50-09104	36.60–38.60	Qbt 3	— ^b	—	—	—	1.3	—
0550-96-0105 ^c	50-09104	44.10–45.10	Qbt 3	—	—	3.2	—	—	—
0550-96-0106 ^c	50-09105	43.91–44.55	Qbt 3	—	—	3	—	—	—
0550-95-0046	50-09106	19.45–21.57	Qbt 3	—	—	9.8	—	—	—
0550-95-0067	50-09106	72.12–73.54	Qbt 3	—	0.86 (J)	—	—	—	—
0550-96-0107 ^c	50-09107	33.16–34.29	Qbt 3	—	—	2.8	—	—	—
0550-95-0231	50-09109	24.11–25.46	Qbt 3	—	11 (J-)	—	100	—	—
0550-96-0112 ^c	50-09109	46.67–47.38	Qbt 3	7900 (J)	—	—	71.6	—	73900
0550-95-0264	50-09110	35.71–37.59	Qbt 3	—	3.1 (J)	—	—	—	—
Part 2									
Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Chromium	Cobalt	Copper	Cyanide (Total)	Lead	Magnesium
Qbt 2,3,4 Background Value^a				7.14	3.14	4.66	n/a^d	11.2	1690
Qbt 1v Background Value^a				2.24	1.78	3.26	n/a	18.4	780
0550-95-0368	50-09100	41.50–43.50	Qbt 3	—	—	—	0.533	—	—
0550-95-0284	50-09101	10.61–12.02	Qbt 3	—	—	—	10.2	—	—
0550-95-0289	50-09101	24.5–25.60	Qbt 3	—	—	—	6.2	—	—
0550-95-0294	50-09101	38.89–39.39	Qbt 3	—	—	—	0.92	—	—
0550-96-0104 ^c	50-09103	32.88–33.81	Qbt 3	—	—	—	—	16.2 (J-)	—
0550-95-0075	50-09104	10.90–12.90	Qbt 3	—	—	—	0.22 (J-)	—	—
0550-95-0079	50-09104	26.30–28.00	Qbt 3	—	—	—	0.23 (J-)	13.8	—
0550-95-0083	50-09104	36.60–38.60	Qbt 3	—	—	5	—	50.3	—
0550-95-0087	50-09104	58.00–60.00	Qbt 3	—	—	—	0.25 (J-)	—	—
0550-95-0095	50-09104	79.00–81.00	Qbt 3	—	—	—	0.3 (J-)	—	—
0550-95-0099	50-09104	85.00–87.00	Qbt 3	—	—	—	0.26 (J-)	—	—
0550-95-0046	50-09106	19.45–21.57	Qbt 3	—	—	—	—	51.1 (J)	—
0550-95-0195	50-09108	10.61–11.88	Qbt 3	—	—	—	—	65	—
0550-95-0200	50-09108	26.16–27.29	Qbt 3	—	—	—	—	22	—
0550-95-0215	50-09108	67.53–68.94	Qbt 3	—	—	—	1	—	—
0550-95-0231	50-09109	24.11–25.46	Qbt 3	—	—	11	—	41	—
0550-96-0112 ^c	50-09109	46.67–47.38	Qbt 3	12.7	3.8 (J)	30.7	—	11.3 (J-)	2690
0550-95-0264	50-09110	35.71–37.59	Qbt 3	—	—	—	3.9	—	—
0550-95-0269	50-09110	55.44–57.13	Qbt 3	—	—	—	—	75.2	—

Table B-21 (continued)

Part 3								
Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Mercury	Nickel	Selenium	Silver	Thallium
Qbt 2,3,4 Background Value ^a				0.1	6.58	0.3	1	1.1
Qbt 1v Background Value ^a				0.1	2	0.3	1	1.24
0550-95-0362	50-09100	10.60–12.60	Qbt 3	—	—	10.5	—	—
0550-95-0304	50-09101	67.88–69.30	Qbt 3	—	—	0.35	—	—
0550-96-0105 ^c	50-09104	44.10–45.10	Qbt 3	—	—	—	—	1.2
0550-95-0071	50-09106	81.67–83.44	Qbt 3	—	—	—	—	1.2 (J)
0550-96-0107 ^c	50-09107	33.16–34.29	Qbt 3	—	—	1.1	—	—
0550-96-0112 ^c	50-09109	46.67–47.38	Qbt 3	—	13.2	1.3	—	1.4

Note: Units are mg/kg.

^a Tuff BVs/FVs obtained from LANL 1998, 59730.

^b Dash indicates that the concentration was not above the BV.

^c Tuff sample collected from curated core.

^d n/a = Not applicable.

Table B-22
Frequency of Detected Radionuclides Above BV in Phase I RFI Subsurface Tuff Samples

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (pCi/g) ^a	Background Value ^b (pCi/g)	Frequency of Detects Above Background Value
Americium-241	Qbt 2	2	0	[0.002 to 0.016]	na ^c	0/2
Americium-241	Qbt 3	79	8	[–0.14] to [0.183]	na	8/79
Americium-241	Qbt 1v	1	0	[0.014]	na	0/1
Cesium-134	Qbt 3	45	2	[–0.026] to 0.32	na	2/45
Cesium-137	Qbt 2	2	0	[–0.029 to 0.002]	na	0/2
Cesium-137	Qbt 3	79	1	[–0.4 to 0.768]	na	1/79
Cesium-137	Qbt 1v	1	0	[0.0272]	na	0/1
Cobalt-60	Qbt 2	2	0	[–0.050 to –0.006]	na	0/2
Cobalt-60	Qbt 3	79	1	[–0.037] to 0.32	na	1/79
Cobalt-60	Qbt 1v	1	0	[0.032]	na	0/1
Europium-152	Qbt 2	2	0	[–0.037 to 0.122]	na	0/2
Europium-152	Qbt 3	63	2	[–0.023 to 0.78]	na	2/63
Europium-152	Qbt 1v	1	0	[0.104]	na	0/1
Plutonium-238	Qbt 2	2	0	[0 to 0.02]	na	0/2
Plutonium-238	Qbt 3	79	1	[–0.011] to [0.014]	na	1/79
Plutonium-238	Qbt 1v	1	0	[0]	na	0/1

Table B-22 (continued)

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (pCi/g) ^a	Background Value ^b (pCi/g)	Frequency of Detects Above Background Value
Plutonium-239	Qbt 2	2	0	[-0.01 to 0.005]	na	0/2
Plutonium-239	Qbt 3	79	2	[-0.005] to 0.08	na	2/79
Plutonium-239	Qbt 1v	1	0	[0]	na	0/1
Ruthenium-106	Qbt 2	2	0	[-0.309 to -0.121]	na	0/2
Ruthenium-106	Qbt 3	79	0	[-0.302 to 1.41]	na	0/79
Ruthenium-106	Qbt 1v	1	0	[0.027]	na	0/1
Sodium-22	Qbt 2	2	0	[-0.004 to 0.005]	na	0/2
Sodium-22	Qbt 3	79	3	[-0.03] to 0.22	na	3/79
Sodium-22	Qbt 1v	1	0	[-0.002]	na	0/1
Strontium-90	Qbt 2	2	0	[0.291 to 0.58]	na	0/2
Strontium-90	Qbt 3	79	4	[-0.52] to 1.44	na	4/79
Strontium-90	Qbt 1v	1	0	[0.55]	na	0/1
Thorium-228	Qbt 2	2	2	1.35 to 1.69	2.52	0/2
Thorium-228	Qbt 3	79	75	[0.083] to 1.81	2.52	0/79
Thorium-228	Qbt 1v	1	1	1.50	3.75	0/1
Thorium-230	Qbt 2	2	2	0.81 to 1.23	1.98	0/2
Thorium-230	Qbt 3	79	50	[0.289 to 1.74]	1.98	0/79
Thorium-230	Qbt 1v	1	1	1.11	3.12	0/1
Thorium-232	Qbt 2	2	2	1.23 to 1.66	2.52	0/2
Thorium-232	Qbt 3	79	77	[0.06] to 1.76	2.52	0/79
Thorium-232	Qbt 1v	1	1	1.50	3.75	0/1
Tritium	Qbt 2	2	1	1.54 to [4.26] (pCi/mL)	na	1/2
Tritium	Qbt 3	64	63	[1.4] to 649261 (pCi/mL)	na	63/64
Tritium	Qbt 1v	1	0	[2.38] (pCi/mL)	na	0/1
Uranium-234	Qbt 2	2	2	0.51 to 1.016	1.98	0/2
Uranium-234	Qbt 3	79	77	0.563 to 1.7	1.98	0/79
Uranium-234	Qbt 1v	1	1	0.993	3.12	0/1
Uranium-235	Qbt 2	2	2	0.02 to 0.05	0.09	0/2
Uranium-235	Qbt 3	79	53	[0.009] to 0.23	0.09	15/79
Uranium-235	Qbt 1v	1	1	0.045	0.14	0/1
Uranium-238	Qbt 2	2	2	0.59 to 1.03	1.93	0/2
Uranium-238	Qbt 3	79	78	0.308 to 2.36	1.93	1/79
Uranium-238	Qbt 1v	1	1	0.991	3.05	0/1

^a Values in square brackets indicate nondetects.^b Tuff BVs obtained from LANL 1998, 59730.^c na = Not available.

Table B-23
Detected Radionuclides Above BVs in Phase I RFI Subsurface Samples at MDA C

Part 1										
Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Americium-241	Cesium-134	Cesium-137	Cobalt-60	Europium-152	Plutonium-238	Plutonium-239
Qbt 2,3,4 Background/Fallout Value^a				— ^b	—	—	—	—	—	—
0550-95-0365	50-09100	26.50–28.50	Qbt 3	0.027	—	—	—	—	—	—
0550-95-0368	50-09100	41.50–43.50	Qbt 3	—	—	—	—	—	—	0.014
0550-95-0284	50-09101	10.61–12.02	Qbt 3	0.018	—	—	—	—	—	—
0550-95-0289	50-09101	24.5–25.60	Qbt 3	0.018	—	—	—	—	—	—
0550-95-0309	50-09101	79.20–80.96	Qbt 3	0.011	—	—	—	—	—	—
0550-95-0104	50-09103	13.08–14.71	Qbt 3	—	—	—	—	0.231	—	—
0550-95-0109	50-09103	25.46–27.44	Qbt 3	0.027	—	—	—	—	—	—
0550-95-0119	50-09103	55.15–56.57	Qbt 3	0.023	—	—	—	0.297	—	—
0550-95-0075	50-09104	10.90–12.90	Qbt 3	—	0.32	—	—	—	—	—
0550-95-0079	50-09104	26.30–28.00	Qbt 3	—	—	—	0.32	—	—	—
0550-95-0135	50-09105	11.38–13.08	Qbt 3	—	—	0.768	—	—	—	—
0550-95-0145	50-09105	40.31–41.72	Qbt 3	0.038	—	—	—	—	—	—
0550-95-0160	50-09105	83.23–84.85	Qbt 3	—	—	—	—	—	—	0.08
0550-95-0166	50-09107	9.90–11.17	Qbt 3	0.012	—	—	—	—	—	—
0550-95-0181	50-09107	53.03–55.58	Qbt 3	0.007	—	—	—	—	—	—
0550-95-0186	50-09107	67.18–68.59	Qbt 3	0.009	—	—	—	—	—	—
0550-95-0191	50-09107	76.37–78.49	Qbt 3	0.032	—	—	—	—	—	—
0550-96-0109 ^c	50-09108	17.32–18.03	Qbt 3	—	0.29	—	—	—	—	—
0550-95-0215	50-09108	67.53–68.94	Qbt 3	—	—	—	—	—	0.014	—
Part 2										
Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Sodium-22	Strontium-90	Thorium-232	Tritium (pCi/mL)	Uranium-235	Uranium-238	
Qbt 2,3,4 Background/Fallout Value^a				—	—	2.52	—	0.09	1.93	
0550-95-0362	50-09100	10.60–12.60	Qbt 3	—	—	—	12.2	—	—	
0550-95-0365	50-09100	26.50–28.50	Qbt 3	—	—	—	622	—	—	
0550-96-0100 ^c	50-09100	32.70–33.70	Qbt 3	—	—	—	—	0.21	—	
0550-95-0368	50-09100	41.50–43.50	Qbt 3	—	—	—	13.4	—	—	
0550-95-0371	50-09100	58.20–60.00	Qbt 3	—	—	—	27.9	—	—	
0550-95-0374	50-09100	71.50–73.50	Qbt 2	—	—	—	1.54	—	—	
0550-95-0284	50-09101	10.61–12.02	Qbt 3	—	—	—	2.86	—	—	
0550-96-0101 ^c	50-09101	18.99–19.69	Qbt 3	—	—	—	—	0.22	—	
0550-95-0289	50-09101	24.75–25.60	Qbt 3	—	—	—	7.33	—	—	
0550-96-0102 ^c	50-09101	31.11–31.89	Qbt 3	—	—	—	—	0.22	—	

Table B-23 (continued)

Part 2 (continued)									
Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Sodium-22	Strontium-90	Thorium-232	Tritium (pCi/mL)	Uranium-235	Uranium-238
Qbt 2,3,4 Background/Fallout Value ^a				—	—	2.52	—	0.09	1.93
0550-95-0294	50-09101	38.89–39.39	Qbt 3	—	—	—	7.77	—	—
0550-96-0103	50-09101	44.19–44.69	Qbt 3	—	—	—	—	0.22	—
0550-95-0299	50-09101	53.03–54.45	Qbt 3	—	—	—	7.5	—	—
0550-95-0304	50-09101	67.88–69.30	Qbt 3	—	—	—	5.63	—	—
0550-95-0309	50-09101	79.20–80.96	Qbt 3	—	—	—	47.5	—	—
0550-95-0004	50-09102	11.31–13.44	Qbt 3	—	—	—	1.84	—	—
0550-95-0009	50-09102	26.16–28.92	Qbt 3	—	—	—	10.4	—	—
0550-95-0014	50-09102	40.31–42.43	Qbt 3	—	—	—	23300	—	—
0550-95-0019	50-09102	51.76–53.74	Qbt 3	—	—	—	6720	—	—
0550-95-0024	50-09102	67.18–68.59	Qbt 3	—	—	—	274	—	—
0550-95-0029	50-09102	76.37–77.78	Qbt 3	—	—	—	376	—	—
0550-95-0104	50-09103	13.08–14.71	Qbt 3	—	—	—	35.8	—	—
0550-95-0109	50-09103	25.46–27.44	Qbt 3	—	—	—	7.14	—	—
0550-96-0104 ^c	50-09103	32.88–33.81	Qbt 3	—	—	—	—	0.21	—
0550-95-0114	50-09103	39.60–41.58	Qbt 3	—	—	—	12.7	—	—
0550-95-0119	50-09103	55.15–56.57	Qbt 3	—	—	—	6.32	—	—
0550-95-0124	50-09103	66.96–69.30	Qbt 3	—	—	—	14.4	—	—
0550-95-0129	50-09103	81.18–82.59	Qbt 3	—	0.599	—	2.17	—	—
0550-95-0075	50-09104	10.90–12.90	Qbt 3	0.22	—	—	3.47	—	—
0550-95-0079	50-09104	26.30–28.00	Qbt 3	—	—	—	290.7	—	—
0550-95-0083	50-09104	36.60–38.60	Qbt 3	0.22	—	—	378.2	—	—
0550-96-0105 ^c	50-09104	44.10–45.10	Qbt 3	—	—	—	—	0.23	—
0550-95-0087	50-09104	58.00–60.00	Qbt 3	—	—	—	43.15	—	—
0550-95-0095	50-09104	79.00–81.00	Qbt 3	—	—	—	3.26	—	—
0550-95-0099	50-09104	85.00–87.00	Qbt 3	—	—	—	1.9	—	—
0550-95-0135	50-09105	11.38–13.08	Qbt 3	—	—	—	3.84	—	—
0550-95-0140	50-09105	24.75–26.87	Qbt 3	—	—	—	1.5	—	—
0550-95-0145	50-09105	40.31–41.72	Qbt 3	—	—	—	481	—	—
0550-96-0106 ^c	50-09105	43.91–44.55	Qbt 3	—	—	—	—	0.21	—
0550-95-0150	50-09105	54.45–56.36	Qbt 3	—	—	—	6.1	—	—
0550-95-0155	50-09105	68.59–70.57	Qbt 3	—	—	—	3.22	—	—
0550-95-0046	50-09106	19.45–21.57	Qbt 3	—	—	—	126	—	—
0550-95-0050	50-09106	28.99–31.11	Qbt 3	—	—	—	38100	—	—
0550-95-0054	50-09106	39.95–41.37	Qbt 3	—	—	—	6440	—	—
0550-95-0058	50-09106	49.85–51.62	Qbt 3	—	—	—	28	—	—
0550-95-0063	50-09106	60.81–62.58	Qbt 3	—	—	—	14.8	—	—

Table B-23 (continued)

Part 2 (continued)									
Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Sodium-22	Strontium-90	Thorium-232	Tritium (pCi/mL)	Uranium-235	Uranium-238
Qbt 2,3,4 Background/Fallout Value ^a				—	—	2.52	—	0.09	1.93
0550-95-0067	50-09106	72.12–73.54	Qbt 3	—	—	—	64.9	—	—
0550-95-0071	50-09106	81.67–83.44	Qbt 3	—	0.767	—	30.1	—	—
0550-95-0166	50-09107	9.90–11.17	Qbt 3	—	—	—	12.1	—	—
0550-95-0171	50-09107	25.46–27.58	Qbt 3	—	—	—	10373	—	—
0550-96-0107 ^c	50-09107	33.16–34.29	Qbt 3	—	—	—	—	0.2	—
0550-95-0176	50-09107	40.31–41.72	Qbt 3	—	—	—	649261	—	—
0550-96-0108 ^c	50-09107	66.20–67.00	Qbt 3	—	—	—	—	0.23	—
0550-95-0181	50-09107	53.03–55.58	Qbt 3	—	—	—	207792	—	—
0550-95-0186	50-09107	67.18–68.59	Qbt 3	—	—	—	13827	—	—
0550-95-0191	50-09107	76.37–78.49	Qbt 3	—	—	—	581.5	—	—
0550-95-0195	50-09108	10.61–11.88	Qbt 3	—	—	—	3.08	—	—
0550-96-0109 ^c	50-09108	17.32–18.03	Qbt 3	—	—	—	—	0.22	—
0550-95-0200	50-09108	26.16–27.29	Qbt 3	—	—	—	12.02	—	—
0550-96-0110 ^c	50-09108	31.75–32.46	Qbt 3	—	—	—	—	0.22	—
0550-95-0205	50-09108	40.31–41.72	Qbt 3	—	—	—	5.46	0.11 (U)	—
0550-95-0210	50-09108	54.16–55.58	Qbt 3	—	—	—	388.8	—	—
0550-95-0215	50-09108	67.53–68.94	Qbt 3	—	0.44	—	974	—	—
0550-95-0220	50-09108	79.20–81.32	Qbt 3	—	—	—	1660	—	—
0550-95-0226	50-09109	12.87–14.28	Qbt 3	—	1.44	—	4.63	—	2.36
0550-95-0231	50-09109	24.11–25.46	Qbt 3	—	—	—	10.3	—	—
0550-96-0111 ^c	50-09109	32.53–33.23	Qbt 3	—	—	—	—	0.21	—
0550-95-0236	50-09109	40.87–42.43	Qbt 3	—	—	—	11.6	—	—
0550-96-0112 ^c	50-09109	46.67–47.38	Qbt 3	—	—	—	—	0.21	—
0550-95-0246	50-09109	54.73–56.36	Qbt 3	—	—	—	6.1	—	—
0550-95-0251	50-09109	62.65–62.79	Qbt 3	—	—	—	5220	—	—
0550-95-0241	50-09109	79.90–81.11	Qbt 3	0.056	—	—	5.43	—	—
0550-95-0259	50-09110	15.97–17.85	Qbt 3	—	—	—	210	—	—
0550-96-0113 ^c	50-09110	22.65–23.30	Qbt 3	—	—	—	—	0.22	—
0550-95-0264	50-09110	35.71–37.59	Qbt 3	—	—	—	36200	—	—
0550-96-0114 ^c	50-09110	45.58–46.51	Qbt 3	—	—	—	—	0.21	—
0550-95-0269	50-09110	55.44–57.13	Qbt 3	—	—	—	4750	—	—
0550-95-0274	50-09110	69.54–71.98	Qbt 3	—	—	—	61.4	—	—
0550-95-0279	50-09110	82.69–84.01	Qbt 3	—	—	—	6.72	—	—

Note: Units are pCi/g.

^a Tuff BVs obtained from LANL 1998, 59730.^b Dash indicates that the concentration was not above the BV.^c Tuff sample collected from curated core.

Table B-24
Frequency of Detected Organic Chemicals in Phase I RFI Subsurface Tuff Samples at MDA C

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)*	Frequency of Detects
Acetone	Qbt 3	54	8	0.003 to 0.055	8/54
Bis(2-ethylhexyl)phthalate	Qbt 3	66	7	0.037 to [0.46]	7/66
Dichloroethene[1,1-]	Qbt 3	54	4	0.003 to [0.006]	4/54
Methylene Chloride	Qbt 3	54	1	[0.004 to 0.016]	1/54
Methylphenol[2-]	Qbt 3	66	1	[0.16 to 0.39]	1/66
Toluene	Qbt 3	54	1	0.003 to [0.006]	1/54

*Values in square brackets indicate nondetects.

Table B-25
Detected Organic Chemicals in Subsurface Tuff Samples at MDA C

Sample ID	Location ID	Depth Below Ground Surface (ft)	Media	Acetone	Bis(2-ethylhexyl)phthalate	Dichloroethene[1,1-]	Methylene Chloride	Methylphenol[2-]	Toluene
0550-95-0289	50-09101	24.75–25.60	Qbt 3	—*	0.037 (J)	—	—	—	—
0550-95-0294	50-09101	38.89–39.39	Qbt 3	—	0.072 (J)	—	—	—	—
0550-95-0299	50-09101	53.03–54.45	Qbt 3	—	0.041 (J)	—	—	—	—
0550-95-0109	50-09103	25.46–27.44	Qbt 3	—	—	0.003 (J)	—	—	—
0550-95-0119	50-09103	55.15–56.57	Qbt 3	—	0.3 (J)	0.004 (J)	—	—	—
0550-95-0124	50-09103	66.96–69.30	Qbt 3	0.009 (J)	—	0.006	—	—	—
0550-95-0129	50-09103	81.18–82.59	Qbt 3	0.055	—	0.004 (J)	—	—	—
0550-95-0099	50-09104	85.00–87.00	Qbt 3	—	—	—	—	0.35	—
0550-95-0145	50-09105	40.31–41.72	Qbt 3	—	0.14 (J)	—	—	—	0.003 (J)
0550-95-0046	50-09106	19.45–21.57	Qbt 3	0.013 (J)	—	—	—	—	—
0550-95-0054	50-09106	39.95–41.37	Qbt 3	0.009 (J)	—	—	—	—	—
0550-95-0200	50-09108	26.16–27.29	Qbt 3	0.028	—	—	—	—	—
0550-95-0210	50-09108	54.16–55.58	Qbt 3	—	—	—	0.0063	—	—
0550-95-0215	50-09108	67.53–68.94	Qbt 3	—	0.19 (J)	—	—	—	—
0550-95-0226	50-09109	12.87–14.28	Qbt 3	0.024	—	—	—	—	—
0550-95-0231	50-09109	24.11–25.46	Qbt 3	0.03	—	—	—	—	—
0550-95-0264	50-09110	35.71–37.59	Qbt 3	—	0.047 (J)	—	—	—	—
0550-95-0279	50-09110	82.69–84.01	Qbt 3	0.003 (J)	—	—	—	—	—

Note: Units are mg/kg.

*Dash indicates that the concentration was not above the EQL.

Table B-26
Percent Moisture for the Subsurface Sample Tritium Data at MDA C

Location ID	Depth (ft bgs)	Media	Sample ID	Percent Moisture
50-09100	10.6–12.6	Qbt 3	0550-95-0362	6.00
50-09100	26.5–28.5	Qbt 3	0550-95-0365	6.00
50-09100	41.5–43.5	Qbt 3	0550-95-0368	6.00
50-09100	58.2–60	Qbt 3	0550-95-0371	1.00
50-09100	71.5–73.5	Qbt 2	0550-95-0374	5.00
50-09100	115.1–116.9	Qbt 2	0550-95-0383	1.00
50-09100	161.3–163.1	Qbt 1v	0550-95-0392	1.00
50-09100	32.7–33.7	Qbt 3	0550-96-0100	NR*
50-09101	10.6–12	Qbt 3	0550-95-0284	10.80
50-09101	24.7–25.6	Qbt 3	0550-95-0289	7.72
50-09101	38.9–39.4	Qbt 3	0550-95-0294	7.94
50-09101	53–54.4	Qbt 3	0550-95-0299	8.29
50-09101	67.9–69.3	Qbt 3	0550-95-0304	8.13
50-09101	79.2–81	Qbt 3	0550-95-0309	7.17
50-09101	19–19.7	Qbt 3	0550-96-0101	NR
50-09101	31.1–31.9	Qbt 3	0550-96-0102	NR
50-09101	44.2–44.7	Qbt 3	0550-96-0103	NR
50-09102	11.3–13.4	Qbt 3	0550-95-0004	5.50
50-09102	26.2–28.9	Qbt 3	0550-95-0009	6.40
50-09102	40.3–42.4	Qbt 3	0550-95-0014	7.17
50-09102	51.8–53.7	Qbt 3	0550-95-0019	NR
50-09102	67.2–68.6	Qbt 3	0550-95-0024	NR
50-09102	76.4–77.8	Qbt 3	0550-95-0029	NR
50-09103	13.1–14.7	Qbt 3	0550-95-0104	3.95
50-09103	25.5–27.4	Qbt 3	0550-95-0109	4.47
50-09103	39.6–41.6	Qbt 3	0550-95-0114	8.00
50-09103	55.2–56.6	Qbt 3	0550-95-0119	6.63
50-09103	67–69.3	Qbt 3	0550-95-0124	6.22
50-09103	81.2–82.6	Qbt 3	0550-95-0129	5.15
50-09103	32.9–33.8	Qbt 3	0550-96-0104	NR
50-09104	10.9–12.9	Qbt 3	0550-95-0075	7.10
50-09104	26.3–28	Qbt 3	0550-95-0079	8.10
50-09104	36.6–38.6	Qbt 3	0550-95-0083	8.60
50-09104	58–60	Qbt 3	0550-95-0087	6.20
50-09104	79–81	Qbt 3	0550-95-0095	8.50
50-09104	85–87	Qbt 3	0550-95-0099	8.20
50-09104	44.1–45.1	Qbt 3	0550-96-0105	NR

Table B-26 (continued)

Location ID	Depth (ft bgs)	Media	Sample ID	Percent Moisture
50-09105	11.4–13.1	Qbt 3	0550-95-0135	6.69
50-09105	24.7–26.9	Qbt 3	0550-95-0140	5.84
50-09105	40.3–41.7	Qbt 3	0550-95-0145	5.99
50-09105	54.4–56.4	Qbt 3	0550-95-0150	4.78
50-09105	68.6–70.6	Qbt 3	0550-95-0155	2.98
50-09105	83.2–84.9	Qbt 3	0550-95-0160	0.00
50-09105	43.9–44.5	Qbt 3	0550-96-0106	NR
50-09106	19.4–21.6	Qbt 3	0550-95-0046	6.49
50-09106	29–31.1	Qbt 3	0550-95-0050	4.89
50-09106	40–41.4	Qbt 3	0550-95-0054	2.44
50-09106	49.9–51.6	Qbt 3	0550-95-0058	1.39
50-09106	60.8–62.6	Qbt 3	0550-95-0063	0.78
50-09106	72.1–73.5	Qbt 3	0550-95-0067	0.74
50-09106	81.7–83.4	Qbt 3	0550-95-0071	0.44
50-09107	9.9–11.2	Qbt 3	0550-95-0166	5.50
50-09107	25.5–27.6	Qbt 3	0550-95-0171	3.90
50-09107	40.3–41.7	Qbt 3	0550-95-0176	5.00
50-09107	53–55.6	Qbt 3	0550-95-0181	5.80
50-09107	67.2–68.6	Qbt 3	0550-95-0186	6.30
50-09107	76.4–78.5	Qbt 3	0550-95-0191	4.90
50-09107	33.2–34.3	Qbt 3	0550-96-0107	NR
50-09107	46.8–47.4	Qbt 3	0550-96-0108	NR
50-09108	10.6–11.9	Qbt 3	0550-95-0195	5.50
50-09108	26.2–27.3	Qbt 3	0550-95-0200	6.70
50-09108	40.3–41.7	Qbt 3	0550-95-0205	3.80
50-09108	54.2–55.6	Qbt 3	0550-95-0210	4.70
50-09108	67.5–68.9	Qbt 3	0550-95-0215	5.85
50-09108	79.2–81.3	Qbt 3	0550-95-0220	6.04
50-09108	17.3–18	Qbt 3	0550-96-0109	NR
50-09108	31.7–32.5	Qbt 3	0550-96-0110	NR
50-09109	12.9–14.3	Qbt 3	0550-95-0226	6.09
50-09109	24.1–25.5	Qbt 3	0550-95-0231	6.23
50-09109	40.9–42.4	Qbt 3	0550-95-0236	5.34
50-09109	79.9–81.1	Qbt 3	0550-95-0241	6.18
50-09109	54.7–56.4	Qbt 3	0550-95-0246	4.26
50-09109	62.6–62.8	Qbt 3	0550-95-0251	3.63
50-09109	32.5–33.2	Qbt 3	0550-96-0111	NR
50-09109	46.7–47.4	Qbt 3	0550-96-0112	NR
50-09110	16–17.9	Qbt 3	0550-95-0259	5.90

Table B-26 (continued)

Location ID	Depth (ft bgs)	Media	Sample ID	Percent Moisture
50-09110	35.7–37.6	Qbt 3	0550-95-0264	5.50
50-09110	55.4–57.1	Qbt 3	0550-95-0269	8.00
50-09110	69.5–72	Qbt 3	0550-95-0274	4.90
50-09110	82.7–84	Qbt 3	0550-95-0279	5.00
50-09110	22.6–23.3	Qbt 3	0550-96-0113	NR
50-09110	45.6–46.5	Qbt 3	0550-96-0114	NR

*NR = Not reported.

Appendix C

MDA C Borehole Logs

APPENDIX C BOREHOLE LOGS

This appendix presents logs of the boreholes drilled at Material Disposal Area C. Footages on the logs are length along each borehole.

Abbreviations and explanations

Bearing = direction

dk. = dark

Dedination =
borehole angle
from horizontal

Fe = iron

FeOx = iron oxide

lt. = light

MDA = material
disposal area

med. = medium

MnO₂ = man-
ganese oxide

MRAL = Mobile
Radiological
Analysis
Laboratory

CJ = operable unit

SAA = same as
above

TA = technical
area

TD = total depth
(end of borehole)

wk. = weak

Lithologic Symbols Explanation	Graphic Log	Lithologic Unit
RLL, organic topsoil and reworked tuff as clay, silt, sand, gravel		
TUFF, devitrified, slightly- welded		See Figure 2.2-1 Stratigraphic Column of MDA C, TA-50
TUFF, devitrified, non-welded		
Phenocryst- rich interval		
TUFF, vitric, non- welded		
Pumice BED		

**LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROJECT
FIELD UNIT 5
BOREHOLE LOG**

BOREHOLE ID: 50-9100 TA/OU: 50/1147 MDA: MDA C Page: 1 of 3
 Drilling Co.: Tonto Environmental Core Box #(s) 9 cuttings Start Date: 7/17/95 End Date: 2/5/96
 Drilling Inc. 32 core Time: 10:30 Time: 15:00
 Drilling Equip./ Method: Ingersoll-Rand track mounted air core with total dust suppression Sampling Method: Continuous 5.0" core barrel
 Driller: Larry Thoren Geologist: Jon Marin, Rene Evans Declination: 90.0° Bearing: NA TD: 316.0 ft
 ERM/Golder

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAI Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
0	1/100%		0	0-10 surface cuttings in 9 boxes	0-5.0'				Borehole 50-9100 is located approximately 15.0' north of Pit 5 in the noncentral portion of MDA C.
10	2/92%	95-0362	1.93	1/0-6.2'-80.0'	5.0'-21.3'				
20	3/57%		11.32	2/12.2'-29.0'	@ 16.5'				
30	5/16%	95-0363	14.73	3/29.0'-37.3'	21.3'-47.5'				
40	7/100%	96-0100	15.69	4/37.3'-53.5'					
50	8/90%	95-0364	10.69	5/53.5'-65.0'	47.5'-71.5'				
60	9/40%		11.41	6/65.0'-78.0'	@ 52.5'				
70	10/40%	95-0371	0	7/78.0'-95.0'	71.5'-88.0'				
80	11/100%	95-0374	0.56	8/95.0'-101.0'					
90	12/70%		0	9/101.0'-110.4'	88.0'-108.5'				
100	13/78%		0.61	10/110.9'-120.0'					
110	14/88%		0.61		108.5'-150.0'				
120	15/33%		0						
	16/84%		0						
	17/40%		0						
	18/0%		0.58						
	19/0%		0.48						
	20/100%		0						
	21/100%		0						
	22/100%		0						
	23/100%		0						
	24/0%		0						
	25/100%		0						
	26/100%		0						
	27/83%		0						
	28/82%		0.05						
	29/100%		0.1						

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROJECT
FIELD UNIT 5
BOREHOLE LOG

BOREHOLE ID: 50-9100		TA/OU: 50/1147	MDA: MDA C	Page: 2 of: 3
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 9 cuttings 32 core	Start Date: 7/17/95 Time: 10:30	End Date: 2/5/96 Time: 15:00
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression			Sampling Method: Continuous 5.0' core barrel	
Driller: Larry Thoren	Geologist: Jon Marin, Rene Evans ERIW Golder		Declination: 90.0°	Bearing: NA TD: 316.0 ft

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
120	30/100%			11/120.0' -128.9'	108.5'-150.0' TUFF, SAA, moderately indurated to strongly indurated, pumice lapilli are lt. gray, indistinct. <0.5-1.0 cm. <5% finely devitrified with minute quartz and sanidine.				① 134.5'. First appearance of lt. pink fibrous vapor phase alteration clay.
130	31/94%		1.2	12/128.9' -137.5'					
140	32/100%		0	13/137.5' -146.1'	① 140.0'				
150	33/96%		0	14/146.1' -155.0'	150.0'-180.0' TUFF, SAA, matrix quartz and sanidine are 20% each, quartz up to 3.0 mm, sandine shows Schiller blue iridescence.		Unit 2, Tshirege Member		① 140.0-150.0'. phenocryst-rich interval is possible surge related deposit.
160	34/100%		0	15/155.0' -170.0'					
170	35/100%	95-0392	0.35	16/170.0' -178.0'					
180	36/100%		0.37	17/178.0' -185.8'	180.0'-223.0' lithics up to 3.0 cm, pumice lapilli and lithics are rimmed by lt. pink fibrous vapor phase alteration clay, also along relict tube structures.				
190	37/88%		0.55	18/185.8' -198.0'					
200	38/62%		0	19/198.0' -205.0'	① 200.0'				
210	39/20%		0.91	20/205.0' -210.0'					
220	40/100%		0	21/210.0' -216.0'					
230	41/100%		0.45	22/216.0' -223.2'					
240	42/100%		0.52	23/223.2' -231.9'	223.0'-233.0' TUFF, grayish orange pink 5 YR 7/2, moderately indurated, nonwelded, ash flow, dry.		Unit 1v(u), Tshirege Member, Bandelier Tuff		
	43/32%		0.76	24/231.9' -240.1'	233.0'-313.0' Pumice lapilli are Fe-rich; lithics are basalt and dacite, angular, 4% up to 2.5 cm.				
	44/100%		0						
	45/100%		0.45						
	46/100%		0.65						
	47/100%		0.52						
	48/100%		0.27						
	49/100%		0.91						
	50/100%		18.23						
	51/100%		0.51						
	52/100%		0.78						
	53/100%		0.79						
	54/100%		0.28						
	55/100%		0.32						

BOREHOLE ID: 50-9101		TA/OU: 50/1147		MDA: MDAC		Page: 1 of: 2	
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 5 cuttings 11 core		Start Date: 9/20/95 Time: 08:15		End Date: 9/22/95 Time: 10:30	
Drilling Equip./ Method: Ingersoll-Rand track mounted air core with total dust suppression				Sampling Method: Continuous 5.0' core barrel			
Driller: Larry Thoren		Geologist: Jon Marin, Rene Evans EPM/Golder		Declination: 45.0°		Bearing: S 82.0° W TD: 117.0 ft	

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
0	1/100%			0-8' surface cuttings in 5 boxes	0-6.0'	TOPSOIL/FILL, clay, silt and sand, red brown, moist.		NA	Borehole 50- 9101 is located approximately 10.0' north of and midway along MDA C and angled beneath Plt 6. Surface casing set at 10.0'.
5	2/100%				6.0'-81.0'	TUFF, pale red 10 R 6/2, moderately indurated, slightly welded, devitrified, oxidized, rhyolite ash flow, moist. Pumice lapilli are light gray to dark brown, 0.2-4.0 cm, 15%. Phenocrysts in matrix are quartz (5%) and sanidine (10%), average 1.0 mm, sanidine with Schiller blue iridescence. Lithics are rare.			
10	3/100%		1.18	1/5.4'- 13.9'					
15	4/100%		1.46						
20	5/100%	95-0284	0.73	2/13.9'- 23.3'					
25	6/100%		3.29						
30	7/83%								
35	8/100%		0.45	3/23.3'- 31.3'					
40	9/100%	95-0101	0.12						
45	10/94%		1.01						
50	11/48%	95-0289	0.95	4/31.3'- 42.0'					
55	12/40%		0.42						
60	13/67%		0.66		40.0'	Tuff, same as above (SAA), oxidized, moderately indurated ash flow, moist.			
65	14/80%		1.19	5/42.0'- 50.0'					
70	15/85%	95-0102	0.27						
75	16/73%								
80	17/78%		1.91	6/50.0'- 60.0'					
85	18/100%	95-0294	1.11						
90	19/60%								

BOREHOLE ID: 50-9101		TA/OU: 50/1147	MDA: MDAC	Page: 2 of 2
Drilling Co.: Tonto Environmental Drilling Inc.	Core Box #(s): 5 cuttings 11 core	Start Date: 9/20/95 Time: 08:15	End Date: 9/22/95 Time: 10:30	
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression		Sampling Method: Continuous 5.0' core barrel		
Driller: Larry Thoren	Geologist: Jon Marin, Rene Evans EPM/Golder	Declination: 45.0°	Bearing: S 82.0° W TD: 117.0 ft	

November 2003

LOS ALAMOS NATIONAL LABORATORY ENVIRONMENTAL RESTORATION PROJECT FIELD UNIT 5 BOREHOLE LOG									
BOREHOLE ID: 50-9102		TA/OU: 50/1147		MDA: MDA C		Page: 1 of 2			
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 7 cuttings 9 core		Start Date: 8/2/95 Time: 08:30		End Date: 8/8/95 Time: 14:30			
Drilling Equip./ Method: Ingersoll-Rand track mounted air core with total dust suppression				Sampling Method: Continuous 5.0' core barrel					
Driller: Larry Thoren		Geologist: Jon Marin, Rene Evans BPM/Golder		Declination: 45.0°		Bearing: S 10.0° W TD: 110.0 ft			
Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
0	1/100%			0-9' surface outtings in 5 boxes	0-3.5' TOPSOIL/FILL, organic clay, silt, sand, dark brown, moist.			NA	Borehole 50-3102 is located approximately 25.0' north of and angled beneath Pit 5. Surface casing set at 9.0'. @ 36.0'-38.0', Light orange brown clay fracture coatings (sampled) and black glassy fragments. In addition, moderate Fe oxide (limonite) stain in matrix.
5			12.24		3.5'-5.0' TUFF, weathered, moist.				
10	2/25%		32.99		5.0'-31.0' TUFF, pale red 10 R 6/2 slightly indurated, slightly welded, rhyolite ash flow, dry. Pumice lapilli are light gray, coarsely devitrified, sugary texture, 0.3-2.5 cm, 10%. Matrix phenocrysts are quartz and sanidine, each 5% and up to 1.5 mm.				
15	3/100%		1.13	1/8.0'-24.0'					
20	4/80%	95-0004	0.55						
25	5/90%		0.48		@ 22.0' TUFF, same as above (SAA), pumice lapilli are 15% and up to 3.0 cm.				
30	6/30%		0.38	2/24.0'-36.0'					
35	7/90%		1.6		31.0'-62.0' TUFF, pale red brown 10 R 5/4, slightly indurated to moderately indurated ash flow, moist. Pumice lapilli are gray to white, coarsely devitrified, 0.5-3.5 cm, 5-10%, with quartz phenocrysts to 0.03 mm, fine-grained moderate-red iron crystals (goethite), and minute anhedral black magnetite crystals. Matrix phenocrysts are sanidine showing Schaller blue iridescence and bipyramidal quartz, each 5-10% and up to 1.0 mm.				
40	8/100%	95-0009	1.4	3/36.0'-47.0'					
45	9/55%		1.97						
50	10/46%		84.83 225.35	4/47.0'-55.3'					
55	11/100%								
60	12/100%								
	13/100%								
	14/100%	95-0014	14.02	5/55.3'-68.0'					

BOREHOLE ID: 50-9102		TA/OU: 50/1147		MDA: MDAC		Page: 2 of: 2	
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 7 cuttings 9 core		Start Date: 8/2/95 Time: 08:30		End Date: 8/8/95 Time: 14:30	
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression				Sampling Method: Continuous 5.0' core barrel			
Driller: Larry Thoren		Geologist: Jon Marin, Rene Evans ERW/Golder		Declination: 45.0°		Bearing: S 10.0° W TD: 110.0 ft	

[illegible]

BOREHOLE ID: 50-9103		TA/OU: 50/1147		MDA: MDAC		Page: 1 of: 2	
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 6 cuttings 10 core		Start Date: 8/10/95 Time: 12:00		End Date: 8/22/95 Time: 12:30	
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression				Sampling Method: Continuous 5.0' core barrel			
Driller: Larry Thoren		Geologist: Jon Marin, Rene Evans EBM/Colder		Declination: 45.0°		Bearing: N 32.0° W TD: 120.0 ft	

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
0	1/100%			0-8' Surface cuttings in 6 boxes	0-0.5' 0.5'-7.0'	TORSOL, organic. FILL, medium brown. reworked tuff, moist.		NA	Borehole 50- 9103 is located approximately 45.0' east of Pt 1 in the southeastern corner of MDA Cand angled beneath the ramp to Pit 3. Surface casing set at 9.0'. © 11.3'-11.9', clay-filled fracture. © 18.7', weak oxidation on open hairline fracture.
5									
10	2/50%			1/6.0'- 15.0'	7.0'-52.0'	TUFF, grayish orange pink 5 YR 7/2 to pale yellowish brown 10 YR 6/2, moderately oxidized, weathered rhyolite ash flow.			
15	3/70%								
20	4/65%								
25	5/100%			2/15.0'- 27.2'	© 12.0'	TUFF, grayish pink 5 YR 8/1, slightly indurated, non- welded, rhyolite ash flow, dry. Pumice lapilli are coarsely devitrified with sugary texture along relict tube structures. 0.5-2.0 cm, 5-10%.			
30	6/100%	95-0104	0.21			TUFF, same as above (SAA), nonindurated.			
35	7/100%			3/27.2'- 39.0'	© 24.0'				
40	8/90%								
45	9/83%								
50	10/90%								
55	11/75%								
60	12/100%		0.15		© 32.0'	TUFF, SAA, pinkish gray 5 YR 8/1.			
65	13/100%	95-0109	5.34		© 36.0'	TUFF, SAA, slightly indurated.			
70	14/98%			4/39.0'- 47.5'	© 42.0'	TUFF, SAA, pumice lapilli up to 2.0 cm, coarsely devitrified with sugary texture.			
75	15/94%	95-0104	0.33						
80	16/68%								
85	17/60%		0.11						
90	18/93%			5/47.5'- 59.5'					
95	19/100%	95-0114	0.84						
100			2.17		52.0'-83.0'	TUFF, grayish orange pink 5 YR 7/2, slightly oxidized matrix, moderately indurated, moderately welded rhyolite ash flow, dry to locally moist. Pumice lapilli are elongate 0.2 by 1.0 cm, 5-10%. Matrix phenocrysts are subhedral quartz (5%) up to 2.0 mm.			© 45.1'-45.3', moderately oxidized tuff. © 56.0'-59.0', strongly oxidized moist tuff and Fe-rich clay in open fracture (sampled).

**LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROJECT
FIELD UNIT 5
BOREHOLE LOG**

BOREHOLE ID: 50-9103 TA/OU: 50/1147 MDA: MDA C Page: 2 of 2
 Drilling Co.: Tonto Environmental Drilling Inc. Core Box #(s) 6 cut tings 10 core Start Date: 8/10/95 End Date: 8/22/95
 Time: 12:00 Time: 12:30
 Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression Sampling Method: Continuous 5.0' core barrel
 Driller: Larry Thoren Geologist: Jon Marin, Rene Evans Declination: 45.0° Bearing: N 32.0° W TD: 120.0 ft
 EPW/Golder

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
60	19/Cont.				52.0'-83.0' (continued)			NA	@ 59.0'-64.0', local oxidation patches on fracture fill.
65	20/23%		0.54	6/59.5'-70.2'					@ 67.0'-69.0', oxidized pumice lapilli remnants.
70	21/85%								@ 69.0'-73.0', Fe oxidation in matrix.
75	22/100%		0.87						
80	23/50%			@ 73.0'					
85	24/100%	95-0119	0	7/70.2'-85.1'					
90	25/50%		0.67						
95	26/67%								
100	27/100%		1.03		83.0'-120.0'				@ 86.0'-91.0', Fe oxidation throughout matrix.
105	28/100%								@ 88.5', Fe oxide stain is possible relict water mark.
110	29/100%			8/85.1'-94.3'					
115	30/37%		0.62						
120	31/100%								
	32/20%		0.85						
	33/100%	95-0124							
	34/100%		1.89	9/94.3'-106.0'					
	35/100%		0.82						
	36/100%								
	37/93%		0.43	10/106.0'-120.0'					
	38/78%	95-0129	0.53						@ 119.0'-120.0', fracture with some clay and Fe oxide.
	39/100%		0	@ 105.0'					
				TD = 120.0'					

BOREHOLE ID: 50-9104		TA/OU: 50/1147	MDA: MDAC	Page: 1 of: 2
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 7 cuttings 8 core	Start Date: 8/15/95 Time: 16:15	End Date: 8/17/95 Time: 09:00
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression			Sampling Method: Continuous 5.0' core barrel	
Driller: Larry Thoren	Geologist: Jon Marin, Rene Evans ERM/Golder	Declination: 90.0°	Bearing: NA	TD: 90.0 ft

ER2003-0696

BOREHOLE ID: 50-9105		TA/OU: 50/1147	MDA: MDAC	Page: 1 of 2
Drilling Co.: Tonto Environmental Drilling Inc.	Core Box #(s) 4 cuttings 11 core	Start Date: 8/23/95 Time: 10:45	End Date: 8/28/95 Time: 11:25	
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression		Sampling Method: Continuous 5.0' core barrel		
Driller: Larry Thoren	Geologist: Jon Mann, Rene Evans EFM/Golder	Declination: 45.0°	Bearing: S 86.0° E	TD: 120.0 ft

ER2003-0696

BOREHOLE ID: 50-9106		TA/OU: 50/1147	MDA: MDAC	Page: 1 of 2
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box # (s) 3 cuttings 10 core	Start Date: 8/9/95 Time: 16:45	End Date: 8/15/95 Time: 14:00
Drilling Equip./ Method: Ingersoll-Rand track mounted air core with total dust suppression			Sampling Method: Continuous 5.0' core barrel	
Driller: Larry Thoren	Geologist: Jon Mann, Rene Evans FRM/Golder	Declination: 45.0°	Bearing: S 75.0° E	TD: 120.0 ft

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
0	1/100%			0-7' surface outings in 3 boxes	0-0.7' 3.7'-5.0'	SOIL, organic, silty, sand, clay. ALL medium brown, reworked tuff, moist.		NA	Borehole 50- 9106 is located approximately 50.0' east of Pit 4 in the central portion of MOA Cand angled beneath vertical disposal shafts and the former ramp at the east end of Pit 4. Surface casing set at 8.0'. @ 11.0'-41.0', poor and inconsistent recovery due to fractured tuff and poor air circulation. @ 28.0'-29.0', phenocryst-rich aggregate is possible surge- related deposit.
5	2/50%		6.05	5.0'-7.0'	TUFF, pulverized, moist.				
10	3/24%		0.81	7.0'-51.5'	TUFF, pale red 5 R 6/2, rhyolite ash flow, nonindurated, dry to slightly moist. Pumice lapilli are relict pits in core. 15%, 1.0-2.0 cm. Core moisture impacts recovery by clogging the circulation hose.				
15	4/0%								
20	5/0%								
25	6/17%		1.25	@ 22.0'	TUFF, same as above (SAA), iron oxide on fracture with some clay.				
30	7/15%	95-0046	6.39	@ 28.0'	PHENOCRYST AGGREGATE, 50% in tuff matrix, light brownish gray 5 YR 6/1 elongate pieces (1.0-4.0 cm) of cemented quartz and sanidine crystals (0.5-1.5 mm).				
35	8/0%		17.97	@ 29.0'	TUFF, SAA, 30% phenocrysts.				
40	9/100%		428.59	2/28.5'- 38.0'					
45	10/90%								
50	11/100%	95-0050	1688.41	3/38.0'- 49.0'					
55	12/50%								
60	13/67%								
65	14/0%								
70	18/100%	95-0054	1396.36	@ 48.0'	TUFF, SAA, light brownish gray 5 YR 6/1, nonindurated, non- welded, rhyolite ash flow, dry.				
75	19/100%								
80	20/100%								
85	21/100%								
90	22/50%								
95	23/100%								
100	24/70%		260.21	4/49.0'- 56.5'	TUFF, pinkish gray 5 YR 8/1, slightly indurated, slightly welded, rhyolite ash flow, dry. Pumice lapilli are elongate up to 1.0 by 5.0 cm, light brown to very light gray, coarsely devitrified, with some Fe oxide				
105	25/100%								
110	26/100%								
115	27/93%		27.29	5/56.5'- 65.3'					
120	28/97%								

Page: 2 of: 2

End Date: 8/15/95
Time: 14:00

Sampling Method: Continuous 5.0' core barrel

Bearing: S 75.0° E TD: 120.0 ft

November 2003

Driller: Larry Thoren Geologist: Jon Marin, Rene Evans
ERM/Golder Declination: 45.0° Bearing: N 4.0° W TD: 118.0 ft

ER2003-0696

**LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROJECT
FIELD UNIT 5
BOREHOLE LOG**

BOREHOLE ID: 50-9108 TA/OU: 50/1147 MDA: MDA C Page: 1 of: 2
 Drilling Co.: Tonto Environmental Core Box #(s) 4 cuttings Start Date: 8/30/95 End Date: 9/6/95
 Drilling Inc. 11 core Time: 16:00 Time: 9:00
 Drilling Equip./Method: Ingersoll-Rand track mounted air Sampling Method: Continuous 5.0' core barrel
 core with total dust suppression
 Driller: Larry Thoren Geologist: Rene Evans, Jon Marin Declination: 45.0° Bearing: N 40.0° E TD: 120.0 ft
 ERM/Golder

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
0	1/100%			0-7.5 surface cuttings in 4 boxes	0-1.0' SOIL, brown, organic, silt, clay. 1.0'-7.5' FILL, reworked fine to coarse tuff, moderate brown to pale gray orange pink 5 YR 7/2, moist.			NA	Borehole 50-9108 is located approximately 25.0' south of the Chemical Pit in the western controlled portion of MDA C and angled beneath the Chemical Pit and Pit 6. Surface casing set at 7.5'.
5	2/80%		1.21	1/6.0 - 14.5'	7.5'-41.0' TUFF, grayish pink orange 5 YR 7/2, nonindurated to slightly indurated, slightly welded to moderately welded rhyolite ash flow, dry. Pumice lapilli are devitrified, gray, <1-5%, 0.3-1.0 cm. Phenocrysts are quartz and sandine, 10-20%, 1.0 mm.				⑧ 8.1'-8.8' and 14.0'-14.5', red stained (moderately oxidized) tuff matrix.
10	3/88%		0						
15	4/80%	95-0195	0.68						
20	5/75%			2/14.5 - 26.0'					
25	6/75%	95-0109	2.14		⑩ 14.5' TUFF, same as above (SAA), very light gray N8 to light to moderate brown 5 YR 5/6 to 5 YR 4/4, slightly welded, weakly oxidized with iron (Fe) oxide splotches in matrix.				
30	7/70%		1.6	3/26.0 - 39.5'					
35	8/40%		1.99		⑩ 31.0' TUFF, SAA, pale light brown gray 5 YR 6/1.				
40	9/100%	95-0200	0.52		⑩ 36.0' TUFF, SAA, pale to moderate brown 5 YR 5/2 to 5 YR 4/4				⑩ 36.0', possible weak oxidation stain.
45	10/88%				⑩ 39.5' TUFF, SAA, pale gray to light brownish gray 5 YR 6/1.				⑩ 40.0'-40.5', brown FeOx stain.
50	11/57%		0.48	4/39.5 - 48.8'	41.0'-95.5' TUFF, light brownish gray 5 YR 6/1, moderately indurated, moderately welded, rhyolite ash flow, dry. Pumice lapilli are 2-5%, white to pale gray, devitrified with remnant tube structures. Matrix phenocrysts are quartz and sandine, 20-30% total. Local rubbly, less-indurated intervals, 0.5-1.0 ft thick.		Unit 3, Tshirege Member, Bandelier Tuff		
55	12/85%	95-0110	1.25						
60	13/88%		1.01	5/48.8 - 59.0'					
	14/100%		1.52						
	15/96%	95-0205	0.96	6/59.0 - 67.3'					

BOREHOLE ID: 50-9109		TA/OU: 50/1147	MDA: MDAC	Page: 1 of: 2
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 5 cuttings 12 core	Start Date: 9/11/95 Time: 14:45	End Date: 9/14/95 Time: 17:30
Drilling Equip./ Method: Ingersoll-Rand track mounted air core with total dust suppression			Sampling Method: Continuous 5.0' core barrel	
Driller: Larry Thoren	Geologist: Rene Evans, Jon Marin ERM/Golder	Declination: 45.0°	Bearing: N 84.0° E	TD: 120.0 R

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
0	1-100%			0-8.0' surface cuttings in 5 boxes	0-0.5' SOIL dark brown, organic, sat. clay. 0.5'-17.5' ALL reworked tuff, clay, silt, sand, fine to coarse, dark brown to red brown, moist.			NA	Borehole 50-9109 is located approximately 35.0' within the most western corner of MDA C and angled beneath Pit 6. Surface casing set at 8.0'.
5	2-100% 3-100%		0						
10	4-40% 5-100%		0.04 0.63	1/6.9'- 15.5'					
15	6-50% 7-10%								
20	8-65% 9-75%	95-0226	0	2/15.5'- 26.5'	17.5'-42.0' TUFF, light brown gray 5 YR 6/1 to grayish orange pink 5 YR 7/2, slightly indurated, slightly welded to moderately welded, rhyolite ash flow, dry. Pumice lapilli are 10%, white, devitrified, and powdery. Phenocrysts are quartz and sanidine, 20-25% total. Lithics absent. Local areas (spotches and streaks) of weak iron oxide in matrix.				
25	10-68% 11-60%		0 4.51						
30	12-100% 13-100%		0	3/26.5'- 38.6'					
35	14-100%	95-0231	0.21 0.64						
40	15-100% 16-100%			4/36.5'- 44.9'	TUFF, grayish orange pink 5 YR 7/2, slightly indurated, slightly welded to moderately welded, rhyolite ash flow, dry. Intermediate composition lava (dacite) lithics are 2%, 2.0 by 2.0 cm and moderate iron oxide spotches in matrix.				
45	17-85% 18-70%		0.09						
50	19-70% 20-90%	96-0111	0.89 0.32	5/44.9'- 53.1'					
55	21-87% 22-50%		0	6/53.1'- 63.9'	PHENOCRYSTS, 40-45%, quartz and sanidine in tuff matrix. TUFF, SAA.				
60	23-20% 23-100%	95-0236	0						

Unit 3, Tshirege Member, Bandelier Tuff

BOREHOLE ID: 50-9109		TA/OU: 50/1147	MDA: MDA C	Page: 2 of: 2
Drilling Co.: Tonto Environmental Drilling Inc.	Core Box #(s) 5 cuttings 12 core	Start Date: 9/11/95 Time: 14:45	End Date: 9/14/95 Time: 17:30	
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression		Sampling Method: Continuous 5.0' core barrel		
Driller: Larry Thoren	Geologist: Rene Evans, Jon Marin ERM/Golder	Declination: 45.0°	Bearing: N 84.0° E	TD: 120.0 ft

Depth (feet)	Core Run # Core Recovery %	Analytical Sample Number 0550-	MRAL Screening Tritium (pCi/g)	Core Box # From - To (feet)	Lithology	Graphic Log	Lithologic Unit	Monitor Well Construction	Notes
60	25/75%		0.98	6/53.1'- 63.9' Cont.	42.0'-102.5' (continued)			NA	
65	26/100%		0.86						
	27/100%		1.35	7/63.9'- 71.7'					● 65.5', installed casing due to lost air circulation.
	28/100%	96-0112	1.27						
70	29/77%				● 70.0'				
	30/100%		1.52	8/71.7'- 81.5'					● 75.5', open fracture, no clay, weak FeOx in 1.0-2.0 mm splotches.
75	31/94%		0.77						
		95-0246							
80	32/100%		0.71						
	33/100%		13.77	9/81.5'- 92.7'	● 91.0'				● 86.0'-86.4', clay with FeOx smeared on core.
85	34/48%		158.96						
90	35/100%		160.47	10/92.7'- 101.5'					● 98.0', clay content increasing to thick clay accumulation.
95	36/94%	95-0251							● 105.5', clay is solid, moderate brown to gray brown (5 YR 4/4 to 5 YR 3/2).
100	37/68%		41.32		102.5'-120.0'				
	38/100%		0	11/101.5'- 111.0'	● 106.0'				
105	39/0%		0.37						
	40/83%		0.2	12/111.0'- 120.0'	● 109.0'				
110	41/50%		0						
	42/57%	95-0247							
115	43/85%								
	44/25%								
120					TD = 120.0'				

Page: 1 of: 2

End Date: 9/18/95
Time: 15:00

Sampling Method: Continuous 5.0' core barrel

Bearing: S 67.0° E TD: 91.0 ft

ER2003-0696

BOREHOLE ID: 50-9110		TA/OU: 50/1147		MDA: MDA C		Page: 2 of: 2	
Drilling Co.: Tonto Environmental Drilling Inc.		Core Box #(s) 6 cuttings 7 core		Start Date: 9/15/95 Time: 12:30		End Date: 9/18/95 Time: 15:00	
Drilling Equip./Method: Ingersoll-Rand track mounted air core with total dust suppression				Sampling Method: Continuous 5.0' core barrel			
Driller: Larry Thoren		Geologist: Rene Evans, Jon Marin ERM/Golder		Declination: 70.0°		Bearing: S 67.0° E TD: 91.0 ft	

[illegible]

REFERENCE

Broxton, D. E., and S. L. Reneau, August 1995. "Stratigraphic Nomenclature of the Bandelier Tuff for the Environmental Restoration Project at Los Alamos National Laboratory," Los Alamos National Laboratory Report LA-13010-MS, Los Alamos, New Mexico. (Broxton and Reneau 1995, 49726)

Appendix D

*Statistical Analysis of Chemical Analytical Data
from Material Disposal Area C*

APPENDIX D STATISTICAL ANALYSIS OF CHEMICAL ANALYTICAL DATA FROM MATERIAL DISPOSAL AREA C

D-1.0 INTRODUCTION

This appendix presents detailed statistical evaluations that support Section B-2 by providing summary statistics, exploratory data analysis, and background comparisons. The statistical methods are described in Section D-2. The plots and evaluation results are presented in Section D-3. Separate subsections in D-3 present different environmental media, including surface soil and fill (D-3.1), subsurface tuff (D-3.2), and pore gas (D-3.3). Soil, fill, and tuff samples were analyzed for constituents including inorganic chemicals (metals and cyanide), radionuclides, and organic chemicals (volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], polychlorinated biphenyls [PCBs], and pesticides).

D-2.0 OVERVIEW OF STATISTICAL METHODS

A variety of statistical methods may be applied to each of the data sets. The method used depends on how appropriate it is for the available data.

D-2.1 Exploratory Data Analysis

Graphical analyses include bubble plots, box plots, and borehole profile plots. These analyses provide a visual representation of the data and determine the presence of outliers or other anomalous data that might affect statistical results and interpretations. The plots allow a visual comparison among concentration distributions. The differences of interest may include an overall shift in concentration (shift of central location) or, when the centers are nearly equal, a difference between the upper tails of the two distributions (elevated concentrations in a small fraction of one distribution). The plots may be used in conjunction with the statistical tests (distributional comparisons) described below. Unless otherwise noted, the nondetects are included in the plots at their reported detection limit (DL) or estimated quantitation limit (EQL).

Bubble plots. Bubble plots provide a spatial representation of the surface soil and fill data at MDA C. The circles, or bubbles, are different sizes based on concentrations, and these bubbles are plotted on a map of the site. The size of the bubble is directly proportional to the relative concentrations in the data set; in other words, relatively smaller concentrations are assigned smaller bubbles and the relatively larger concentrations are represented by larger bubbles. The legend of each figure gives the interpretation of the bubble size. Unless otherwise specified, the legend provides the minimum, median, and maximum for all of the data (both detected and nondetected concentrations). If the background value (BV) is between the minimum and maximum concentrations of the site data, the BV and a bubble proportional to the background value are also presented in the legend. For every location where a sample concentration for an inorganic chemical or radionuclide was reported, a bubble is plotted that is proportional to that concentration. For organic chemicals, only the detected concentrations are shown in the figure. The bubble plots are useful for identifying patterns of increased surface concentrations for a particular analyte across the site. The pit boundaries have been revised based on review of as-built drawings, geophysical surveys, and other sources of information. Therefore, the pit boundaries on the bubble plot figures may not be exactly the same as other figures in this document. However, the pit boundaries are similar enough to allow for general conclusions.

Box plots. A box plot consists of a box, a line across the box, whiskers (lines extended beyond the box and terminated with a short perpendicular line), and points outside the whiskers. The box area of the plot is the region between the 25th percentile and the 75th percentile of the data, the interquartile range or

middle half of the data. The horizontal line within the box represents the median (50th percentile) of the data. The whiskers give an interval of 1.5 times the interquartile range, outside of which data may be evaluated for their potential as outliers. Often, the concentrations are plotted as points overlaying the box plot. When a data set contains both detected concentrations and nondetected results reported as DLs, the detected concentrations are plotted as x's, and the nondetected results are plotted as o's.

Borehole Profile Plots. Borehole profile plots depict the concentration results by depth in boreholes. They are used to evaluate evidence of release from the disposal structure associated with a given borehole and to determine if the extent of any contamination has been bounded (decreasing trend). The filled shapes (i.e., circles) represent detects and the open shapes represent nondetects. A dotted line in the figure represents the BV. The solid lines on the right side of the plot labeled with shafts or pit numbers indicate which samples were collected beneath a shaft or a pit. These solid lines represent the approximate location of the pit or shaft above each borehole. Because pit boundaries were revised according to as-built drawings, geophysical surveys, and other sources of information, these representations are as accurate as possible.

D-2.2 Distributional Comparisons

Comparisons between data sets that might represent different concentration distributions, such as site-specific data and Los Alamos National Laboratory (LANL or the Laboratory) background data, are performed using a variety of statistical methods. For background comparisons, the first step is to compare the site data with a BV. A BV may be an estimated value for the background data set (upper tolerance limit [95, 95] or the 95% upper confidence bound on the 95th quartile), a detection limit, a fallout value, a minimum detectable activity (MDA), or it may be calculated based on secular equilibrium or a total analysis. The term "background value" will be used in the text to represent any of these values. The upper tolerance limit (UTL) comparisons are followed, when appropriate, by statistical tests that evaluate potential differences between the distributions. These tests are used for testing hypotheses about data from two potentially different distributions, for example, a test of the hypothesis that site concentrations are elevated above background levels. Nonparametric tests that are most commonly performed include the two-sample Wilcoxon Rank Sum test (Wilcoxon test), the Gehan test (modification of the Wilcoxon test), and the quantile test (Gehan 1965, 55611; Gilbert and Simpson 1990, 55612). The Gehan test is best suited for assessing complete shifts in distributions. This test accounts for nondetects at multiple DLs in a statistically robust manner. If nondetects are absent in the data, the Gehan test is equivalent to the Wilcoxon test. The quantile test is better suited for assessing shifts of a subset of the data¹. Between the two tests (Gehan and quantile), most differences between distributions can be identified.

Occasionally, if the differences between two distributions appear to occur far into the tails, the slippage test might be performed to evaluate the potential for some of the site data to be greater than the maximum BV if, in fact, the site data and background data came from the same distribution. If the data reasonably satisfy normality assumptions, as demonstrated with the exploratory data analysis², and there are relatively few nondetects, then a parametric t-test can be used to compare two distributions. Observed significance levels (p-values) are obtained from the Gehan, quantile, slippage, and/or t-tests. If a p-value is much less than a specified probability, that is, 0.05 (a nominal significance level), then there

¹ The quantile test is performed at a specified quantile level, usually 80%. This threshold is established to determine if the relative proportion of the two populations being tested is different in the top 20% of the data than it is in the remainder of the data. If this difference is recognized, then there is reason to believe that the distributions are partially shifted because of different tail effects. However, this shift implies that the test cannot be performed if more than 80% (or the threshold percentage) of the combined data are nondetects.

² Formal tests for normality might also be performed, such as the Kolmogorov-Smirnov test (Gilbert 1987, 56179).

is some reason to suspect that differences exist between the distributions. If the p-value is much greater than 0.05, no difference is indicated. If the p-value is close to 0.05, then the need for further evaluation is indicated. In particular, when many tests are performed on the same set of data, there is an increased possibility of observing a p-value of less than 0.05 by random chance alone. Adjustments to the nominal significance level can be considered using methods described in Box et al. (1978, 56653, pp. 203–207) and Keppel (1982, 56652, pp. 145–165).

The standard set of tests is run whenever the detection rate for both material disposal area (MDA) C and Laboratory background is greater than 50%; if there are fewer than 50% in either set, then the Gehan test is not applicable.

D-3.0 STATISTICAL RESULTS

MDA C Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) data include surface soil or fill samples from 190 locations, subsurface tuff samples from 11 borehole locations, surface-flux samples from 101 locations, and pore-gas samples from 2 boreholes. The locations of the disposal shafts and the sampling locations are shown in Figures B-3 and B-9.

D-3.1 Surface Soil and Fill Sample Results

Surface soil and fill samples at MDA C were collected from a 60- by 60-ft grid laid out across and beyond MDA C. A total of 203 soil samples were collected from the 0–6 in. interval at nodes of the 60- by 60-ft grid. As shown on Figure B-3, sampling density was highest in the northeast corner of MDA C. Samples were screened for gross alpha, beta, and gamma radiation; tritium; and soil moisture. The samples were analyzed as follows: 81 samples were analyzed for radionuclides (gamma-emitting radionuclides by gamma spectroscopy, tritium, uranium isotopes, plutonium isotopes, strontium-90, and americium-241); 68 samples were analyzed for SVOCs and inorganic chemicals; 193 samples were analyzed for pesticides/PCBs (59 samples were analyzed at a fixed laboratory and 134 samples were analyzed only in a mobile laboratory); and 9 samples were analyzed for VOCs.

D-3.1.1 Inorganic Chemicals

The surface soil and fill samples were analyzed for a limited list of target analyte list (TAL) metals. Although samples were identified as either soil or fill, they are grouped together for purposes of comparing the site data to BVs. Inorganic chemical concentrations were compared with Laboratory-wide BVs for all-soil horizon (ALLH) (LANL 1998, 59730). The frequency of detects greater than the BV of the inorganic chemicals in surface soil and fill is summarized in Table B-10.

Because these samples were analyzed only for a limited list of inorganic chemicals, the distribution of concentrations of the MDA C data (and DLs for nondetects) and the distribution of concentrations from the ALLH background data set for all analytes are presented in Figure D-1.

The figure shows that the distributions of concentrations for most inorganic chemicals are no larger than the distribution of background concentrations. For most analytes, there are no results above the Laboratory-wide soil BVs, and the distributions appear to be shifted lower than the Laboratory background distribution. The only exception, lead, is discussed below. Table D-1 shows the results of the statistical tests for all analytes.

The Gehan and quantile tests show a significant difference for mercury; however, the size of the sample set was much smaller for mercury. In addition, the results for all of the site data for mercury were

nondetects with a detection limit of 0.1 mg/kg, which is equal to the maximum of the mercury background data set of 0.1 mg/kg. Silver was reported with two detected values (the maximum was 6 mg/kg), but no data set is available for any further background tests. The distribution of lead concentrations in surface soil and fill at MDA C is elevated compared to the distribution of lead in the background data. This finding is further supported by the results of the Gehan and quantile tests where the p-values are less than 0.05 in both cases, indicating that a difference in the distributions exists. Figure D-2 shows the distribution of lead in the surface soil.

The highest concentrations of lead on the surface are in the surface soil along the southwest side of MDA C. The maximum concentration was detected in a sample that is not near any pits or shafts. In addition, the maximum concentration of lead is 30 mg/kg, which is only slightly elevated relative to a BV of 22.3 mg/kg. The box plot of the surface soil and fill data for lead compared to the background data for lead shows that the two distributions are almost identical. The higher concentrations in the soil samples along the southwest margin of MDA-C may reflect lead contamination associated with disposal activities that was covered when fill was applied in the 1984 interim action.

D-3.1.2 Radionuclides

The surface soil and fill samples were analyzed for radionuclides. Although samples were identified as either soil or fill, they are grouped together for purposes of comparing the site data to BVs. The term "background values" will be used in the text to refer to any background values, whether or not they are for fallout radionuclides. The detected radioactivity concentrations were compared with Laboratory background values (LANL 1998, 59730). Fallout radionuclides include americium-241, cesium-137, plutonium-238, plutonium-239, strontium-90, and tritium. Tritium data from surface soil and fill samples are not presented in this appendix since they are not used to support the evaluation of nature and extent of contamination. The frequency of detects greater than BV of the radionuclides in surface soil and fill is summarized in Table B-12.

Americium-241, plutonium-238, plutonium-239, thorium-232, and uranium-238 were detected above the all soil horizon BV in at least one sample. The BVs for thorium-232 and uranium-238 are surrogates from sediment data. The concentrations of these radionuclides in the Laboratory's background canyon sediment data set were measured using different analytical methods than the site soil samples at MDA C. Mesa-top soil and canyon sediment also may have different concentrations of these radionuclides resulting from differences in the parent material from which the soils and sediments are formed. Therefore, further statistical tests were not performed for thorium-232 and uranium-238. Background data sets were available for americium-241, plutonium-238, and plutonium-239 to perform further statistical tests. The results of the statistical tests are presented in Table D-2.

The distributions of americium-241, plutonium-238, and plutonium-239 are shown in Figures D-3 to D-5. The highest concentrations of americium-241, plutonium-238, and plutonium-239 are in the northeast corner of MDA C and along the eastern edge of MDA C. These are areas where the least amount, if any, fill material was applied and where run off into Ten Site Canyon occurs.

D-3.1.3 Organic Chemicals

The surface soil and fill samples were analyzed for pesticides, PCBs, and SVOCs. Nine samples were also analyzed for VOCs. Five organic chemicals were detected in these samples. The frequency of detects of the organic chemicals in surface soil and fill are summarized in Table B-14. Acenaphthene and pentachlorophenol were each detected in only one sample (fill and soil, respectively) on the south side of MDA C. Aroclor-1254, Aroclor-1260, and bis(2-ethylhexyl)phthalate were detected in fill samples.

As shown in Figure D-6, the highest detected concentration of Aroclor-1254 was 1 mg/kg on the northern boundary of Pit 2. The other two detected concentrations of 0.17 and 0.07 mg/kg were in the southeast corner of MDA C. By contrast, the four detected concentrations of Aroclor-1260 were all above Pit 6 in the northwest corner of MDA C. Figure D-7 shows the detected concentrations of Aroclor-1260 in the surface soil and fill samples. Bis(2-ethylhexyl)phthalate was detected twice in fill samples in the northwest portion of MDA C in the area of Pit 6 (see Figure D-8).

D-3.2 Subsurface Tuff

Two vertical boreholes and nine angled boreholes were drilled in the immediate vicinity of the inactive disposal shafts and seven pits (Figure B-9). From these boreholes, 82 core tuff samples were collected for fixed laboratory analyses, 79 from unit 3 Tshirege Member (Qbt 3), 2 from unit 2 Tshirege Member (Qbt 2) and 1 from the unit 1v Tshirege Member (Qbt 1v). The samples were analyzed for a full suite of TAL metals and cyanide, pesticides/PCBs, SVOCs, VOCs, americium-241, isotopic plutonium, isotopic thorium, isotopic uranium, strontium-90, tritium, and gamma-emitting radionuclides.

D-3.2.1 Inorganic Chemicals

Inorganic chemical results for samples collected from the Qbt 3 and Qbt 2 units were compared with the BVs for upper Qbt units (Qbt 2, Qbt 3, Qbt 4). Samples collected from the Qbt 1v unit were compared with Qbt 1v BVs (LANL 1998, 59730). The frequency of detects greater than BV of the inorganic chemicals in subsurface tuff is presented in Table B-20.

Statistical analysis (box plots and distribution shift tests) to determine whether a release may have occurred in tuff must be used in addition to other information because of the way these samples were collected and what they represent. Any individual tuff sample from beneath a pit or shaft field may potentially contain residual contamination related to localized infiltration of contaminants from the disposal unit. Therefore, while statistical analyses may be a useful part of data evaluation, it is also necessary to examine the data for evidence of one or more outliers in contaminant concentrations that may not be statistically significant but nevertheless could be indicative of a release.

All inorganic chemicals are presented in Figure D-9. These box plots show that the distribution of concentrations for most inorganic chemicals is similar to the distribution of background concentrations. The exceptions are antimony, lead, and selenium.

The sample data from all subsurface tuff samples collected in Qbt 3 and Qbt 2 were treated as a whole group, and statistical tests were run to identify whether or not any inorganic chemicals were elevated above background in the tuff. Table D-3 shows the results of the statistical tests for inorganic chemicals in Qbt 2 and Qbt 3.

As shown in the box plots, cyanide and mercury do not have a background data set for Qbt 2 and Qbt 3. Therefore, further statistical tests could not be performed for these two analytes. Cyanide and mercury data will be reviewed later in this section using other methods.

Although the DL for mercury in eleven tuff samples was slightly above the BV of 0.1 mg/kg, further evaluation of the results found that three samples collected from Qbt2 and Qbt1v had DLs of 0.05 mg/kg, which is less than the BV of 0.1 mg/kg. The eleven samples that were detected above the BV were reported with a DL of 0.11 mg/kg, which is equivalent to the BV of 0.1 mg/kg. The lack of detectable mercury slightly above or below the BV does not indicate a release from MDA C. Additional mercury data will be collected in proposed boreholes.

Cyanide was detected in eleven samples collected from Qbt3. There is no BV for cyanide in tuff, so detection status was used as a guide for further evaluation. The detected concentrations of cyanide ranged between 0.22 and 10.2 mg/kg (see Table B-21). Figure D-14 provides additional review of the cyanide data in the form of borehole concentration profiles. Cyanide was detected three times in borehole 50-09101 and five times in borehole 50-09104. Cyanide was also detected once in three additional boreholes: 50-09100, 50-09108, and 50-09110. As discussed in Section B-2.3, cyanide results were also rejected for sixteen samples (a maximum of two samples from nine different boreholes). Fifteen of these samples were collected from curated core; the cyanide data were rejected because holding times had been exceeded. Collection of additional cyanide data is specified in the proposed boreholes.

Four inorganic chemicals (antimony, selenium, silver, and thallium) were analyzed by two different analytical methods. The antimony background data was analyzed by inductively coupled plasma mass spectroscopy (ICPMS); however, the MDA C site data was analyzed by at least one other method inductively coupled plasma emission spectroscopy (ICPES). Many of the higher detection limits are the elevated values. Selenium site and background data were analyzed by graphite furnace atomic absorption. A subset of the site data was analyzed by flame atomic absorption and ICPES. Silver site and background data were also analyzed by ICPES, but a subset of the site data was also analyzed by other methods. Thallium, which is supposed to be analyzed by ICPMS to be comparable to the background data, was analyzed by at least two additional methods. Antimony and selenium were significantly above the BV based on the box plots. These two analytes have elevated DLs that make reviewing the data in this manner inappropriate. The DL problems resulted from differences in the methods used to analyze the samples. Because of the differences in analytical methods, statistical tests were not run for these analytes. Silver and thallium samples were also run by more than one method. The maximum detect of thallium was above the BV but not above the maximum of the background data set, so the statistical test supports the conclusion that thallium is similar to background. Silver was not above the BV in any subsurface tuff sample.

Figures D-10 to D-17 show the borehole profile or pattern of analytical concentrations by depth (below ground surface [bgs]) within individual boreholes for inorganic chemicals detected above the BV at least twice. Detected concentrations (filled circles) and DLs for nondetects (open circles) identify patterns that might be associated with a release. The BV for each tuff unit is shown for comparison to the analytical concentrations. The related pits and shafts are also shown for each borehole to show when higher concentrations of an analyte were detected directly beneath a pit or shaft.

D-3.2.2 Radionuclides

Borehole samples were analyzed for americium-241, isotopic plutonium, isotopic thorium, isotopic uranium, strontium-90, tritium, and radionuclides by gamma spectroscopy. The Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) did not evaluate all the radionuclides in the gamma spectroscopy suite. The full-suite analyte list, which is given in the RRES-RS analytical services statement of work (LANL 1995, 49738), includes the decay series of the naturally occurring radionuclides, uranium-235, uranium-238, and thorium-232, as well as fission and activation products and their progeny. Measurements of naturally occurring radionuclides known to be present in Laboratory soils provide an indication of the quality of the gamma spectroscopy analysis.

Actinium-228, barium-140, bismuth-212, neptunium-237, protactinium-231, protactinium-234, lead-210, lead-211, radium-223, radium-224, radium-226, and radon-219 are not reliably measured by gamma spectroscopy and are not evaluated. Of the radionuclides that are analyzed reliably by gamma spectroscopy, ten have half-lives of less than 365 days and are not considered further. Data for many of these short-lived radionuclides can be useful when evaluating parent radionuclide data because the

relative activity of parent and daughter isotopes is a known quantity. These data are used by the analytical laboratory as well as by RRES-RS during baseline validation. The naturally occurring radionuclide potassium-40 is present in Laboratory soils at concentrations ranging between 25 pCi/g and 40 pCi/g and is always present in the gamma spectrum of Laboratory soil samples. The potassium-40 gamma emission peak provides a qualitative indicator of the accuracy of the gamma spectroscopy measurement. Potassium-40 is not considered to be a potential historical contaminant at MDA C and is not evaluated further.

The gamma spectroscopy radionuclides that are evaluated in this report are those considered to be potential historical contaminants at Laboratory sites. They include naturally occurring uranium-235 and seven fission and activation products (americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, and sodium-22). Uranium-235 is compared with Laboratory-wide BVs for the appropriate tuff group (LANL 1998, 59730), and the other radionuclides are evaluated on the basis of detection status. The frequency of detects of the radionuclides in subsurface tuff is summarized in Table B-22.

Americium-241, plutonium-238, plutonium-239, sodium-22, strontium-90, and tritium were all detected in the subsurface tuff in more than two samples. Uranium-235 was detected above the appropriate BV in more than two subsurface samples. Cesium-134, cesium-137, cobalt-60, europium-152, and uranium-238 were detected once or twice in the subsurface tuff samples.

Tritium was detected in every borehole and in almost every sample. Figure D-18 shows the borehole profile for tritium in all of the boreholes at MDA C.

Because of the variability involved with calculating uncertainties and MDAs on a sample-specific basis, the radionuclide data must be considered carefully. In particular, uncertainty in the detect status of americium-241 in some samples may affect interpretation of the extent of americium-241 in tuff. Data were qualified as nondetects according to one of three reason codes. The result was considered to be a nondetect if the result was less than 3 multiplied by the uncertainty, if the result was less than the MDA, or if the blank showed evidence of contamination. In the case of americium-241 results being reported at concentrations less than the MDA, focused validation revealed that the MDA reported electronically in the database could not be verified by the hard-copy data package. This disparity raised the question of whether the result should be considered a detect because the result was greater than 3 multiplied by the uncertainty, but less than the MDA (where the MDA could not be verified). This uncertainty affected three results in borehole 50-09101. Because americium-241 may be present in these samples, the americium-241 profile plots in Figure D-19 reflect these three results as detects.

Plutonium-238 was detected in one borehole, and plutonium-239 was detected in two boreholes. Americium-241 was detected in both boreholes where plutonium-239 was detected although not at the same depths. Figure D-20 shows the borehole profiles for plutonium-239 data.

The only detects of uranium-235 above the BV were from the samples submitted for analysis in 1996. These samples were analyzed by ICPMS instead of alpha spectroscopy. ICPMS usually results in higher concentrations, so these concentrations probably do not indicate a release of uranium but rather a difference in analytical methods. Figure D-21 illustrates that all samples analyzed by ICPMS in 1996 not only have the higher results but also were from the same analytical laboratory.

D-3.2.3 Organic Chemicals

Tuff samples were analyzed for PCBs, pesticides, SVOCs, and VOCs. Only six organic chemicals were detected in one or more of the 54 core samples. Of these six organic chemicals, methylene chloride, 2-methylphenol, and toluene were detected only once at concentrations below the EQL. Acetone,

bis(2-ethylhexyl)phthalate, and 1,1-dichloroethene were each detected in a maximum of eight samples. Only acetone was detected above the EQL. The frequency of detects of the organic chemicals in subsurface tuff is summarized in Table B-24.

Figure D-22 illustrates where the detected concentrations of acetone were located at MDA C.

Bis(2-ethylhexyl)phthalate was detected once in boreholes 50-09103, 50-09105, 50-09108, and 50-09110 (see Figure D-23). Figure D-24 shows that 1,1-dichloroethene was detected only in borehole 50-09103 at four different depths below Pits 3 and 2.

D-3.3 VOCs in Pore-Gas Samples

Pore-gas data are available for borehole 50-09100 for five quarters between August 2000 and November 2001 and one additional quarter in January 2003. Pore-gas data are available from borehole 50-10131 from November 2001 and January 2003. Twenty-four VOCs were detected in these samples. A summary of the detected VOCs from all sampling in both boreholes is presented in Table D-4.

The sampling events that occurred between August 2000 and November 2001 resulted in two SUMMA canister samples collected at each sampling event with one exception. The sampling that took place for borehole 50-09100 on August 8, 2001, resulted in four SUMMA samples being sent to the analytical laboratory. So, in some cases, multiple results exist for the same depth although the samples were collected at different times and by different people. For some depths, no samples were collected. This sample collection pattern makes it difficult to look for trends.

Tetrachloroethene (PCE) and trichloroethylene (TCE) were detected most frequently and at the highest concentrations in the pore gas. These two analytes were also detected in at least half of the soil-gas survey samples. Figures D-25 and D-26 show all of the reported concentrations for PCE and TCE in borehole 50-10131. PCE appears to be decreasing with depth in this borehole, and the overall maximum from all sampling events is near the top of the borehole. TCE results have generally been constant over all depths. The concentrations range between 1.1 and 2.3 ppmv in all samples.

Figures D-27 and D-28 show all of the reported concentrations for PCE and TCE in borehole 50-09100. Except for a few anomalous results in 2001, all the SUMMA analysis appears to show consistent concentrations of PCE in borehole 50-09100. TCE shows a pattern of increasing concentrations with increasing depth in this borehole. Although there is some variability between the results, the maximum concentrations are below 200 ft in this borehole.

Samples were collected at both boreholes in January 2003. To discern any patterns, SUMMA samples were collected, screened, and analyzed at every port in both boreholes. Figures D-29 and D-30 show plots with the Brüel and Kjaer (B&K) versus the SUMMA data from borehole 50-09100 for both TCE and PCE. As the plots show, the correlation between the B&K and SUMMA data is not strong.

3.4 Tritium in Pore-Gas Samples

Fifteen samples were collected from tritium probes at MDA C. All fifteen tritium results were reported as detected values. The individual results are presented in Table D-5. Two of the tritium results were a factor of ten higher than the rest of the results. Figure D-31 shows a bubble plot of these tritium results. As the figure illustrates, the two highest results were found north of Pit 6 and south of Pit 6.

4.0 REFERENCES

Box, G. E. P., W. G. Hunter, and J. S. Hunter, 1978. *Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building*, John Wiley and Sons, New York. (Box et al. 1978, 56653)

Gehan, E. A., "A Generalized Wilcoxon Test for Comparing Singly-Censored Samples," *Biometrika*, Vol. 52, pp. 203–223. (Gehan 1965, 55611)

Gilbert, R. O., 1987. *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold, New York, New York. (Gilbert 1987, 56179)

Gilbert, R., and J. Simpson, 1991, "Statistical Sampling and Analysis Issues and Needs for Testing Attainment of Background-Based Cleanup Standards at Superfund Sites," in *Proceedings of the Workshop on Superfund Hazardous Waste: Statistical Issues in Characterizing a Site: Protocols, Tools, and Research Needs*, published by Pennsylvania State University, University Park, Pennsylvania. (Gilbert and Simpson 1990, 55612)

Keppel, G., 1982. *Design and Analysis: A Researcher's Handbook*, 2nd ed., Prentice-Hall Inc., Englewood Cliffs, New Jersey. (Keppel 1982, 56652)

LANL (Los Alamos National Laboratory), July 1995. "Statement of Work—Analytical Support," Revision 2, RFP No. 9-XS1-Q4257, Los Alamos, New Mexico. (LANL 1995, 49738)

LANL (Los Alamos National Laboratory), September 1998. "Inorganic and Radionuclide Background Data for Soils, Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-98-484, Los Alamos, New Mexico. (LANL 1998, 59730)

Environmental Restoration Project, September 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Draft, Los Alamos National Laboratory report LA-UR-98-4847, Los Alamos, New Mexico. (Environmental Restoration Project 1998, 59730)

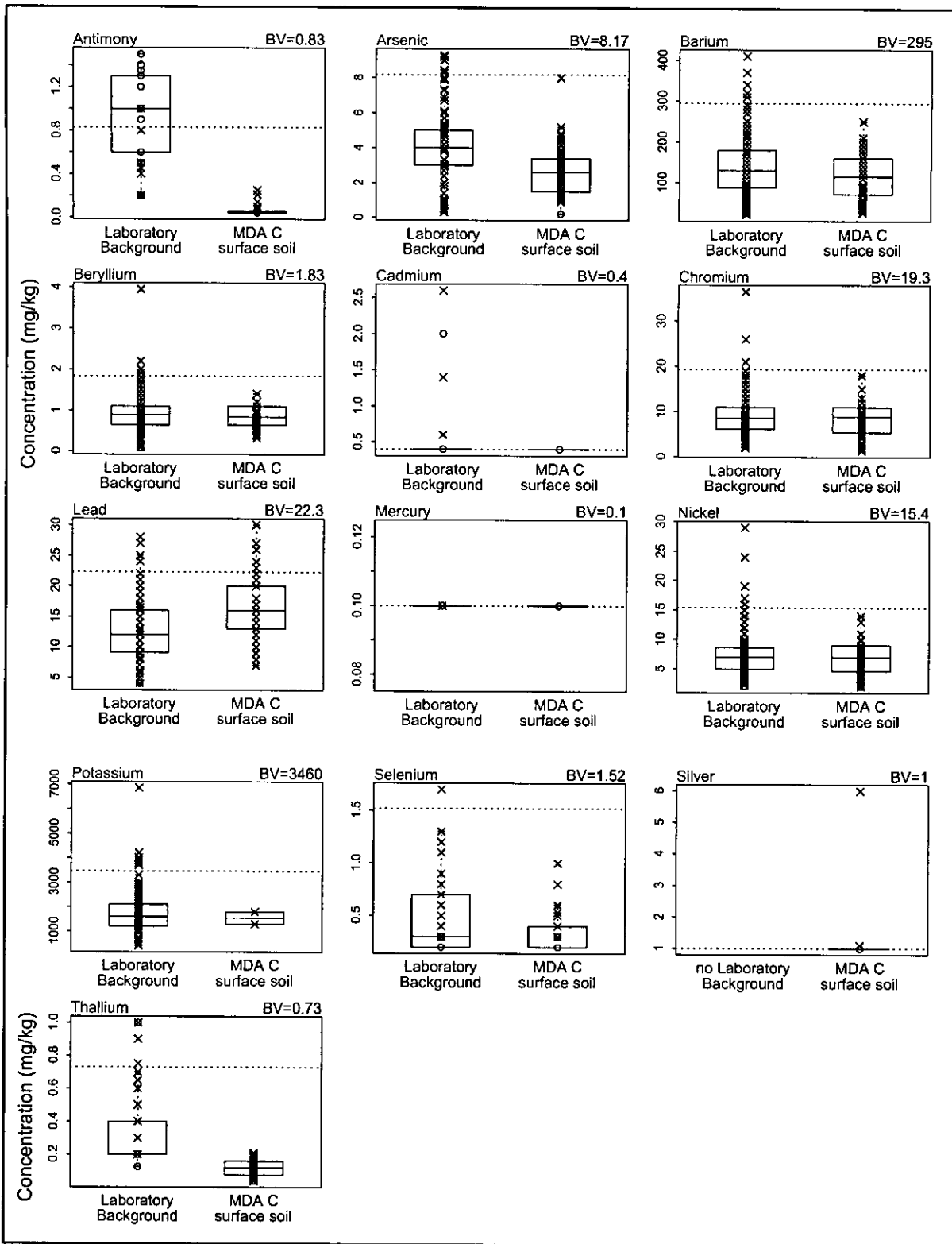


Figure D-1. Box plots of inorganic chemical concentrations from LANL all horizon background data and surface soil and fill material at MDA C

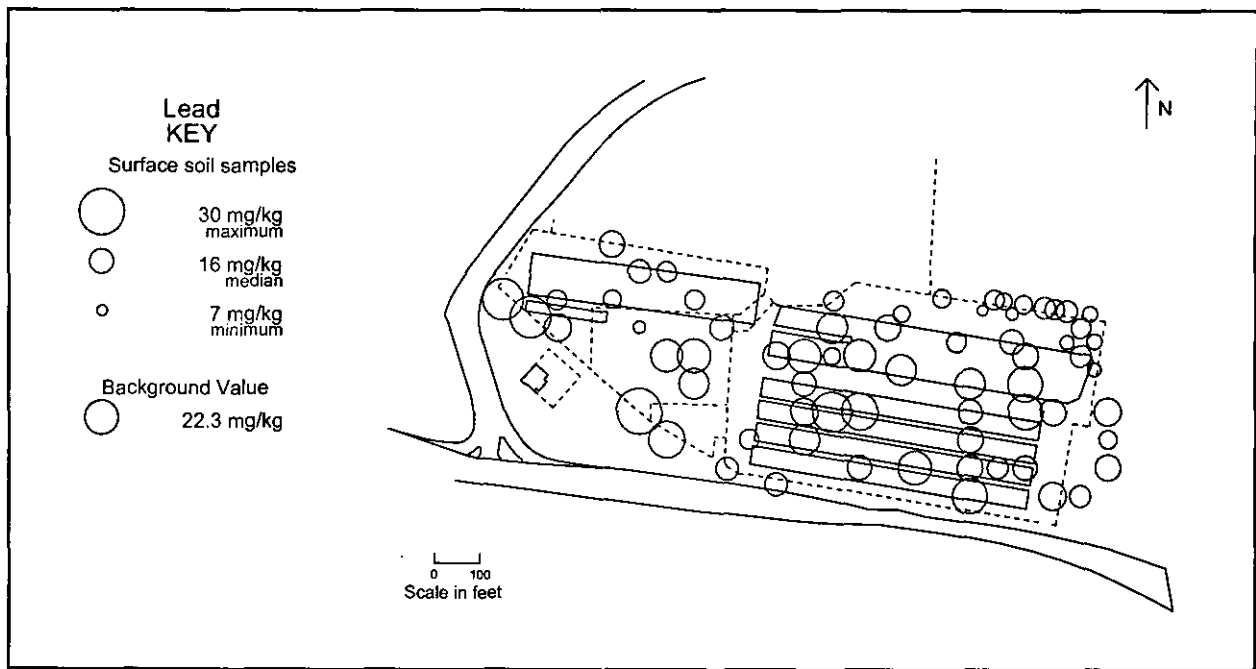


Figure D-2. Bubble plot of lead concentrations from surface soil and fill material at MDA C

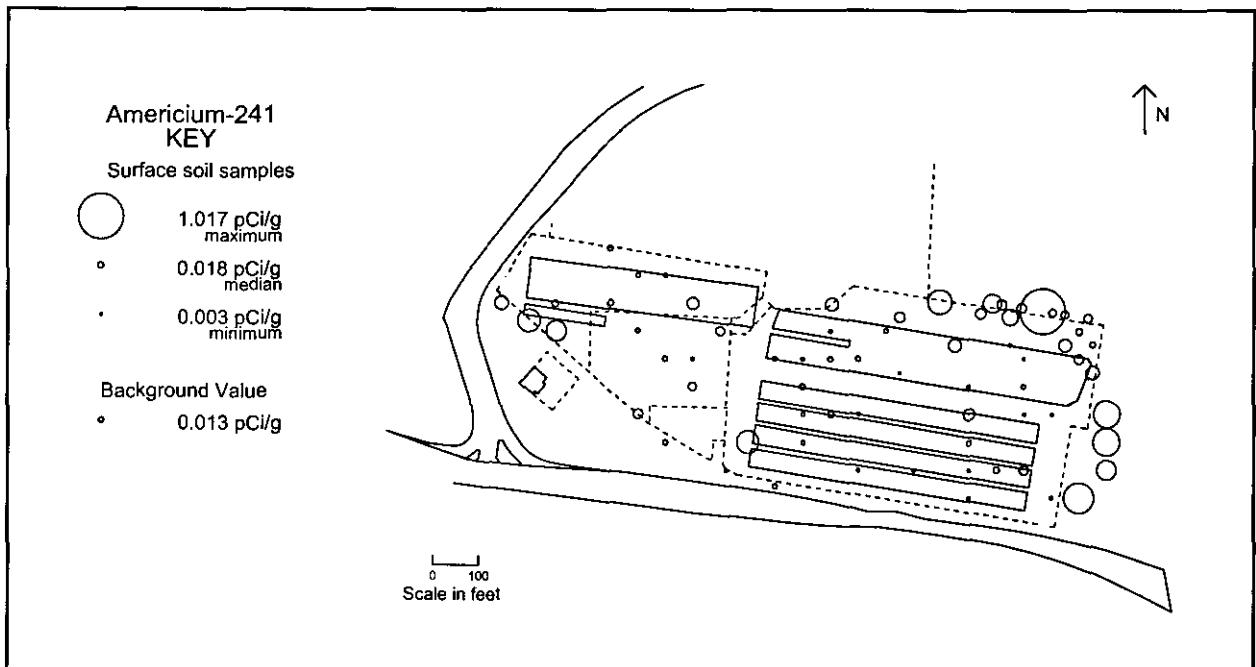


Figure D-3. Bubble plot of americium-241 concentrations from surface soil and fill material at MDA C

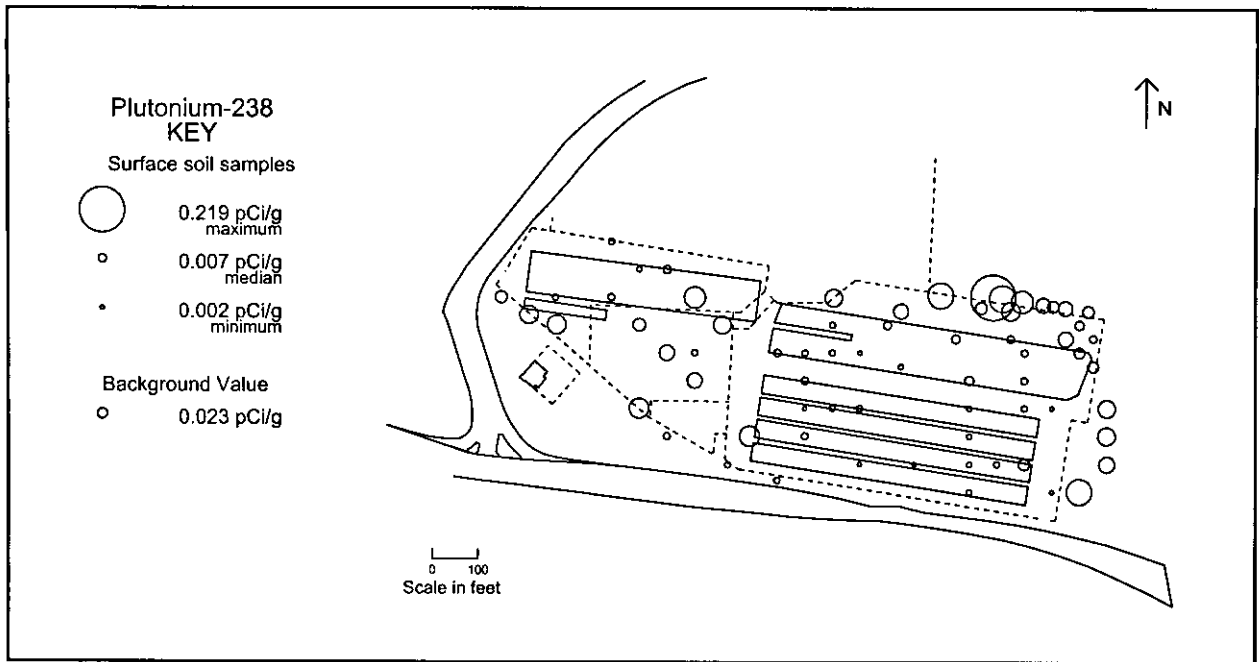


Figure D-4. Bubble plot of plutonium-238 concentrations from surface soil and fill material at MDA C

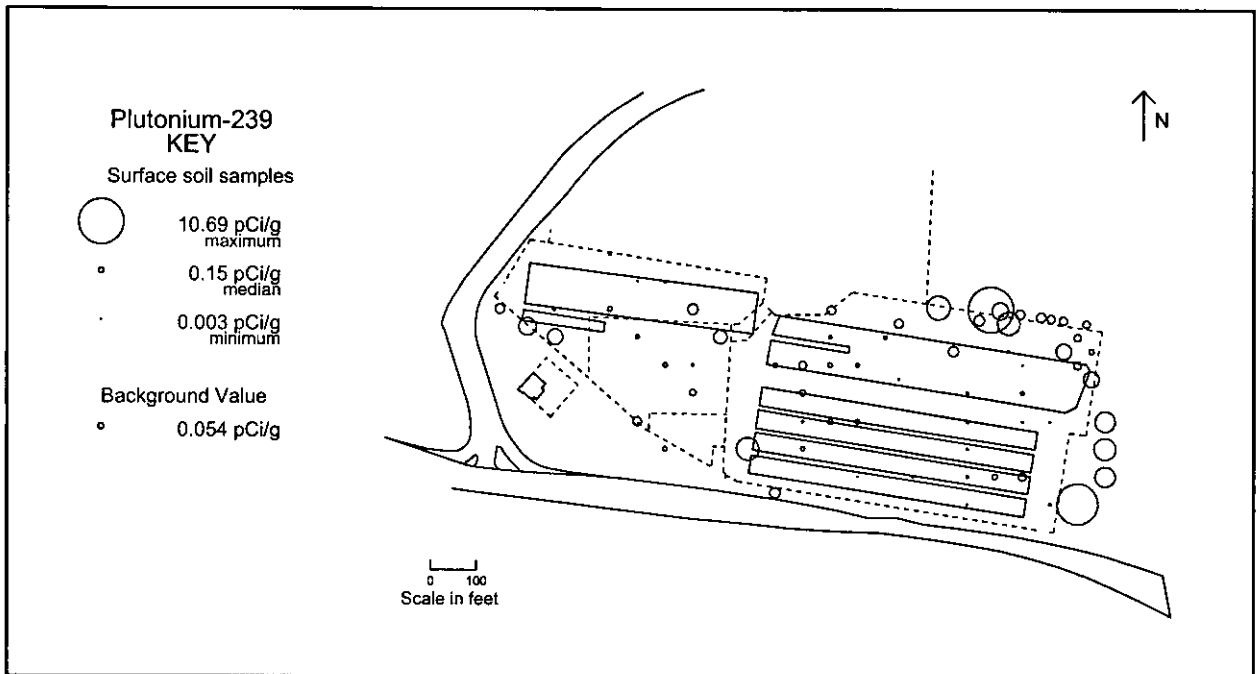


Figure D-5. Bubble plot of plutonium-239 concentrations from surface soil and fill material at MDA C

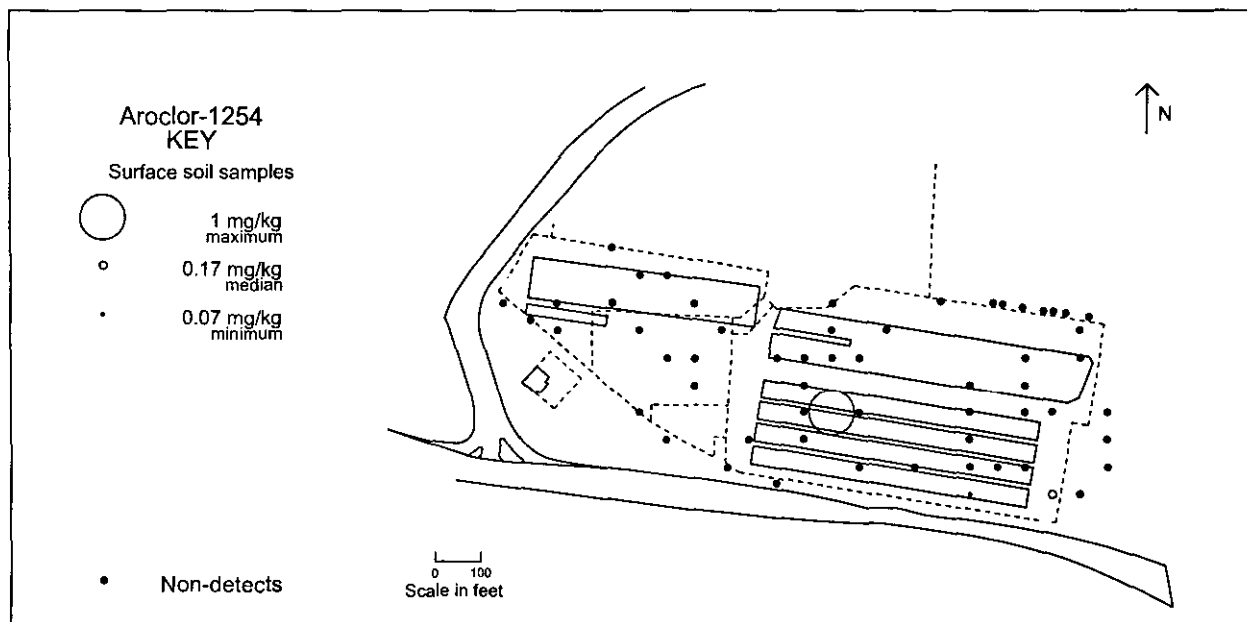


Figure D-6 Bubble plot of Aroclor-1254 detected concentrations from surface soil and fill material at MDA C

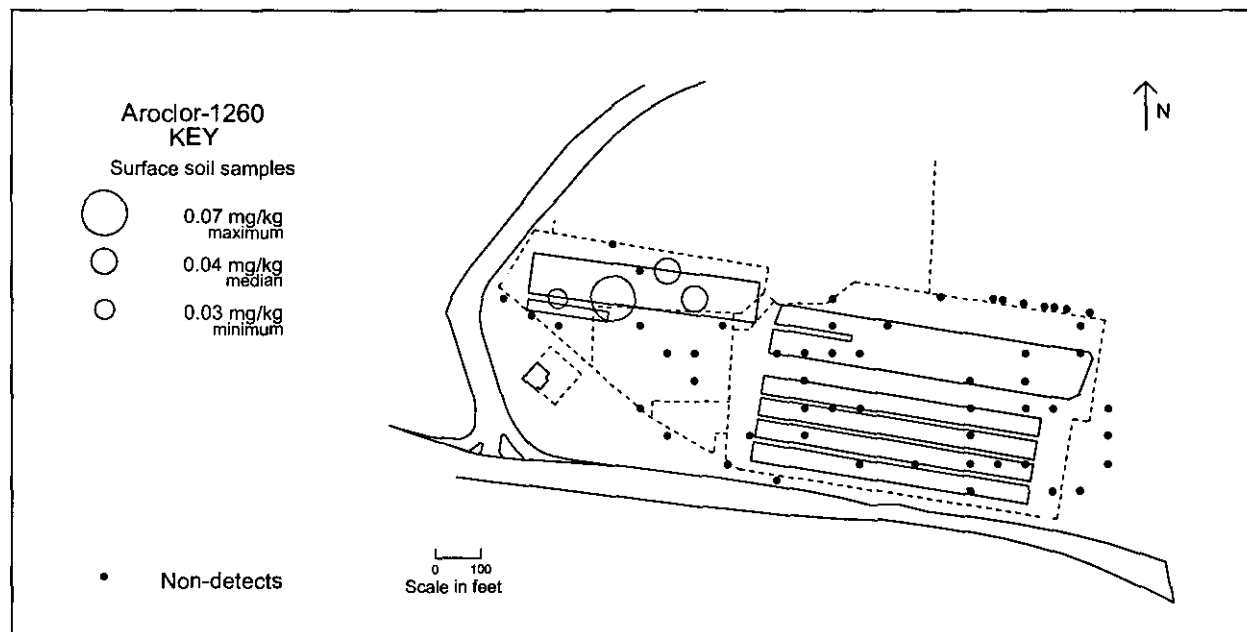


Figure D-7 Bubble plot of Aroclor-1260 detected concentrations from surface soil and fill material at MDA C

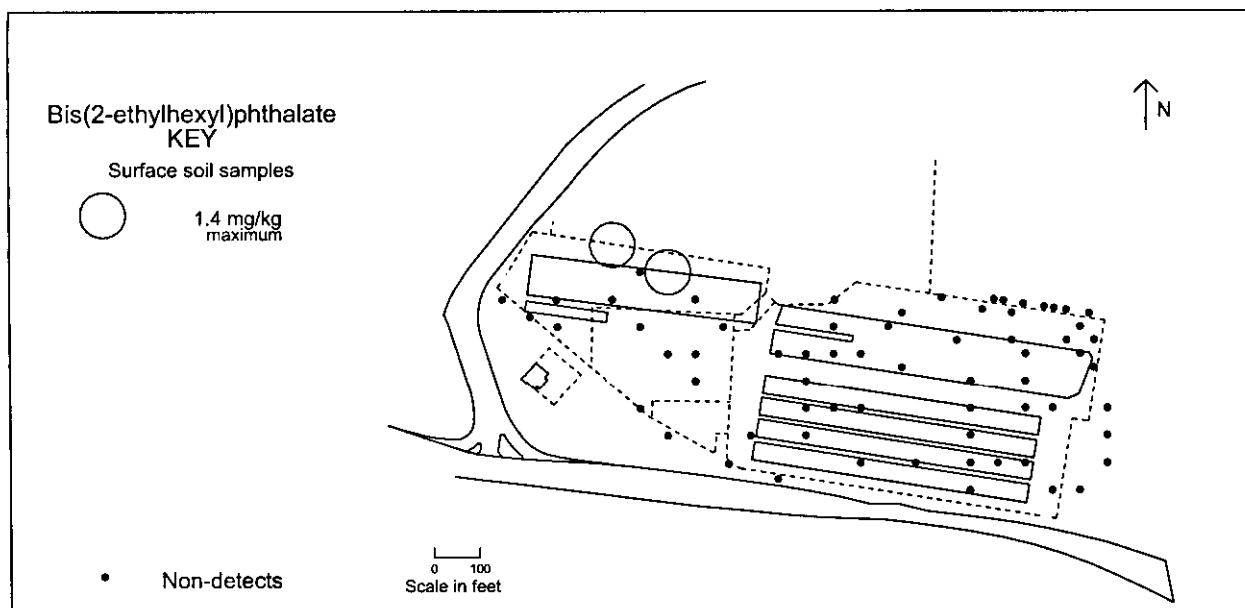


Figure D-8 Bubble plot of bis(2-ethylhexyl)phthalate detected concentrations from surface soil and fill material at MDA C

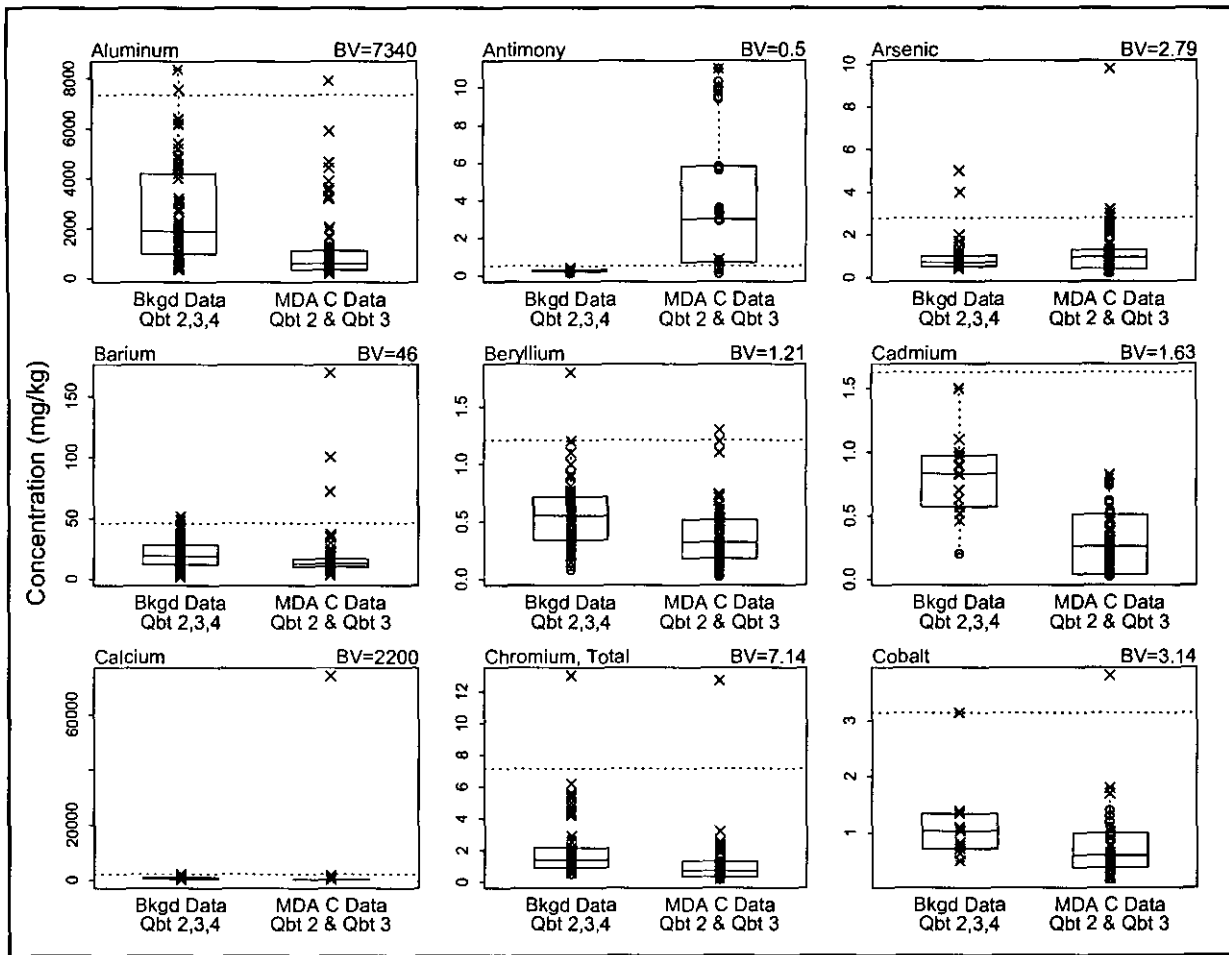


Figure D-9. Box plots of inorganic chemical concentrations from MDA C Qbt 2 and Qbt 3

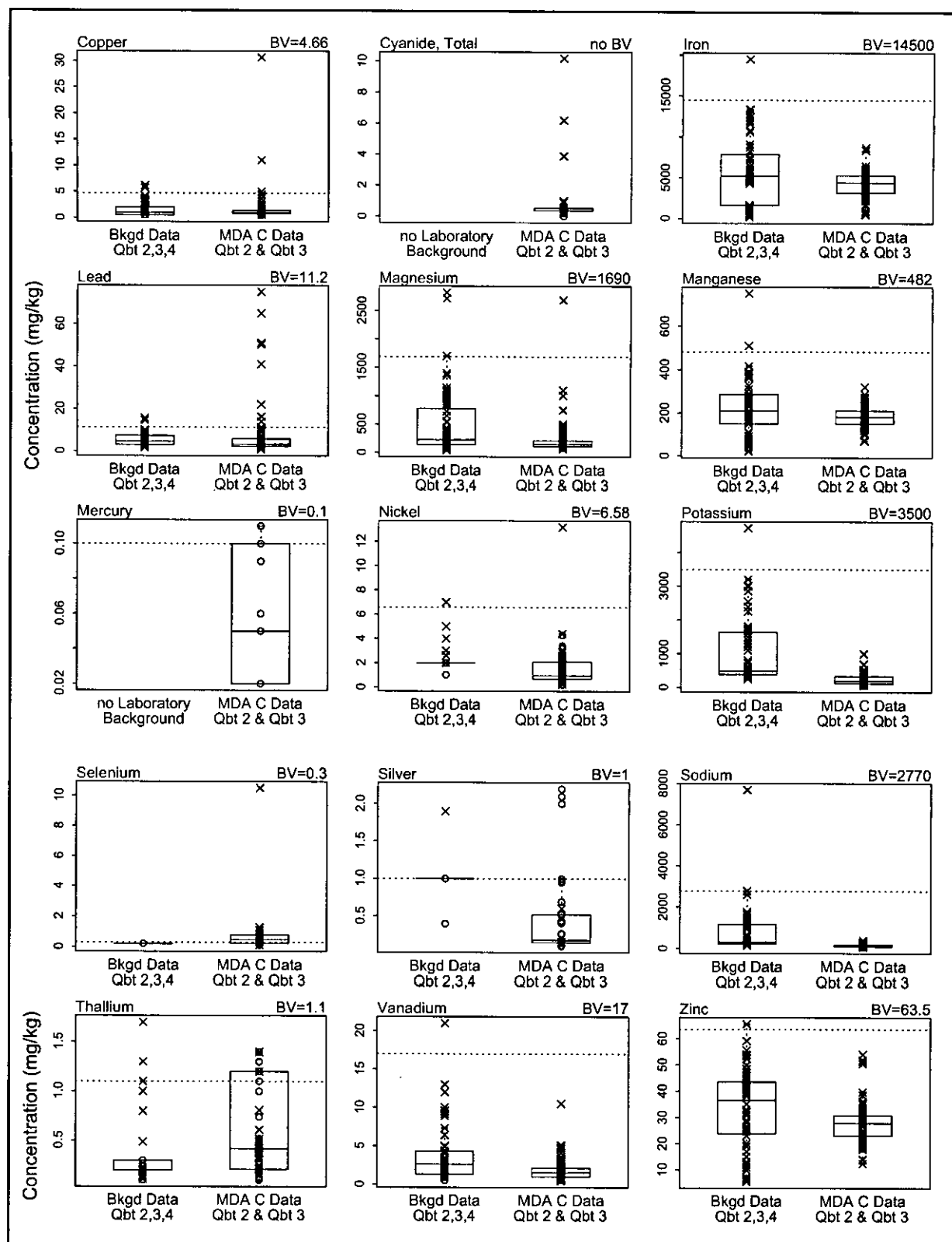


Figure D-9 (continued). Box plots of inorganic chemical concentrations from MDA C Qbt 2 and Qbt 3

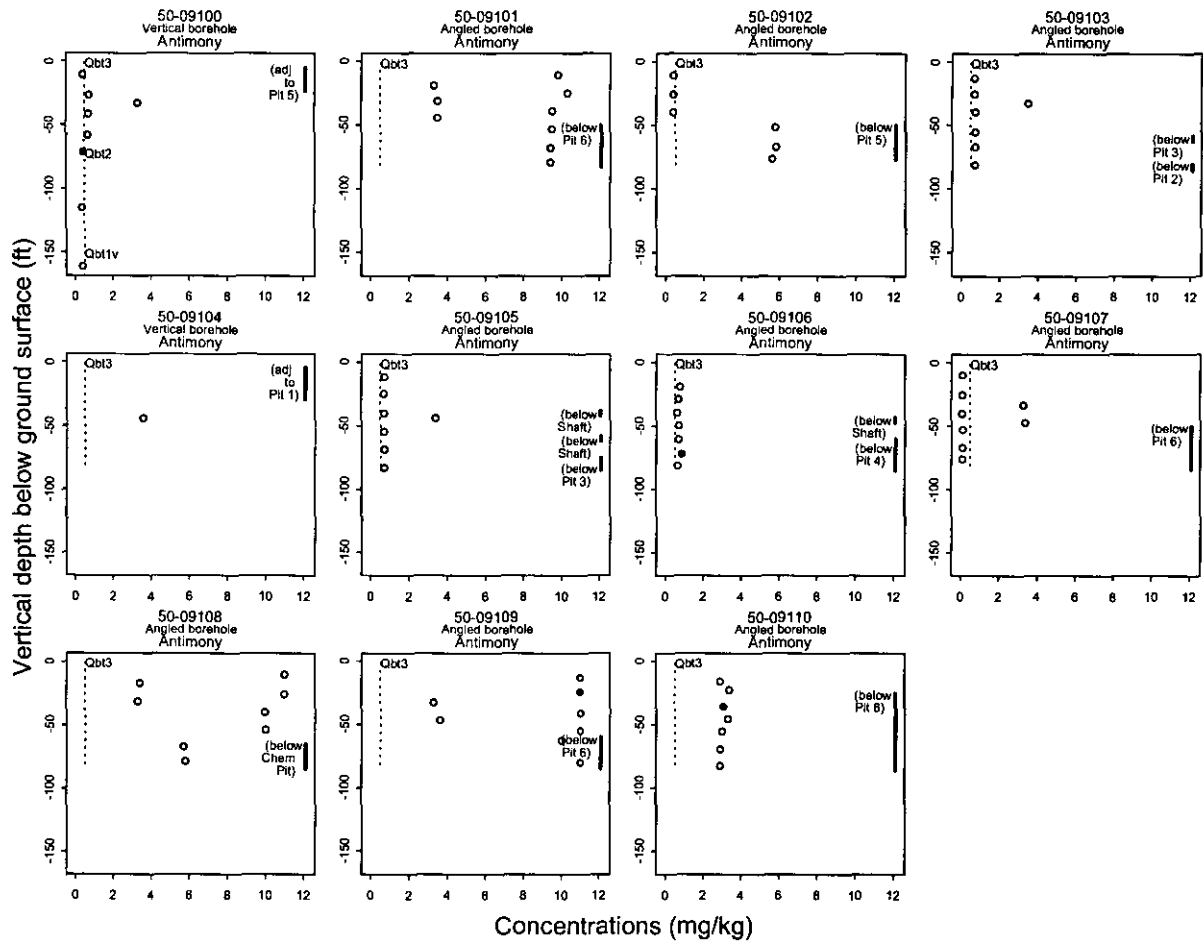


Figure D-10. Borehole profile plot for antimony at MDA C

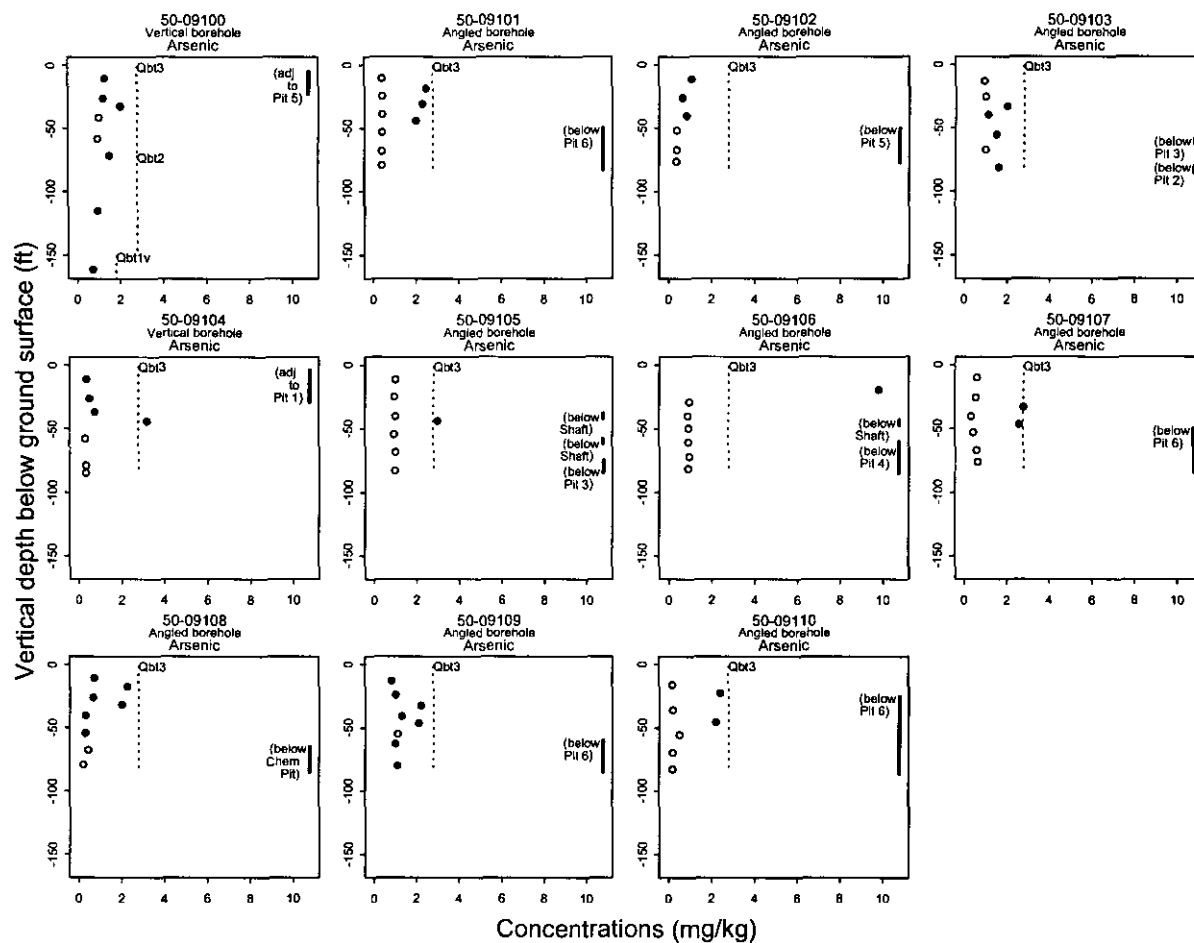


Figure D-11. Borehole profile plot for arsenic at MDA C

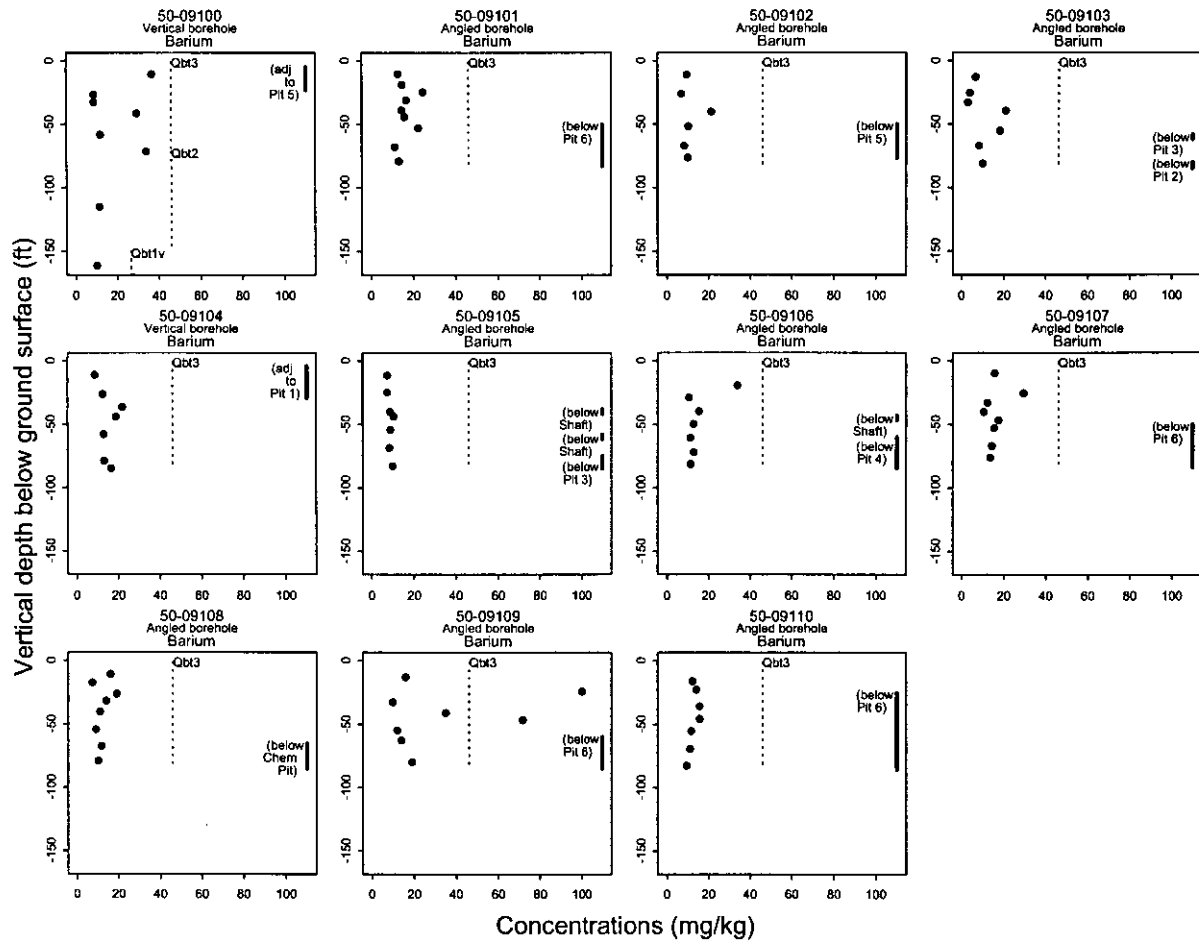


Figure D-12. Borehole profile plot for barium at MDA C

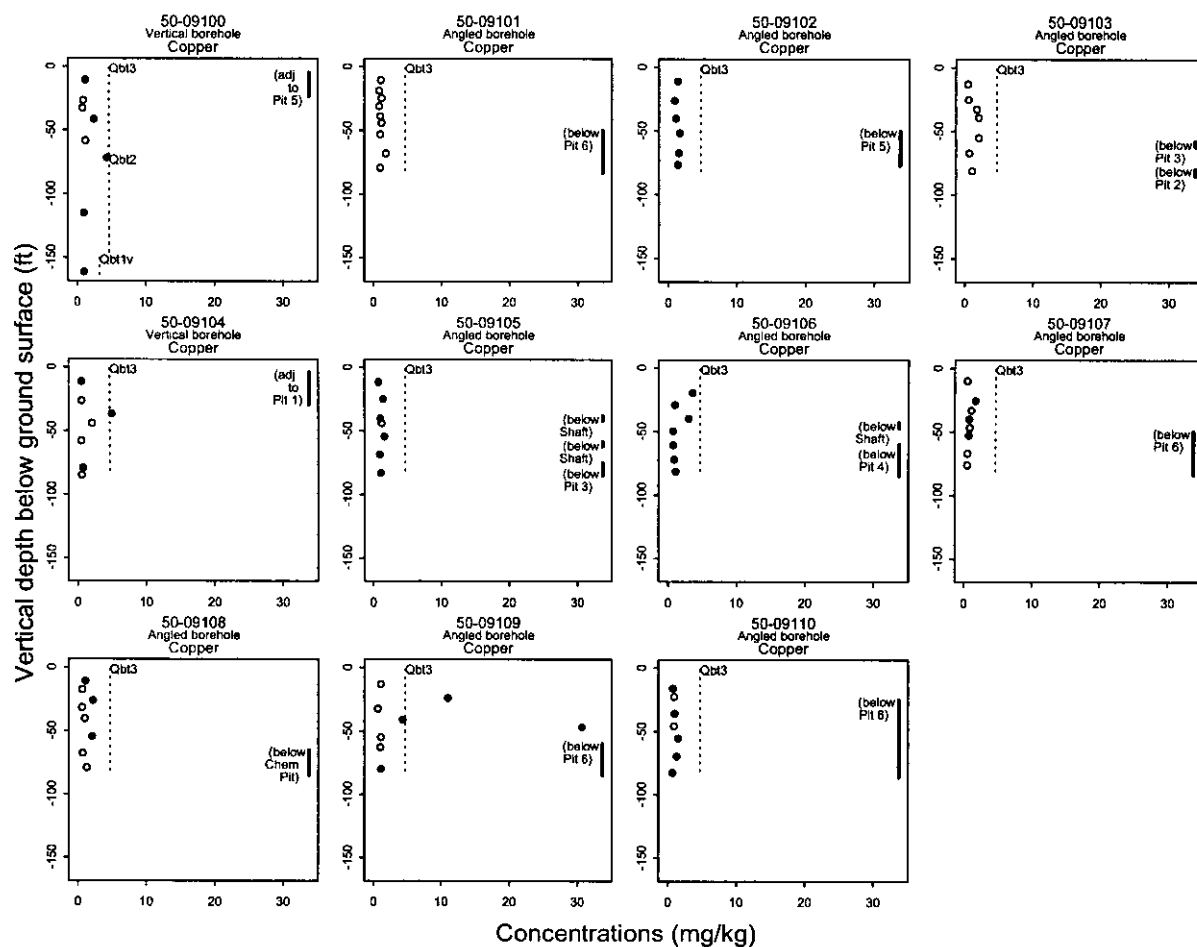


Figure D-13. Borehole profile plot for copper at MDA C

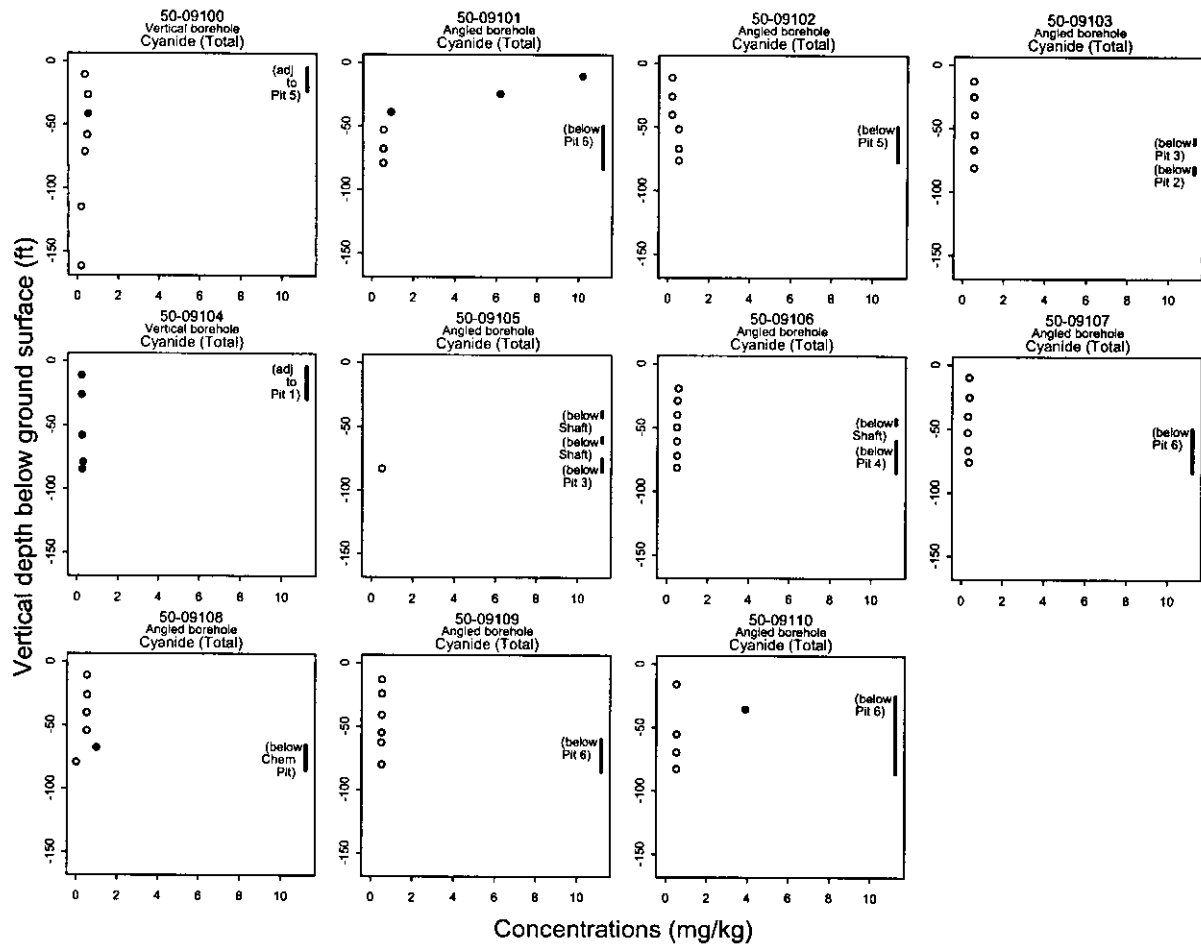


Figure D-14. Borehole profile plot for cyanide at MDA C

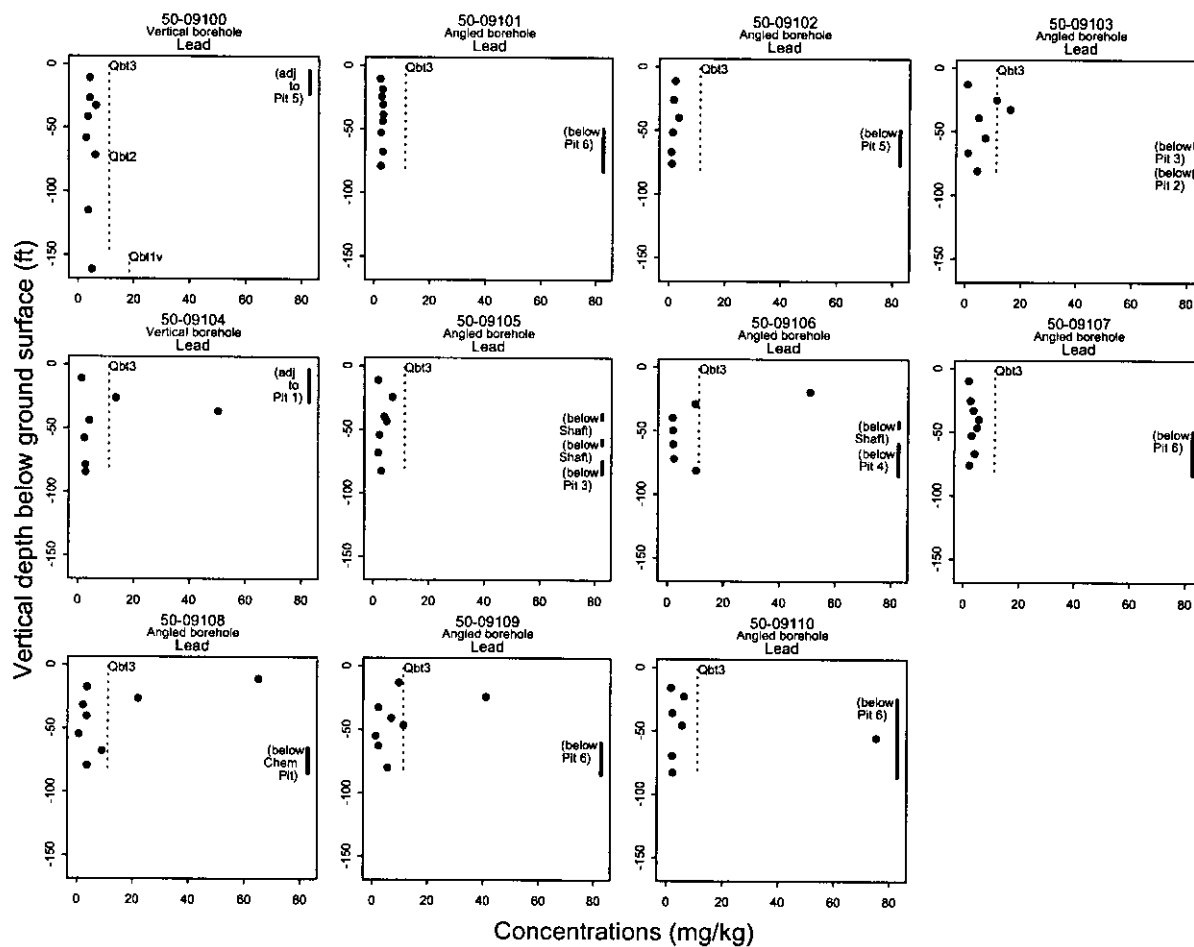


Figure D-15. Borehole profile plot for lead at MDA C

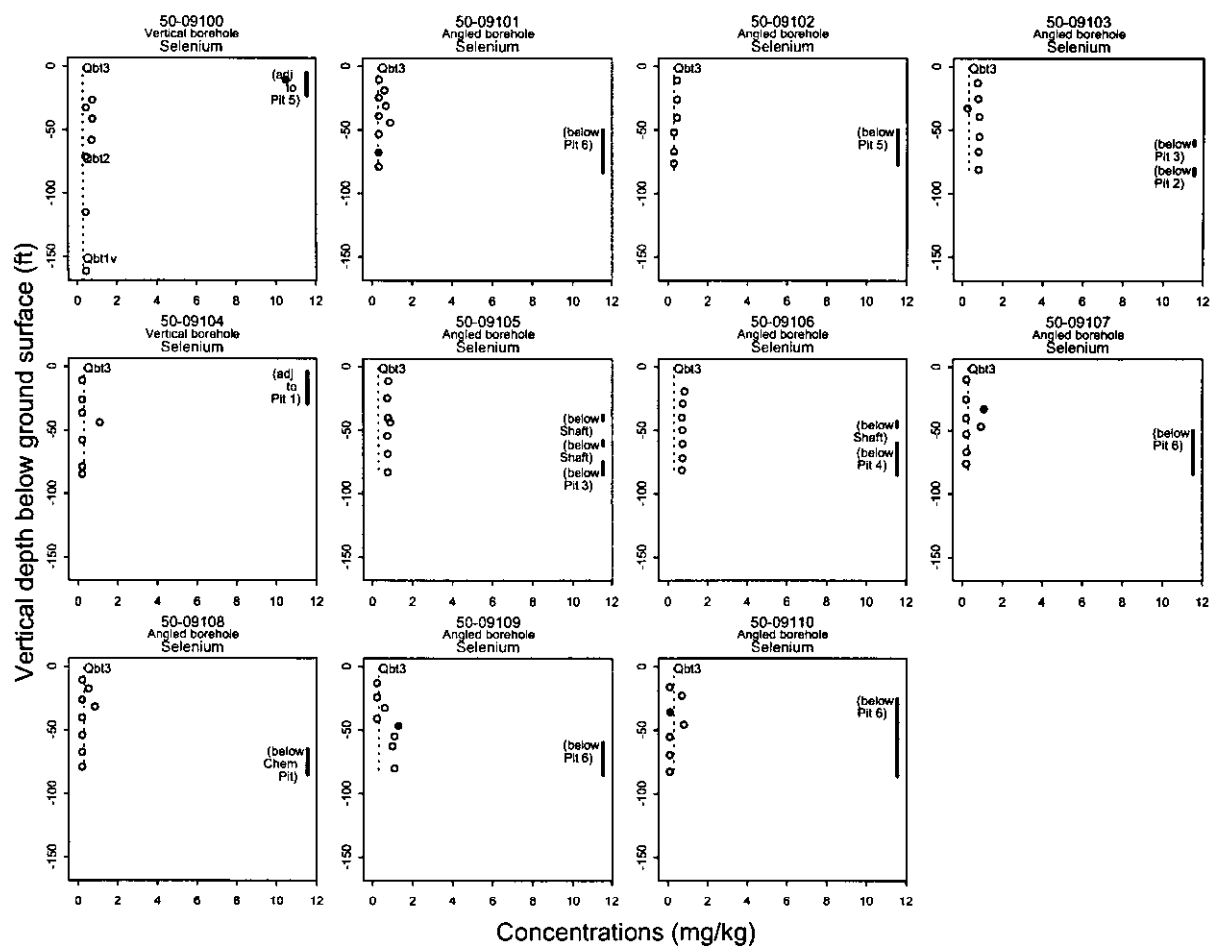


Figure D-16. Borehole profile plot for selenium at MDA C

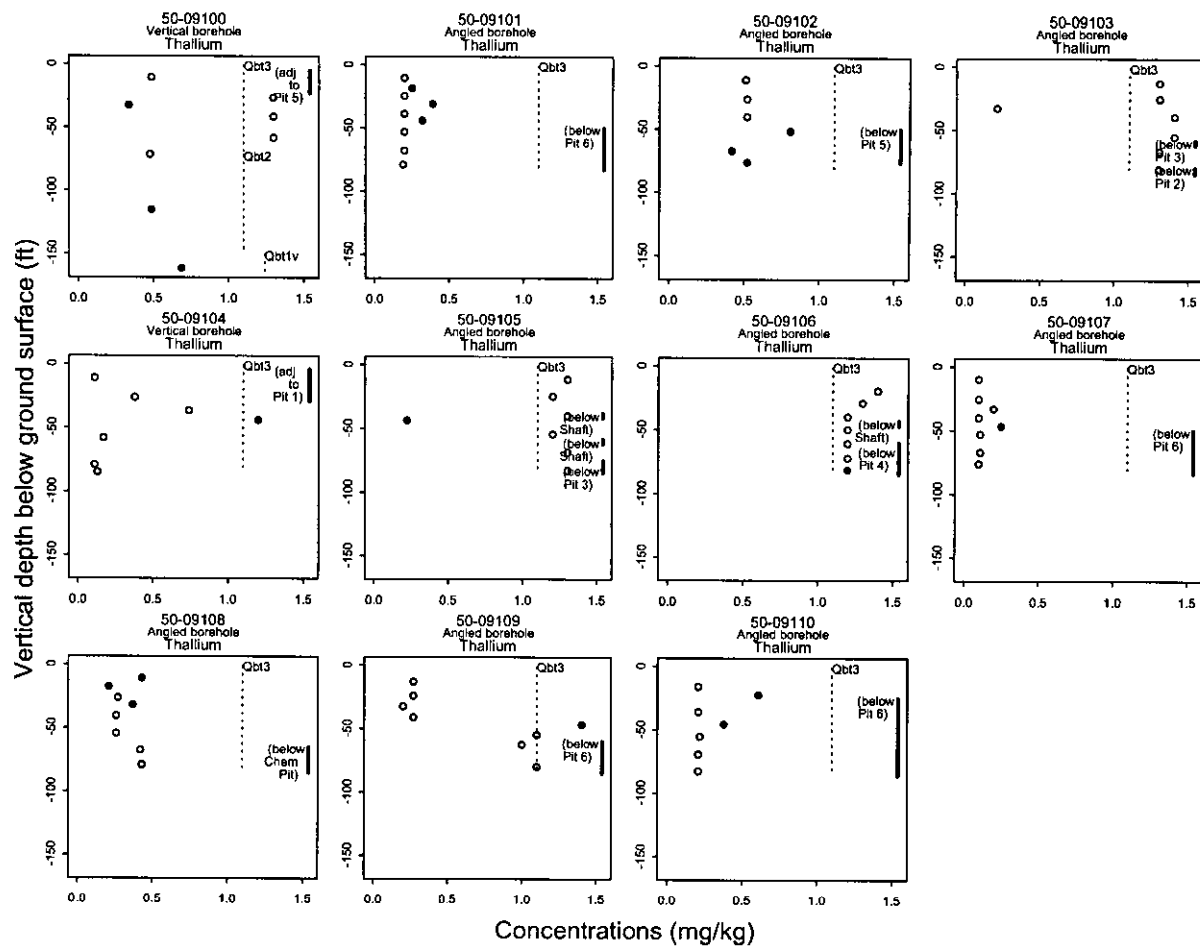


Figure D-17. Borehole profile plot for thallium at MDA C

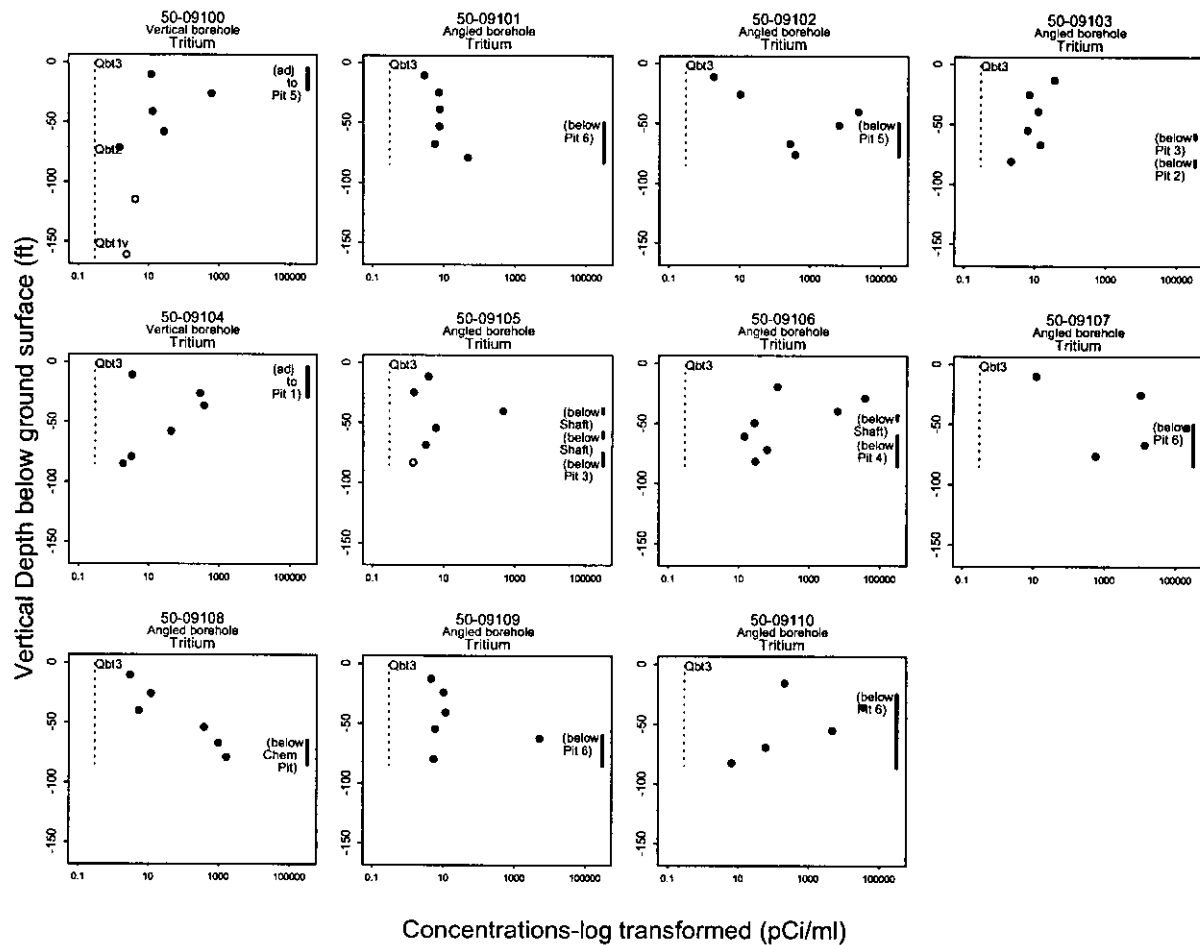


Figure D-18. Borehole profile plot for tritium at MDA C

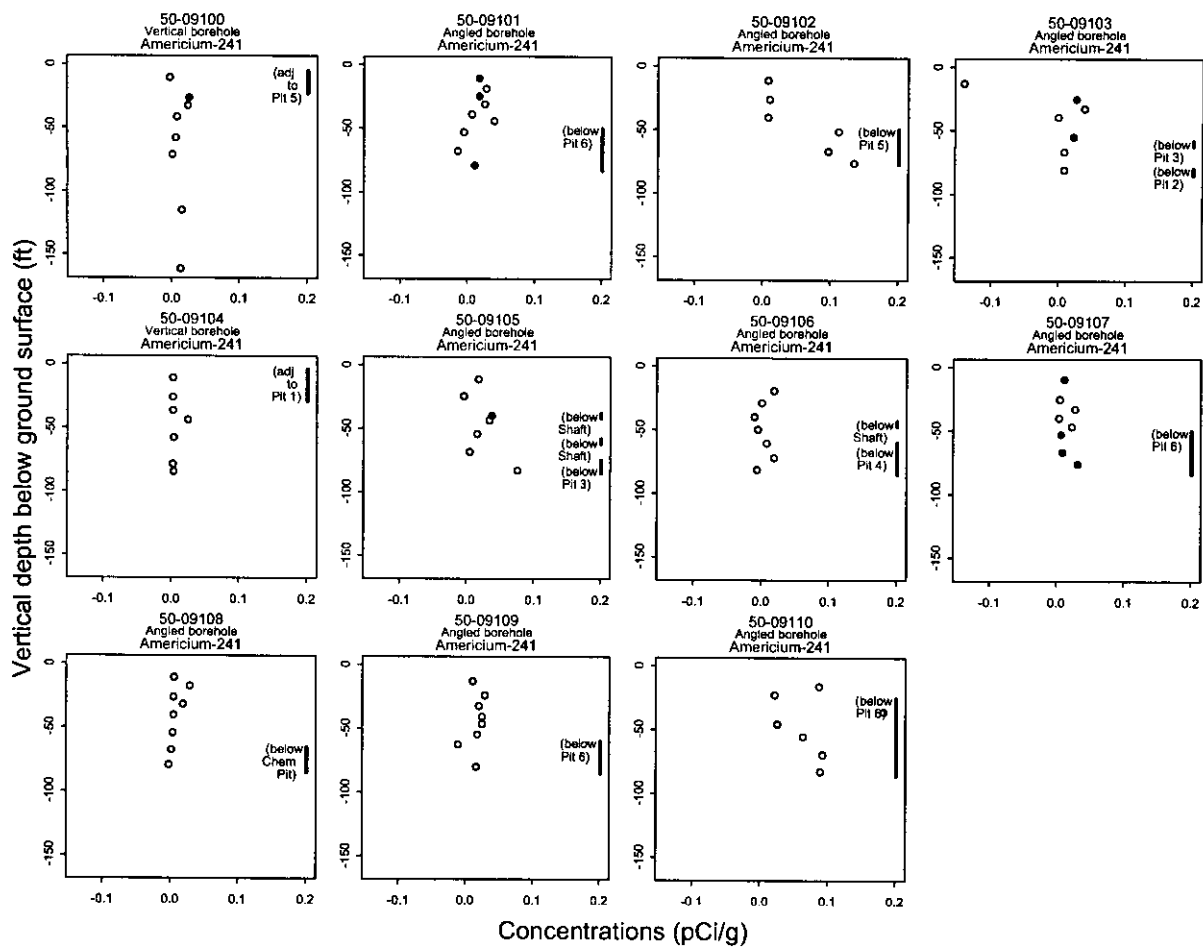


Figure D-19. Borehole profile plot for americium-241 at MDA C

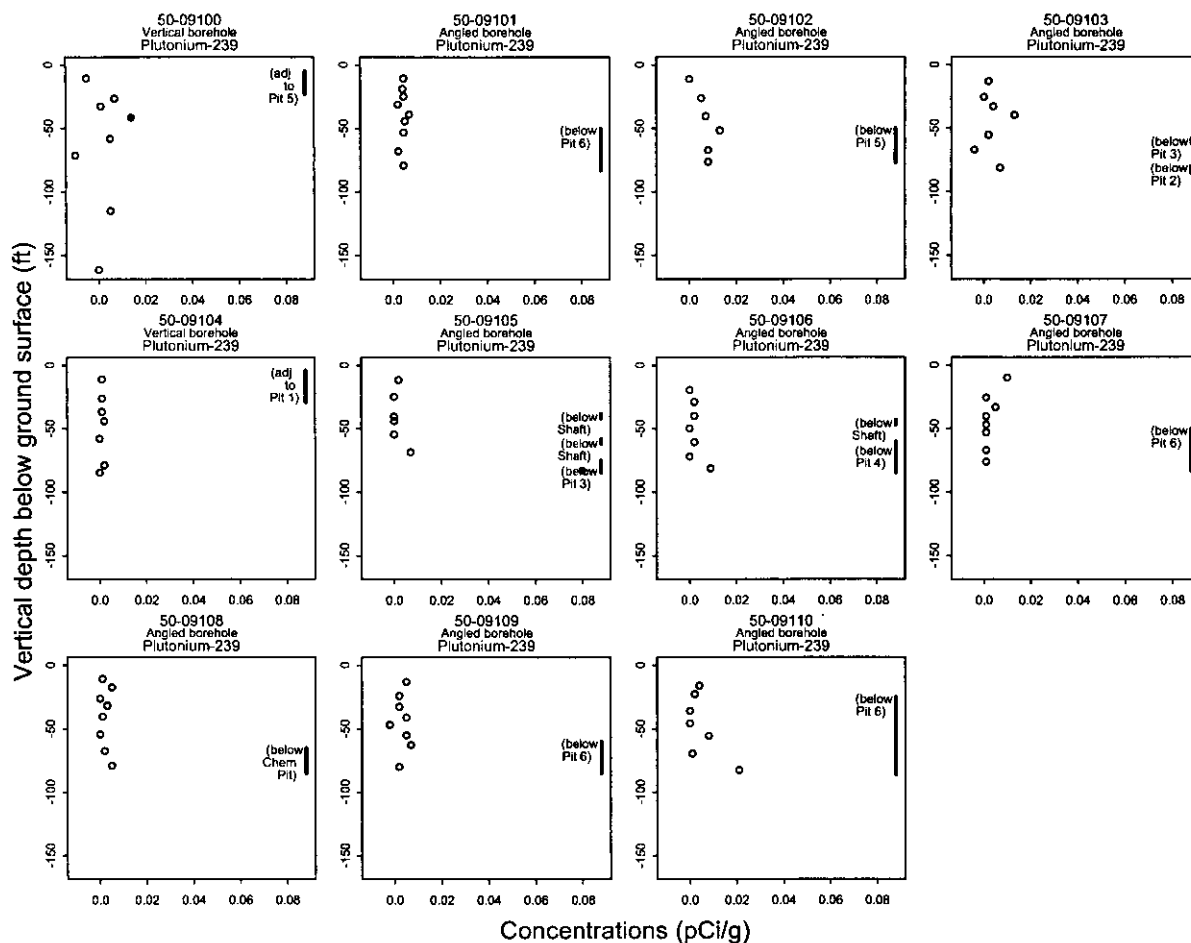
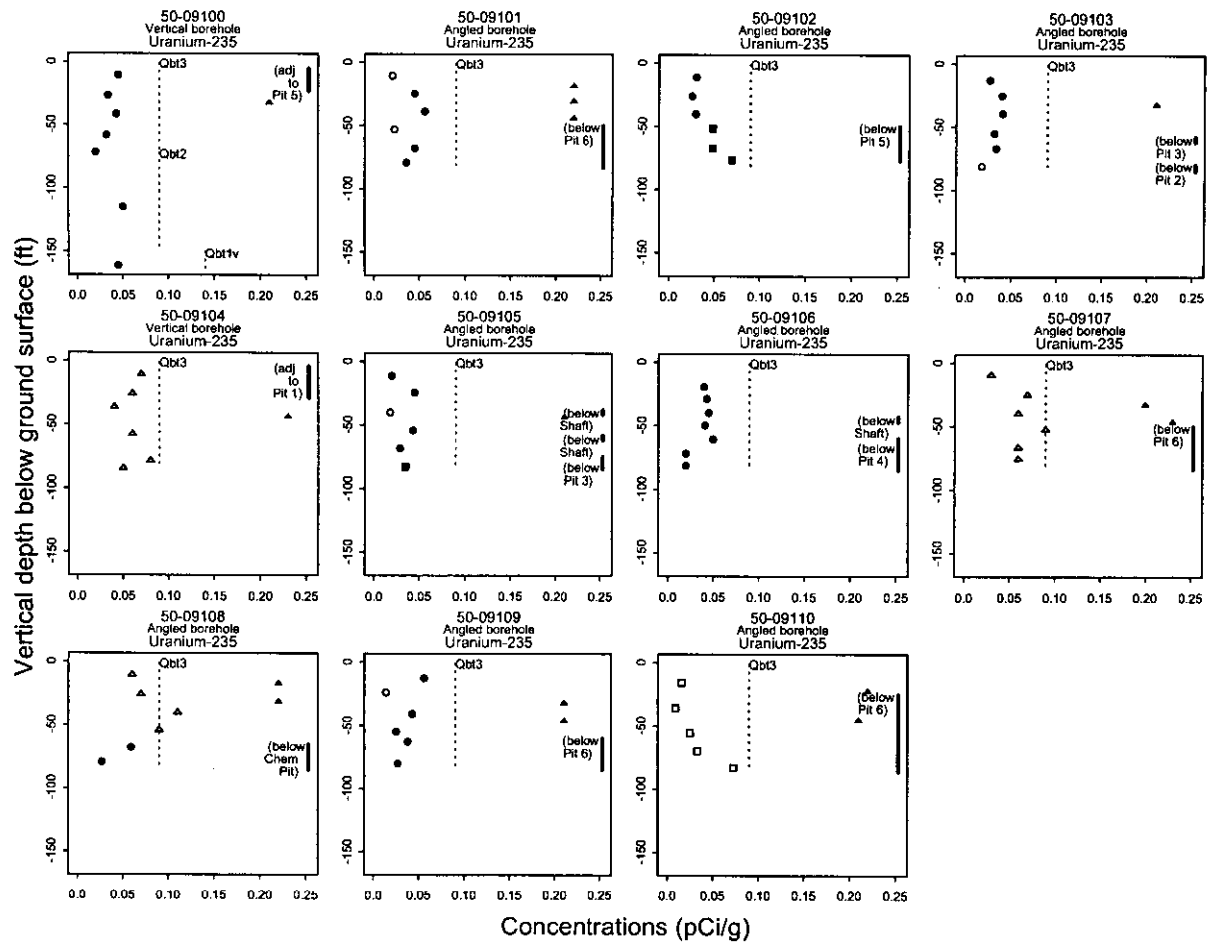


Figure D-20. Borehole profile plot for plutonium-239 at MDA C



Laboratory Key: ATI = circles; ESE = squares; Geotech = triangles

Figure D-21. Borehole profile plot for uranium-235 at MDA C

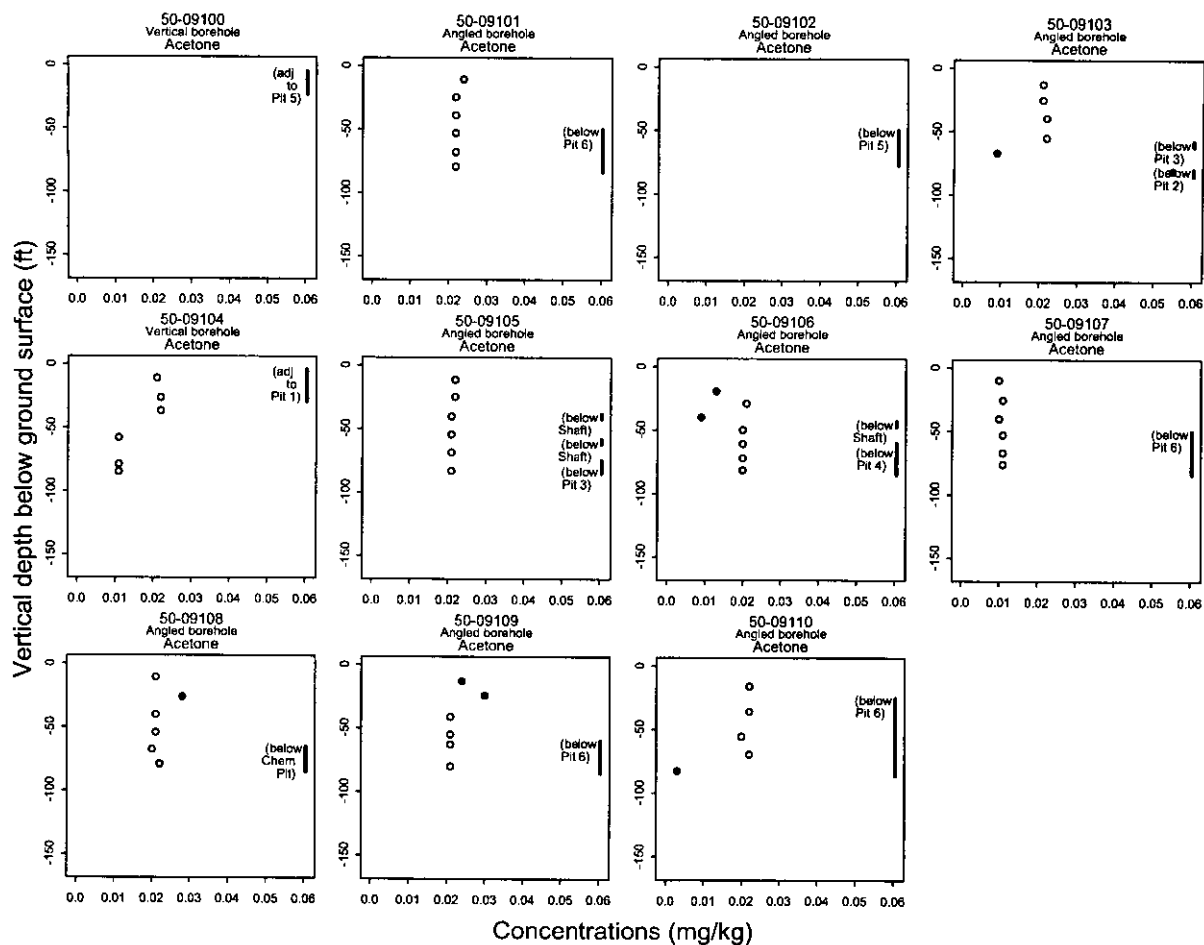


Figure D-22. Borehole profile plot for acetone at MDA C

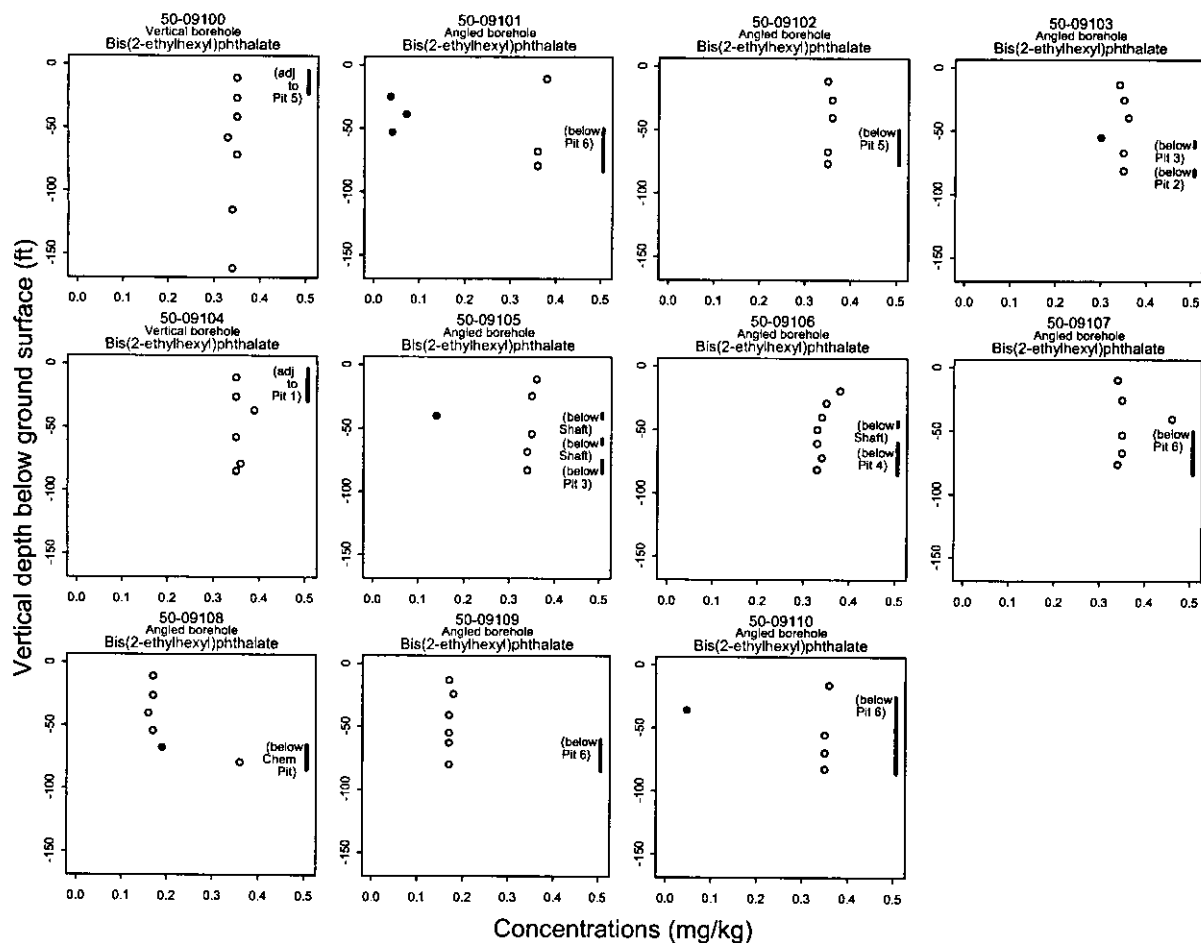


Figure D-23. Borehole profile plot for bis(2-ethylhexyl)phthalate at MDA C

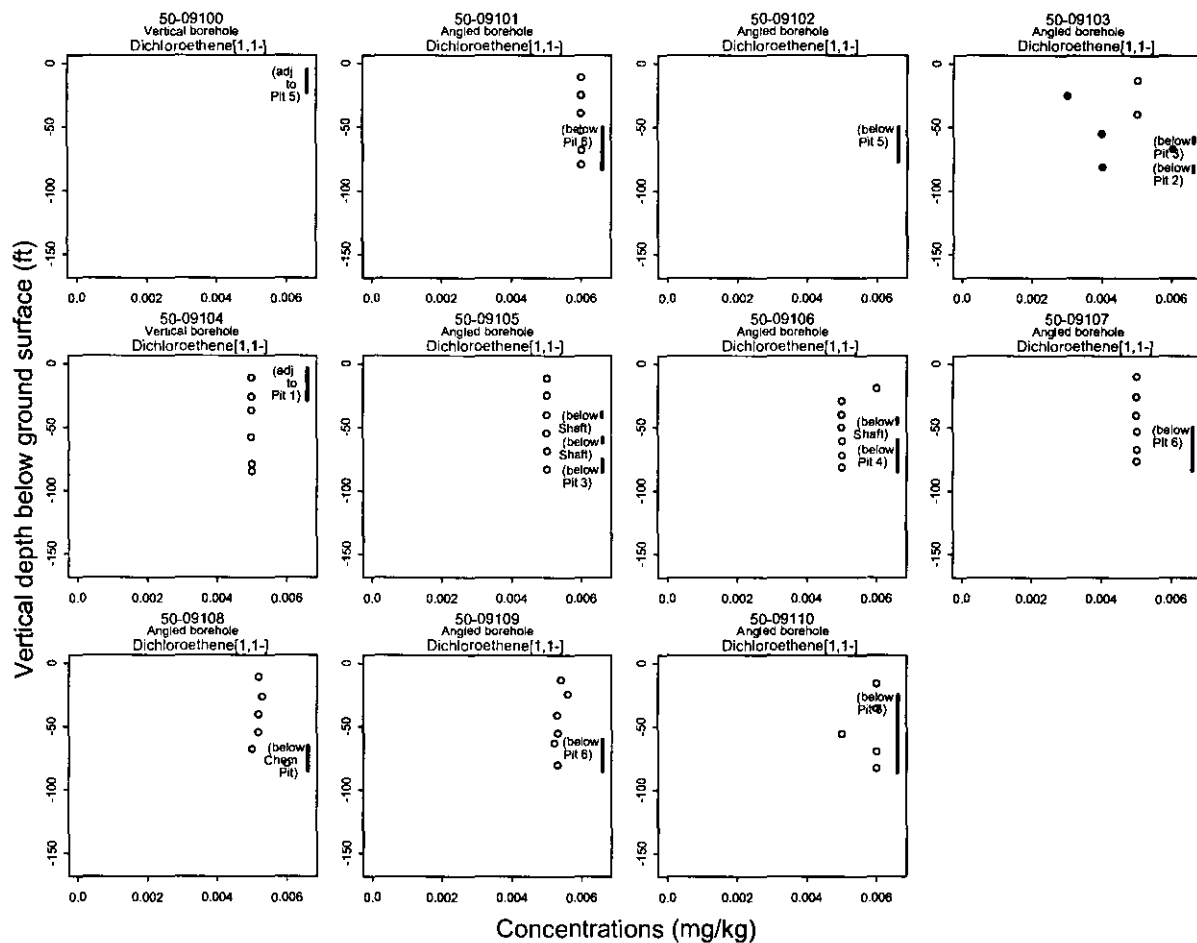


Figure D-24. Borehole profile plot for 1,1-dichloroethene at MDA C

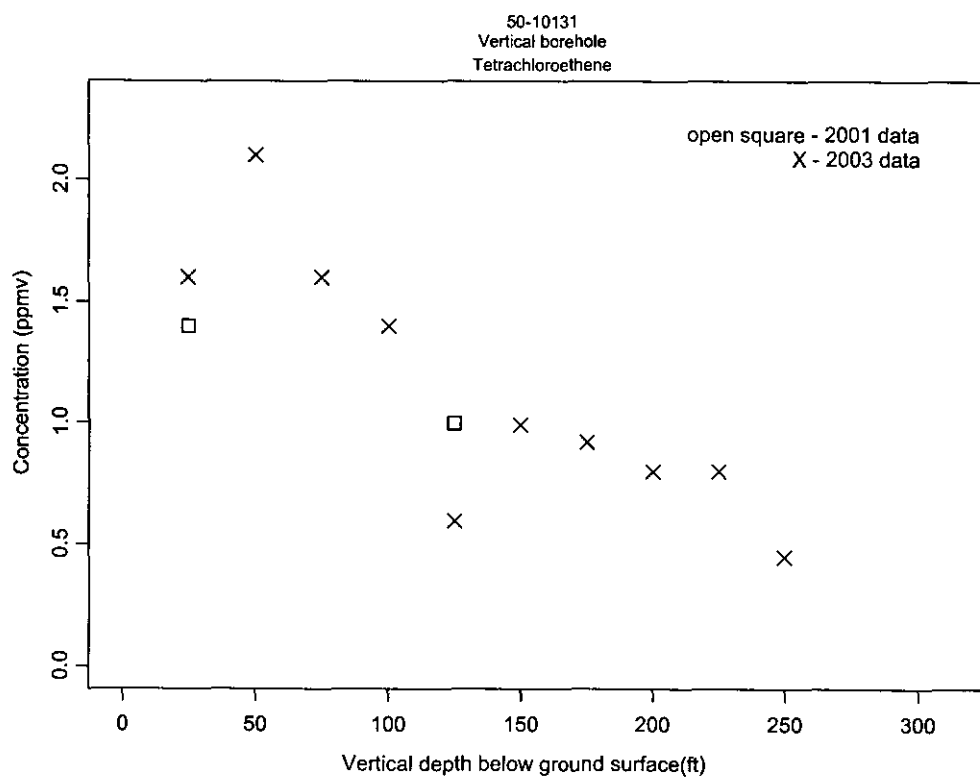


Figure D-25. Pore-gas data for tetrachloroethene in borehole 50-10131

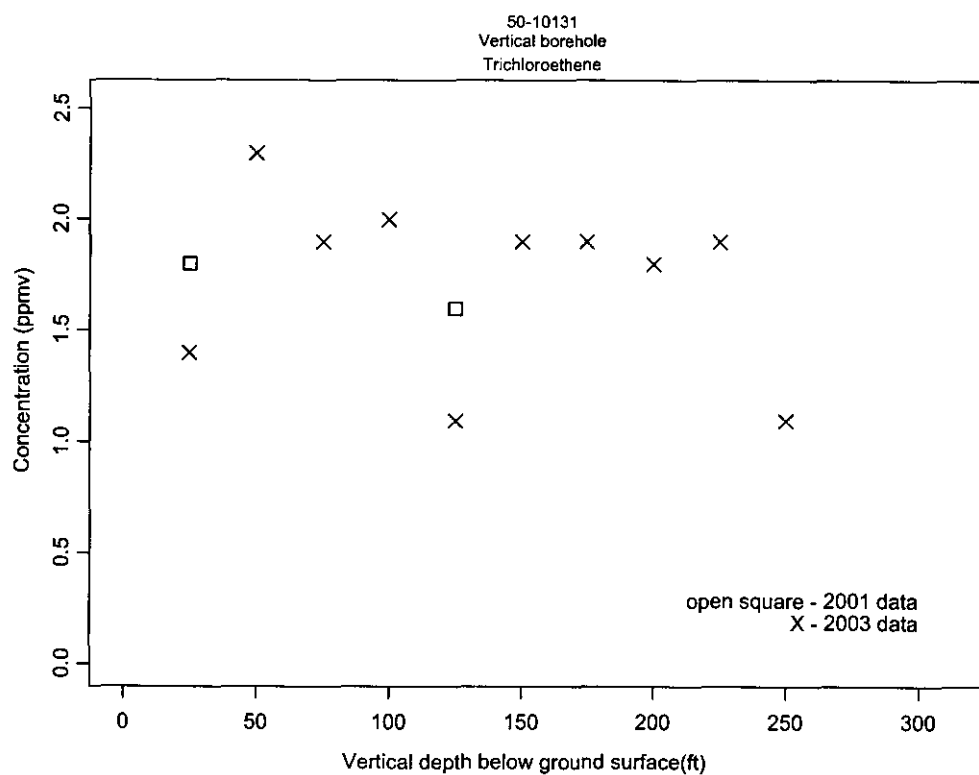


Figure D-26. Pore-gas data for trichloroethene in borehole 50-10131

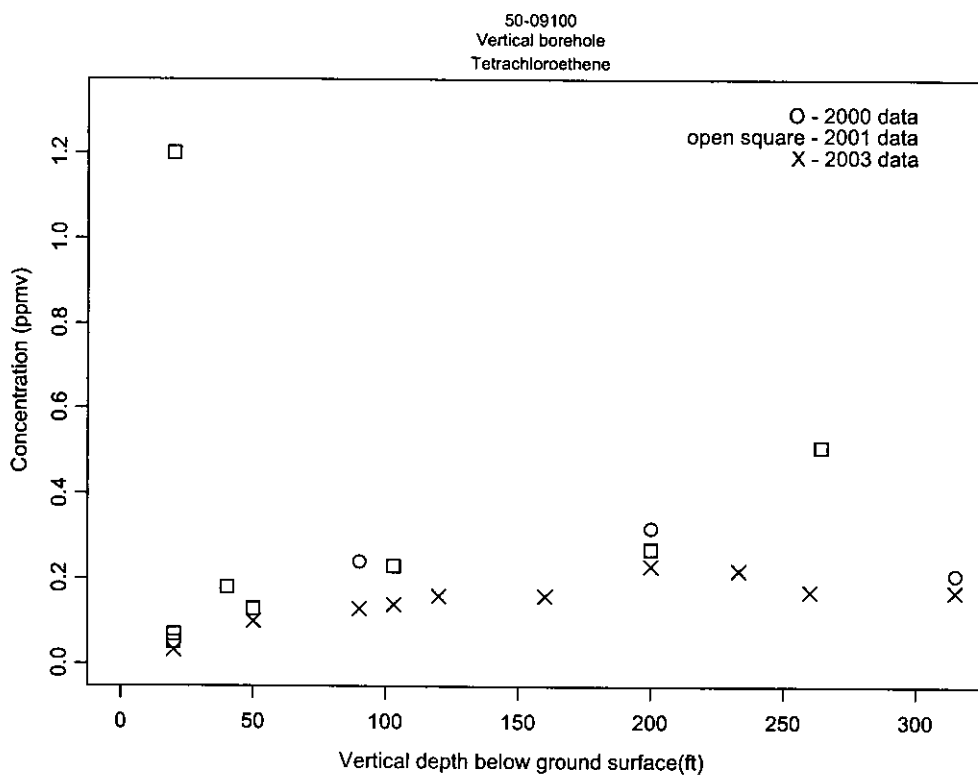


Figure D-27. Pore-gas data for tetrachloroethene in borehole 50-09100

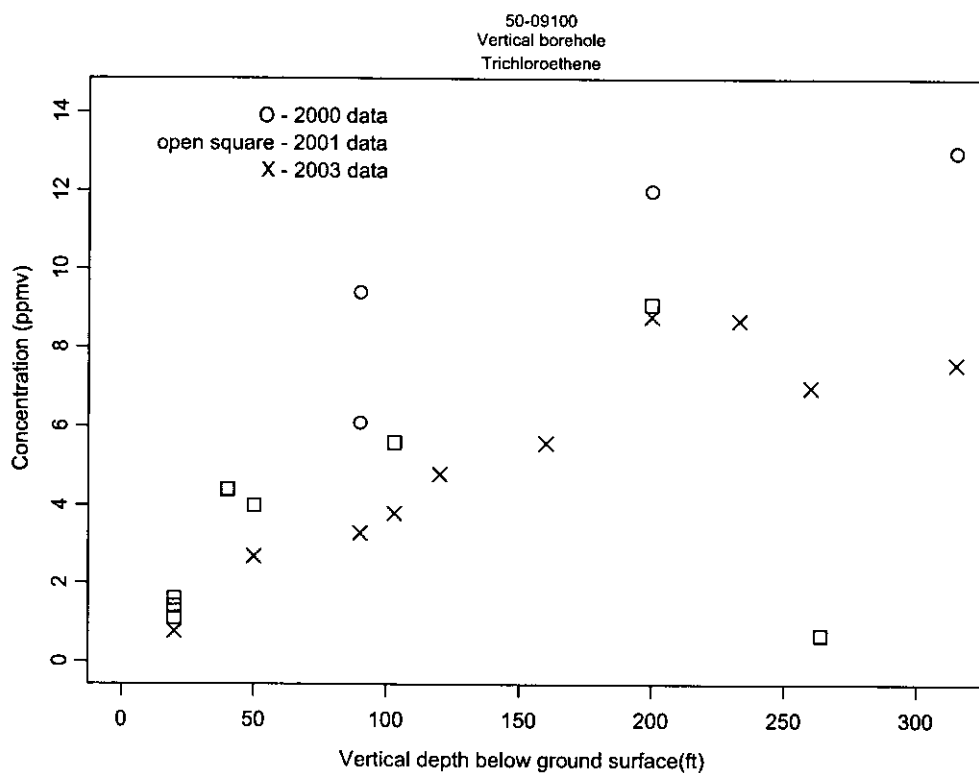


Figure D-28. Pore-gas data for trichloroethene in borehole 50-09100

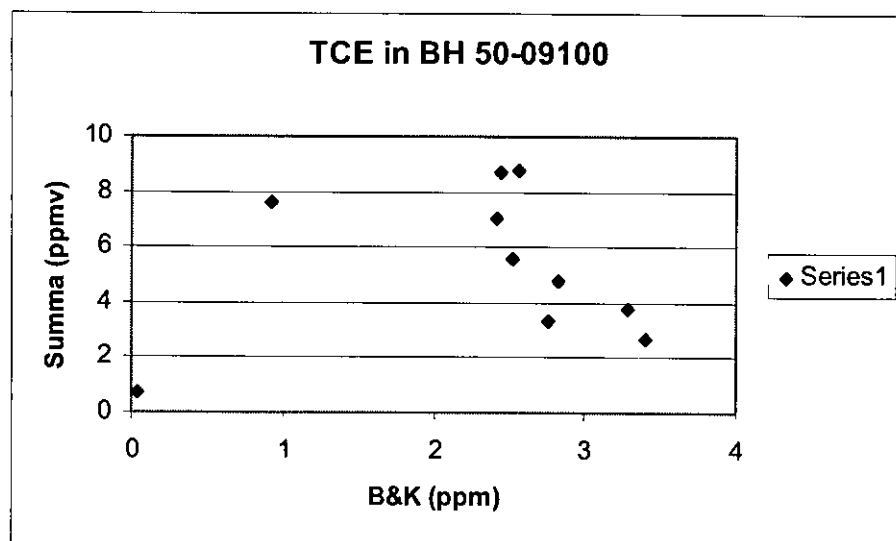


Figure D-29. Correlation plot for B&K and SUMMA data for trichloroethene in borehole 50-09100

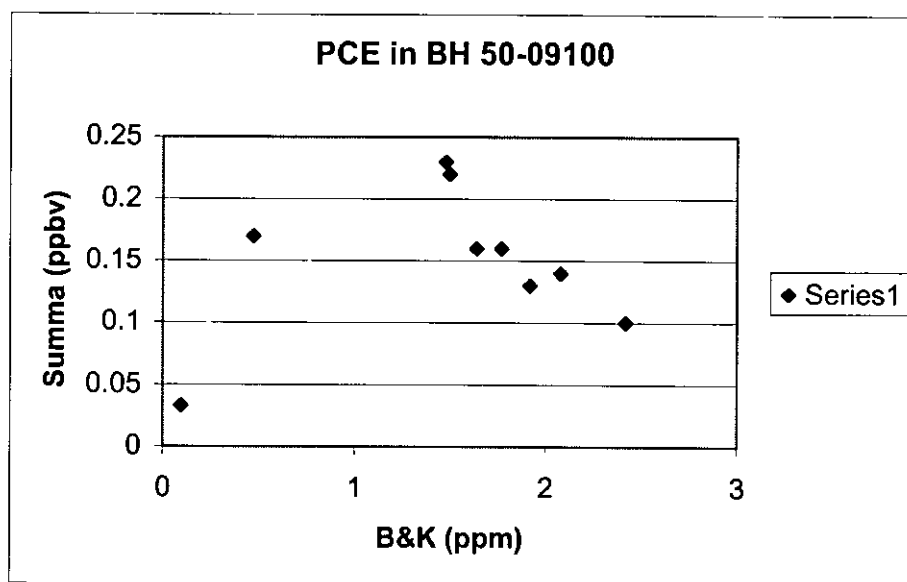


Figure D-30. Correlation plot for B&K and SUMMA data for tetrachloroethene in borehole 50-09100

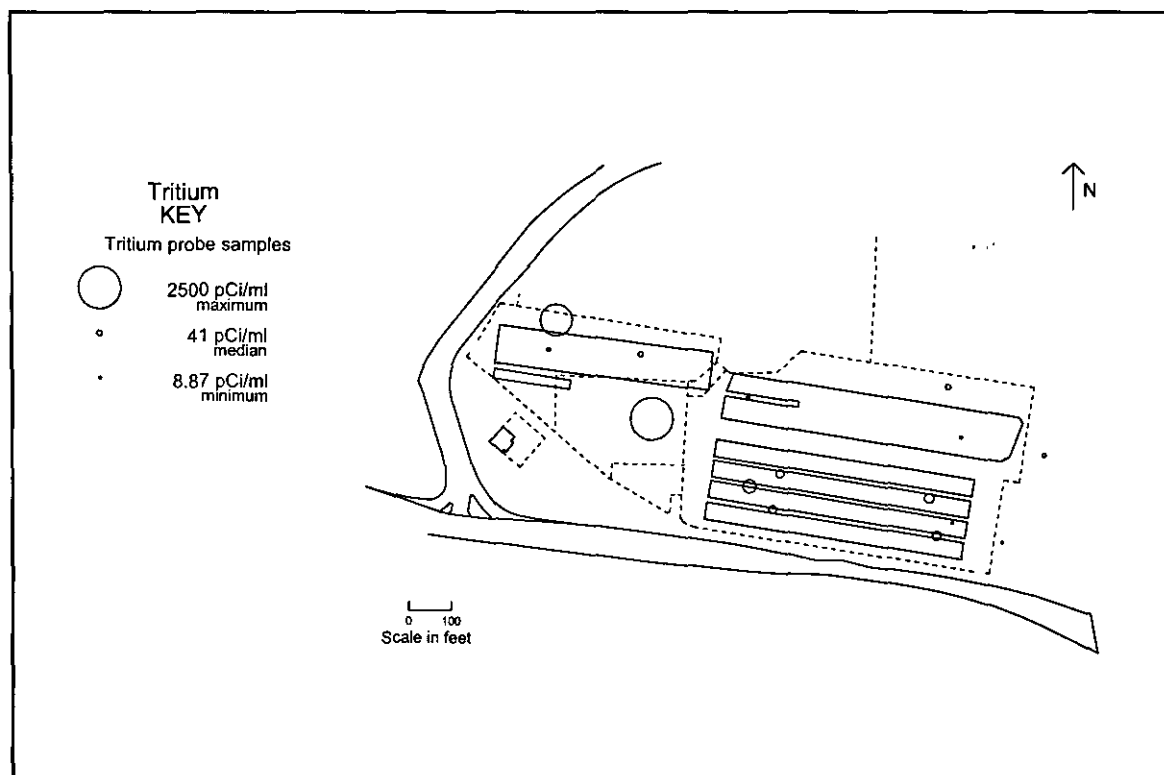


Figure D-31. Bubble plot of tritium from tritium probes at MDA C

Table D-1
Results of Statistical Tests for MDA C Inorganic Chemicals in Surface Soil and Fill

Analyte	Gehan p-value	Quantile p-Value	No. Site Data	No. Background Data	Max Site	Max Background	Above BV? (Y/N)
Antimony	0.94	n/a*	68	135	0.25	1	N
Arsenic	0.99	1	68	150	8	9.3	N
Barium	0.99	0.998908	68	173	250	410	N
Beryllium	0.75	0.987015	68	174	1.4	3.95	N
Cadmium	0.94	n/a	68	39	-0.4	2.6	N
Chromium	0.74	0.144962	68	173	18	36.5	N
Lead	<0.05	<0.05	68	173	30	28	Y
Mercury	<0.05	<0.05	10	39	0.1	0.1	N
Nickel	0.60	0.35	68	174	14	29	N
Potassium	0.62	1	2	174	1800	6850	N
Selenium	0.98	0.99	68	39	1	1.7	N
Silver	n/a	n/a	68	n/a	6	n/a	n/a
Thallium	1	1	68	173	0.21	1	N

*n/a = Not applicable.

Table D-2
Results of Statistical Tests for MDA C Radionuclides in Surface Soil and Fill

Analyte	Gehan p-value	Quantile p-value	No. Site Data	No. Background Data	Max Site (pCi/g)	Max Background (pCi/g)
Americium-241	<0.05	<0.05	68	27	1.017	0.013
Plutonium-238	<0.05	<0.05	68	56	0.219	0.037
Plutonium-239	<0.05	<0.05	68	56	10.687	0.055

Table D-3
Results of Statistical Tests for MDA C Inorganic Chemicals in Subsurface Tuff

Analyte	Gehan p-Value	Quantile p-Value	No. Site Data	No. Background Data	Max Site (mg/kg)	Max Background (mg/kg)	Above BV? (Y/N)
Aluminum	1	0.99	81	63	7900	8370	Y
Antimony	NR ^a	NR	75	64	11	0.4	Y
Arsenic	0.66	0.17	81	64	9.8	5	Y
Barium	1	0.99	81	63	100	51.6	Y
Beryllium	1	0.99	81	64	1.3	1.8	N
Cadmium	1	1	81	15	0.82	1.5	N
Calcium	1	1	81	64	7390	2230	Y
Chromium	0.99	0.97	81	64	12.7	13	Y
Cobalt	0.99	0.96	81	11	3.8	3.14	Y
Copper	0.83	0.99	81	64	30.7	6.2	Y
Cyanide	n/a ^b	n/a	60	n/a	10.2	n/a	n/a
Iron	0.99	1	81	64	8670	19500	N
Lead	0.99	0.88	81	63	75.2	15.5	Y
Magnesium	0.99	0.99	81	64	2690	2820	N
Manganese	0.99	0.99	81	64	319	752	N
Mercury	n/a	n/a	81	n/a	0.11(U)	n/a	n/a
Nickel	0.54	0.88	81	63	13.2	7	Y
Potassium	1	1	81	75	1000	41360	N
Selenium	NR	NR	81	15	10.5	0.2	Y
Silver	0.55	NR	81	64	0.6	1.9	N
Sodium	1	1	81	64	387	7700	N
Thallium	0.23	0.29	81	64	1.4	1.7	Y
Vanadium	1	0.99	81	64	10.5	21	N
Zinc	0.99	1	81	64	54	65.6	N

^a NR = Not run.

^b n/a = Not applicable.

Table D-4
Summary Table for Detected VOCs in Pore Gas

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-09100	MD50-01-0022	20	Acetone	18	None	08/08/01
50-09100	MD50-01-0022	20	Carbon tetrachloride	18	None	08/08/01
50-09100	MD50-03-49738	20	Carbon tetrachloride	18	None	01/09/03
50-09100	MD50-01-0027	20	Carbon tetrachloride	22	None	11/26/01
50-09100	MD50-01-0001	20	Carbon tetrachloride	23	None	03/26/01
50-09100	MD50-01-0001	20	Chlorodifluoromethane	49	None	03/26/01
50-09100	MD50-03-49738	20	Chloroform	77	None	01/09/03
50-09100	MD50-01-0027	20	Chloroform	110	None	11/26/01
50-09100	MD50-01-0001	20	Chloroform	130	None	03/26/01
50-09100	MD50-01-0022	20	Chloroform	170	None	08/08/01
50-09100	MD50-03-49738	20	Dichlorodifluoromethane	62	None	01/09/03
50-09100	MD50-01-0027	20	Dichlorodifluoromethane	86	None	11/26/01
50-09100	MD50-01-0022	20	Dichloroethane[1,2-]	8.5	None	08/08/01
50-09100	MD50-01-0022	20	Dichloroethene[cis-1,2-]	6.3	None	08/08/01
50-09100	MD50-03-49738	20	Dichloroethene[cis-1,2-]	9.3	None	01/09/03
50-09100	MD50-01-0027	20	Dichloroethene[cis-1,2-]	14	None	11/26/01
50-09100	MD50-01-0001	20	Dichloroethene[cis-1,2-]	18	None	03/26/01
50-09100	MD50-03-49738	20	Dichloropropane[1,2-]	2.8	None	01/09/03
50-09100	MD50-01-0027	20	Dichloropropane[1,2-]	6.4	None	11/26/01
50-09100	MD50-01-0022	20	Dichloropropane[1,2-]	29	None	08/08/01
50-09100	MD50-03-49738	20	Methylene chloride	2.9	None	01/09/03
50-09100	MD50-01-0022	20	Methylene chloride	11	None	08/08/01
50-09100	MD50-01-0027	20	Methylene chloride	69	None	11/26/01
50-09100	MD50-01-0022	20	Propanol[2-]	16	None	08/08/01
50-09100	MD50-03-49738	20	Tetrachloroethene	33	None	01/09/03
50-09100	MD50-01-0027	20	Tetrachloroethene	51	None	11/26/01
50-09100	MD50-01-0001	20	Tetrachloroethene	70	None	03/26/01
50-09100	MD50-01-0022	20	Tetrachloroethene	1200	None	08/08/01
50-09100	MD50-01-0022	20	Toluene	24	None	08/08/01
50-09100	MD50-01-0022	20	Trichloro-1,2,2-trifluoroethane[1,1,2-]	26	None	08/08/01
50-09100	MD50-03-49738	20	Trichloro-1,2,2-trifluoroethane[1,1,2-]	130	None	01/09/03
50-09100	MD50-01-0027	20	Trichloro-1,2,2-trifluoroethane[1,1,2-]	230	None	11/26/01
50-09100	MD50-01-0001	20	Trichloro-1,2,2-trifluoroethane[1,1,2-]	260	None	03/26/01
50-09100	MD50-01-0022	20	Trichloroethane[1,1,1-]	22	None	08/08/01
50-09100	MD50-03-49738	20	Trichloroethane[1,1,1-]	32	None	01/09/03

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-09100	MD50-01-0001	20	Trichloroethane[1,1,1-]	52	None	03/26/01
50-09100	MD50-01-0027	20	Trichloroethane[1,1,1-]	54	None	11/26/01
50-09100	MD50-03-49738	20	Trichloroethene	760	None	01/09/03
50-09100	MD50-01-0027	20	Trichloroethene	1100	None	11/26/01
50-09100	MD50-01-0022	20	Trichloroethene	1400	None	08/08/01
50-09100	MD50-01-0001	20	Trichloroethene	1600	None	03/26/01
50-09100	MD50-03-49738	20	Trichlorofluoromethane	3.7	None	01/09/03
50-09100	MD50-01-0027	20	Trichlorofluoromethane	6	None	11/26/01
50-09100	MD50-01-0022	20	Xylene (Total)	8.9	None	08/08/01
50-09100	MD50-01-0022	20	Xylene[1,2-]	3.8	None	08/08/01
50-09100	MD50-03-49739	50	Carbon tetrachloride	49	None	01/09/03
50-09100	MD50-01-0023	50	Carbon tetrachloride	52	None	08/08/01
50-09100	MD50-01-0028	50	Carbon tetrachloride	67	None	11/26/01
50-09100	MD50-03-49739	50	Chloroform	220	None	01/09/03
50-09100	MD50-01-0023	50	Chloroform	270	None	08/08/01
50-09100	MD50-01-0028	50	Chloroform	360	None	11/26/01
50-09100	MD50-03-49739	50	Dichlorodifluoromethane	100	None	01/09/03
50-09100	MD50-01-0028	50	Dichlorodifluoromethane	150	None	11/26/01
50-09100	MD50-03-49739	50	Dichloroethane[1,2-]	8.3	J	01/09/03
50-09100	MD50-03-49739	50	Dichloroethene[1,1-]	9.7	None	01/09/03
50-09100	MD50-03-49739	50	Dichloroethene[cis-1,2-]	40	None	01/09/03
50-09100	MD50-01-0023	50	Dichloroethene[cis-1,2-]	52	None	08/08/01
50-09100	MD50-01-0028	50	Dichloroethene[cis-1,2-]	63	None	11/26/01
50-09100	MD50-03-49739	50	Dichloropropane[1,2-]	12	None	01/09/03
50-09100	MD50-01-0023	50	Dichloropropane[1,2-]	21	None	08/08/01
50-09100	MD50-01-0028	50	Dichloropropane[1,2-]	28	None	11/26/01
50-09100	MD50-03-49739	50	Methylene chloride	11	None	01/09/03
50-09100	MD50-01-0028	50	Methylene chloride	30	None	11/26/01
50-09100	MD50-03-49739	50	Tetrachloroethene	100	None	01/09/03
50-09100	MD50-01-0023	50	Tetrachloroethene	130	None	08/08/01
50-09100	MD50-01-0028	50	Tetrachloroethene	180	None	11/26/01
50-09100	MD50-03-49739	50	Trichloro-1,2,2-trifluoroethane[1,1,2-]	200	None	01/09/03
50-09100	MD50-01-0023	50	Trichloro-1,2,2-trifluoroethane[1,1,2-]	350	None	08/08/01
50-09100	MD50-01-0028	50	Trichloro-1,2,2-trifluoroethane[1,1,2-]	410	None	11/26/01
50-09100	MD50-03-49739	50	Trichloroethane[1,1,1-]	62	None	01/09/03
50-09100	MD50-01-0023	50	Trichloroethane[1,1,1-]	86	None	08/08/01
50-09100	MD50-01-0028	50	Trichloroethane[1,1,1-]	110	None	11/26/01

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-09100	MD50-03-49739	50	Trichloroethene	2700	None	01/09/03
50-09100	MD50-01-0023	50	Trichloroethene	4000	None	08/08/01
50-09100	MD50-01-0028	50	Trichloroethene	4400	None	11/26/01
50-09100	MD50-03-49740	90	Carbon tetrachloride	60	None	01/09/03
50-09100	MD50-00-0124	90	Carbon tetrachloride	80	None	12/18/00
50-09100	MD50-00-0099	90	Carbon tetrachloride	140	J	08/02/00
50-09100	MD50-03-49740	90	Chloroform	230	None	01/09/03
50-09100	MD50-00-0124	90	Chloroform	370	None	12/18/00
50-09100	MD50-03-49740	90	Dichlorodifluoromethane	110	None	01/09/03
50-09100	MD50-00-0099	90	Dichlorodifluoromethane	230	J	08/02/00
50-09100	MD50-03-49740	90	Dichloroethene[cis-1,2-]	52	None	01/09/03
50-09100	MD50-00-0124	90	Dichloroethene[cis-1,2-]	72	None	12/18/00
50-09100	MD50-00-0099	90	Dichloroethene[cis-1,2-]	110	J	08/02/00
50-09100	MD50-00-0124	90	Dichloropropane[1,2-]	31	None	12/18/00
50-09100	MD50-03-49740	90	Methylene chloride	28	None	01/09/03
50-09100	MD50-00-0124	90	Methylene chloride	54	None	12/18/00
50-09100	MD50-03-49740	90	Tetrachloroethene	130	None	01/09/03
50-09100	MD50-00-0099	90	Tetrachloroethene	240	J	08/02/00
50-09100	MD50-00-0124	90	Tetrachloroethene	240	None	12/18/00
50-09100	MD50-03-49740	90	Trichloro-1,2,2-trifluoroethane[1,1,2-]	200	None	01/09/03
50-09100	MD50-00-0124	90	Trichloro-1,2,2-trifluoroethane[1,1,2-]	350	None	12/18/00
50-09100	MD50-00-0099	90	Trichloro-1,2,2-trifluoroethane[1,1,2-]	520	J	08/02/00
50-09100	MD50-03-49740	90	Trichloroethane[1,1,1-]	60	None	01/09/03
50-09100	MD50-00-0124	90	Trichloroethane[1,1,1-]	110	None	12/18/00
50-09100	MD50-00-0099	90	Trichloroethane[1,1,1-]	140	J	08/02/00
50-09100	MD50-03-49740	90	Trichloroethene	3300	None	01/09/03
50-09100	MD50-00-0124	90	Trichloroethene	6100	None	12/18/00
50-09100	MD50-00-0099	90	Trichloroethene	9400	None	08/02/00
50-09100	MD50-03-49741	103	Carbon tetrachloride	66	None	01/09/03
50-09100	MD50-01-0021	103	Carbon tetrachloride	89	None	08/08/01
50-09100	MD50-03-49741	103	Chloroform	250	None	01/09/03
50-09100	MD50-01-0021	103	Chloroform	380	None	08/08/01
50-09100	MD50-03-49741	103	Dichlorodifluoromethane	120	None	01/09/03
50-09100	MD50-03-49741	103	Dichloroethene[cis-1,2-]	58	None	01/09/03
50-09100	MD50-01-0021	103	Dichloroethene[cis-1,2-]	84	None	08/08/01
50-09100	MD50-03-49741	103	Dichloropropane[1,2-]	18	None	01/09/03
50-09100	MD50-01-0021	103	Dichloropropane[1,2-]	32	None	08/08/01

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-09100	MD50-03-49741	103	Methylene chloride	38	None	01/09/03
50-09100	MD50-01-0021	103	Methylene chloride	57	None	08/08/01
50-09100	MD50-03-49741	103	Tetrachloroethene	140	None	01/09/03
50-09100	MD50-01-0021	103	Tetrachloroethene	230	None	08/08/01
50-09100	MD50-03-49741	103	Trichloro-1,2,2-trifluoroethane[1,1,2-]	200	None	01/09/03
50-09100	MD50-01-0021	103	Trichloro-1,2,2-trifluoroethane[1,1,2-]	350	None	08/08/01
50-09100	MD50-03-49741	103	Trichloroethane[1,1,1-]	53	None	01/09/03
50-09100	MD50-01-0021	103	Trichloroethane[1,1,1-]	98	None	08/08/01
50-09100	MD50-03-49741	103	Trichloroethene	3800	None	01/09/03
50-09100	MD50-01-0021	103	Trichloroethene	5600	None	08/08/01
50-09100	MD50-03-49742	120	Carbon tetrachloride	68	None	01/09/03
50-09100	MD50-03-49742	120	Chloroform	260	None	01/09/03
50-09100	MD50-03-49742	120	Dichlorodifluoromethane	120	None	01/09/03
50-09100	MD50-03-49742	120	Dichloroethene[cis-1,2-]	70	None	01/09/03
50-09100	MD50-03-49742	120	Dichloropropane[1,2-]	22	None	01/09/03
50-09100	MD50-03-49742	120	Methylene chloride	62	None	01/09/03
50-09100	MD50-03-49742	120	Tetrachloroethene	160	None	01/09/03
50-09100	MD50-03-49742	120	Trichloro-1,2,2-trifluoroethane[1,1,2-]	170	None	01/09/03
50-09100	MD50-03-49742	120	Trichloroethane[1,1,1-]	42	None	01/09/03
50-09100	MD50-03-49742	120	Trichloroethene	4800	None	01/09/03
50-09100	MD50-03-49743	160	Carbon tetrachloride	77	None	01/09/03
50-09100	MD50-03-49743	160	Dichlorodifluoromethane	120	None	01/09/03
50-09100	MD50-03-49743	160	Dichloroethene[cis-1,2-]	74	None	01/09/03
50-09100	MD50-03-49743	160	Methylene chloride	120	None	01/09/03
50-09100	MD50-03-49743	160	Tetrachloroethene	160	None	01/09/03
50-09100	MD50-03-49743	160	Trichloro-1,2,2-trifluoroethane[1,1,2-]	130	None	01/09/03
50-09100	MD50-03-49743	160	Trichloroethane[1,1,1-]	33	None	01/09/03
50-09100	MD50-03-49743	160	Trichloroethene	5600	None	01/09/03
50-09100	MD50-01-0002	200	Carbon tetrachloride	100	None	03/26/01
50-09100	MD50-03-49744	200	Carbon tetrachloride	110	None	01/09/03
50-09100	MD50-00-0123	200	Carbon tetrachloride	120	None	12/18/00
50-09100	MD50-01-0002	200	Chloroform	300	None	03/26/01
50-09100	MD50-03-49744	200	Chloroform	300	None	01/09/03
50-09100	MD50-00-0123	200	Chloroform	380	None	12/18/00
50-09100	MD50-03-49744	200	Dichlorodifluoromethane	170	None	01/09/03
50-09100	MD50-00-0123	200	Dichloroethene[1,1-]	48	None	12/18/00
50-09100	MD50-01-0002	200	Dichloroethene[cis-1,2-]	100	None	03/26/01

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-09100	MD50-03-49744	200	Dichloroethene[cis-1,2-]	100	None	01/09/03
50-09100	MD50-00-0123	200	Dichloroethene[cis-1,2-]	110	None	12/18/00
50-09100	MD50-00-0123	200	Dichloropropane[1,2-]	59	None	12/18/00
50-09100	MD50-03-49744	200	Methylene chloride	240	None	01/09/03
50-09100	MD50-01-0002	200	Methylene chloride	270	None	03/26/01
50-09100	MD50-00-0123	200	Methylene chloride	410	None	12/18/00
50-09100	MD50-03-49744	200	Tetrachloroethene	230	None	01/09/03
50-09100	MD50-01-0002	200	Tetrachloroethene	270	None	03/26/01
50-09100	MD50-00-0123	200	Tetrachloroethene	320	None	12/18/00
50-09100	MD50-03-49744	200	Trichloro-1,2,2-trifluoroethane[1,1,2-]	180	None	01/09/03
50-09100	MD50-01-0002	200	Trichloro-1,2,2-trifluoroethane[1,1,2-]	190	None	03/26/01
50-09100	MD50-00-0123	200	Trichloro-1,2,2-trifluoroethane[1,1,2-]	310	None	12/18/00
50-09100	MD50-03-49744	200	Trichloroethane[1,1,1-]	44	None	01/09/03
50-09100	MD50-01-0002	200	Trichloroethane[1,1,1-]	62	None	03/26/01
50-09100	MD50-00-0123	200	Trichloroethane[1,1,1-]	840	None	12/18/00
50-09100	MD50-03-49744	200	Trichloroethene	8800	None	01/09/03
50-09100	MD50-01-0002	200	Trichloroethene	9100	None	03/26/01
50-09100	MD50-00-0123	200	Trichloroethene	12000	None	12/18/00
50-09100	MD50-03-49745	233	Carbon tetrachloride	97	None	01/09/03
50-09100	MD50-03-49745	233	Chloroform	270	None	01/09/03
50-09100	MD50-03-49745	233	Dichlorodifluoromethane	140	None	01/09/03
50-09100	MD50-03-49745	233	Dichloroethene[cis-1,2-]	100	None	01/09/03
50-09100	MD50-03-49745	233	Methylene chloride	230	None	01/09/03
50-09100	MD50-03-49745	233	Tetrachloroethene	220	None	01/09/03
50-09100	MD50-03-49745	233	Trichloro-1,2,2-trifluoroethane[1,1,2-]	140	None	01/09/03
50-09100	MD50-03-49745	233	Trichloroethene	8700	None	01/09/03
50-09100	MD50-01-0024	260	Acetone	68	None	08/08/01
50-09100	MD50-01-0024	260	Benzene	4.3	None	08/08/01
50-09100	MD50-01-0024	260	Butanone[2-]	32	None	08/08/01
50-09100	MD50-01-0024	260	Carbon tetrachloride	12	None	08/08/01
50-09100	MD50-03-49746	260	Carbon tetrachloride	86	None	01/09/03
50-09100	MD50-01-0024	260	Chloroform	67	None	08/08/01
50-09100	MD50-03-49746	260	Chloroform	180	None	01/09/03
50-09100	MD50-03-49746	260	Dichlorodifluoromethane	130	None	01/09/03
50-09100	MD50-01-0024	260	Dichloroethane[1,2-]	3.8	None	08/08/01
50-09100	MD50-01-0024	260	Dichloroethene[cis-1,2-]	3.7	None	08/08/01
50-09100	MD50-03-49746	260	Dichloroethene[cis-1,2-]	73	None	01/09/03

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-09100	MD50-01-0024	260	Dichloropropane[1,2-]	14	None	08/08/01
50-09100	MD50-01-0024	260	Ethanol	42	None	08/08/01
50-09100	MD50-01-0024	260	Ethylbenzene	3.3	None	08/08/01
50-09100	MD50-01-0024	260	Methanol	210	None	08/08/01
50-09100	MD50-01-0024	260	Methylene chloride	8.6	None	08/08/01
50-09100	MD50-03-49746	260	Methylene chloride	150	None	01/09/03
50-09100	MD50-01-0024	260	Propanol[2-]	35	None	08/08/01
50-09100	MD50-03-49746	260	Tetrachloroethene	170	None	01/09/03
50-09100	MD50-01-0024	260	Tetrachloroethene	510	None	08/08/01
50-09100	MD50-01-0024	260	Toluene	43	None	08/08/01
50-09100	MD50-01-0024	260	Trichloro-1,2,2-trifluoroethane[1,1,2-]	11	None	08/08/01
50-09100	MD50-03-49746	260	Trichloro-1,2,2-trifluoroethane[1,1,2-]	83	None	01/09/03
50-09100	MD50-01-0024	260	Trichloroethane[1,1,1-]	17	None	08/08/01
50-09100	MD50-01-0024	260	Trichloroethene	680	None	08/08/01
50-09100	MD50-03-49746	260	Trichloroethene	7000	None	01/09/03
50-09100	MD50-01-0024	260	Xylene (Total)	13	None	08/08/01
50-09100	MD50-01-0024	260	Xylene[1,2-]	5	None	08/08/01
50-09100	MD50-03-49747	315	Carbon tetrachloride	74	None	01/09/03
50-09100	MD50-00-0100	315	Carbon tetrachloride	140	J	08/02/00
50-09100	MD50-03-49747	315	Chloroform	190	None	01/09/03
50-09100	MD50-03-49747	315	Dichloroethene[cis-1,2-]	77	None	01/09/03
50-09100	MD50-00-0100	315	Dichloroethene[cis-1,2-]	100	J	08/02/00
50-09100	MD50-03-49747	315	Methylene chloride	160	None	01/09/03
50-09100	MD50-00-0100	315	Methylene chloride	560	J	08/02/00
50-09100	MD50-03-49747	315	Tetrachloroethene	170	None	01/09/03
50-09100	MD50-00-0100	315	Tetrachloroethene	210	J	08/02/00
50-09100	MD50-03-49747	315	Trichloro-1,2,2-trifluoroethane[1,1,2-]	34	None	01/09/03
50-09100	MD50-03-49747	315	Trichloroethene	7600	None	01/09/03
50-09100	MD50-00-0100	315	Trichloroethene	13000	None	08/02/00
50-10131	MD50-01-0025	25	Acetone	28	None	11/26/01
50-10131	MD50-01-0025	25	Butanone[2-]	69	None	11/26/01
50-10131	MD50-03-49728	25	Carbon tetrachloride	12	None	01/08/03
50-10131	MD50-01-0025	25	Carbon tetrachloride	25	None	11/26/01
50-10131	MD50-03-49728	25	Chloroform	180	None	01/08/03
50-10131	MD50-01-0025	25	Chloroform	220	None	11/26/01
50-10131	MD50-01-0025	25	Dichlorodifluoromethane	34	None	11/26/01
50-10131	MD50-03-49728	25	Dichloroethane[1,2-]	6	None	01/08/03

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-10131	MD50-01-0025	25	Dichloroethane[1,2-]	9.9	None	11/26/01
50-10131	MD50-01-0025	25	Dichloroethene[cis-1,2-]	6.9	None	11/26/01
50-10131	MD50-03-49728	25	Dichloropropane[1,2-]	16	None	01/08/03
50-10131	MD50-01-0025	25	Dichloropropane[1,2-]	37	None	11/26/01
50-10131	MD50-01-0025	25	Methylene chloride	11	None	11/26/01
50-10131	MD50-01-0025	25	Tetrachloroethene	1400	None	11/26/01
50-10131	MD50-03-49728	25	Tetrachloroethene	1600	None	01/08/03
50-10131	MD50-01-0025	25	Toluene	98	None	11/26/01
50-10131	MD50-03-49728	25	Trichloro-1,2,2-trifluoroethane[1,1,2-]	16	None	01/08/03
50-10131	MD50-01-0025	25	Trichloro-1,2,2-trifluoroethane[1,1,2-]	27	None	11/26/01
50-10131	MD50-03-49728	25	Trichloroethane[1,1,1-]	23	None	01/08/03
50-10131	MD50-01-0025	25	Trichloroethane[1,1,1-]	62	None	11/26/01
50-10131	MD50-03-49728	25	Trichloroethene	1400	None	01/08/03
50-10131	MD50-01-0025	25	Trichloroethene	1800	None	11/26/01
50-10131	MD50-03-49728	25	Trichlorofluoromethane	6.2	None	01/08/03
50-10131	MD50-01-0025	25	Trichlorofluoromethane	9.2	None	11/26/01
50-10131	MD50-03-49729	50	Carbon tetrachloride	24	None	01/08/03
50-10131	MD50-03-49729	50	Chloroform	340	None	01/08/03
50-10131	MD50-03-49729	50	Dichloroethane[1,2-]	20	None	01/08/03
50-10131	MD50-03-49729	50	Dichloroethene[cis-1,2-]	9.4	None	01/08/03
50-10131	MD50-03-49729	50	Dichloropropane[1,2-]	52	None	01/08/03
50-10131	MD50-03-49729	50	Ethanol	5700	J-	01/08/03
50-10131	MD50-03-49729	50	Methylene chloride	12	None	01/08/03
50-10131	MD50-03-49729	50	Propanol[2-]	220	None	01/08/03
50-10131	MD50-03-49729	50	Tetrachloroethene	2100	None	01/08/03
50-10131	MD50-03-49729	50	Trichloro-1,2,2-trifluoroethane[1,1,2-]	31	None	01/08/03
50-10131	MD50-03-49729	50	Trichloroethane[1,1,1-]	28	None	01/08/03
50-10131	MD50-03-49729	50	Trichloroethene	2300	None	01/08/03
50-10131	MD50-03-49730	75	Carbon tetrachloride	30	None	01/08/03
50-10131	MD50-03-49730	75	Chloroform	300	None	01/08/03
50-10131	MD50-03-49730	75	Dichloroethane[1,2-]	19	None	01/08/03
50-10131	MD50-03-49730	75	Dichloroethene[cis-1,2-]	9.1	None	01/08/03
50-10131	MD50-03-49730	75	Dichloropropane[1,2-]	59	None	01/08/03
50-10131	MD50-03-49730	75	Methylene chloride	16	None	01/08/03
50-10131	MD50-03-49730	75	Tetrachloroethene	1600	None	01/08/03
50-10131	MD50-03-49730	75	Trichloro-1,2,2-trifluoroethane[1,1,2-]	35	None	01/08/03
50-10131	MD50-03-49730	75	Trichloroethane[1,1,1-]	28	None	01/08/03

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-10131	MD50-03-49730	75	Trichloroethene	1900	None	01/08/03
50-10131	MD50-03-49730	75	Trichlorofluoromethane	8.2	None	01/08/03
50-10131	MD50-03-49731	100	Carbon tetrachloride	42	None	01/08/03
50-10131	MD50-03-49731	100	Chloroform	260	None	01/08/03
50-10131	MD50-03-49731	100	Dichloroethane[1,2-]	18	None	01/08/03
50-10131	MD50-03-49731	100	Dichloroethene[cis-1,2-]	12	None	01/08/03
50-10131	MD50-03-49731	100	Dichloropropane[1,2-]	71	None	01/08/03
50-10131	MD50-03-49731	100	Methylene chloride	18	None	01/08/03
50-10131	MD50-03-49731	100	Tetrachloroethene	1400	None	01/08/03
50-10131	MD50-03-49731	100	Trichloro-1,2,2-trifluoroethane[1,1,2-]	48	None	01/08/03
50-10131	MD50-03-49731	100	Trichloroethane[1,1,1-]	34	None	01/08/03
50-10131	MD50-03-49731	100	Trichloroethene	2000	None	01/08/03
50-10131	MD50-03-49731	100	Trichlorofluoromethane	9.4	None	01/08/03
50-10131	MD50-03-49732	125	Carbon tetrachloride	29	None	01/08/03
50-10131	MD50-01-0026	125	Carbon tetrachloride	36	None	11/26/01
50-10131	MD50-03-49732	125	Chloroform	120	None	01/08/03
50-10131	MD50-01-0026	125	Chloroform	180	None	11/26/01
50-10131	MD50-01-0026	125	Dichlorodifluoromethane	50	None	11/26/01
50-10131	MD50-03-49732	125	Dichloroethane[1,2-]	9.8	None	01/08/03
50-10131	MD50-01-0026	125	Dichloroethane[1,2-]	12	None	11/26/01
50-10131	MD50-03-49732	125	Dichloroethene[cis-1,2-]	8.4	None	01/08/03
50-10131	MD50-01-0026	125	Dichloroethene[cis-1,2-]	10	None	11/26/01
50-10131	MD50-03-49732	125	Dichloropropane[1,2-]	43	None	01/08/03
50-10131	MD50-01-0026	125	Dichloropropane[1,2-]	59	None	11/26/01
50-10131	MD50-01-0026	125	Ethanol	35	None	11/26/01
50-10131	MD50-03-49732	125	Methylene chloride	18	None	01/08/03
50-10131	MD50-01-0026	125	Methylene chloride	19	None	11/26/01
50-10131	MD50-03-49732	125	Tetrachloroethene	600	None	01/08/03
50-10131	MD50-01-0026	125	Tetrachloroethene	1000	None	11/26/01
50-10131	MD50-01-0026	125	Toluene	42	None	11/26/01
50-10131	MD50-03-49732	125	Trichloro-1,2,2-trifluoroethane[1,1,2-]	32	None	01/08/03
50-10131	MD50-01-0026	125	Trichloro-1,2,2-trifluoroethane[1,1,2-]	52	None	11/26/01
50-10131	MD50-03-49732	125	Trichloroethane[1,1,1-]	21	None	01/08/03
50-10131	MD50-01-0026	125	Trichloroethane[1,1,1-]	49	None	11/26/01
50-10131	MD50-03-49732	125	Trichloroethene	1100	None	01/08/03
50-10131	MD50-01-0026	125	Trichloroethene	1600	None	11/26/01
50-10131	MD50-03-49732	125	Trichlorofluoromethane	5.4	None	01/08/03

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-10131	MD50-01-0026	125	Trichlorofluoromethane	9.7	None	11/26/01
50-10131	MD50-03-49733	150	Carbon tetrachloride	61	None	01/08/03
50-10131	MD50-03-49733	150	Chloroform	160	None	01/08/03
50-10131	MD50-03-49733	150	Dichloroethane[1,2-]	13	None	01/08/03
50-10131	MD50-03-49733	150	Dichloroethene[cis-1,2-]	14	None	01/08/03
50-10131	MD50-03-49733	150	Dichloropropane[1,2-]	64	None	01/08/03
50-10131	MD50-03-49733	150	Methylene chloride	26	None	01/08/03
50-10131	MD50-03-49733	150	Tetrachloroethene	990	None	01/08/03
50-10131	MD50-03-49733	150	Trichloro-1,2,2-trifluoroethane[1,1,2-]	51	None	01/08/03
50-10131	MD50-03-49733	150	Trichloroethane[1,1,1-]	34	None	01/08/03
50-10131	MD50-03-49733	150	Trichloroethene	1900	None	01/08/03
50-10131	MD50-03-49733	150	Trichlorofluoromethane	8.7	None	01/08/03
50-10131	MD50-03-49734	175	Carbon tetrachloride	75	None	01/08/03
50-10131	MD50-03-49734	175	Chloroform	120	None	01/08/03
50-10131	MD50-03-49734	175	Dichloroethane[1,2-]	9.4	None	01/08/03
50-10131	MD50-03-49734	175	Dichloroethene[cis-1,2-]	15	None	01/08/03
50-10131	MD50-03-49734	175	Dichloropropane[1,2-]	59	None	01/08/03
50-10131	MD50-03-49734	175	Methylene chloride	25	None	01/08/03
50-10131	MD50-03-49734	175	Tetrachloroethene	920	None	01/08/03
50-10131	MD50-03-49734	175	Trichloro-1,2,2-trifluoroethane[1,1,2-]	41	None	01/08/03
50-10131	MD50-03-49734	175	Trichloroethane[1,1,1-]	31	None	01/08/03
50-10131	MD50-03-49734	175	Trichloroethene	1900	None	01/08/03
50-10131	MD50-03-49734	175	Trichlorofluoromethane	8.1	None	01/08/03
50-10131	MD50-03-49735	200	Carbon tetrachloride	85	None	01/08/03
50-10131	MD50-03-49735	200	Chloroform	87	None	01/08/03
50-10131	MD50-03-49735	200	Dichloroethene[cis-1,2-]	13	None	01/08/03
50-10131	MD50-03-49735	200	Dichloropropane[1,2-]	47	None	01/08/03
50-10131	MD50-03-49735	200	Methylene chloride	26	None	01/08/03
50-10131	MD50-03-49735	200	Tetrachloroethene	800	None	01/08/03
50-10131	MD50-03-49735	200	Trichloro-1,2,2-trifluoroethane[1,1,2-]	32	None	01/08/03
50-10131	MD50-03-49735	200	Trichloroethane[1,1,1-]	27	None	01/08/03
50-10131	MD50-03-49735	200	Trichloroethene	1800	None	01/08/03
50-10131	MD50-03-49735	200	Trichlorofluoromethane	8.3	None	01/08/03
50-10131	MD50-03-49736	225	Carbon tetrachloride	99	None	01/08/03
50-10131	MD50-03-49736	225	Dichlorodifluoromethane	76	None	01/08/03
50-10131	MD50-03-49736	225	Dichloroethene[cis-1,2-]	13	None	01/08/03
50-10131	MD50-03-49736	225	Dichloropropane[1,2-]	43	None	01/08/03

Table D-4 (continued)

Location ID	Sample ID	Depth (ft)	Analyte	Result (ppbv)	FU4_QUAL	Collection Date
50-10131	MD50-03-49736	225	Methylene chloride	26	None	01/08/03
50-10131	MD50-03-49736	225	Tetrachloroethene	800	None	01/08/03
50-10131	MD50-03-49736	225	Trichloro-1,2,2-trifluoroethane[1,1,2-]	28	None	01/08/03
50-10131	MD50-03-49736	225	Trichloroethane[1,1,1-]	26	None	01/08/03
50-10131	MD50-03-49736	225	Trichloroethene	1900	None	01/08/03
50-10131	MD50-03-49736	225	Trichlorofluoromethane	8.6	None	01/08/03
50-10131	MD50-03-49737	250	Carbon tetrachloride	67	None	01/08/03
50-10131	MD50-03-49737	250	Dichlorodifluoromethane	51	None	01/08/03
50-10131	MD50-03-49737	250	Dichloroethene[cis-1,2-]	7.2	None	01/08/03
50-10131	MD50-03-49737	250	Dichloropropane[1,2-]	22	None	01/08/03
50-10131	MD50-03-49737	250	Methylene chloride	14	None	01/08/03
50-10131	MD50-03-49737	250	Tetrachloroethene	450	None	01/08/03
50-10131	MD50-03-49737	250	Trichloro-1,2,2-trifluoroethane[1,1,2-]	14	None	01/08/03
50-10131	MD50-03-49737	250	Trichloroethane[1,1,1-]	15	None	01/08/03
50-10131	MD50-03-49737	250	Trichloroethene	1100	None	01/08/03
50-10131	MD50-03-49737	250	Trichlorofluoromethane	5.6	None	01/08/03

Table D-5
Tritium Probe Data at MDA C

Location ID	Sample Depth (ft)	Sample ID	Analyte	Result (pCi/mL)
50-03-21464	2.5	MD50-03-49958	Tritium	111
50-03-21465	2.5	MD50-03-49959	Tritium	8.87
50-03-21466	2.5	MD50-03-49960	Tritium	128
50-03-21467	2.5	MD50-03-49961	Tritium	2500
50-03-21468	2.5	MD50-03-49962	Tritium	36.2
50-03-21469	2.5	MD50-03-49963	Tritium	90.5
50-03-21470	2.5	MD50-03-49964	Tritium	84.2
50-03-21471	2.5	MD50-03-49965	Tritium	246
50-03-21472	2.5	MD50-03-49966	Tritium	1400
50-03-21473	2.5	MD50-03-49967	Tritium	20.2
50-03-21474	2.5	MD50-03-49968	Tritium	12.7
50-03-21475	2.5	MD50-03-49969	Tritium	41
50-03-21476	2.5	MD50-03-49970	Tritium	17.6
50-03-21477	2.5	MD50-03-49971	Tritium	9.93
50-03-21478	2.5	MD50-03-49972	Tritium	23.9

Appendix E

Phase I RFI Data
(CD on inside back cover of this report)

List of Tables (on CD)

Table E-1	MDA C Subsurface Data for Inorganic Chemicals.....	E-1
Table E-2	MDA C Subsurface Data for Organic Chemicals.....	E-48
Table E-3	MDA C Subsurface Data for Radionuclides.....	E-276
Table E-4	MDA C Surface Data for Inorganic Chemicals	E-309
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Table E-7	MDA C Pore-Gas Data for Organic Chemicals.....	E-483
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Table E-9	MDA C Rejected Data from Surface and Subsurface Samples	E-537

Appendix F

Investigation-Derived Waste Management

APPENDIX F INVESTIGATION-DERIVED WASTE MANAGEMENT

This appendix to the work plan describes how investigation-derived waste (IDW) generated during the investigation of Material Disposal Area (MDA) C at Los Alamos National Laboratory (the Laboratory) will be managed. IDW is solid waste generated as a result of field investigation activities and may include, but is not limited to, drill cuttings, purge water, contaminated personal protective equipment (PPE), sampling supplies and plastic, fluids from the decontamination of PPE and sampling equipment, and all other wastes potentially contacting contaminants. Certain field investigation activities may also displace environmental media, which is defined as naturally occurring material indigenous to the environment, including groundwater, surface water, surface and subsurface soils, rocks, bedrock, and gravel. Consistent with the US Environmental Protection Agency (EPA) "area of contamination" policy, environmental media are not considered to be waste (and, hence, not IDW) if they are returned to their point of origin. IDW generated during the investigation of MDA C will be managed to protect human health and the environment, comply with applicable regulatory requirements, and adhere to the Laboratory waste minimization goals.

All IDW generated during field investigation activities will be managed in accordance with applicable Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) Project Standard Operating Procedures (SOPs). These SOPs incorporate the requirements of all applicable EPA and the New Mexico Environment Department (NMED) regulations, Department of Energy (DOE) orders, and Laboratory Implementation Requirements (LIRs). RRES-RS SOPs applicable to the characterization and management of IDW are

- LANL-ER-SOP-1.06, Management of Environmental Restoration Project Waste and
- LANL-ER-SOP-1.10, Waste Characterization.

These SOPs are among the SOPs applicable to the MDA C investigation and are available at the following URL: <http://erproject.lanl.gov/documents/procedures.html>.

Investigation activities will be conducted in a manner that minimizes waste generated by implementing the requirements of the RRES-RS Waste Minimization Awareness Plan, which is updated annually as a requirement of Module VIII of the Laboratory's Hazardous Waste Facility Permit.

The IDW waste streams associated with the investigation of MDA C are identified in Table F-1 and are described briefly below. Table F-1 also summarizes the waste type, estimated volume, method of on-site management, and expected disposition for each of these waste streams.

Drill cuttings: The drill cuttings waste stream will consist of cuttings from boreholes that will be completed as vapor monitoring wells. Drill cuttings from other boreholes will be returned to the boreholes in accordance with EPA's "area of contamination" policy. Drill cuttings will be collected and containerized at the point of generation (i.e., at the drill rig). The drill cutting waste stream will be characterized in accordance with LANL-ER-SOP-01.10 to determine waste type and disposition. The Laboratory expects these wastes to be designated as low-level waste (LLW) that will be disposed of at TA-54 Area G.

Spent PPE: The spent PPE waste stream will consist of equipment that cannot be decontaminated. The bulk of this waste stream will consist of protective clothing such as coveralls, gloves, and shoe covers. Spent PPE will be collected in containers at personnel decontamination stations. The spent PPE stream will be characterized in accordance with LANL-ER-SOP-01.10 to determine waste type and disposition. The Laboratory expects these wastes to be designated as LLW to be disposed of at TA-54 Area G.

Table F-1
Summary of Estimated IDW Generation and Management

Waste Stream	Expected Waste Type	Estimated Volume	On-Site Management	Expected Disposition
Drill cuttings ^a	Low-level waste		Accumulation in drums? rollofs?	Disposal at TA-54, Area G
Spent PPE	Low-level waste		Accumulation in 55-gal. drums	Disposal at TA-54, Area G
Disposable sampling supplies	Low-level waste		Accumulation in 55-gal. drums	Disposal at TA-54, Area G
Decontamination fluids	Low-level waste	<55 gal. ^b	Accumulation in 55-gal. drums.	Treatment at TA-50 Radioactive Liquid Waste Treatment Facility

^aIncludes only those cuttings that cannot be returned to the point of origin.

^bDry decontamination methods will be used to the maximum extent possible and only minimal amounts of decontamination fluids are expected to be generated.

Appendix G

*NMED Position Paper on
Determination of Extent of Contamination*

HAZARDOUS AND RADIOACTIVE MATERIALS BUREAU

New Mexico Environment Department



Position Paper

Position Paper

DETERMINATION OF EXTENT OF CONTAMINATION

The vertical and horizontal extent of contamination at a specific site (including off-site migration) is considered adequately determined once concentrations of (1) inorganic constituents (including radionuclides) have been spatially (in three dimensions) delineated relative to background concentrations and (2) organic constituents have been spatially (in three dimensions) delineated relative to practical quantitation limits.

The Facility may petition the Hazardous and Radioactive Materials Bureau for a variance from the above-stated requirements on a case-by-case basis by applying other criteria/considerations which demonstrate the protection of human health and the environment. Factors that may affect the determination of the extent (vertical and horizontal) of contamination include, but are not limited to, the following:

- contaminant concentration gradient,
- contaminant characteristics which influence environmental fate and transport,
- site environmental setting (e.g., geology, hydrogeology, erosion potential, etc.),
- operational history,
- number and location of samples,
- detection limits relative to background or other reference values¹,
- media,
- type of source (e.g., surface impoundment, outfall, etc.), and
- source integrity.

¹Other reference values may include environmental standards (e.g., New Mexico Water Quality Control Commission regulations, etc.) or criteria (e.g., Ambient Water Quality Criteria, etc.).

**Response to
NMED Comments on the Investigation Work Plan for MDA C
at TA 50, Dated July 2003
Los Alamos National Laboratory, EPA ID#NM0890010515**

INTRODUCTION

To facilitate review of this response, the New Mexico Environment Department's (NMED's) comments are included verbatim. The comments are divided into general and specific categories, as presented in the letter. Los Alamos National Laboratory's (LANL's) responses follow each NMED comment.

GENERAL COMMENTS

NMED Comment

1. *Justification for altering the scope of work as described in the November 26, 2002 Order was not provided.*

LANL Response

The work plan presents a scope of work for completing the investigation at MDA C and the technical basis for this proposed scope. The technical basis was formed from an evaluation of the results of the Phase I RFI, other previous investigation activities and NMED's June 17, 1999 position paper entitled "Determination of Extent of Contamination". The key elements of LANL's technical basis are the identification of data gaps needed to meet the investigation objectives and the specific technical approach needed to satisfy these data gaps. The technical basis for LANL's proposed investigation constitutes the justification for altering the scope of work described in the November 26, 2002, Order. That is, LANL believes that the proposed work, in conjunction with the results of previous investigations, satisfies the objectives for the investigation spelled out in the Order. In order to prepare a more detailed justification for deviating from each specific Order requirement, LANL needs to know the technical bases of these requirements, which were not provided in the Order or in NMED's comments on this work plan.

NMED Comment

2. *The Permittees shall include the page, table, and figure numbers when referencing information from previous reports.*

LANL Response

As specified in Section IV.C.3.b of the NMED Order, the requested information will be provided as described in the guidance in the United States Geological Survey "Suggestions to Authors of the Reports of the United States Geological Survey" (http://www.nwrc.usgs.gov/lib/lib_sta.htm).

SPECIFIC COMMENTS

NMED Comment

3. *Executive Summary*

The acronym IWP references the Facility-Wide Installation Work Plan. The Permittees shall refer to this, document as a work plan.

LANL Response

Agreed.

NMED Comment

4. Section 1.0: Introduction; Footnote 1

NMED does not agree with the need to include the disclaimer regarding radioactive waste data in this section or on the title page of the document. NMED maintains that it has the authority to regulate radioactive wastes, other than source, special nuclear and byproduct material as narrowly defined in the Atomic Energy Act of 1954, and to require the monitoring and reporting of radionuclides as necessary to properly regulate non-exempt wastes. The Permittees shall delete this disclaimer.

LANL Response

LANL does not concur with NMED's position regarding authority to regulate radioactive wastes, as stated in the comment. The disclaimer will not be deleted. This disclaimer applies to this Response to NMED comments as well. Any information on radionuclides is provided herein for information only.

NMED Comment

5. Section 2.4: Contaminant Transport Mechanisms and Potential Receptors

The Permittees shall delete the reference to the future MDA C Corrective Measures Study (CMS). It is unknown at this time whether there will be a CMS for this site. All references to the CMS shall be deleted throughout the document.

LANL Response

Reference to the CMS will be deleted from the work plan. LANL recognizes that, as described in Section VII.D.1 of the NMED Order, NMED will make a determination whether corrective measures are required based on the results of the investigation. LANL included a reference to the CMS because of the relationship of the CMS to investigation data needs. Based on previous discussions with NMED technical staff, LANL anticipates that a CMS will be required at MDA C (i.e., LANL does not expect that the results of the investigation will support a recommendation for no further action and MDA C is not a candidate for voluntary corrective measures). Consistent with EPA and DOE guidance on streamlining the cleanup process, LANL has identified data needs associated with the CMS so that these data can be collected during the proposed investigation, rather than requiring an additional phase of investigation.

NMED Comment

6. Section 3.2.1: Stratigraphy

The Permittees shall include brief descriptions of the stratigraphic units beneath MDA C. Move the text from Appendix I, Section 1-2.0 to this section.

LANL Response

The stratigraphic information will be moved to Section 3.2.1 of the work plan, as specified in Section XI.B.6.b of the NMED Order.

NMED Comment

7. Section 3.2.3: Groundwater

The claim that "to date, data obtained indicate that dry mesas such as Mesita del Buey show no evidence of perched aquifers" is unsubstantiated at this time and must be deleted. Perched groundwater was encountered under MDA L at 592 feet. (Refer to the letter from LANL to NMED, dated April 7, 1995 titled, "Notification of groundwater encountered below Material Disposal Area L"). In addition, the drill logs in Appendix C indicate "wet" zones suggesting saturated conditions may exist in the subsurface.

LANL Response

Section XI.B.6.b of the NMED Order requires a discussion of the presence of groundwater. LANL believes that the results of previous investigations do not indicate the presence of groundwater at the site. The presence of wet cuttings in a borehole is not equivalent to the presence of a perched aquifer. The borehole log for borehole 54-01016 indicates that 1 cup of water was recovered from the borehole at MDA L during drilling and no water was produced the next day. One porous cup lysimeter was installed at the depth of saturation and two were installed at deeper depths as part of the Solinst well completion. No water has been produced from any of the three lysimeters in quarterly sampling in this borehole subsequent to drilling. Therefore, to date, there is no indication of perched groundwater. A goal of this investigation is to determine the presence of perched groundwater.

NMED Comment

8. Section 4.0: Scope of Activities

(a) The Permittees shall include a description of all proposed activities related to Investigation-Derived Waste (IDW) storage and disposal.

(b) Samples should be collected every 10 feet and in areas of higher permeability, such as interbedded surge beds, pumice deposits, and alluvial deposits found in the Bandelier Tuff. Higher permeability lithologies and secondary fractures should be targeted as well (for example, rubbly basalt tops and bases, gravels of the Puye Formation).

LANL Response

(a) Storage and disposal of IDW will be discussed in the "Scope of Activities" section of the work plan, as specified in Section XI.B.7 of the NMED Order.

(b) As explained in Sections 5.1.1 and 5.1.2 of the work plan, continuous core samples will be collected from each borehole and these continuous core samples will be radiologically screened and visually inspected to identify core intervals to submit for laboratory analysis. Section IV.C.3.c.iii of the NMED Order requires samples to be collected at 10-ft intervals for screening. LANL's proposed approach exceeds these Order requirements.

NMED Comment

9. Section 4.2.1: Sampling and Analysis Activities to Address Data Gap 1 (metal and radionuclide contamination in tuff beneath Pit 6)

(a) The data in this work plan indicate that contamination, including radionuclides, is extensive beneath Pit 6. Contaminants were detected at depth in several boreholes near and beneath Pit 6:

Borehole 50-09101 (Am-241 at 112'), 50-09107 (Am-241 at 75', 95', and 108'), 50-09108 (Pu-238 and Sr-90 at 95'), and 50-09109 (Na-22 and Sr-90 at 113'). Many contaminant detections, including radionuclides, were at or near the bottom interval of the boreholes, which ranged in depth from 90 feet to 316 feet bgs. Neither the lateral or vertical extent of contamination has been determined.

(b) The scope of work to address this data gap proposes drilling only two boreholes (A and B), to depths of 140 to 150 feet. The data obtained from these two proposed boreholes will not be sufficient to determine the lateral and vertical extent of radionuclide and metals contamination in this area of the site. The Permittees shall modify the scope of work to propose additional vertical and angled boreholes to be drilled around and beneath (angled) Pit 6. The Permittees shall include plans for extending the depth of boreholes if contaminants are detected at the bottom of the borehole(s). Additional boreholes shall be sampled in accordance with the requirements listed in the NMED Order dated November 26, 2002.

LANL Response

(a) The Work Plan acknowledges that the extent of contamination beneath Pit 6 is not yet established. However, the results of the Phase I investigation do not suggest that contamination is "extensive." The sample depths cited by NMED in the comment are actually the lengths along the angled boreholes rather than the vertical depth below ground surface (bgs). The correct depths for the cited results are 79 ft bgs for Am-241 in borehole 50-09101; 53 ft bgs, 67 ft bgs, and 76 ft bgs for Am-241 in borehole 50-09107; 67 ft bgs for Pu-238 and Sr-90 in borehole 50-09108; and 80 ft bgs for Na-22 and Sr-90 in borehole 50-09109.

(b) As noted in the response to (a) above, the maximum depth at which radionuclides were detected beneath Pit 6 was 80 ft bgs. LANL believes that the proposed borehole depths of 140 to 150 ft (approximately twice the vertical depth of the previous boreholes) will be sufficient to establish the vertical extent of contamination. LANL's approach exceeds the requirements in Section IV.C.3.c.iii, item 6, of the NMED Order for boreholes to extend 25 ft below the depth of contamination detected in previous investigations. Establishing the "extent" of a liquid-borne release of metals or radionuclides from a disposal unit is problematic because migration of contaminants with water infiltrating below a pit or shaft may occur via fractures in the tuff rather than in the tuff matrix. Under fracture flow conditions, detection of residual contamination in tuff is largely "hit or miss," and establishing the vertical and horizontal extent of such contamination is inherently subjective. This is the case even with respect to concentrations relative to background or a decreasing concentration gradient, criteria noted in NMED's June 17, 1999 position paper "Determination of Extent of Contamination". The sample locations, depths, and sampling design (paired samples of fracture fill and surrounding intact tuff) of proposed Boreholes A and B were specified to supplement existing tuff data beneath Pit 6 and determine whether contamination may have migrated via fractures. The frequency of sample collection along the boreholes for submittal to an analytical laboratory is one sample per 20 ft, whereas Section IV.C.3.a.iv of the November 26, 2002 NMED Order states, "A minimum of two samples per 100 feet of drilling depth shall be selected from each boring for laboratory analysis". The requirement for installation of additional boreholes is not justified based on review of existing data. The specifications in the NMED Order call for a minimum of 14 boreholes around Pit 6. Absent the technical basis for the borehole spacing presented in the Order, LANL cannot compare it to the rationale for the proposed approach. LANL notes that extending the depths of the proposed angled boreholes would not generate useful information as the boreholes would be extended beyond the boundaries of the disposal pit (see Figures 12 and 13 in the work plan).

NMED Comment

10. Section 4.2.2: Sampling and Analysis Activities to Address Data Gap 2 (concentrations and spatial extent of VOCs in the vapor phase in subsurface tuff)

(a) Two boreholes have been sampled for pore-gas VOCs, 50-09100 and 50-10131. VOC contamination is present at many depths and at the bottom interval of both of these boreholes. Neither the lateral or vertical extent of contamination at the site has been determined. The highest TCE contamination was encountered at the bottom of borehole 50-09100 at 316 feet; the maximum concentration of TCE detected in this borehole was always below a depth of 200 feet. The concentrations of TCE and PCE are relatively constant in borehole 50-10131 to 200 feet and are present at detectable levels at the bottom of the borehole at 315 feet. Proposed Borehole M is located near 50-09100. The borehole's proposed total depth of 800 feet is likely to be adequate to assess the vertical extent of the contaminant plume in the northeast portion of the site. However, the data collected from borehole M will not be sufficient to determine the vertical extent of contamination for the entire 11.8 acre-site.

(b) Borehole A is located near borehole 50-10131. The proposed borehole has a planned total depth of 140 to 150 feet. In order to determine the vertical extent of the contaminant plume in the tuff beneath Pit 6, the Permittees shall drill the proposed borehole to at least 340 feet, 25 feet deeper than the deepest previously detected contamination in Borehole 50-10131 at 315 feet. The Permittees shall modify the scope of work to advance Borehole A to a depth of at least 340 feet. Plans shall be included for extending the borehole to greater depths if field screening indicates the presence of contaminants at the bottom interval of the borehole.

(c) The proposed sample interval for collecting vapor samples in borehole M is every 100 feet and at the bottom interval of the borehole. Sampling is proposed for boreholes A-L at only two depths: 40-50 feet and 140-150 feet (the planned total depth). The Permittees shall sample for VOCs at 10-foot intervals to screen for the presence of contaminants. Plans shall be included for extending the boreholes to greater depths if field screening indicates the presence of contaminants at the bottom interval of any borehole.

(d) There are no plans to sample the existing pore-gas monitoring boreholes 50-09100 and 50-10131 in conjunction with sampling of the new boreholes. NMED does not believe, and the data do not indicate, that the nature of the contaminant plume in the existing boreholes has been defined. The Permittees shall modify the scope of work to add sampling of all ports in boreholes 50-09100 and 50-10131 to the scope of activities.

(e) This section states, "surface flux may not always be an accurate indication of higher subsurface VOC concentrations". The results of the EMFLUX (surface flux) survey were used to determine the location of Borehole D, but no boreholes were proposed for the other locations where detected surface flux measurements were high at the site. In order to determine whether the surface flux and subsurface pore-gas results can be correlated, additional boreholes are needed in the locations with the highest surface flux measurements. The locations of highest surface flux are above the Chemical Pit and on the southern boundary of Pit 5. The Permittees shall modify the scope of work to propose additional vertical boreholes at the southern boundary of the Chemical Pit and at the southern boundary of Pit 5. Plans shall be included for extending boreholes to greater depths if field screening indicates the presence of contaminants at the bottom interval any borehole.

(f) The Permittees shall include a diagram of the general design for vapor monitoring well construction.

(g) The Permittees shall clarify the intent to instrument boreholes for monitoring of contaminants in pore gas. It is unclear whether the proposed boreholes will be completed as pore-gas monitoring wells, set up as temporary monitoring points, or left as open boreholes.

LANL Response

(a) Borehole M is not the only location proposed for VOC sampling. As described in Section 4.2.2 of the Work Plan, VOC pore gas samples will also be collected from all of the proposed boreholes (Boreholes A – L). LANL's approach satisfies the requirement in Section IV.C.3.c.v, item 1, of the NMED Order for vapor samples to be collected from all newly drilled boreholes. VOC pore gas data from all proposed new boreholes will be used in conjunction with existing VOC pore gas data from Boreholes 50-09100 and 50-10131 to establish the extent of VOCs in tuff at MDA C as defined in NMED's Position Paper on Determination of Extent of Contamination. The results of previous investigations of the VOC plume at MDA L, which is far more extensive than that at MDA C, indicate that the vertical extent of VOC migration is controlled by stratigraphic features (i.e., permeable units that allow rapid communication with the atmosphere) and, thus, does not vary widely across the site. Installation of one 800-ft deep borehole, therefore, will be adequate to establish the vertical extent of VOC vapor phase contamination for the 11.8-acre site.

(b) Pore gas data for TCE and PCE shown in Plots D-25 and D-26 in the Work Plan indicate that VOC concentrations in Borehole 50-10131 are low (less than 3 ppm) and are not increasing with depth thus defining extent per NMED's Position Paper on Determination of Extent of Contamination. Hence, these data do not support the need for collection of additional VOC data from great depths at this location. The need for collecting VOC data at greater depths in the area of Pit 6 to define extent of contamination will be reevaluated following collection of VOC data from Boreholes A and B. As noted in the response to Comment 9(b), extending the depth of the angled borehole A would cause the borehole to extend beyond the boundary of Pit 6.

(c) Section IV.C.3.c.v, item 4, of the NMED Order requires vapor samples to be collected at "discrete zones selected based on investigation and monitoring results." LANL's proposed approach satisfies this requirement and there is no requirement in Section IV.C.3.c.v of the NMED Order for vapor samples to be collected every 10 ft. The technical rationale for NMED's request for more frequent VOC sampling should be presented. The purpose of VOC sampling in borehole M is to establish vertical extent and the proposed sampling frequency will allow the vertical extent to be established to within 100 ft. LANL could identify no need for data establishing vertical extent to a finer resolution than this. Plots D-25, D-26, D-28 and D-29 in the Work Plan show that fewer vapor sampling intervals are adequate to establish VOC concentration trends with depth. Unlike metals and radionuclides, VOCs migrate by diffusion in relatively dry tuff, absent of organic material; therefore, the maximum extent of a VOC will be as a vapor. Given the predominant diffusive behavior, concentration gradients in tuff are apparent near the source. The presence of low concentrations of VOCs in pore-gas at the base of a borehole is not considered a rationale for extending the depth of a borehole unless the concentration gradient indicates higher levels at depth (such as TCE in Borehole 50-09100) per NMED's Position Paper on Determination of Extent of Contamination.

(d) Although Section IV.C.3.c.v of the NMED Order requires vapor sampling in existing vapor wells, Section 4.2.2 of the work plan presents LANL's rationale for not sampling existing boreholes 50-09100 and 50-10131. Specifically, these boreholes were sampled in January 2003 to determine how results had changed from previous sampling during 2000 through 2002 and these results showed minimal changes over time (see Figures D-25, D-26, D-28 and D-29). Therefore, results from additional sampling of these boreholes are unlikely to provide any useful information on the extent of contamination.

(e) As noted in the comment, the locations of highest VOC flux are above the Chemical Pit and on the southern boundary of Pit 5. Borehole 50-10131, and proposed Borehole A, will provide VOC pore gas information in the area of the Chemical Pit. VOC pore gas data from proposed Borehole D will provide information on VOC pore gas concentrations on the southern boundary of Pit 5. Correlation of surface flux data and subsurface pore gas data was not identified as a data gap, is not an objective of the investigation at MDA C, and is not a requirement of the NMED Order.

(f) A general diagram for construction of a vapor monitoring well will be provided, as specified in Section IV.C.3.c.iii, item 8, of the NMED Order.

(g) As described in Section 4.2.2 and Section 7, pore gas samples will be collected from the proposed boreholes during drilling and again approximately 10 weeks following drilling. A decision on whether to collect additional monitoring data from any of the proposed boreholes will then be made on the basis of these data (see Section 7, paragraph 1). Each borehole will be completed at the surface with a section of steel well casing grouted five feet into the bedrock. The surface casing will be sealed with an air tight cap and locked to prevent tampering. The seals will be opened for pore gas sampling as described in sections 5.1.3 and 5.2.2. As necessary, the boreholes may be equipped with positive pressure sampling membranes for longer term monitoring.

NMED Comment

11. Section 4.2.3: Sampling and Analysis Activities to Address Data Gap 3 (concentrations and spatial extent of tritium in the vapor phase in subsurface tuff)

(a) During previous investigations, tritium was detected in almost every tuff sample at MDA C. Many tritium detections were at or near the bottom interval of the boreholes. In Borehole 50-09108, the highest tritium measurement was at the bottom of the borehole, indicating that the vertical extent of contamination has not been determined. The proposed number of boreholes will not provide sufficient data to determine either the lateral or the vertical extent of tritium contamination in the subsurface. The Permittees shall include the additional borehole locations described in the NMED Order dated November 26, 2002 to determine the spatial extent of the undefined tritium plume.

(b) The correlation of the data from subsurface tritium samples and the near-surface tritium probe samples is poor. In order to determine whether the near-surface and subsurface tritium results can be correlated, boreholes must be advanced in the locations with high near-surface tritium measurements. A high concentration of near-surface tritium was detected under Pit 6 (sample point 50-03-21472). Borehole A is proposed close to this location and will help define the extent of the tritium plume near Pit 6. However, there are no boreholes proposed for the other areas with high near-surface tritium detections. The Permittees shall modify the scope of work to propose an additional vertical boring west of Pit 4, near sample point 50-21467, the location of the highest near-surface tritium measurement. The source of the tritium in this area may be Shaft Group 3. Data from a borehole near 50-21467 and at the proposed Borehole K location will help define the extent of the subsurface tritium plume in this portion of the site. In addition, the Permittees shall modify the scope of work to include a vertical boring at the west end of Pit 2.

(c) The Permittees shall provide justification for the proposed sampling intervals. Sampling only at the proposed depths of 40 to 50 feet and 140 to 150 feet will not provide sufficient data to characterize the tritium plume. No depth appears to be the singular choice for sampling depth across the site. The highest detected tritium concentrations range in depths from 18 feet to 112 feet, with no detectable pattern. Additionally, there is no tritium data for borehole 50-10131. Include plans to sample for tritium at 10-foot intervals to screen for the presence of contaminants.

(d) Plans shall be included for extending boreholes to greater depths if field screening indicates the presence of contaminants at the bottom interval of any borehole.

LANL Response

(a) Borehole 50-09108 is an angled borehole that ends beneath the Chemical Pit. While the Phase I RFI data show increasing concentration with depth, the 50-09108 data should also be interpreted as showing increasing concentration as one approaches Pit 6 and the Chemical Pit since only the last two samples are beneath the Chemical Pit. Borehole profile plots for tritium (Figure D-18) show that where relatively high concentrations of tritium are detected in two or more samples beneath a disposal unit (50-09102, 50-09107, 50-09109, 50-09110), the tritium concentrations decrease beneath about 50 ft below ground surface (bgs). This is consistent with the presence of a tritium source in the pits and shafts, which extend to depths between 25–30 ft bgs. The proposed data collection for tritium will provide similar spatial coverage as the proposed data collection for VOCs, radionuclides, metals, cyanide, nitrates and perchlorate. Also, ambient air data are being collected to confirm that atmospheric concentrations do not pose a potentially unacceptable dose to site workers and the quantity of tritium is decreasing in quantity at the site at a rate of 50% every 12.3 years in accordance with the half-life of tritium.

The mechanisms for transport of tritium vapor in the subsurface are identical to those for VOCs, and the resultant plumes have similar characteristics. As noted in the response to Comment 10(a), boreholes A-N will be sufficient to establish the vertical extent of the tritium plume. The proposed boreholes originate on, or extend to, the boundaries of the MDA C disposal units and, therefore, provide the same lateral extent of coverage as the borehole locations described in Section IV.C.3.c.iii of the November 26, 2002 NMED Order. That is, the Order does not specify borehole locations further from the disposal unit boundaries than those proposed by LANL. The borehole locations in the Order would only provide greater coverage between disposal units, which is not necessary to establish the spatial extent of the plume.

(b) The near surface tritium sample 50-03-21472 was collected approximately 1 meter bgs, not under Pit 6. Boreholes K and A are proposed in the locations of relatively high tritium concentrations near the north side of Pit 6 and between Pit 6 and Pit 4 (see Figure D-32). These data will provide information on subsurface tritium concentrations near locations of high near-surface tritium. Similarly, Borehole H is already proposed in the area west of Pits 1–3.

Correlation of surface and subsurface tritium data was not identified as a data gap is not an objective of the investigation at MDA C, and is not a requirement of the NMED Order. The lack of correlation may be related to uncertainty in tritium concentrations in low-moisture core samples. The Phase I data were adequate to characterize surface flux and the pore gas samples proposed in the Work Plan are sufficient to delineate the extent of tritium in subsurface pore gas.

(c) The rationale for sampling for tritium at the proposed depths of approximately 40 – 50 ft and 140 – 150 ft is described in Section 4.2.3 of the Work Plan. The shallower sample is immediately below the disposal units where concentrations associated with a release from pits or shafts should be highest. The deeper sample will ascertain whether concentrations are lower beneath the disposal units. Documenting the concentration gradient between the base of the disposal units and the deepest sampling interval is not very useful information – the gradient can be inferred from the two concentrations measured and there is no particular application of this information for site decision making.

Section IV.C.3.c.v, item 4, of the NMED Order requires vapor samples to be collected at "discrete zones selected based on investigation and monitoring results." LANL's proposed approach satisfies this requirement and there is no requirement in Section IV.C.3.c.v of the NMED Order for vapor samples to be collected every 10 ft. The technical rationale for NMED's request for more frequent tritium sampling should be presented. The purpose of tritium sampling in boreholes A-N is to establish vertical extent. The proposed sampling frequency will allow the vertical extent to be established within 100 ft and LANL could not identify any need for data establishing vertical extent to a finer resolution. With respect to boreholes A through L, based on the Phase I results LANL expects to detect tritium at both the sampled depths (40 to 50 ft bgs and 140 to 150 ft bgs) and expects to see a decreasing trend. These data will be sufficient to conclude that tritium is present in the interval between these two sample depths without the need to collect additional samples every 10 ft.

(d) Boreholes A through J are angled boreholes and extending the depths of these boreholes would cause the boreholes to extend beyond the boundaries of the associated disposal units (see Figures 12 through 21).

NMED Comment

Section 4.2.4: Sampling and Analysis Activities to Address Data Gap 4 (nature and extent of releases of metals, cyanide, and radionuclides to tuff beneath Pits 1-5, Shaft Groups 1 and 2, and the Strontium-90 disposal shaft)

(a) Radionuclides were detected at depth in several boreholes in the parts of the site relevant to this data gap: 50-09103 (Eu-152 and Am-241 at 80 feet; Sr-90 at 116 feet), 50-09105 (Pu-239 at 120 feet), and 50-09106 (Sr-90 at 115 feet; Pu-239 at 118 feet). The number of proposed boreholes is not adequate to determine the lateral extent of contaminants in this portion of the site. The Permittees shall modify the scope of work to propose additional vertical or angled boreholes around all of these pits and shafts in accordance with the requirements described in the November 26, 2002 Order.

(b) The proposed drilling exploration depths of 140 to 150 feet may not be adequate to determine vertical extent of contamination. Many radionuclide detections were at or near the bottom interval of the boreholes. The Permittees shall include plans to extend boreholes if field screening indicates the presence of contaminants at the bottom of any borehole.

(c) Borehole H: Based on the revised geophysical map (Figure B-7) of the pit locations, it appears that a vertical borehole can be drilled adjacent to the Strontium-90 shaft. The Permittees shall modify the scope of work to propose an additional borehole at this location.

(d) Borehole J: Based on the revised geophysical map (Figure B- 7) of the locations of the pits, it appears that both vertical and angled boreholes can be drilled from the west side of Pits 1 and 3 to collect data on potential releases from these pits and from Shaft Group 2. The Permittees shall modify the scope of work to propose additional boreholes at these locations.

(e) Borehole L: The proposal to drill one borehole along the south boundary of Pit 1 will not provide adequate data to determine the lateral extent of contamination in this area. The Permittees shall modify the scope of work to propose additional vertical boreholes along the south side of Pit 1.

LANL Response

(a) The depths of contamination are less than noted in the comment. The sample depths cited by NMED in the comment are actually the lengths along the angled boreholes rather than the vertical

depth below ground surface (bgs). The correct depths for the cited results are 57 ft bgs for Am-241 and Eu-152 in borehole 50-09103; 82 ft bgs for Sr-90 in borehole 50-09103, 85 ft bgs for Pu-239 in borehole 50-09105; 81 ft bgs for Sr-90 in borehole 50-09106, and 83 ft bgs for Pu-239 in borehole 50-09106. The extent of radionuclides in locations 50-09105 and 50-09106 will be addressed by the boreholes described in 12.(c & d). The ten boreholes proposed to address the data gaps associated with Data Gap 4 include at least one borehole beneath or adjacent to each of the five pits, two shaft groups, and Sr-90 shaft (see Figures 14 through 23 in the work plan). The results of the Phase I analysis show isolated detections in boreholes, rather than widespread contamination indicative of large releases. Thus, the eight additional angled boreholes and two additional vertical boreholes should be sufficient to establish the vertical and lateral extent of contamination. As previously noted in the response to Comment 9, LANL's proposed approach is also designed to evaluate migration through fractures and diffusion of vapors. LANL notes that extending the depths of the proposed angled boreholes would not generate useful information as the boreholes would be extended beyond the boundaries of the disposal units (see Figures 14 through 21 in the work plan). The specifications in Section IV.C.3.c.iii of the NMED Order dated November 26, 2002, call for at least 50 boreholes around these pits and shafts. Absent the technical basis for the borehole spacing specified in the Order, LANL cannot compare it to the rationale for the approach proposed in the work plan.

(b) As noted in the response to (a) above, the maximum depth at which radionuclides were detected was 85 ft bgs. LANL believes that the proposed borehole depths of 140 to 150 ft (approximately twice the vertical depth of the previous boreholes) will be sufficient to establish the vertical extent of contamination. LANL's approach exceeds the requirements in Section IV.C.3.c.iii, item 6, of the NMED Order for boreholes to extend 25 ft below the depth of contamination detected in previous investigations.

(c) Proposed vertical borehole N will be drilled adjacent to the strontium-90 shaft and Pit 1 to characterize these units versus borehole H

(d) Borehole H will be reorientated and angled to pass beneath shaft group 3 and Pit 3. The borehole will be extended to greater depths than where radionuclides were detected in adjacent Phase I RFI boreholes 50-09105 and 50-09106 (Figure 11). The best location for investigating Shaft Group 2 is from the east, i.e., proposed Borehole J.

(e) Lateral extent of contamination will be characterized along the southern boundary of MDA C by RFI borehole 50-09104 and proposed boreholes I, L and N (4 boreholes along a distance of approximately 700-ft).

NMED Comment

Section 4.2.5: Sampling and Analysis Activities to Address Data Gap 5 (extent of perchlorate, nitrate, dioxin, and furan contamination in tuff beneath MDA C)

(a) Dioxins and furans are not specifically noted in the historical report's review of waste inventory, but the inventory is admittedly incomplete. Additionally, these types compounds are typically by-products of burning organic materials that contain or are in the presence of chlorine atoms. The chlorinated hydrocarbon TCE was commonly disposed at MDA C. Its presence is noted in the disposal history for several of the pits. In addition, Section 2.6 of this work plan quotes from the OU 1147 Work Plan that "chemical wastes were responsible for many fires at Areas B and C," and that there were five documented fires at MDA C between 1950 and 1958. Consequently, NMED requires analysis of all samples for dioxins and furans. The Permittees shall modify the scope of work to propose analysis of all samples for dioxins and furans.

(b) Section B-1.1 of the Historical Investigation Report notes that debris from the demolition of the Bayo site, which includes firing sites, was disposed of at MDA C. Additionally, Section B-1.1.2 notes that trinitrotoluene (TNT) element samples were disposed of in Shaft Group 3. The Permittees shall modify the scope of work to propose analysis of all samples for energetic and high explosives (HE) compounds.

LANL Response

(a) Section IV.C.3.c.iv, item 4, of the NMED Order requires laboratory analysis of all samples to include dioxins and furans. This Order requirement is not consistent with the environmental behavior of organic contaminants, or supported by, the results of the Phase I RFI, which indicate that VOCs are the only organic chemicals that have undergone significant migration into the subsurface. Dioxins and furans are extremely nonvolatile and insoluble, and would be expected to have very low mobility in the subsurface at MDA C. Given that chemical fires at MDA C could have produced dioxins or furans, it may be appropriate to analyze for dioxins and furans in some samples. LANL will modify the scope of work to call for analysis of dioxins and furans in the samples collected nearest the base elevation of each disposal pit. Given the low mobility of dioxins and furans, LANL does not believe it is appropriate to analyze for dioxins and furans in all samples, as indicated in the comment.

(b) Section IV.C.3.c.iv, item 4, of the NMED Order requires laboratory analysis of all samples to include HE. This Order requirement is not supported by the operational history of the site. Available information on the wastes referred to in the comment does not indicate that HE is likely to be present or that sampling for HE is necessary at MDA C. Additional details on the wastes associated with Bayo Canyon demolition are contained in the associated RFI work plan and reports and historical reference documents, and indicates that HE is not present in the wastes sent to MDA C from Bayo Canyon. When the firing sites in Bayo Canyon were active, residuals and debris from the firing sites were disposed of to a disposal pit, SWMU 10-005. During decontamination and decommissioning of this disposal site in 1957, the wastes in SWMU 10-005 were excavated and burned, and the ash was subsequently disposed of at MDA C (LANL 1992, 07668, p. 3-63). Any HE present in the residuals would have been destroyed by burning. Subsurface samples were collected at the site of SWMU 10-005 during the RFI of this site and were analyzed for HE. No HE was detected in these samples (LANL 1996, 54332, pp. x-y). The only other wastes from Bayo Canyon identified as potentially having been sent to MDA C was ash from a burn pit used to burn combustible wastes (SWMU 10-006) (LANL 1992, 07668, pp. 4-1 – 4-3). As with SWMU 10-005, the ash is unlikely to have contained appreciable HE. Final cleanup of the Bayo Canyon firing sites in 1963 is described in an historical report (LASL 1963, 04771). All remaining firing site debris was removed at this time and no HE was found in this debris (LASL 1963, 04771, p. 6).

TNT is listed in three disposal logbook entries for Shaft Group 3. Its origin is always Wing 9 of the Chemical and Metallurgy Building, where significant quantities of HE would not be present. The waste description for some of the TNT refers to "TNT SS center elements", "TNT element samples" or "TNT mounts". There is also accompanying fission product or U with the TNT. The units of disposal are gallon cans, so there was only a minor quantity disposed.

Phase I RFI borehole samples were screened for HE and there were no detects, including those core samples in boreholes 50-09105 and 50-09106 which passed beneath Shaft Group 3.. LANL will provide a copy of the sample collection logs to NMED. Based on the above information, it is necessary to analyze samples from MDA C for HE.

NMED Comment

Section 4.2.6: Sampling and Analysis Activities to Address Data Gap 6 (Potential Presence of Perched Groundwater Beneath MDA C)

The Permittees shall include a description of all activities that will be performed if perched groundwater is encountered in Borehole M or in any other borehole at the site. Include proposed well construction diagrams, sample suites, and plans for advancing additional boreholes.

LANL Response

Section IV.C.3.c.vi requires that an intermediate monitoring well design plan be submitted to NMED for approval prior to construction of the intermediate well, and does not require this information to be included in the work plan. The design of a well to monitor perched groundwater would be based on the actual conditions encountered in the field. If perched water is encountered, LANL will prepare a well design and submit the design, construction methods, and SOP for sampling to NMED. Based on the stratigraphy at the site and drilling methods to be used, LANL anticipates no difficulty in maintaining an open borehole until a well can be designed and installed.

NMED Comment

Section 4.2.7: Sampling and Analysis Activities to Address Data Gap 7 (information on hydrogeologic properties and fracture characteristics of the vadose zone to support contaminant transport modeling in the vadose zone)

Include a description of the planned fracture investigation, including the location of the construction, the dimensions and depth of the proposed cut in the tuff, and whether an samples will be field screened for contaminants during construction activities.

LANL Response

The shoring plan for the excavation of the pit for the TA-50 Influent Storage Tank Project has not been finalized. It is unclear whether the sidewalls of the excavation will be available for fracture mapping. If fracture mapping can be performed, it will be performed per ER-SOP-3.06, R1 Fracture Characterization. The orientation, dip, density, aperture, and fill material will be recorded. The walls of a planned 100 x 150 ft excavation 40 ft deep will be mapped, as available, during construction. On-site operations may restrict some access to wall sections. Walls trending approximately east-west and north-south will be mapped. Fracturing in the Bandelier tuff throughout the Pajarito Plateau is predominantly NE-SW. Two primary types of fractures occur in trench walls: cooling fractures and construction fractures. Only those fractures interpreted as cooling fractures will be included in this exercise. Construction fractures appear as lower angle, discontinuous fractures that are predominantly near surface. Cooling fractures are of primary interest for fracture studies related to potential contaminant transport.

NMED Comment

Section 5.0: Investigation Methods

(a) The Permittees shall describe all methods for conducting the proposed activities during the investigation. The work plan lists the Standard Operating Procedures to be followed during the investigation. The Permittees shall provide descriptions of investigation, sampling, and analytical methods and procedures to be employed in documents submitted to NMED.

(b) The Permittees shall include a description of all field-screening methods. The work plan states, "total depth of boreholes may increase if elevated field screening is detected." The methods for VOC screening must be included, as well as the definition of "elevated field screening."

(c) Paragraph 3 of Section 4.2.1 notes that sampling may depend on radiation field screening. NMED requests voluntary submittal of the methods for radiological/tritium screening of samples.

LANL Response

(a) Section IX.A of the NMED Order indicates that LANL shall not reference SOPs when describing investigation, sampling or analytical methods and procedures. The Quality Assurance (QA) program for the RRES-ER Project requires that these SOPs be used when performing investigation, sampling, and analysis. Order requirements that would preclude use of these SOPs would be inconsistent with QA requirements. LANL will continue to provide references to appropriate SOPs in Section 5.0 of the work plan, but the referenced SOPs will also be appended to the work plan. In this manner, written descriptions of investigation, sampling, and analysis procedures will be incorporated into the work plan.

(b) Section IX.B.2.d of the NMED Order requires core samples to be screened by visual examination, headspace VOC analysis, and x-ray fluorescence (XRF). The sentence before the referenced sentence states that core will be visually inspected and radiologically screened. The primary objective of all boreholes except M is to establish the extent of inorganic and radionuclide (exclusive of tritium) contamination beneath disposal units. Radiological screening is the most appropriate field method consistent with this objective. Field screening is not required to establish VOC sampling depths for these boreholes and, therefore, the VOC headspace analysis required by the Order would not yield useful information. The Order requirement for XRF screening is not consistent with the Phase I RFI results. Of the metals detected above background in tuff samples during the Phase I RFI, only 2 detections of barium, 1 of calcium, and 6 of lead were above detection limits for XRF. The maximum concentrations of other detected metals were generally less than half the respective XRF detection limit.

(c) Core will be screened in the field using field survey instruments for alpha and beta/gamma radioactivity as defined in the Radiological Work Permit issued by HSR-1. Field screening for tritium will not be performed, as there are no field screening methods capable of detecting tritium and locations of tritium samples are not dependent on field screening results.

NMED Comment

Section 5.1.2: Collection of Tuff Samples

(a) The Permittees shall provide a detailed description of sample collection, preservation, and preparation methods for laboratory analysis.

(b) The Permittees shall collect QA/QC samples as follows: Collect field duplicates at a rate of ten percent. Collect field blanks at a frequency of one per day. Collect equipment blanks from all sampling apparatus at a frequency of ten percent for chemical analysis. Collect equipment blanks at a frequency of one per day if disposable sampling equipment is used. The Permittees shall modify the scope of work to include these QA/QC samples.

LANL Response

- (a) SOPs providing the requested information will be appended to the work plan (see response to Comment 16(a)).
- (b) The QA/QC sample frequencies specified in Section IX.B.2.e of the NMED Order will be used.

NMED Comment

Section 5.1.3: Collection of Pore-Gas Samples

- (a) The Permittees shall provide a detailed description of sample collection, preservation, and preparation methods for laboratory analysis.*
- (b) The Permittees shall collect QA/QC samples as follows: Collect field duplicates at a rate of ten percent. Collect field blanks at a frequency of one per day. Collect equipment blanks from all sampling apparatus at a frequency of ten percent for chemical analysis. Collect equipment blanks at a frequency of one per day if disposable sampling equipment is used. The Permittees shall modify the scope of work to include these QA/QC samples.*

LANL Response

- (a) SOPs providing the requested information will be appended to the work plan.
- (b) Section IX.B.2.g of the NMED Order, which addresses vapor sampling, does not include requirements for QA/QC samples. QA/QC samples will be collected at the frequency specified in ER-SOP-06.31, which will be appended to the work plan. This SOP requires collection of field duplicates at a frequency of five percent, equipment rinsate blanks at a frequency of one per day or five percent, and trip blanks at a frequency of one per day or five percent for VOC samples.

NMED Comment

19. Section 5.2: Methods for Drilling and Sampling Borehole M

- (a) The Permittees shall add a subsection that provides a detailed description of methods that will be followed for collection of groundwater samples, if perched groundwater is encountered during drilling at the site. Include methods for well construction.*
- (b) Radionuclides (Pu-239 and Am-241) and inorganic constituents (cyanide and selenium) have been detected in borehole 50-09100, the borehole closest to the proposed Borehole M. The Permittees shall modify the scope of work to include analyzing the samples collected from Borehole M for the full suite of contaminants, including dioxins and furans.*

LANL Response

- (a) The purpose of Borehole M is to investigate the presence of perched water and to obtain site-specific hydrogeologic data for future fate and transport modeling for MDA C. The design and sampling of a well to monitor perched groundwater would be based on the actual conditions encountered in the field. If perched water is encountered, LANL will prepare a well design and submit the design, construction methods, and SOP for sampling to NMED. Based on the stratigraphy at the site and drilling methods to be used, LANL anticipates no difficulty in maintaining an open borehole until a well can be designed and installed. (See response to Comment 14.)

(b) Section IV.C.3.c.iv, item 4, of the NMED Order requires laboratory analysis of all samples to include VOCs, SVOCs, pH, HE compounds, PCBs, dioxins, furans, nitrates, perchlorate, TAL metals, total uranium, cyanide, and radionuclides. This Order requirement and the requirement in the comment, are not supported by the Phase I data. Am-241 was detected in one sample from borehole 50-09100 at a depth of 18.7 to 20.2 ft bgs, Pu-239 was detected in one sample at a depth of 29.3 to 30.8 ft bgs, cyanide was detected in one sample at a depth of 29.3 to 30.8 ft bgs and selenium was detected in one sample at a depth of 7.4 to 8.9 ft. These limited detections do not provide justification for expanding the sampling to be conducted for borehole M. In fact, these limited detections indicate that the extent of inorganic and radionuclide contamination at borehole 50-09100 (which was sampled to a depth of 163.1 ft bgs) has been established. Refer to response to Comment 13(a) concerning analysis for dioxins and furans.

NMED Comment

20. Section 5.2.2: Collection of VOC and Tritium Samples

(a) The Permittees shall provide a detailed description of sample collection, preservation, and preparation methods for laboratory analysis.

(b) The Permittees shall collect QA/QC samples as follows: Collect field duplicates at a rate of ten percent. Collect field blanks at a frequency of one per day. Collect equipment blanks from all sampling apparatus at a frequency of ten percent for chemical analysis. Collect equipment blanks at a frequency of one per day if disposable sampling equipment is used. The Permittees shall modify the scope of work to include these QA/QC samples.

LANL Response

(a) SOPs providing the requested information will be appended to the work plan (see response to Comment 16(a)).

(b) Section IX.B.2.g of the NMED Order, which addresses vapor sampling, does not include requirements for QA/QC samples. QA/QC samples will be collected at the frequency specified in ER-SOP-06.31, which will be appended to the work plan. This SOP requires collection of field duplicates at a frequency of five percent, equipment rinse blanks at a frequency of one per day or five percent, and trip blanks at a frequency of one per day or five percent for VOC samples.

NMED Comment

21. Section 5.2.3: Collection of Geotechnical Data

The Permittees shall provide a detailed description of sample collection and preparation methods for laboratory analysis.

LANL Response

Core collected for hydrogeologic property analysis will be encased in a Protector bag (hermetically sealed, moisture protected). The samples will be sent to Daniel B. Stephens & Associates, Inc. laboratory for analysis of saturated hydraulic conductivity, volumetric moisture content, dry bulk density, calculated total porosity, moisture retention characteristics and calculated unsaturated hydraulic conductivity.

NMED Comment

22. Figure 10 (Radionuclides Detected in tuff beneath Pit 6 at MDA C)

This figure shows the Phase I RFI borehole locations. The figure is based engineering drawings instead of the 2001/2002 geophysical survey results. Because the locations of the pit boundaries have been revised based on the new geophysical data, it is impossible to determine the locations of the borings in relation to the pits and shafts or to assess safety issues using the outdated figures. The Permittees shall provide an updated map with the proposed borehole locations.

LANL Response

Figure 10 is correct. The 1992 GIS data for MDA C was updated in December 2002 based on Los Alamos Scientific Laboratory (LASL) engineering drawing (LASL Engineering Drawing ENG-R-4459) and the LASL engineering drawing is the basis for locating pit boundaries.

Figure B-7 is an overlay of the results of the 2001/2002 geophysical surveys on the 1974 LASL engineering drawing. The inferred results of the geophysical surveys generally overlay the boundaries of the LASL engineering drawing. The 2001/2002 geophysical survey used both a terrain conductivity (EM31) method to measure the electrical conductivity of earth/fill materials and a high-sensitivity metal detector (EM61) method to discriminate between conductive soils and metal objects. The EM-31 survey was constructed using 22,462 measurement locations along a total line distance of 8.85 miles. The EM-61 survey was constructed using 92,026 measurements along a total line distance of 12.61 miles. Sufficient anomalies were detected in Pits 1 through 5 to infer pit boundaries. There were no clear anomalies observed to indicate the boundaries of Pit 6 or the Chemical Pit.

The locations of Phase I RFI and proposed boreholes in relation to pits and shafts is based on the LASL engineering drawing, not the data from the inferred pit boundaries from the geophysical survey.

NMED Comment

23. Figure 11 (Proposed Boreholes at MDA C)

This figure shows the proposed borehole locations. The figure is based on 1974 engineering drawings instead of the 2001/2002 geophysical survey results. Because the locations of the pit boundaries have been revised based on the new geophysical data, it is impossible to sufficiently determine the exact locations of the borings in relation to the pits and shafts or to assess drilling accessibility and safety issues using the outdated figures. The Permittees shall provide an updated map with the proposed borehole locations.

LANL Response

See response to comment 22.

NMED Comment

24. Table 2: Inorganic Chemicals and Radionuclides Detected Above BVs Beneath Pit 6 at MDA C

(a) The Permittees shall indicate the samples on this table that were analyzed from curated core. The samples from curated core were not analyzed for all constituents and the holding times were exceeded. A footnote shall be added to the bottom of the table.

(b) There is a discrepancy between the tritium value reported in Table 2 for the tuff sample collected from 112-115 feet in borehole 50-09108 and the value for the same sample described in the "Response to NOD: TA-50, Part B, Permit Application, Rev.2.0". The value in Table 2 is reported as 1,660 pCi/mL; however, the permit application notes that the tritium concentration for this sample was 1,660,000 pCi/g, which was the maximum tritium concentration measured at site. The Permittees shall correct the incorrect document. NMED requests voluntary submittal of the corrected data.

LANL Response

(a) A total of 67 tuff samples were originally collected from boreholes at MDA C in 1995 and submitted to an off-site contract laboratory for analysis of SVOCs, TAL metals, cyanide, and radionuclides. A subset of 54 of the 1995 Phase I RFI tuff samples were also analyzed for VOCs and pesticides/PCBs at an off-site contract laboratory. An additional 15 tuff samples were collected from curated core in 1996 and submitted to an off-site contract laboratory for analysis of TAL metals (except cyanide and mercury) and radionuclides (gamma-emitting radionuclides by gamma spectroscopy, strontium-90, americium-241, total and isotopic uranium, isotopic plutonium, and isotopic thorium) except tritium. All of the samples in Table 2 that have a sample ID beginning with 0550-96-XXXX are from curated core. A footnote can be added for these samples stating "This sample was not analyzed for all constituents and the holding times were exceeded for mercury." Note that Table B-6 (Summary of Phase I RFI Subsurface Tuff Samples Collected at MDA C) has the 1996 samples footnoted as "Tuff sample collected from curated core". This table also shows that the 1996 samples were not analyzed for tritium, cyanide, pesticides, PCBs, SVOCs, or VOCs.

(b) The sample referred to in the comment is sample 0550-95-0220 from location 50-09108 at a depth of 112-115 ft. The tritium analysis was under request number 1128. The result for this sample was originally reported as 1660000 pCi/g. During focused data validation, the reporting units for this sample were found to be incorrect. The units were corrected to pCi/L and the result was reported as 1660000 pCi/L. After converting the correct result to pCi/mL for the MDA C IWP, the result was reported as 1660 pCi/mL, which is the correct result for this sample.

NMED Comment

25. Table 3: Summary of Revised Borehole Sampling

The Permittees shall include field screening for VOCs and tritium.

LANL Response

Section IX.B.2.d of the NMED Order requires core samples to be screened by visual examination, headspace VOC analysis, and x-ray fluorescence (XRF). As noted in the response to Comment 16(b), the screening requirements in the Order are not consistent with the results of the Phase I RFI. In addition, these requirements are not consistent with the data gaps and objectives of the investigation. With the exception of proposed borehole M, the primary purpose of these new boreholes is to establish the extent of inorganic and radionuclide (except tritium) contamination beneath disposal units at MDA C. Field screening for VOCs and tritium would not serve this purpose. Data gaps related to VOCs and tritium can be met without the need for field screening (See MDA H RFI Report and Addendum).

NMED Comment

26. Appendix B: Historical Investigation Report

Sections B-2.0, B-3.0, and B-4.0 of the Historical Investigation Report are poorly organized and repetitive. The Permittees shall combine the text in these 3 sections and the text in Appendix D to provide efficient summaries of the activities, results, and data interpretation for each type of historical investigation that was conducted. For example, the work plan describes the subsurface investigation in one section, reviews the data from the investigation in another section, interprets the data in another sections, and analyzes the data in a separate appendix. Combining all of the information about each type of investigation into one comprehensive and complete section will make the document easier to read and understand.

LANL Response

Section IV.C.3.b of the NMED Order contains requirements for the content if the Historical Information Report (HIR), but does not specify the format or organization of the report. The organization for the HIR follows the annotated outline for RFI reports, which was agreed to by NMED. The format for HIRs is not addressed in the November 26, 2002, NMED Order, and NMED has not issued any further guidance or requirements to supercede the annotated outline for RFI reports. The two sets of comments received from NMED on the draft Work Plan for MDA C also did not address the format or organization of the HIR. Before reorganizing the HIR, LANL and NMED should reach agreement on the required format for HIRs that will appear in all Investigation Work Plans.

NMED Comment

27. Section B-1.1.1: MDA C Disposal Pit Inventory

The RFI Work Plan for OU 1147 notes that mercury was disposed in Pit 5, but it is not listed as a constituent in the description of Pit 5 in this section. The Permittees shall correct this section.

LANL Response

The waste inventory information for the pits and shafts at MDA C gleaned from waste disposal logbooks is discussed in Section 2.3.1 of the approved OU-1147 RFI Work Plan and is summarized in Table 2-10. The summary of contaminants in the text in the RFI Work Plan references specific LANL disposal logbooks where disposal information was recorded, whereas Table 2-10 is described as a list of contaminants "based on site logbooks". The text summary from Section 2.3.1 of the approved OU-1147 RFI Work Plan was used in the new MDA C WP since it contains more specific references as well as greater detail on the nature of the disposals. Mercury was listed as a contaminant in Pit 5 in Table 2-10 of the approved RFI kWork Plan, but was not described in the text summary of the work plan. The waste disposal logbooks for MDA C are currently being reviewed and a more definitive estimate of specific quantities of specific contaminants in the MDA C disposal inventory is being developed for the Investigation Report.

NMED Comment

28. Section B-1.2.2: Surface Radiation Surveys and Sampling (1979-1986)

The Permittees shall include the data from Table 2-14 of the RFI Work Plan for OU 1147 to use with Figure B-1.

LANL Response

Table 2-14 will be added. The last paragraph of Section B-1.2.2 will be revised as follows:

Surface soil samples were collected from the surface at 0 to 1 cm in 1985 and analyzed for tritium, plutonium-238, -239, -240, and uranium. Tritium samples from the eastern half of MDA C were below the local background concentration of 4.0 pCi/mL (LANL 1998, 59730). Isotopic plutonium (up to 10 pCi/g of plutonium-239 and -240 and 30 pCi/g of plutonium-238) was detected on the north and east sides of MDA C. Concentrations of uranium were all less than the local background within the MDA C boundary. The areas with elevated radionuclides correspond to the portion of MDA C that was not covered in 1984. Additional soil sampling was performed in 1986 at the radiation survey locations shown in Figure B-1. Surface soil samples were analyzed for americium-241, cesium-137, plutonium-238 and -239, and tritium. Results of these analyses are presented in Table B-2 and are consistent with the 1985 results.

NMED Comment

29. Section B-1.2.3: Perimeter Pore-Gas Sampling (1989)

The sample locations are not numbered in this section or on the corresponding map, Figure B-2. The information on detected contaminants cannot be used, because it is not noted which sample location each detection corresponds to, or even the general area(s) where detections were measured. The Permittees shall provide sample location identifications and analytical data on a revised map.

LANL Response

A revised figure has been prepared. Please note that these data pre-date the Phase I RFI and are of uncertain quality. The data and accompanying figure are provided in order to document the results of earlier field investigations, but these data are not used to guide the collection of additional data in the Work Plan.

30. Section B-2.1.1: Surface Soil and Fill Sampling

(a) This section states that 203 soil samples were collected and their locations are shown on Figure B-3. However, the statement has no value, because Figure B-3 does not number the sample locations. Refer to the comment for Figure B-3 (comment number 44) below.

(b) This section also states that 59 of the samples were analyzed for tritium, but the data were not used; however, it does not state why the data were not used. Table E-9 only states that the data were rejected by the laboratory. Modify the explanation found in B-3.2.1 regarding rejection of data.

LANL Response

(a) Figure B-3 will be revised to show the soil sample location numbers.

(b) Section B-2 of Appendix B describes the sampling and analysis activities of the Phase I investigation of MDA C. The sentence in question, "Fifty-nine samples were analyzed for tritium but the data were not used" appears out of context in this section and will be deleted. Section B-3 of Appendix B describes evaluation of the Phase I data. The text of the 7th paragraph of Section B-3.2.1 has been edited as follows: *"During the Phase I RFI, 59 surface soil/fill samples were analyzed for tritium and soil moisture to evaluate the spatial distribution of tritium concentrations in surface soil. Although tritium related to historical surface releases would long since have dissipated to the atmosphere, locally elevated concentrations of tritium in surface soil may reflect areas where*

subsurface tritium is diffusing to the atmosphere as tritiated water vapor. The analytical results from these surface samples, with tritium concentrations ranging between 0.17 and 12.82 pCi/mL, showed that the higher tritium concentrations were consistently correlated with low moisture contents in the soil/fill samples. The reason for this correlation is related to the greater uncertainty in tritium values when there is little moisture in a sample available for analysis. Because this correlation may confound interpretation of the tritium soil data, 15 shallow pore-gas vapor probes were installed across MDA C in accordance with the MDA C SAP Addendum (LANL 2003, 74067). Pore-gas samples were collected in February 2003 from each probe using absorbent silica gel columns and analyzed for tritium (Section B-2.3). The vapor probe data provide a more reliable indication of locations where releases of tritium to the atmosphere occurs. The surface tritium data, including sample locations and sample IDs, are provided in Appendix E but were not used to support the evaluation of the nature and extent of tritium contamination at MDA C."

NMED Comment

31. Section B-2.1.3: Biota Screening and Sampling

The Permittees shall include a reference to Tables B-7 and B-8 for the results of biota screening.

LANL Response

These tables will be referenced in the 3rd paragraph of Section B-2.1.3 as follows: "...Figure B-4 shows the sample locations of the ant mound and animal burrow samples. Field screening results for the ant mounds and mammal burrows are provided in Tables B-7 and B-8, respectively."

NMED Comment

32. Section B-2.3: Subsurface Investigations: Phase I RFI Core Sampling

(a) This section states "field-screening results were not used to select samples because gross alpha, beta, or gamma activity in the core did not exceed local background levels." However, as an example, the borehole log screening level for 50-09107 records a field tritium screening level of 49,964 pCi/L at 55 ft. While field screening may not have been used to select samples, this sample appears to greatly exceed local background levels. The Permittees shall describe how the background levels for each type of activity were derived.

(b) This section also notes that core samples were field tested for HE and VOCs. These results are not noted on the borehole logs nor are they included in the work plan. The Permittees shall provide all available screening and analytical data.

(c) The last paragraph of this subsection describes moisture encountered in two boreholes. Revise the paragraph to include mention of the wet tuff encountered in borehole 50-09100 from 71.5 to 73.5 feet.

LANL Response

(a) Field screening for gross alpha, beta, and gamma activity was performed using field survey instruments to measure alpha and beta/gamma radioactivity. Tritium concentrations were determined by analysis in the mobile radioanalytical laboratory, which is not a "field screening" method and does not provide real-time results to aid in sample location. Because tritium is such a low-energy beta emitter, it is not detectable using a field beta/gamma survey instrument. Thus, the statement that field screening did not indicate elevated radioactivity is accurate.

(b) Field screening data that are not presented in the borehole logs are documented on sample collection logs. These data consist of the results for field screening of alpha radioactivity and beta/gamma radioactivity, HE field tests, and PID surveys. Copies of the sample collection logs will be provided to NMED.

(c) The text will be revised to state that moist tuff was encountered at a depth of 71.5 ft to 73.5 ft below ground surface in borehole 50-09100.

NMED Comment

33. Section B-3.1.J: Biota Sampling

Correct the fourth sentence to read, "Biota sampling data will be reported in the MDA C Investigation Report."

LANL Response

Text will be changed as indicated.

NMED Comment

34. Section B-3.1.2: Geophysical Survey Results

The figures in this work plan are based on 1974 engineering drawings instead of the 2001/2002 geophysical survey results. There is a 40-ft discrepancy between the reported [2001/2002] boundaries and the historical data. Because the locations of the pit boundaries have been revised based on this new information, it is impossible to assess drilling accessibility and safety issues, including previous and proposed boreholes and sampling locations, using the outdated figures. The Permittees shall update and submit revised maps with borehole locations.

LANL Response

See response to Comment 22.

NMED Comment

35. Section B-3.2.1: Phase I RFI Surface Soil and Fill Samples

The first paragraph claims that all data are suitable for data assessment. The Permittees shall delete this statement. It is not accurate. As an example, the Radionuclide Comparison with BVs and Fallout Values section of this work plan describes rejection of the tritium data.

LANL Response

The statement that all surface data are suitable for data assessment is correct. The 28 tritium results reported as rejected in Table H-1 were in fact not rejected by the analytical laboratory. Table H-1, and the text in the third paragraph of Appendix H, will be corrected to reflect the fact that these tritium data were not rejected by the analytical laboratory. The data qualifiers for these tritium data will also be corrected in Appendix E. See the response to Comment 30(b) for additional information on the use of the surface soil tritium data.

NMED Comment

36. Section B-3.2.1: Phase I RFI Surface Soil and Fill Samples: Evaluation of Organic Chemicals

(a) This work plan does not propose any additional surface soil sampling above Pit 6. The executive summary states "limited evidence indicates that Aroclor-1260 and bis (-ethylhexyl) phthalate may be elevated locally in the surface soil and fill above Pit 6." However, because there are no location numbers on Figure 3 to correspond to the data in Table B-14, it cannot be determined where the detections were measured. The bubble plots of the organic data on Figures D-6, D-7, and D-8 show approximately where the detections were measured. The diagrams are acceptable only as visual aids to complement data tables.

(b) At least one PCB detection was measured above it SAL. The Permittees shall include appropriate SALs on a revised table of data.

(c) NMED requires data to determine whether there is a data gap here and whether additional surface sampling for PCBs, pesticides, or SVOCs is needed.

(d) The Permittees shall modify the scope of work to propose plans for surface sampling at this location, or provide sufficient data and rationale to demonstrate that additional sample collection is not necessary.

LANL Response

(a) See responses to Comment 30(a) and 40(b) The requirements for the HIR are contained in Section IV.C.3.b of the NMED Order and do not include presentation of regulatory criteria and applicable cleanup or screening levels. The purpose of the HIR is to present and evaluate existing data to identify the data needs that must be addressed during the investigation. This evaluation determines whether existing data are adequate to establish the nature and extent of contamination. Comparisons with regulatory criteria and cleanup or screening levels is not performed during the historical evaluation, but will be included as part of the investigation report.

(b) Tables B-13 and B-14 present the results of surface sampling for organic chemicals. These tables show the low number of detections, which justify LANL's conclusion that there are no data gaps. Existing surface data are adequate to establish the nature and extent of organic chemical contamination of in surface soil and fill at MDA C. The nature and extent of contamination in surface soil and fill is discussed in Section B-4.1 of the Work Plan.

(c) and (d) Section B.4.2 (mistakenly numbered B-4.2.1) provides LANL's rationale for concluding that the nature and extent of organic contamination in surface soils has been established and that there are no data gaps. As noted in this paragraph, the detected concentrations of organic chemicals have been bounded by samples where organic chemicals were not detected, thus defining the extent of contamination. Because the nature and extent of organic contamination has been determined, there are not data gaps and modification of the scope of work for additional surface sampling is not necessary.

NMED Comment

37. Section B-3.2.3: Pore Gas Samples: VOCs in Soil-Gas Survey Samples

The Permittees shall include locations with that data in Table B-21. The bubble diagram (Figure D-27) shows only the highest concentration of PCE. The diagram is acceptable only as a visual aid to complement a data table.

LANL Response

A new figure and table will be provided showing sample locations and concentrations.

NMED Comment

38. Section B-3.2.3: Pore Gas Samples: VOCs in Pore-Gas Samples

(a) *The second paragraph of this section states that the bottom of borehole 50-10131 is at 250 feet. However, Table E-7 indicates that samples were collected from the borehole at 315 feet. The Permittees shall correct this section.*

(b) *The last paragraph of this subsection states that B&K screening may not be useful for predicting low pore-gas concentrations. However, Section 5.0 cites ER-SOP-6.31, Rev. 1 "Atmospheric and Sub-Atmospheric Air Sampling" as the methods that will be followed in this investigation. The cited SOP describes screening methods using the B&K instrument. This is an example of the reason why NMED requires field screening methods to be described in this work plan. The B&K limits VOC detection to three or four selected compounds. This limitation is not acceptable in this application.*

(c) *The Permittees shall provide a description of the methods for field screening for VOCs, and the purpose of conducting field screening (for example, extending boreholes if contamination is encountered at the bottom interval). VOCs have been detected at the bottom interval of both pore-gas monitoring boreholes.*

(d) *This section states, "the aliphatic hydrocarbons, benzene, carbon tetrachloride, chloroform, PCE, and TCE are identified as COPCs at MDA C." A screening instrument must be used that is capable of detecting all VOCs that are potentially present at MDA C.*

LANL Response

(a) The depth will be corrected to 315-ft.

(b) The figures show that the B&K and SUMMA TO-14 results do not correlate well for low ppm concentrations (i.e., <10ppm). The B&K will not be used at MDA C unless concentrations are > 10 ppm. LANL would like to discuss with NMED the effectiveness of field screening for VOCs using a photo ionization detector (PID) equipped with a 11.7 eV lamp to perform headspace vapor screening on core samples as described in Section IX.B.2.d of the Order.

(c) As previously described in the responses to Comments 16 and 25, field screening for VOCs is not necessary to satisfy the data gaps related to subsurface VOC vapor contamination. Field screening for VOCs is not effective since these contaminants are present in the vapor phase at low concentrations (See MDA H RFI and RFI Addendum).

(d) As previously described in the responses to Comments 16 and 25, field screening for VOCs is not necessary to satisfy the data gaps related to subsurface VOC vapor contamination.

NMED Comment

39. Section B-4.1: Nature and Extent of Contamination in Surface Soil and Fill: Radionuclides

The highest concentrations of Am-241, Pu-238, and Pu-239/240 were found in surface samples in the NE corner of the site. No surface sampling is proposed for this portion of the site. The Permittees

shall modify the scope of work to propose plans for surface sampling at this location, or provide sufficient data and rationale to demonstrate that additional sample collection is not necessary.

LANL Response

As discussed in Section B-4.2.1, the special extent of potential surface releases from MDA C has been established by the Phase I RFI data and no data gap was identified.

NMED Comment

40. Section B-4.2.1: Data Gaps Related to Surface Soil and Fill

This section claims that the detected concentrations of organic chemicals are bounded by other soil and fill samples where they were not detected. However, the data provided in this work plan is not sufficient to demonstrate this assertion. The bubble plots do not adequately show or prove the validity of this statement. The Permittees shall provide sufficient data and rationale to demonstrate that additional sample collection is necessary.

LANL Response

The bubble plots in Appendix D will be revised to show locations where samples were collected but the analyte was not detected. Also see response to Comment 36(c) and 36(d) with respect to evaluation of the extent of organic chemical contamination in surface soil and fill.

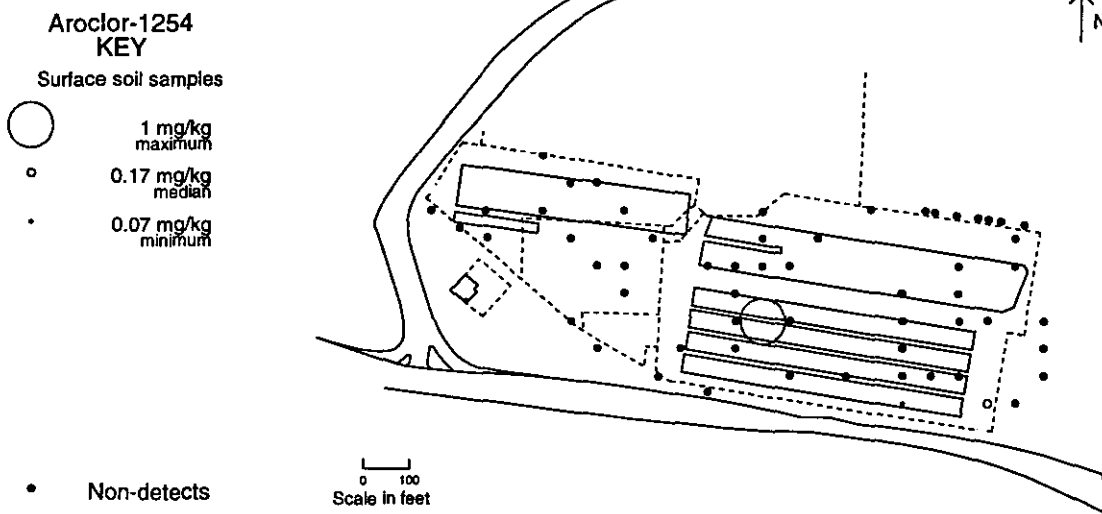


Figure D-6 Bubble plot of Aroclor-1254 detected concentrations from surface soil and fill material at MDA C

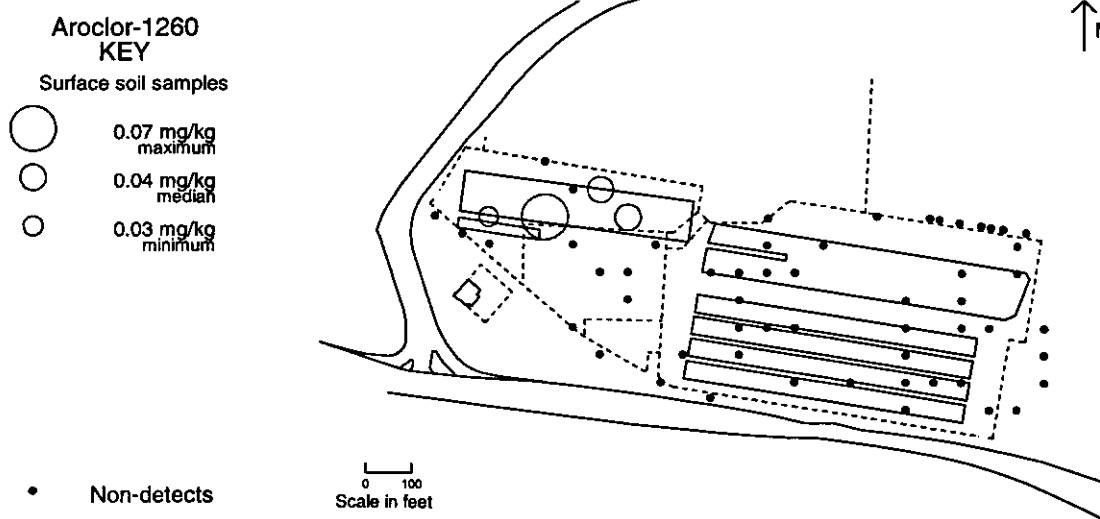


Figure D-7 Bubble plot of Aroclor-1260 detected concentrations from surface soil and fill material at MDA C

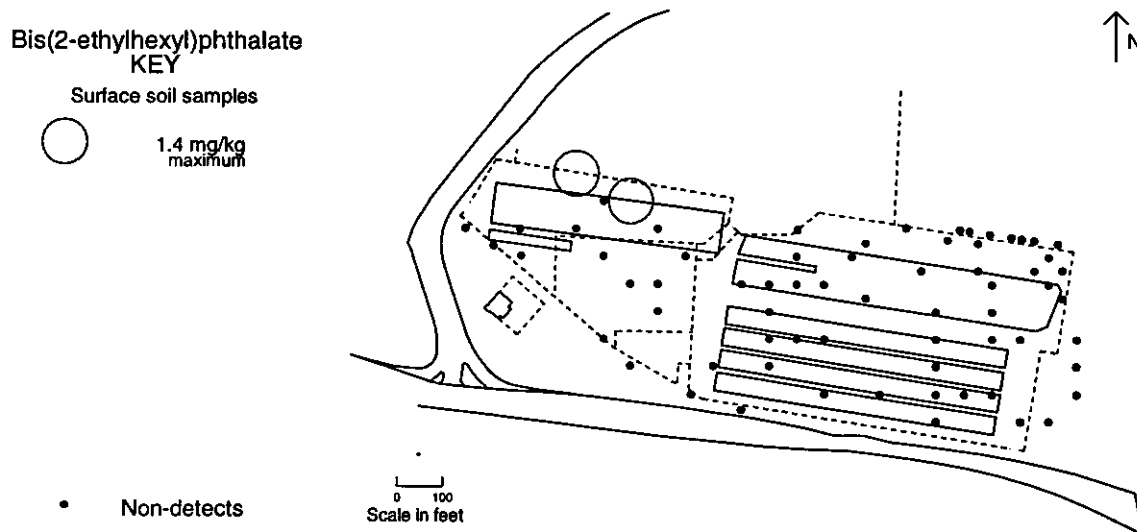


Figure D-8 Bubble plot of bis(2-ethylhexyl)phthalate detected concentrations from surface soil and fill material at MDA C

NMED Comment

41. Figures and Tables in the Historical Investigation Report

Some of the historical data is not usable. NMED requires the background information and data to determine the amount of further data collection that is needed to complete the investigation of the site. Tables that include data and sample identification numbers but no corresponding figures with the identification numbers do not serve this purpose. The Permittees shall present the detections of contaminants encountered during previous investigations in table format, with accompanying figures showing identifiable sample locations.

LANL Response

The requested figures will be provided, including figures plotting the sample location Id numbers. See responses to Comments 29 and 30(a).

NMED Comment

42. *Tables in the Historical Investigation Report*

(a) The Permittees shall include tables with summaries of regulatory criteria and applicable cleanup or screening levels. This information may be included on the tables of analytical data or as separate tables.

(b) The Permittees shall include tables with summaries of historical field screening and field parameter measurements of soil, tuff, and air quality data.

LANL Response

(a) The requirements for the HIR are contained in Section IV.C.3.b of the NMED Order and do not include presentation of regulatory criteria and applicable cleanup or screening levels. The purpose of the HIR is to present and evaluate existing data to identify the data needs that must be addressed during the investigation. This evaluation determines whether existing data are adequate to establish the nature and extent of contamination. Comparisons with regulatory criteria and cleanup or screening levels is not performed during the historical evaluation, but will be included as part of the investigation report.

(b) Copies of field measurement data forms will be provided to NMED. See response to Comment 32(b).

NMED Comment

43. *Figure B-2: Pre-RFI characterization sample locations-1989*

The Permittees shall include sample ID numbers at the sample locations marked on the figure, or the locations where the detections were measured (as described in Section B- .2.3).

LANL Response

The detected values referred to in the text will be added to Figure B-2. See response to Comment 29.

NMED Comment

44. *Figure B-3: Phase I RFI surface sample locations at MDA C-1995*

The Permittees shall include sample ID numbers at the sample locations marked on the figure. These must correlate with the ID numbers and data in Tables B-10, B-12, and B-14.

LANL Response

See response to Comment 30(a).

NMED Comment

45. *Figure B-4: Locations of tritium probe and biota samples collected in 2003 at MDA C*

The Permittees shall include sample ID numbers for the biota screening samples at the sample locations marked on the figure. The screening location ID numbers in Tables B-7 and B-8 do not

match those on Figure B-4. The sampling results are not available and should be included in the Investigation Report. The report must include a figure with the locations where biota samples were actually collected. This work plan states that 14 ant mounds and 63 burrows were screened, but only 9 ant mounds and 20 burrows were sampled.

LANL Response

Figure B-4 shows the locations where the following biota samples were actually collected. The sample and location Id numbers are listed below. This data will be reported in the Investigation Report.

Sample ID	Location ID	Depth (ft)	Media
MD50-03-50891	50-21981	0-0.5	Soil
MD50-03-50892	50-21982	0-0.5	Soil
MD50-03-50893	50-21983	0-0.5	Soil
MD50-03-50894	50-21984	0-0.5	Soil
MD50-03-50895	50-21985	0-0.5	Soil
MD50-03-50896	50-21986	0-0.5	Soil
MD50-03-50897	50-21987	0-0.5	Soil
MD50-03-50898	50-21988	0-0.5	Soil
MD50-03-50899	50-21989	0-0.5	Soil
MD50-03-50900	50-21990	0-0.5	Soil
MD50-03-50901	50-21991	0-0.5	Soil
MD50-03-50902	50-21992	0-0.5	Soil
MD50-03-50903	50-21993	0-0.5	Soil
MD50-03-50904	50-21994	0-0.5	Soil
MD50-03-50905	50-21995	0-0.5	Soil
MD50-03-50906	50-21996	0-0.5	Soil
MD50-03-50907	50-21997	0-0.5	Soil
MD50-03-50908	50-21998	0-0.5	Soil
MD50-03-50909	50-21999	0-0.5	Soil
MD50-03-50910	50-22000	0-0.5	Soil
MD50-03-50911	50-22001	0-0.5	Soil

4-1

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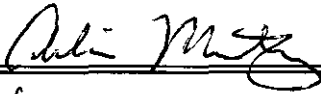
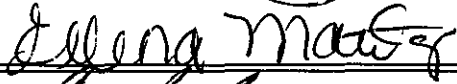
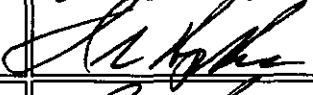
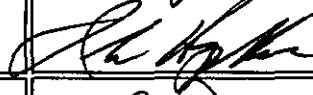
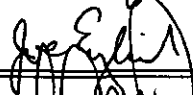
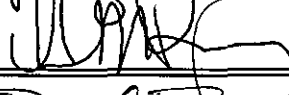
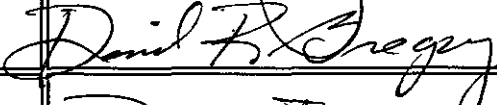
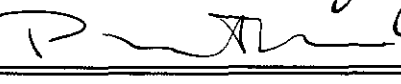
Status/Comments:

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Proof Reader			
Author			
Team Leader			
Regulatory Compliance Reviewer			
RRES-RS Program Manager, Dave McInroy			
DOE/OLASO Program Manager			

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Status/Comments	

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Word Processor ADELINA MARTINEZ		10/23/03
Proof Reader ELENA MARTINEZ		10/23/03
Author JOHN HOPKINS		10/23/03
Team Leader JOHN HOPKINS		10/23/03
Regulatory Compliance Reviewer JOE ENGLISH		10/23/03
RS Project Director, Dave McInroy DAVE MCINROY		11/6/03
DOE/OLASO Program Manager DAVID GREGORY		11/6/03
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RRES Remediation Services (RS) Project Document Signature Form

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ER2003-0488 ER2003-0667 ER2004-0009 ER2004-0038

Document Title /Subject: INVESTIGATION WORK PLAN FOR MATERIAL DISPOSAL AREA C, SOLID WASTE MANAGEMENT UNIT 50-009 AT TECHNICAL AREA 50, REVISION 1

PRSs: None **Privileged Information:** Y / N

Associated Document Catalog Number(s): ER2003-0338

Author: Hopkins, John K 667-9551 johnhopkins@lanl.gov

Author Organization: Material Disposal Areas

Document Team: Herrera, Tanya 667-8285 pth@lanl.gov

Document Type: IWP Update **Former OU:** N/A

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Date Sent to NMED: 11/6/2003

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LA-UR Number: LA-UR-03-8201

RPF ER ID Number: **Performance Measure:** No

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Certification Required: No

Force Peer Review: No

Distribution TO: John Young, NMED
DOE/LASO

Distribution FROM: David McInroy, RRES-RS David Gregory,

Distribution COPY:

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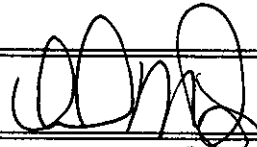
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Conditional approval may be indicated by checking the COMMENTS ATTACHED box.)

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Team Leader			
Regulatory Compliance Reviewer			
Legal Reviewer			
DOE/LASO Reviewer			
RRES-RS Program Manager, Dave McInroy			

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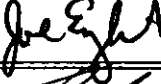
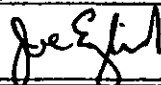
Reviewer (Print reviewer's name under title)	Signature	Date
Author JOHN HOPKINS		11/6/03
ESH-19 Reviewer JOE ENGLISH		11/8/03
Team Leader JOHN HOPKINS		11/6/03
Regulatory Compliance Reviewer JOE ENGLISH		11/6/03
Legal Reviewer ELLEN LOUDERBOUGH	see attached	
DOE/LAAO Reviewer WOODY WOODWORTH		
RS Project Director, Dave McInroy		11/06/03
DOE/OLASO Program Manager DAVID GREGORY		11/06/03

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Team Leader JOHN HOPKINS		11/6/03
Regulatory Compliance Reviewer JOE ENGLISH		11/6/03
Legal Reviewer ELLEN GUNDERBOUGH	Ellen T. Gunderbough	11/06/03
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Document Title /Subject: MDA C Investigation Work Plan RSI Response

PRSS: None Privileged Information: Y / N

Associated Document Catalog Number(s): None

Author: Hopkins, John K 667-9551 johnhopkins@lanl.gov

Author Organization: Material Disposal Areas

Document Team: None

Document Type: RSI Response Former OU: N/A

Date Due: Unknown

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LA-UR Number: RPF ER ID Number: Performance Measure: No

AA Deliverable: No Certification Required: No Force Peer Review: No

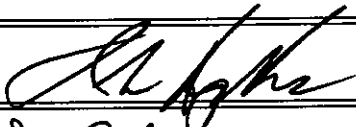
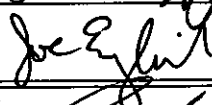
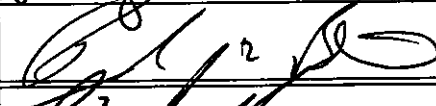
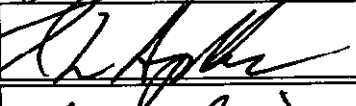
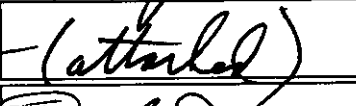
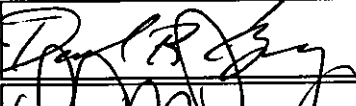
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ESH-19 Reviewer JOE ENGLISH		10/23/03	
Reg. Compliance Deployed Reviewer PAULA BERTINO		10/23/03	
Team Leader JOHN HOPKINS		10/23/03	
Legal Reviewer ELLEN LOUDERBOUGH	(attached)		
DOE/LAAO Reviewer LANCE WOODWORTH		11/06/03	
ER Program Manager		11/6/03	

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Document Title /Subject: MDA C Investigation Work Plan RSI Response

PRs: None Privileged Information: Y / N

Associated Document Catalog Number(s): None

Author: Hopkins, John K 667-9551 johnhopkins@lanl.gov

Author Organization: Material Disposal Areas

Document Team: None

Document Type: RSI Response Former OU: N/A

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LA-UR Number: RPF ER ID Number: Performance Measure: No

AA Deliverable: No

Certification Required: No

Force Peer Review: No

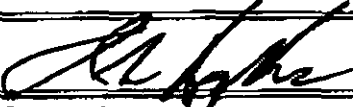
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ESH-19 Reviewer JOE ENGLISH		10/23/03	
Reg. Compliance Deployed Reviewer PAVIA BERTINO		10/23/03	
Team Leader JOHN HOPKINS		10/23/03	
Legal Reviewer ELLEN LOODERBOUST		10/23/03	
DOE/LAO Reviewer			
ER Program Manager			

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