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Material Disposal Area P Site Closure Certification Report

CD included with this document

Los Alamos NM 87545

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Produced by
Risk Reduction and Environmental Stewardship Division–Remediation Services

EXECUTIVE SUMMARY

This closure certification report summarizes the activities performed to meet closure requirements and demonstrate clean closure for two regulated hazardous waste management units: Material Disposal Area (MDA) P and the 387 Flash Pad. Both units are located within the Technical Area 16 (TA-16) Burning Ground, within the high explosives (HE) exclusion area at Los Alamos National Laboratory. MDA P is also identified as Solid Waste Management Unit (SWMU) 16-018 and the 387 Flash Pad as SWMU 16-010(b). Additionally, voluntary corrective action (VCA) activities were conducted simultaneously with the MDA P and 387 Flash Pad closure activities for a consolidated group of SWMUs, designated SWMU 16-016(c)-99, which is contiguous with MDA P and the 387 Flash Pad. SWMU 16-016(c)-99 includes the TA-16 386 Flash Pad, a former barium nitrate pile, and a septic system [SWMU 16-010(a), SWMU 16-016(c), and SWMU 16-006(e), respectively]; these are sometimes referred to as the "Burning Ground North." The two hazardous waste management units and SWMU 16-016(c)-99 were combined for cleanup purposes and are referred to collectively in this report as the "MDA P Site." Field activities, including waste excavation, waste characterization, waste disposition, and the final demonstration of clean closure were conducted for the entire MDA P Site.

Cleanup of the MDA P Site was conducted in two phases. Phase I activities included waste excavation, waste removal, segregation, staging, characterization, and disposal. The types and quantities of wastes generated during the excavation and removal activities at the MDA P Site are summarized in Table ES-1. Phase II activities included a detailed geophysical and geochemical study for characterization of the bedrock fractures at the site, and post-removal confirmation sampling and analysis in support of the assessment of the potential for adverse effects to human health or the environment from residual chemical concentrations at the site. The risk assessment analysis is used as the basis for determining whether clean closure has been demonstrated for the regulated hazardous waste management units (MDA P and the 387 Flash Pad) and whether corrective action activities are complete at SWMU 16-016(c)-99.

Table ES-1
Quantities of Wastes Generated During MDA P Site Phase I Activities

Quantity	Unit	Description
21,506	yd^3	Hazardous waste soils
26,150	yd^3	Industrial waste soils
1111	yd^3	Rock: decontaminated, used as riprap at TA-16 Burning Ground
757	yd^3	Rock: released, used as riprap within MDA P footprint
3200	yd^3	Concrete debris: recycle and industrial waste
2200	yd^3	Metal debris: recycle and industrial waste
3947	lb	Asbestos-containing material
888	each	Containers of unknown content
95	each	Miscellaneous metal objects
441	lb	HE
85	lb	Ash from burning HE
500	lb	Ash and contaminated debris
6706	lb	Barium nitrate pieces
3240	lb	Radioactive low-level waste (LLW)
5389	lb	Mixed waste

Table ES-1 (continued)

Quantity	Unit	Description
219,545	gal.	Decontamination water
16,318	gal.	Stormwater
37	gal.	Acetone
33	bag	Personal protective equipment
70	lb	Waste aerosol cans
250	lb	Soil/transmission oil
70	lb	Miscellaneous laboratory trash

This closure certification report provides all the details and supporting documentation required to demonstrate that the clean closure performance standards for MDA P and the 387 Flash Pad, and the no further action criterion for SWMU 16-016(c)-99, have been met. All waste removal and management activities were conducted in accordance with the approved closure plans, the VCA plan, and applicable regulations. All contaminated debris, soils, equipment, structures, and other wastes generated as a result of closure/remediation activities were properly characterized, managed, decontaminated, and/or disposed of. Only soils and tuff containing residual concentrations of hazardous constituents that are below levels that pose an unacceptable risk to human health or the environment are left in place at the MDA P Site.

Confirmation sampling provided sufficient data for adequately characterizing the lateral and vertical extent of residual chemical concentrations at the site. Natural, physiographic boundaries have limited (and continue to limit) the lateral extent of off-site transport. The residual concentrations of contaminants are concentrated near, and within, the boundaries of the SWMUs (the area of the excavation and removal activities) and there are general trends of decreasing concentrations laterally. There are clear trends of decreasing concentrations with depth. The residual contamination at the site is most prevalent in the near-surface (0–1 ft) soil and tuff, and residual concentrations of contaminants in soil samples below 4 ft and in tuff samples below 8 ft decrease to detection limits or levels below background. Additionally, the residual contamination at the site is primarily confined to tuff, indicating that excavation activities successfully removed contaminated soils from the site.

The results of both the human health and ecological risk assessment analyses conclude that the remaining site soils and tuff that contain residual concentrations of hazardous constituents do not pose unacceptable current or potential future risk to human and ecological receptors. Data collected from borehole geophysical and geochemical studies and the fracture characterization study indicate that there is no surface-to-groundwater pathway at the MDA P Site, which supports the Laboratory's request for a determination that a post-closure permit for groundwater monitoring is not warranted.

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1.0 INTRODUCTION

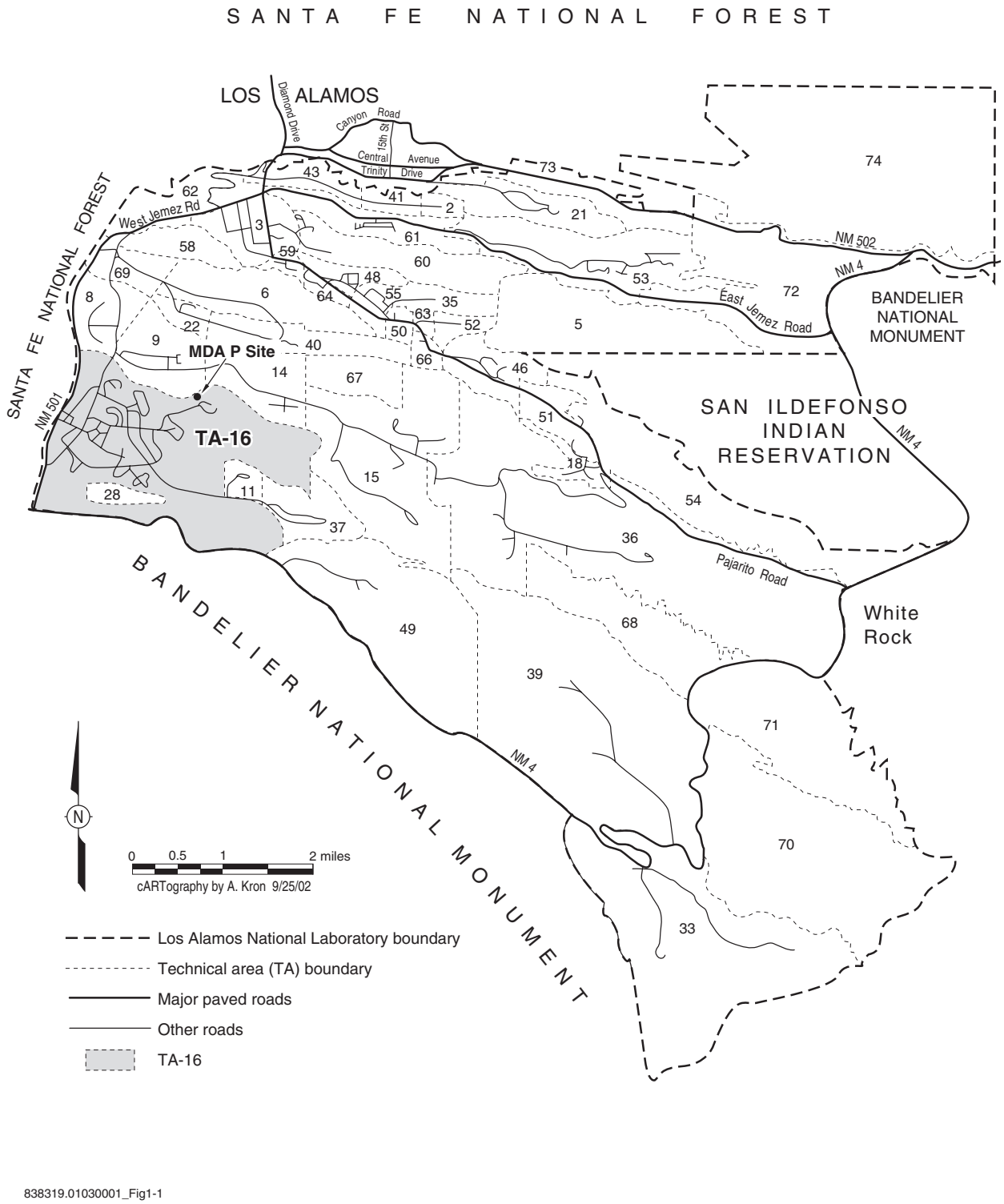
This closure certification report summarizes the activities performed to demonstrate clean closure for two hazardous waste management units: Material Disposal Area (MDA) P and the TA-16-387 Flash Pad (Flash Pad 387). Both units are located at the Technical Area (TA) 16 Burning Ground within the high explosives (HE) exclusion area at Los Alamos National Laboratory (the Laboratory) (Figure 1.0-1). MDA P is also identified as Solid Waste Management Unit (SWMU) 16-018 and Flash Pad 387 as SWMU 16-010(b). Voluntary corrective action (VCA) activities for a consolidated group of SWMUs, designated SWMU 16-016(c)-99, which is contiguous with MDA P and Flash Pad 387, were conducted simultaneously with the MDA P and Flash Pad 387 closure activities. SWMU 16-016(c)-99 includes the TA-16-386 Flash Pad (Flash Pad 386), a former barium nitrate pile, and a septic system [SWMU 16-010(a), SWMU 16-016(c), and SWMU 16-006(e), respectively]; these are sometimes referred to as the "Burning Ground North." The two hazardous waste management units and SWMU 16-016(c)-99 were combined for cleanup purposes and are collectively referred to as the "MDA P Site."

1.1 Project and Report Objectives

The Laboratory is a multi-disciplinary research facility owned by the US Department of Energy (DOE) and managed by the University of California. The Laboratory's Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) Project (formerly the Environmental Restoration [ER] Project) is part of a national effort by the DOE to clean up sites and facilities formerly involved in weapons production. The primary goal of the RRES-RS Project is to ensure that the DOE's past weapons operations do not threaten human health and safety or the environment, currently or in the future. To achieve this objective at the MDA P Site, the RRES-RS Project, with approval from the New Mexico Environment Department (NMED), performed clean closure by waste removal from the MDA P Site. The purpose of this closure certification report is to demonstrate that the clean closure (MDA P and Flash Pad 387) and corrective action [SWMU 16-016(c)-99] requirements for the MDA P Site have been achieved. This report demonstrates compliance with all applicable regulatory requirements (detailed in section 2.1), including certification by an independent, registered professional engineer, as required in the New Mexico Administrative Code, Title 20, Chapter 4, Subpart 600 (20.4.1.600 NMAC), Section 265.115.

Cleanup of the MDA P Site was conducted in two phases. Phase I activities included waste excavation; waste removal; and waste segregation, staging, characterization, and disposal of materials from the MDA P Site. Phase II activities included a detailed geophysical and geochemical study for characterization of the bedrock fractures, and post-removal confirmation sampling and analysis in support of the assessment of the potential for adverse effects to human health or the environment from residual chemical concentrations at the site. As required by the NMED (NMED 2003, 76017), Phase I and II activities were described in detail in the following documents

- "Material Disposal Area P Site: Phase I Closure Implementation Report," June 2003, LA-UR-02-7002 (LANL 2003, 76054).
- "Bedrock Fracture Characterization at Material Disposal Area P Site: Phase II Closure Investigation Report," July 2003, LA-UR-02-7200 (LANL 2003, 77423)



838319.01030001_Fig1-1

Figure 1.0-1. Location of TA-16 and the MDA P Site

These two reports are incorporated herein by reference in order to satisfy the information requirements for this closure certification report.

The closure activities for MDA P and Flash Pad 387 were performed in accordance with the closure plan for each unit, as reviewed and approved by the NMED Hazardous Waste Bureau (formerly the Hazardous and Radioactive Materials Bureau). Cleanup activities at SWMU 16-016(c)-99 were performed in accordance with an NMED-approved VCA plan. The following documents delineate the specific closure and VCA completion requirements under which activities at the MDA P Site were conducted:

- Technical Area 16, Material Disposal Area P Closure Plan, Revision 0 (LANL 1995, 58713), approved by NMED on February 20, 1997
- Notice of deficiency (NOD) on the MDA P closure plan (NMED 1996, 57903) and response to NOD (LANL 1996, 54452)
- Closure Plan for the TA-16-387 Flash Pad (LANL 1999, 63547), approved by NMED on April 28, 2000
- VCA plan for SWMU 16-016(c)-99, submitted as part of the sampling and analysis plan (SAP) for MDA P (LANL 1999, 63546) and approved by NMED on July 7, 2001
- Response to request for supplemental information (RSI) for the MDA P SAP, and the VCA plan for SWMU 16-016(c)-99 (LANL 2000, 67481)
- Approved closure plan modification request, May 2002 (LANL 2002, 73159), which consolidated the information and modifications included in the RSI response (LANL 2000, 67481); additional information for MDA P Phase II confirmation sampling (LANL 2001, 70272); and SAP deviations (LANL 2001, 70252).

1.2 Report Organization

This closure certification report is organized as follows:

- Section 1, Introduction, contains a brief overview of the report and its objectives, and information about MDA P, Flash Pad 387, SWMU 16-016(c)-99, and the MDA P Site as a whole;
- Section 2, Performance of Closure, presents all the information required for demonstrating clean closure at MDA P and Flash Pad 387, and information pertaining to completion of the VCA at SWMU 16-016(c)-99. This section includes 2.1, closure strategy and regulatory requirements; 2.2, a summary of waste removal and decontamination activities for the MDA P Site; 2.3, a summary of the bedrock fracture characterization study for the MDA P Site; 2.4, a description of confirmation sampling and results; and 2.5, a summary of the human health and ecological risk assessments, which are described in detail in Appendix A;
- Section 3, Assessment of Impact to Groundwater, provides the basis for the Laboratory's request for a determination by NMED that a post-closure care permit for groundwater monitoring is not required at MDA P. This section addresses regulatory requirements that apply specifically to MDA P because it is a land-based unit;
- Sections 4 through 6 present conclusions, the required certifications, and references, respectively.

1.3 Location of Supporting Documentation

As committed to in the closure plan for MDA P, the location of the following supporting documentation is provided in this report: field log books, quality assurance/quality control (QA/QC) documentation, and chain-of-custody records. Field log books for the Phase I activities were scanned and provided electronically on CD #1 as part of the Phase I report. Phase I and Phase II log books, QA/QC documentation, and chain-of-custody records are stored in the RRES-RS Records Processing Facility (RPF). (Chain-of-custody forms are also provided as Appendix E to this closure certification report.)

Additional documentation related to the Phase I disposal activities (industrial and hazardous) that is also stored in the RPF includes

- disposal documentation records for all waste streams [by Waste Profile Form (WPF) number],
- soil lots,
- shipment dates,
- bills of lading,
- waste manifests, and
- certificates of receipt.

Phase I analytical data are provided electronically on a CD included with the Phase I report (LANL 2003, 76054) and are stored in the RRES-RS Project RPF.

Phase II analytical data are provided electronically on the CD included at the front of this report and in hard copy in Appendix B. The data are also stored in the RRES-RS Project RPF.

Log books for operations of Flash Pad 387 (from the 1980s) are in storage at the Burning Ground within TA-16.

1.4 MDA P Site Description and Use

The MDA P Site is located within TA-16, in the southwest corner of the Laboratory (Figure 1.0-1). TA-16 is bordered by Bandelier National Monument along State Highway 4 to the south and the Santa Fe National Forest along State Highway 501 to the west. To the north and east, it is bordered by TAs-8, -9, -11, -14, -15, -37, and -49. TA-16 is fenced and posted along State Highway 4. Water Canyon, a 200-ft-deep ravine with steep walls, separates State Highway 4 from active sites at TA-16. Cañon de Valle forms the northern border of TA-16. The MDA P Site boundary and the location of each unit associated with the MDA P Site is shown on Plate 1 (at the end of this report). Photograph 1.4-1 captures an aerial view of the site in 1997, immediately prior to the start of excavation and removal activities. Figure 1.4-1 shows the general area of TA-16 immediately surrounding the MDA P Site.

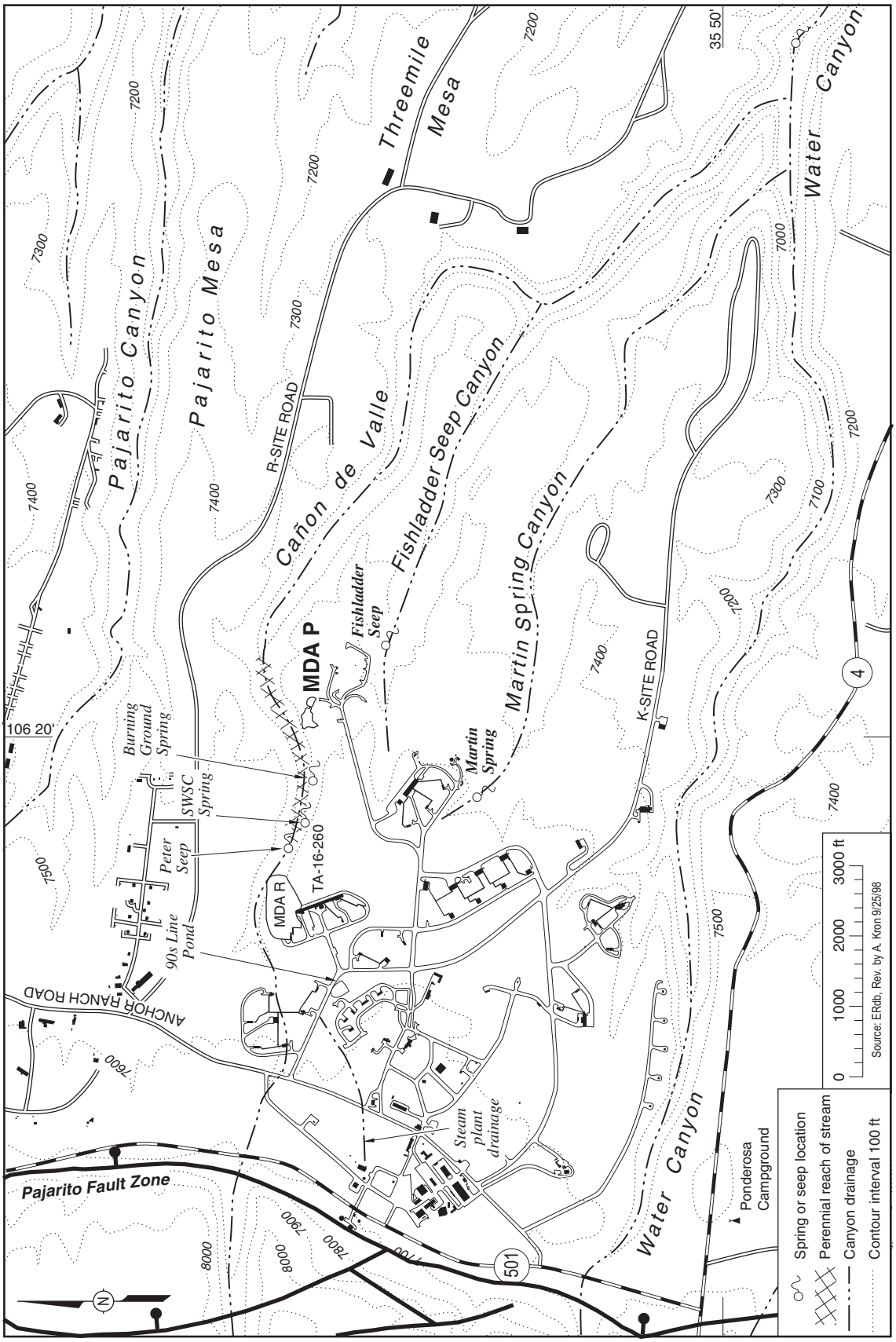


Figure 1.4-1. Area surrounding MDA P Site

MDA P is located within an operational area known as the TA-16 Burning Ground, which began operations in 1950 and is currently the location of two active hazardous waste treatment units and two treatment units undergoing closure under interim status standards. The TA-16 Burning Ground is located within a broad topographic saddle on an east-trending mesa. The saddle runs between two hills to the east and west and at its lowest point is at an elevation of approximately 7454 ft, approximately the mean elevation of TA-16. The MDA P Site is on the north side of the burning ground within a small open watershed with no springs or other natural, perennial sources of water; the runoff from the site drains to Cañon de Valle, which is a small tributary of Water Canyon. Within TA-16, the RRES-RS Project is conducting activities to address other potential, historic sources of contamination to the Cañon de Valle system. MDA P is located in geographic proximity to these activities, but the MDA P Site is not within their scope.

Current conditions at the MDA P Site promote runoff and inhibit infiltration. Currently, run-on is directed away from the site into two adjacent watersheds, using natural and engineered landscape features; the bar ditch along the north side of the access road leading from the west into the burning ground is diverted through a culvert to the drainage south of the saddle. Precipitation that falls within the watershed provides ephemeral runoff to two arroyos that serve as hydrologic boundaries on the east and west margins of the site. Overland flow from the former location of Flash Pad 387 in the northern portion of the site currently is diverted through a remnant of the MDA P run-on trench to the east arroyo. Direct precipitation is the only potential source of surface water transport within the interior portion of the site.

The current, post-excavation MDA P Site consists of two distinct zones: an “exposed tuff zone” and a “biological zone.” The biological zone consists of undisturbed or reclaimed areas (approximately 5 acres of the nearly 9.25-acre site), which border the main excavation area to the south, east, and west. The reclaimed areas within the MDA P Site footprint have approximately 2 ft of topsoil, though the soils in some locations near the east and west perimeters of the site are as deep as approximately 5 ft. Undisturbed areas outside the MDA P Site footprint contain soils up to 5 ft deep on average. The exposed tuff zone consists of a single large and continuous area of exposed tuff (approximately 4.25 acre of consolidated tuff or unconsolidated tuff with large boulders) from which the topsoil was completely removed during Phase I excavation activities. Photograph 1.4-2 shows the MDA P Site as excavation activities were being completed; the middle area of the site is the flat portion of the exposed tuff zone. In front of that is the unconsolidated tuff area that slopes steeply towards Cañon de Valle; the uppermost portion of the site is the now-restored and reseeded biological zone (shown in the photograph with soil piles in the right half of the biological zone). Photograph 1.4-3 is an October 2002 photograph of the site, showing the restored/revegetated areas in green surrounding the exposed tuff zone (toward the left of the excavation area, adjacent to the forest boundary). Figure 1.4-2 shows the extent of the biological and exposed tuff zones and the boundaries of the units within the MDA P Site.

Photograph 1.4-1. Aerial view of the MDA P Site prior to excavation, 1997

Photograph 1.4-2. Post-excavation condition of the MDA P Site

Photograph 1.4-3. MDA P Site, October 2002

1.4.1 MDA P

From 1950 to 1984, MDA P was used for disposal of rubble and debris generated by the burning of HE, HE-contaminated equipment and material, vehicles, building materials, drums, containers, and trash. During the operational period of MDA P, few items were allowed to leave the HE exclusion area, so most materials suspected of having HE residue were disposed of at MDA P. Residual materials from the burning and flashing operations within the TA-16 Burning Ground were disposed of over the mesa edge, accumulating at the base and along the slope of the canyon wall. MDA P eventually expanded toward the canyon floor along the leading margins of the construction backfill placed during the construction of Flash Pad 387 (section 1.4.2)

Throughout its history, the east lobe of MDA P was the most active portion of the disposal area. Material from the burning ground was disposed of over the leading edge of the east lobe and occasionally covered with soil. Photographs indicate that the lobe grew slowly but continuously. The leading edge of the east lobe aggraded approximately 60 ft over the entire period of use. Disposed materials excavated at the east lobe included ashes and burned residues of HE compounds, HE-contaminated equipment and materials, barium nitrate compounds, miscellaneous containers from Flash Pad 387, including sands and soils from the sand filters and the base of Flash Pad 387 (Photograph 1.4-4). Although depleted uranium (DU) was detected in trace amounts in some of the soils and debris at MDA P, materials with potential DU contamination were typically not disposed of at MDA P.

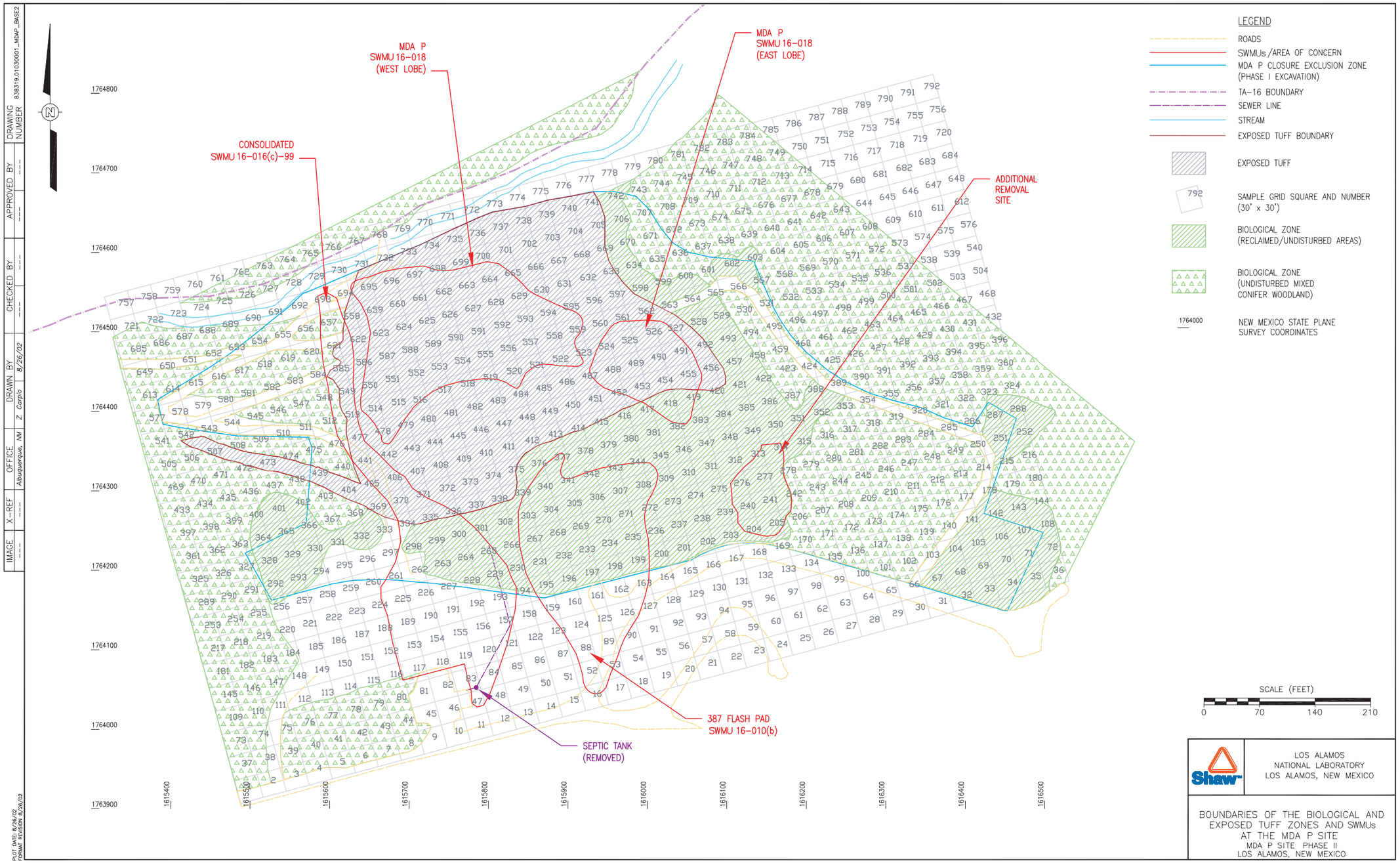


Figure 1.4-2. Boundaries of the biological and exposed tuff zones and SWMUs at the MDA P Site

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Photograph 1.4-4. East lobe of MDA P (waste and debris from adjacent flash pad operations), 1965

Episodic disposal occurred in the west lobe, which filled a small channel eroded into the southern canyon wall, and which was used primarily for the disposal of HE-contaminated construction debris. In the 1960s, several World War II–era wooden frame structures that housed the original facilities for HE research, development, and production at TA-16 were razed. The west lobe received all noncombustible materials with residual HE from these deconstruction/demolition activities—as many as 1325 dump truck loads (Photograph 1.4-5). Materials and debris included piping (water, sewer, steam, and process piping), electrical conduit, concrete (sidewalks, foundations, and sumps), asbestos tile, and miscellaneous soil and trash. Larger items that had been treated at Flash Pad 387 were also disposed of at the west lobe, including at least ten vehicles in the 1950s and 1960s that had been flashed for the removal of HE residues and pushed over the lobe's edge. In the early 1970s, the rear apron of Building 260 was renovated and concrete from the demolition of sidewalks and sumps was added to the west lobe. With the exception of the periods noted between 1965 and 1975, the annual volume of waste disposed of at the west lobe appears constant.

The location of MDA P is almost entirely within the current exposed tuff zone, the area from which all topsoil and unconsolidated materials were removed during Phase I excavation activities. Runoff from precipitation that falls within MDA P generally is diverted to either the eastern or western arroyos that bound the site. Erosion from steep areas within the unconsolidated tuff area towards the northern boundary of the site that are subject to erosion has largely been mitigated by the implementation of best management practices (BMPs), including the placing of riprap and other erosion control features such as straw bales.

Photograph 1.4-5. West lobe of MDA P (debris from 1960s burning as well as concrete from 1970s deconstruction of Building 260), 1973

1.4.2 Flash Pad 387

Flash Pad 387 operated from 1951 to 2000 as a treatment unit for solid and scrap HE, HE-contaminated equipment and debris, and HE-contaminated combustible materials.

Originally remote and heavily forested, the construction of Flash Pad 387 required the cutting and clearing of trees and burning of the timber and slash. The ground surface was leveled and a substantial amount of backfill was brought in to provide a barren, roughly flat-lying area for the construction of the flash pad and a control building for the flash pad operations and tests. The backfill consisted of crushed Bandelier Tuff and large angular boulders up to 2 m across. The 100- x 100-ft pad area that was created was enclosed by an 8-ft chain link fence, originally installed in the 1950s. From 1951 to the late 1980s, the base of the pad was soil; flash pad operations were conducted on the soil pad, which was overlain with sand. In the late 1980s to early 1990s, a 30- x 30-ft concrete base with 8-ft-high concrete shield reflector sidewalls to the north, east, and west was constructed for the flash pad operations. Operations at the flash pad were largely wood-fired, but kerosene or other fire accelerants were sometimes used. Burning operations occasionally resulted in partial detonations and incomplete burns. Sands and residues from the operations at Flash Pad 387 were disposed of at MDA P. During the operational period of the flash pad, the base of the pad was excavated periodically and the contaminated soils were also disposed of at MDA P.

During the Phase I excavation activities, a trench was discovered in the eastern portion of the Flash Pad 387 area. The trench, containing remnants of a 4-in.-diameter vitrified clay pipe (VCP), originated in the middle of the southern boundary, trended northeast and terminated approximately 20 ft east of the

eastern boundary. Both ends of the pipe were crushed and there was no evidence of original source fittings or termination outfall. The interior of the pipe was contaminated with HE, indicating that it was used in some capacity for operations at TA-16, though no information was found to indicate specific uses of the pipe.

The former location of Flash Pad 387 is isolated hydrologically from the downgradient portions of the MDA P Site. Runoff from precipitation received within the boundaries of the former location of the flash pad is largely diverted to the east drainage via a remnant of the east-west trending MDA P run-on trench. Sheet flow of surface water, as may occur during intense precipitation events, may breach the run-on trench; this run-on would be diverted to the east and west arroyos along with the precipitation received within the boundaries of MDA P.

1.4.3 SWMU 16-016(c)-99

SWMU 16-016(c)-99 consisted of Flash Pad 386, a former barium nitrate pile, and a septic system. Flash Pad 386 was built in 1951 for operations similar to those conducted at Flash Pad 387; however, no evidence could be found to indicate that Flash Pad 386 was ever used as a burn pad for the treatment of HE-contaminated materials. Photographic evidence shows that Flash Pad 386 was used to store barium nitrate sometime during the 1950s, prior to which the barium nitrate pile was located to the north of Flash Pad 386. In 1998, a metal building was installed in the southeast corner of the area. The septic system was connected to Building 16-389 and was used for sanitary wastewater from 1963 through 1988; no evidence exists to indicate any other historic uses for the septic tank. During the excavation, no evidence of a leach field or drainfield was found.

The boundaries of Flash Pad 386 and the barium nitrate pile overlapped considerably, in part because a portion of Flash Pad 386 was used to store the barium nitrate pile sometime after the flash pad was constructed. Runoff that results from precipitation received within both these areas flows downgradient towards Cañon de Valle, and generally is diverted into the western arroyo, the steeper portions of which have BMP erosion-control features in place. Surface water runoff from the area where the septic tank was located is negligible because residual contamination associated with this former sanitary wastewater holding tank is limited to the subsurface. However, runoff from precipitation falling in the small area of the former septic tank has the same fate as runoff from Flash Pad 386 and the barium nitrate pile: it moves downgradient towards Cañon de Valle and towards the western arroyo.

1.5 Process Description

This section provides a summary of the hazardous waste operations conducted at MDA P and Flash Pad 387. SWMU 16-016(c)-99 did not operate as a hazardous waste storage, treatment, or disposal unit. Accordingly, requirements for closure of a hazardous waste management facility do not apply to SWMU 16-016(c)-99 and a process description is not provided.

1.5.1 MDA P

MDA P is a regulated hazardous waste management unit subject to Resource Conservation and Recovery Act (RCRA) interim status standards and is designated SWMU 16-018 (LANL, 1995, 58713). MDA P was redefined by NMED from a landfill to a waste pile for the purpose of closure activities (NMED, 2003, 76017). MDA P was used from 1950 to 1984 as a disposal area for wastes generated from burning ground operations. MDA P was identified as a regulated hazardous waste management unit because residues containing barium in excess of extraction procedure (EP) toxicity limits had been placed in the waste pile after 1980. Six US Environmental Protection Agency (EPA) Hazardous Waste Numbers for

characteristic wastes are identified for MDA P in the August 2002 Part A permit application (LANL 2002, 73799): D001 (ignitable), D003 (reactive), D005 (barium), D006 (cadmium), D008 (lead), and D030 (2,4-dinitrotoluene). These EPA Hazardous Waste Numbers are consistent with the types of hazardous waste that were identified through characterization activities and managed at the site during Phase I.

1.5.2 Flash Pad 387

Flash Pad 387 was used as a treatment unit for solid and scrap HE, HE-contaminated equipment and debris, and HE-contaminated combustible materials. It is subject to RCRA interim status closure standards, and is also designated SWMU 16-010(b) (LANL 1999, 63547).

The treatment consisted of open burning to remove the hazardous characteristic of reactivity (D003).

The estimated maximum weight of equipment and structures that could be treated at one time was 40,000 lb, the maximum capacity of the unit (LANL 2002, 73799). Facility records indicated that the maximum weight of equipment and structures treated at one time was 38,000 lb, although most burns were considerably smaller. The total annual quantities of waste treated at the flash pad in 1997 and 1998 were 63,000 and 31,000 lb, respectively (LANL 1999, 63547).

2.0 PERFORMANCE OF CLOSURE

This section provides the specific information needed to demonstrate that closure activities were performed in accordance with all applicable regulations and the requirements of the approved closure plans, and that clean closure has been achieved. Section 2.1 presents the strategy for combining MDA P, Flash Pad 387, and SWMU 16-016(c)-99; applicable regulatory requirements; and a summary of the basis for the clean closure demonstration. Waste removal and decontamination activities are described in section 2.2. The Phase II focused investigations (i.e., fracture study and borehole geophysical and geochemical analyses) are summarized in section 2.3. Confirmation sampling is described in section 2.4. The results of the human health and ecological risk assessments are presented in section 2.5.

2.1 Closure Strategy, Requirements, and Basis for Clean Closure Demonstration

2.1.1 Closure Strategy

The two hazardous waste management units and the consolidated SWMU that comprise the MDA P Site were combined for cleanup purposes to enhance the efficiency of field operations for each site and because a risk-based approach is appropriate for demonstrating completion of both clean closure and corrective action.

The approved closure plan for MDA P **(**LANL 1995, 58713) established that MDA P would undergo closure by removal and decontamination in order to meet the clean closure performance standard of 20.4.1.600 NMAC, Section 265.111 (see section 2.1.2.1). In the approved closure plan, a strategy was proposed for comparing Phase II confirmation sampling data to baseline levels of environmental contamination attributable to sources adjacent to MDA P. This strategy was intended to distinguish between MDA P-related contamination and that which was attributable to nearby sites.

After the MDA P closure plan was approved by NMED in 1997 and closure activities began, the Laboratory recognized that the MDA P closure activities were likely to affect the schedule of closure activities at Flash Pad 387 and remediation activities at SWMU 16-016(c)-99, which would be proceeding simultaneously (LANL 1999, 63546). Because of the sites' proximity to one another and their similar characteristics, the Laboratory determined that combining the three activities would allow for more

efficient use of resources, such as mobilization of field equipment. The Laboratory also concluded that confirmation sampling and assessment of human health and ecological impacts of the three sites together following the closure/remediation activities would be appropriate. Therefore, in February 1999, the Laboratory and NMED agreed that: the sites adjacent to MDA P would be closed or remediated concurrently with MDA P; any residual contamination would be assessed concurrently; and the sites would be closed or remediated to a common cleanup standard (LANL 1999, 63546). This decision was made for two reasons: (1) the hazardous wastes and hazardous constituents within the sites were similar, and (2) the boundaries of the sites overlap. During discussions between the Laboratory and NMED concerning the MDA P SAP, it was further agreed that

- two additional plans would be developed in conjunction with the MDA P SAP: a VCA plan for SWMU 16-016(c)-99, and a closure plan for Flash Pad 387.
- equipment from the ongoing closure operations at MDA P would remain mobilized at MDA P to clean up these additional sites.
- one set of operational preliminary remediation goals (PRGs) would be developed for field screening during cleanup activities at all three sites.
- the scope of the MDA P SAP would be expanded to include a confirmation sampling plan for verifying that operational PRGs had been achieved for all three sites and demonstrating that post-cleanup residual contamination levels pose no unacceptable risk to human health or the environment (LANL 1999, 63546).

Thus, the footprint of MDA P was expanded to include Flash Pad 387 and SWMU 16-016(c)-99, referred to collectively in this report as the MDA P Site.

2.1.2 Applicable Regulatory Requirements

Three different cleanup objectives were consolidated into the activities described in this report to achieve a common result, which relies on risk assessment as a tool for determining whether residual levels of hazardous constituents pose potential unacceptable risk to human health or the environment. The first objective is clean closure of MDA P, a hazardous waste disposal unit. The second is clean closure of Flash Pad 387, a hazardous waste treatment unit. The third is completion of a VCA for SWMU 16-016(c)-99, in order to demonstrate that the applicable criterion for no further action (NFA) has been met.

2.1.2.1 MDA P Clean Closure Performance Standard

The Laboratory has clean-closed MDA P, which was redefined from a landfill to a waste pile for closure purposes (NMED 2003, 76017), in accordance with the clean closure performance standard of 20.4.1.600 NMAC, 265.111, which requires that the unit be closed in a manner that

- minimizes the need for further maintenance, and
- controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to ground or surface waters or to the atmosphere, and

- complies with the appropriate unit-specific closure requirements of 40 CFR Part 265 (as adopted by 20.4.1.600 NMAC). For MDA P, the appropriate requirement is 265.258(a), which states the following:

> At closure, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste unless 261.3(d) of this chapter applies.

EPA has clarified that "decontamination and removal" of "all waste residues," as described in the closure performance standard, means removal of hazardous constituents derived from hazardous wastes that are present in the environment at or above levels that pose a potential unacceptable risk to human health or the environment (52 FR 8704, March 19, 1987; 53 FR 9844, March 28, 1988). This concept supports the risk-based approach to demonstration of clean closure presented in section 2.5. The use of risk-based approaches during clean closure is consistent with EPA guidance and policy directives that encourage coordination of cleanup requirements and eliminate duplication of effort (EPA 1998, 73777). It is EPA's longstanding position that regulated units may be clean closed to protective, risk-based media cleanup standards and that post-closure care is unnecessary if, after closure, no hazardous wastes or waste residues remain at the site of the unit above levels that present unacceptable risk to human health or the environment.

Table 2.1-1 summarizes how the Laboratory has complied with each aspect of the closure performance standard for MDA P, and where each of these aspects of the performance standard is addressed in this document.

Table 2.1-1
Requirements for Demonstration of Clean Closure, MDA P

Requirement	Regulatory Citation[a]	Location in Report	Comments
Closure performance standard. The owner or operator must close the facility in a manner that	265.111	—	—
minimizes the need for further maintenance, and	265.111(a)	Sections 2.2 – 2.5 and 3.0	The Laboratory has removed or decontaminated all wastes, components, structures, equipment, and contaminated subsoils associated with the MDA P Site. Because all waste has been removed and waste residues are below levels that present a potential unacceptable risk to human health and the environment, there is no need for further maintenance in the post-closure period.

Table 2.1-1 (continued)

Requirement	Regulatory Citation[a]	Location in Report	Comments
controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment:	265.111(b)	—	—
the post-closure escape of hazardous waste or hazardous constituents		Sections 2.2, 2.4, and the Phase I report[b]	The Laboratory performed closure by removal and decontamination, thereby eliminating the potential for post-closure escape of hazardous wastes or hazardous constituents. Waste management was conducted in accordance with the approved closure plan and applicable regulations. All contaminated equipment, structures, soils, and other wastes generated as a result of closure activities were properly characterized, managed, decontaminated, and/or disposed.
post-closure escape of leachate		Section 2.2 and the Phase I report[b]	Because all waste has been removed, there is no potential for post-closure leachate generation.
post-closure escape of contaminated run-off		Sections 2.2, 2.5.3, and the Phase I report[b]	Post-closure escape of contaminated run-off is minimized because all waste has been removed and waste residues are below levels that present a potential unacceptable risk to human health and the environment.
post-closure escape of hazardous waste decomposition products		Sections 2.2, 2.5.3, and the Phase I report[b]	The Laboratory performed closure by removal and decontamination and managed all waste in accordance with the approved closure plan and applicable regulations. Waste residues are below levels that present a potential unacceptable risk to human health and the environment, including generation of decomposition products.
to surface water		Sections 2.5.2, 2.5.3, 3.0	There are no surface water bodies within the MDA P site. Post-closure escape of hazardous waste or surface water is minimized because all waste has been removed and waste residues are below levels that present a potential unacceptable risk to human health and the environment.
to groundwater		Sections 2.3, 2.5.2, 3.0, and the Phase II report[c]	Data collected from borehole geophysical and geochemical studies, the fracture characterization study, and the confirmation sampling indicate no surface-to-groundwater pathway at the MDA P Site.
to the atmosphere		Sections 2.5.2, 2.5.3	Because waste residues in soil and tuff are below levels that present a potential unacceptable risk to human health and the environment, the potential for exposure via release of contamination to the atmosphere is negligible.

Table 2.1-1 (continued)

Requirement	Regulatory Citation[a]	Location in Report	Comments
Complies with the closure requirements of this subpart, including but not limited to:	265.111(c)	—	—
	265.197	Not applicable	Applies to closure of tanks
	265.228	Not applicable	Applies to closure of surface impoundments
	265.258	**see below**	**Applies to closure of waste piles**
	265.280	Not applicable	Applies to closure of land treatment units
	265.310	Not applicable	Applies to closure of landfills
	265.351	Not applicable	Applies to closure of incinerators
	265.381	Not applicable	Applies to closure of thermal treatment units
	265.404	Not applicable	Applies to closure of chemical, physical, and biological treatment units
	264.1102	Not applicable	Applies to closure of containment buildings
For waste piles: At closure, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components (liners, etc), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste, unless 261.3(d) applies; or	265.258(a)	Sections 2.2, 2.4, 2.5.3, and the Phase I report[b]	The contents of MDA P, including waste residues and structures, were removed and/or decontaminated, and disposed. All contaminated containment system components, contaminated subsoils, and structures and equipment contaminated with waste were removed and/or decontaminated. Only soils and tuff containing residual levels of hazardous constituents that are below acceptable risk-based levels for human and ecological receptors are left in place. Waste management was conducted in accordance with the approved closure plan and applicable regulations. All contaminated equipment, structures, soils, and other wastes generated as a result of closure/remediation activities were properly characterized, managed, decontaminated, and/or disposed.
If, after removing or decontaminating all residues and making all reasonable efforts to effect removal and decontamination of contaminated components, subsoils, structures, and equipment as required in paragraph (a) of this section, the owner or operator finds that not all contaminated subsoils can be practicably removed or decontaminated, he must close the facility and perform post-closure care in accordance with the closure and post-closure requirements that apply to landfills.	265.258(b)	Not applicable, as demonstrated in sections 2.4, 2.5, 3.0	Confirmation sampling was conducted to verify removal to operational PRGs and to provide sufficient data for the human health and ecological risk assessment. Only soils and tuff containing residual levels of hazardous constituents that are below acceptable risk-based levels for human and ecological receptors are left in place.

Table 2.1-1 (continued)

Requirement	Regulatory Citation[a]	Location in Report	Comments
Certification of closure. The owner or operator must submit a certification that the hazardous waste management unit has been closed in accordance with the specifications in the approved closure plan. The certification must be signed by the owner or operator and an independent, registered professional engineer.	265.115	Section 5	The independent registered professional engineer, by his certification, attests that the approved closure plan for achieving clean closure has been followed.

[a] Citations are to 20.4.1.600 NMAC, which adopts 40 CFR Part 265.

[b] As required by NMED (NMED 2003, 76017), information pertaining to the waste removal and decontamination activities are documented under separate cover, but incorporated by reference, in the "MDA P Site Phase I Closure Implementation Report" (LANL 2003, 76054).

[c] As required by NMED (NMED 2003, 76017), information pertaining to the bedrock fracture characterization study is documented under separate cover, but incorporated by reference, in "Bedrock Fracture Characterization at MDA P Site: Phase II Closure Implementation Report" (LANL 2003, 77423).

At the time that the closure plan for MDA P was submitted, a clean closure equivalency demonstration pursuant to 20.4.1.900 NMAC, 270.1(c)(5) and (6) was believed to be necessary. However, the Laboratory and NMED have determined and agreed that this additional step to demonstrate clean closure is not required because of the conforming changes to the regulations that made interim status closure requirements equally as stringent as those for permitted hazardous waste management units. Further explanation of this regulatory approach and supporting references are provided in Appendix F.

2.1.2.2 Flash Pad 387 Clean Closure Performance Standard

The closure plan for Flash Pad 387 was prepared and submitted to NMED in August 1999 and was approved in April 2000 (LANL 1999, 63547). As stated in the approved closure plan, the objective of the Flash Pad 387 closure was to meet the general facility closure performance standard in 20.4.1.600 NMAC, 265.111, which states that the unit will be closed in a manner that

- minimizes the need for further maintenance;
- controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to ground or surface waters or to the atmosphere; and
- complies with the appropriate unit-specific closure requirements of the Code of Federal Regulations Title 40 (40 CFR) Part 265 (as adopted by 20.4.1.600 NMAC). For Flash Pad 387, the appropriate standard is 265.381, which states that:

> At closure, the owner or operator must remove all hazardous waste and hazardous waste residues (including, but not limited to, ash) from the thermal treatment process or equipment.

As discussed in section 2.1.2.1, "removal of all hazardous waste residues" was clarified by EPA to mean all hazardous constituents at or above levels that pose a potential unacceptable risk to human health or the environment.

Table 2.1-2 summarizes how the Laboratory complies with each aspect of the closure performance standard for Flash Pad 387, and where each of these aspects of the performance standard is addressed in this document.

Table 2.1-2
Requirements for Demonstration of Clean Closure, Flash Pad 387

Requirement	Regulatory Citation[a]	Location in Report	Comments
Closure performance standard. The owner or operator must close the facility in a manner that	265.111	—	—
minimizes the need for further maintenance, and	265.111(a)	Sections 2.2–2.5	Because all waste has been removed and waste residues are below levels that present a potential unacceptable risk to human health and the environment, there is no need for further maintenance in the post-closure period.
controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment:	265.111(b)	—	—
the post-closure escape of hazardous waste or hazardous constituents,		Sections 2.2, 2.4, 2.5.3, and the Phase I report[b]	The Laboratory performed closure by removal and decontamination, thereby eliminating the potential for post-closure escape of hazarous waste or hazardous constituents. Waste management was conducted in accordance with the approved closure plans and applicable regulations. All contaminated equipment, structures, soils, and other wastes generated as a result of closure activities were properly characterized, managed, decontaminated, and/or disposed. Waste residues are below levels that present a potential unacceptable risk to human health and environment.
post-closure escape of leachate		Not applicable	Flash Pad 387 operations did not result in leachate generation. No waste that would result in post-closure leachate generation is present at the site.
post-closure escape of contaminated run-off		Sections 2.2, 2.5.3, and the Phase I report[b]	Post-closure escape of contaminated run-off is minimized because all waste has been removed and waste residues are below levels that present a potential unacceptable risk to human health and the environment.

Table 2.1-2 (continued)

Requirement	Regulatory Citation[a]	Location in Report	Comments
post-closure escape of hazardous waste decompostion products	265.111(b) (continued)	Sections 2.2, 2.5.2, 2.5.3, and the Phase I report[b]	The Laboratory performed closure by removal and decontamination and managed all waste in accordance with the approved closure plan and applicable regulations. Waste residues are below levels that present a potential unacceptable risk to human health and the environment, including generation of decomposition products.
to surface water		Sections 2.5.2, 2.5.3, 3.0	There are no surface water bodies in the immediate vicinity of the former location of Flash Pad 387. Post-closure escape of hazardous wastes or constituents to surface water is minimized because all waste has been removed and waste residues are below levels that present a potential unacceptable risk to human health and the environment.
to groundwater		Sections 2.3, 2.5.2, 3.0, and the Phase II report[c]	Data collected from borehole geophysical and geochemical studies, the fracture characterization study, and the confirmation sampling indicate no surface-to-groundwater pathway at the MDA P Site, which includes Flash Pad 387.
to the atmosphere		Sections 2.5.2, 2.5.3	Because waste residues in soil and tuff are below levels that present a potential unacceptable risk to human health and the environment, the potential for exposure via release of contamination to the atmosphere is negligible.
Complies with the closure requirements of this subpart, including but not limited to:	265.111(c)	—	—
	265.197	Not applicable	Applies to closure of tanks
	265.228	Not applicable	Applies to closure of surface impoundments
	265.258	Not applicable	Applies to closure of waste piles
	265.280	Not applicable	Applies to closure of land treatment units
	265.310	Not applicable	Applies to closure of landfills
	265.351	Not applicable	Applies to closure of incinerators
	265.381	**See below**	**Applies to closure of thermal treatment units**
	265.404	Not applicable	Applies to closure of chemical, physical, and biological treatment units
	264.1102	Not applicable	Applies to closure of containment buildings

Table 2.1-2 (continued)

Requirement	Regulatory Citation[a]	Location in Report	Comments
For thermal treatment units: At closure, the owner or operator must remove all hazardous waste residues (including, but not limited to, ash) from the thermal treatment process or equipment.	265.381	Sections 2.2, 2.5.3, 2.4, and the Phase I report[b]	The Flash Pad 387 structure and hazardous waste residues, including ash, and potentially contaminated underlying material were removed. Decontamination of the debris associated with the concrete pad was conducted prior to disposal. All equipment and structures associated with closure operations were decontaminated, reclaimed, recycled, or disposed. Only soils and tuff containing residual levels of hazardous constituents that are below acceptable risk-based levels for human and ecological receptors are left in place. Waste management was conducted in accordance with the approved closure plan and applicable regulations. All contaminated equipment, structures, soils, and other wastes generated as a result of closure/remediation activities were properly characterized, managed, decontaminated, and/or disposed.
Certification of closure. The owner or operator must submit a certification that the hazardous waste management unit has been closed in accordance with the specifications in the approved closure plan. The certification must be signed by the owner or operator and an independent, registered professional engineer.	265.115	Section 5	The independent registered professional engineer, by his certification, attests that the approved closure plan for achieving clean closure has been followed.

[a] Citations are to 20.4.1.600 NMAC, which adopts 40 CFR Part 265.

[b] As required by NMED (NMED 2003, 76017), information pertaining to the waste removal and decontamination activities are documented under separate cover, but incorporated by reference, in the "MDA P Site Phase I Closure Implementation Report" (LANL 2003, 76054).

[c] As required by NMED (NMED 2003, 76017), information pertaining to the bedrock fracture characterization study is documented under separate cover, but incorporated by reference, in "Bedrock Fracture Characterization at MDA P Site: Phase II Closure Implementation Report" (LANL 2003, 77423).

2.1.2.3 SWMU 16-016(c)-99 VCA Objectives

SWMU 16-016(c)-99 is not a regulated hazardous waste management unit, but is a SWMU and is, therefore, subject to RCRA/Hazardous and Solid Waste Amendments (HSWA) corrective action requirements specified in 20.4.1.500 NMAC, 264.101, and in Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585; EPA 1994, 44146). The VCA for this SWMU was completed in accordance with an approved VCA plan, which was included as an appendix to the MDA P SAP (LANL 1999, 63546). Based on the results of the coordinated activities described in this report, the VCA completion requirements have been satisfied and SWMU 16-016(c)-99 is proposed for NFA based on Criterion 5, which states that the SWMU has been characterized or remediated in accordance with applicable state or federal regulations and that the available data indicate that chemicals of concern are either not present or are present at concentrations that pose no potential unacceptable risk to human or

ecological receptors under projected future land use (NMED 1998, 57897). The risk-based approach used for demonstrating NFA is identical to the one used for demonstrating clean closure by removal and decontamination for the hazardous waste disposal and treatment units and is presented in section 2.5.

Because of the differences in programmatic requirements between corrective action and closure, a separate VCA completion report for SWMU 16-016(c)-99 will be submitted to NMED.

2.1.3. Basis for Demonstration of Clean Closure

In summary, the Laboratory demonstrates that the clean closure performance standards for MDA P and Flash Pad 387, as well as the NFA criterion for SWMU 16-016(c)-99 are met, based on the following:

- The contents of MDA P, including waste residues and structures, were removed and/or decontaminated, and disposed. All contaminated containment system components, contaminated subsoils, and structures and equipment contaminated with waste were removed and/or decontaminated. Only soils and tuff containing residual levels of hazardous constituents that are below acceptable risk-based levels for human and ecological receptors are left in place.

- The Flash Pad 387 structure and potentially contaminated underlying material were removed. Decontamination of the debris associated with the concrete pad was conducted prior to disposal. All equipment and structures associated with closure operations were decontaminated, reclaimed, recycled, or disposed. Only soils and tuff containing residual levels of hazardous constituents that are below acceptable risk-based levels for human and ecological receptors are left in place.

- SWMU 16-016(c)-99 was characterized and remediated in accordance with the approved VCA plan and all applicable regulations. Only soils and tuff containing residual levels of hazardous constituents that are below acceptable risk-based levels for human and ecological receptors are left in place.

- Waste management was conducted in accordance with the approved closure plans, the VCA plan, and applicable regulations. All contaminated equipment, structures, soils, and other wastes generated as a result of closure/remediation activities were properly characterized, managed, decontaminated, and/or disposed.

- Confirmation sampling was conducted to verify that the operational PRGs were met and to provide sufficient data for the human health and ecological risk assessment. Risk assessment results demonstrate that the remaining soils and tuff at the site containing residual hazardous constituents pose no unacceptable potential risk to human and ecological receptors.

- Data collected from borehole geophysical and geochemical studies, the fracture characterization study, and the confirmation sampling indicate no surface-to-groundwater pathway at the MDA P Site.

2.2 Waste Removal and Decontamination

2.2.1 Introduction

Phase I closure activities at the MDA P Site principally consisted of those activities directed toward removal of the waste inventory and decontamination of the site. Major activities included preclosure activities, establishment of operational PRGs, initial waste and soil removal activities, final soil removal,

waste management, demobilization and site stabilization, and site restoration. These major activities are described in sections 2.2.2 through 2.2.8, respectively. More detailed descriptions are included in the Phase I report (LANL 2003, 76054).

2.2.2 Preclosure Activities

Preclosure activities were conducted prior to the start of waste removal and decontamination. Preclosure activities include those actions needed to prepare for excavation of wastes and soil at the MDA P Site. These activities, which are described in the following paragraphs, included surface screening surveys for barium and radiation, investigation of disposed materials via test pits, and various construction, installation, and other mobilization activities.

Barium and surface radiation surveys were conducted in 1996 to establish background surface conditions and map areas of elevated barium concentrations and radiation. A 30- x 30-ft grid was established over the site to identify survey locations. The survey was conducted using field instruments to measure the concentration of barium in soil and beta-gamma radiation levels. Survey results are presented in the Phase I report (LANL 2003, 76054).

Construction activities were undertaken to construct various ancillary facilities needed to support excavation. The materials segregation area, designed for waste segregation operations, was constructed in late 1996 on the east side of MDA P. Also in late 1996, a materials decontamination pad, designed for the debris decontamination operations, was constructed on the upland area south of MDA P and directly east of Flash Pad 387. In 1997, three runoff trenches with a total length of approximately 470 ft were constructed at the base of MDA P to collect stormwater runoff during Phase I activities; two trenches were constructed below the west lobe in the terrace materials and one was constructed below the east lobe in the bedrock. Construction of the east lobe trench required the construction of an access road, known as the East Access Road, along the upper east side of the project area. Construction drawings are included in the Phase I report (LANL 2003, 76054).

A series of test pits were excavated in 1997 prior to full-scale excavation to characterize the extent of the waste pile boundaries and types and extent of debris, waste pile soil cover, fill, and contamination in areas designed for access, haul roads, and excavation support. The results of the test pits were also needed to support preparation of a site-specific health and safety plan (SSHASP) and radiological work permits. The depths to bedrock, debris, and other soil horizons were observed in the six sets of pits that were excavated. The pit observations established a debris line, north of which the subsurface included waste materials, and south of which the subsurface was comprised of soil and rock backfill with only small amounts of scattered surface debris. The test pit observations are summarized in the Phase I report (LANL 2003, 76054).

Other site preparations for the closure implementation activities included the installation of haul roads, staging pads, water tanks, office and support trailers, and waste sorting areas, as well as mobilization of equipment for excavation, decontamination, safety, and communications.

A SSHASP was prepared to document worker protection requirements for waste removal and decontamination activities. The test pit results, which identified the presence of pieces of detonable HE, were used to develop the waste pile excavation strategy and key features of the SSHASP. The SSHASP also addressed management of asbestos and containers of unknown content. A copy of the SSHASP (including all attachments and modifications) is included in the Phase I report (LANL 2003, 76054).

The detection of detonable pieces of HE in test pits indicated the need for remote excavation in order to avoid placing personnel in direct contact with potential explosive hazards. A computer-controlled, remotely-operated, 25 metric ton, hydraulic excavator was, therefore, developed and deployed to the site to perform all initial excavation operations. Initial debris removal operations were conducted near the canyon floor in December 1998 and January 1999 to test the system and establish the coordination efforts between the robotics system and the technical personnel on the ground.

The surface radiation surveys did not indicate the presence of radioactive contamination at the site. Based on the history of the site, however, the potential existed for buried radioactive material that might not be detectable at the surface. Radiological protection requirements, including radiological work permits (RWPs) and establishment of a Radiological Controlled Area (RCA), were established to cover the possibility of encountering radiologically contaminated debris during excavation. Copies of the RWPs are included in the Phase I report (LANL 2003, 76054).

An excavation grid (the same as the 30- x 30-ft grid used for the 1996 barium survey) was established for tracking the progress of the excavation. This grid was designed to be small enough to be utilized for confirmation sampling during Phase II without having to create a different grid, and large enough to represent a measurable portion of MDA P. The barium survey grid and the excavation grid were offset by 15 ft, north and east, such that the centers of the survey grid cells represented the nodes of the excavation grid cells. Because the barium surface survey only covered the upper terrace of MDA P, the excavation grid was extended northward to cover the entire MDA P footprint. The excavation grid was exactly overlain by the grid later used for confirmation sampling (section 2.4).

2.2.3 Preliminary Remediation Goals

PRGs were established to serve as operational guidelines during excavation. Barium was established as the primary index for removal activities for inorganic chemicals for the following reasons: barium contamination was ubiquitous across the MDA P Site; barium was assumed to be collocated with other inorganic chemicals; barium was likely to be at higher concentrations, and may have been more mobile, in the environment than other metals; and barium concentrations could be readily measured with a field x-ray fluorescence (XRF) instrument. It was determined that the human health risk-based barium PRG of 5600 mg/kg presented in the closure plan would not meet the removal criterion for hazardous waste soils, i.e., soils for which a sample extract could fail the toxicity characteristic leaching procedure (TCLP) limit of 100 milligrams per liter (mg/L) for barium. Thus, the “20-times” rule (i.e., a total concentration of 20 times the regulatory limit of 100 mg/L for barium) was used to establish the operational PRG of 2000 mg/kg for field-screening determinations of suspected hazardous waste for staging purposes and for making determinations of whether sufficient materials had been excavated to reduce human health and ecological risks related to residual contamination at the MDA P Site.

Other contaminants known to be ubiquitous across the MDA P Site were the HE compounds RDX (1,3,5-trinitro-1,3,5-triazacyclohexane) and TNT (2,4,6-trinitrotoluene). As with barium, RDX and TNT were measured in the excavated materials for assessing health and safety concerns during waste segregation operations and to determine whether sufficient material had been excavated and removed. RDX and TNT measurements were not as efficient or as timely as the XRF results, as soil samples had to be collected and processed for analysis by EPA Solid Waste 846 (SW-846) Methods 8510 and 8515. RDX was established as the operational index for removal activities for HE for the following reasons: RDX was found to be more prevalent than TNT; RDX has a higher toxicity than TNT (thus, removal based on RDX is based on a more restrictive standard and is more protective of human health than TNT); RDX was assumed to be collocated with other HE contamination; and RDX was likely to be at higher concentrations, and is more mobile in the environment, than other HE compounds. An operational PRG of

16 mg/kg was used for RDX to determine if sufficient materials had been excavated and removed to address human health and ecological risk concerns. This value is consistent with the EPA Region 6 industrial human health medium-specific screening level (EPA 1999, 64637).

2.2.4 Initial Waste and Soil Removal

Initial waste and soil removal activities were guided by visual observation of waste or contamination and the results of field surveys. These activities were conducted to remove the waste inventory and the bulk of contaminated soil. Removal activities conducted at MDA P, Flash Pad 387, and SWMU 16-016(c)-99 are described in sections 2.2.4.1 through 2.2.4.3, respectively.

2.2.4.1 MDA P

Excavation of MDA P began on February 2, 1999, on the upper portion of the west lobe, followed by excavation of the east lobe. Excavation operations were monitored by an explosives specialist designated by the on-site contractor accompanying the robotics operator and observing operations on a video monitor in the control trailer. Photograph 2.2-1 shows the remote excavation in progress. Benches were excavated across the lobes, providing working surfaces for access down the slopes. Some debris materials were removed from the streambed, but no excavation was performed in the stream. The excavation of the east lobe began in August 2000 and was relatively uneventful. The lobe was entirely underlain by bedrock and the debris of the east lobe did not extend down the lower slopes, as had been the case with the west lobe. No robotics excavation was necessary at the lower east lobe because detonable explosives debris was not identified (or encountered) in this area of the MDA P. The excavation extended southward until no additional debris was encountered.

Photograph 2.2-1. Remote excavation of MDA P contents, 1999 (view to east)

Excavation occurred in approximately 100 to 200 yd^3 increments. Excavated materials were placed in a pile adjacent to the excavation. Excavation was suspended every 20 to 30 yd^3 to allow personnel to inspect the materials to ensure that hazardous explosives materials were not overlooked by the robotics operator. Excavation operations were also suspended to allow additional inspections whenever the robotics operator or the explosives specialist observed suspicious items. After determining there was little danger of a detonation from a large or suspicious object, the excavated materials were handled with conventional heavy equipment equipped with Lexan blast shields. Excavation events typically occurred once a week to allow for inspection and waste segregation of the excavated materials within the limited space for staging materials. Photographs 2.2-2 and 2.2-3 show the west and east lobes of MDA P with excavation in progress. Additional details on excavation of debris at MDA P are presented in the Phase I report (LANL 2003, 76054).

Photograph 2.2-2. Excavation activities in the west lob of MDA P, 1999 (view to south)

Photograph 2.2-3. Excavation activities in the east lob of MDA P, 2000 (view to south)

Photograph 2.2-4 shows debris excavated in 2000 from MDA P. After the debris excavation and prior to the start of the excavation of contaminated soils, an interim barium surface survey was conducted across the excavated portions of MDA P and Flash Pad 387 in order to identify areas requiring additional excavation to achieve the operational barium PRG of 2000 mg/kg. Residual barium concentrations were measured using a field XRF instrument collected at the grid centers. Measurement activities designed to test for residual DU were performed using a beta-gamma radiation counter, providing the basis for the removal of RCA restrictions of large areas; no grids had activity measured above instrument background after excavating. Grid cells with barium concentrations greater than the operational PRG of 2000 mg/kg underwent additional excavation. HE concentrations in individual grid cells were not measured in this interim survey. Grid cells that met the barium operational PRG underwent a “final release survey” to determine whether additional excavation was necessary (see section 2.2.5).

Photograph 2.2-4. Example of excavated materials, shown during segregation process, 2000 (view to northeast)

At the completion of the removal of the MDA P contents via remote operations, excavation continued for the removal of contaminated soils (i.e., over-excavation as shown in Photograph 2.2-5) via conventional methods; this began August 13, 2000. Approximately 21,000 yd^3 of contaminated soil and rock were excavated from MDA P. Soils were excavated in each grid cell in approximately 6-in. lifts, followed by an XRF survey. XRF measurements of barium concentrations were taken at five locations within a grid cell and then averaged. Material removal continued until the average value met the barium operational PRG of 2000 mg/kg. Once the barium operational PRG was met, a grab sample was collected near the grid center for HE field analysis. As with the barium screen, material removal continued until the operational PRG for RDX (16 mg/kg) was also met, at which time the excavation was deemed complete. The entire former MDA P footprint and the operational support areas were subjected to the field-screening process for barium and RDX to ensure that the extent of contamination had been defined and remediated to the operational PRGs.

Photograph 2.2-5. Soil excavation (over-excavation)

After completion of the MDA P excavation, the excavation grid was enlarged to the south and west to include areas of contaminated soils that existed beyond the borders of the MDA P debris/excavation areas, Flash Pad 387, and SWMU 16-016(c)-99 in the grid system. Added grid cells were 30 x 30 ft.

2.2.4.2 Flash Pad 387

Remote excavation operations started on the lower portions of Flash Pad 387 and progressed southward. All initial excavation operations were performed by the remote excavation system because of the potential presence of HE; however, no buried HE was encountered. Minor amounts of metallic debris were scattered at the flash pad, some wholly or partially buried. Bedrock was encountered across the entire area. Some bedrock was scraped with the excavator teeth to achieve the operational PRGs for barium and RDX.

During excavation, a previously unknown trench was located in the eastern part of the area. The trench appeared to originate in the middle of the south boundary and trended northeasterly where it terminated approximately 20 ft east of the eastern boundary fence. The trench also contained remnants of a previously unknown 4-in. VCP. Both ends of the pipe were crushed with no evidence of original source fittings or termination outfall. The VCP remnants were excavated and staged for waste sampling and characterization.

The decontamination pad and the hand-sorting pad adjacent to the Flash Pad 387 concrete were demolished and staged for waste sampling. The soils under and adjacent to these pads were surveyed for barium and HE. The soils adjacent to the decontamination pad, extending west to Flash Pad 387, were found to be contaminated with barium and HE, but the soils extending eastward from the decontamination pad were not. All excavated soils were staged for waste sampling and characterization.

2.2.4.3 SWMU 16-016(c)-99

Most of the SWMU 16-016(c)-99 excavation was performed after the removal of MDA P and Flash Pad 387 was complete (approximately August 2000 to March 2001).

Excavation within the boundary of the barium nitrate pile included both remote and conventional means. Because part of the boundary of the barium nitrate pile extended down the western margin of MDA P, contaminated materials in this area were excavated during the excavation of MDA P. No attempt was made to segregate or identify materials that were specifically related to migration of barium nitrate from the pile area.

Soils within Flash Pad 386 were excavated and staged with soils from adjacent areas of the MDA P excavation. Field screening for barium was used to identify the extent of excavation. Surface soils and some bedrock materials were removed from within the flash pad area. Discontinuous areas downgradient of the flash pad were removed. Barium contamination was not found to have penetrated the bedrock beneath the flash pad. Some residual bedrock contamination was identified in the drainage along the western margin of MDA P, but it was below the barium operational PRG of 2,000 mg/kg. The remaining areas of exposed soil within the Flash Pad 386 fence were screened for barium contamination. After excavation, a layer of soil and gravel was placed in the excavation within the current fence. Gravel was placed on the north side of the current fenceline as an erosion control measure.

The septic tank and waste line were remediated in two stages (March 2001 and March 2002). In March 2001, the waste line (4-in.-diameter VCP) was located and excavated from the tank to its endpoint. The pipe was empty and the connection with the tank had been plugged. The tank outlet was plugged and the waste line was taken out of service. Field-screening of the pipe interior indicated that no HE or barium contamination was present. The distal 10 ft of the waste line was crushed pipe with no defined outfall. The metal top and riser of the tank were excavated to expose the tank itself, estimated to be a 100-gal. metal tank. A representative of NMED Field Operations Division inspected the tank and the tank was backfilled with clean soil to grade and left in place. A copy of the NMED inspector's form is included in the Phase I report (LANL 2003, 76054). The pipe inlet was plugged with a polyvinyl chloride pipe fitting and the water was turned off inside the building at the toilet to decommission the source. Soil surrounding the tank and the edges and interior portions of the tank were field-tested for HE and barium and found to be below operational PRGs for both. In March 2002, the tank and pipe were excavated, sampled, and removed completely.

2.2.5 Final Soil Removal

Following completion of initial waste and soil removal activities, confirmation sampling was performed to quantify residual soil contamination (section 2.4). The results of the confirmation sampling showed concentrations greater than operational PRGs at certain locations, indicating the need for additional soil excavation. These final soil removal activities are summarized below and described in detail in the Phase I report (LANL 2003, 76054).

Additional excavations were performed at all locations found to exceed the operational PRGs, based on Phase II analytical results. Fourteen sample locations were identified with concentrations of barium or RDX (or both) above the operational PRGs. Eight of the 14 locations contained bedrock outcrop that could not be easily excavated with the available equipment and six locations contained soil or other unconsolidated deposits that could be excavated further, including four grid cells with elevated barium concentrations in the upper and lower east drainages.

Confirmation samples collected from the upper east drainage indicated that barium was present above the operational PRG. Barium surveys with the XRF instrument indicated that barium concentrations increased southward. Excavation was performed between September 10 and 14, 2001. Approximately 1000 yd^3 of materials were removed.

This removal was followed by another round of confirmation sampling on the excavated area down the center of the drainage and along the drainage margins. The confirmation results and another field survey indicated that barium and RDX were still present above the operational PRGs. These results directed additional excavation in the upper east drainage until surveys indicated the operational PRGs had been met.

Confirmation samples identified isolated areas in the east and west sides of the drainage above operational PRGs. To ensure the extent of contamination was investigated, the entire circumference of the upper reach of the east drainage was surveyed for barium with the XRF instrument at 5-ft intervals. Soils from areas identified by the XRF as having high barium concentrations were excavated and removed until barium and RDX concentrations were below the operational PRGs. This resulted in approximately 300 yd^3 of soil and rock being removed from the upper east drainage.

A secondary survey of the lower east drainage was performed after the excavation of the upper east drainage revealed elevated levels of barium beneath surface materials. The entire length of the lower reach of the east drainage was investigated with the field XRF. While most of the sediment in the lower east drainage met the barium operational PRG, elevated concentrations of barium were present at two locations. One location was excavated with hand tools, due to the small volumes of sediments with elevated barium concentrations and the difficulty accessing that area of the drainage. The other location was excavated by conventional techniques using heavy equipment. Approximately 24 yd^3 of sediment were removed from the lower east drainage.

Upon completion of the excavation of contaminated soils, a final screening surface survey was conducted for residual barium and HE contamination, using a field XRF instrument for barium and a field test kit for HE. The final HE survey measured TNT, nitroamines, and HMX, in addition to RDX, to ensure that residual HE contamination was appropriately characterized and was addressed with additional excavation and removal, if necessary. These surveys were conducted at all grid cells that passed the interim survey and those grid cells that received additional excavation. The surveys were conducted across the excavated portions of the entire MDA P Site, as well as the field support areas, including the soil and water tank staging areas, decontamination pad, and haul roads.

XRF measurements were performed at four locations within each grid and at the grid center, for an average concentration of barium for each grid cell. An average barium concentration greater than the operational PRG directed additional excavation, if such excavation was possible. Grab samples were collected from the grid centers for analysis of HE for those grid cells with an average barium concentration below the operational PRG. HE analyses were performed using EPA SW-846 Method 8515 for nitroaromatics (e.g., TNT) followed by EPA SW-846 Method 8510 for RDX and HMX for those samples that met the PRG of 530 mg/kg for TNT defined in the SAP (LANL 1999, 63546). The additional surveys (beyond barium and RDX) were performed to ensure that residual contamination had been characterized appropriately and removed, if necessary. Minor excavation was performed to remove TNT contamination above the PRG and, where feasible, some grid cells received additional excavation due to residual RDX contamination above the operational PRG.

The results of the final screening survey identified grid cells that (1) contained bedrock outcrop that had been excavated as much as possible using the available technology and still contained measurable

residual barium and/or HE contamination, or (2) contained unconsolidated deposits consisting of fill or soil materials that met the operational PRGs for barium and HE, and could be left in place. Six test pits excavated in the unconsolidated deposits north, northeast, and northwest of Flash Pad 387 were found to meet the operational PRGs for barium and RDX. The Phase I report provides a map of the final survey results at the completion of Phase I (LANL 2003, 76054).

2.2.6 Waste Management

Wastes generated during Phase I included waste, debris, and soil excavated from the MDA P Site, as well as incidental wastes generated during support activities, such as decontamination. Waste management activities included segregation and storage, characterization, and disposition. These activities are summarized in sections 2.2.6.1 through 2.2.6.3, respectively, and described in detail in the Phase I report (LANL 2003, 76054).

2.2.6.1 Waste Segregation and Staging

Waste segregation was performed for waste minimization, to facilitate proper waste characterization, and to meet the RCRA treatment, storage, and disposal (TSD) facility's waste acceptance criteria (WAC). Segregation operations included removing pieces of HE, barium nitrate, asbestos, metal and concrete debris, containers of unknown content, and a small amount of DU from soil. The entire contents of MDA P were subjected to this segregation process, although no segregation was performed on soil excavated during the manual over-excavation portion. Soils excavated to achieve the operational PRGs did not contain debris and did not undergo the segregation process because these soils were assumed to be contaminated with barium and HE. Photograph 2.2-6 shows examples of post-segregation debris.

Photograph 2.2-6. Example of metal and concrete debris, post-segregation, 1999

Waste staging areas were constructed within the area of contamination for contaminated soils, decontamination water, stormwater, and containers of unknown content. The staging area for contaminated soil proved to be inadequate because the volume greatly exceeded initial expectations. As a result, the staging areas at the 90s Line, west of MDA P within TA-16, were used for suspected industrial waste soils and decontaminated debris.

The waste segregation and staging processes applied to each of the major waste streams are summarized in Table 2.2-1. Segregation and staging activities are described in detail in the Phase I report (LANL 2003, 76054).

Table 2.2-1
Summary of Phase I Waste Segregation and Staging Processes

Waste Stream	Segregation and Staging Process
Soils from MDA P	Staged in 100 yd^3 piles. Soils segregated by barium greater than PRG, barium less than PRG, and elevated DU.
Decontamination wastewater from MDA P	Staged in 20,000-gal. tanks.
Debris from MDA P	Staged in 100 yd^3 lots.
Asbestos-containing material (ACM) from MDA P	Packaged for disposal as asbestos waste.
Other MDA P wastes	Containerized and segregated by known contents and unknown contents.
Building debris from Flash Pad 387	Given radiological survey, size reduced (if possible), decontaminated, and staged in piles.
Soils from Flash Pad 387	Staged in 100 yd^3 piles.
Waste lines from Flash Pad 387	Covered with plastic and staged on site.
Wastes from SWMU 16-016(c)-99	Soil staged in 100 yd^3 piles. Debris staged on site.
Stormwater	Staged in 10,000-gal. tanks.
Hazardous waste generated during closure	Containerized and staged in satellite accumulation areas or less-than-90-day accumulation areas.

2.2.6.2 Waste Characterization

Waste characterization included sampling, analysis, data review, and waste determination. A sampling team from the Laboratory's Solid Waste Regulatory Compliance (SWRC) group (formerly ESH-19) and EES-15 tracked, sampled, and reviewed analytical results for all materials excavated from the MDA P Site, in accordance with procedures for sampling specified in the approved MDA P and Flash Pad 387 closure plans (LANL 1995, 58713; LANL 1999, 63547) and the consolidated SWMU 16-016(c)-99 VCA plan (LANL 1999, 63546).

Waste determinations were made by the Waste Management Coordinator (WMC) assigned by the ER Project. The WMC reviewed the analytical results and other information available for each waste stream and determined the proper pathways for disposal. The WMC was responsible for compiling and submitting a WPF to the Laboratory's Facility Waste Operations (FWO) group at TA-54. The WPF included a description of the waste and all pertinent characterization information, including analytical data. FWO reviewed and approved the WPF package and assigned a unique number to each waste stream.

Once the WPF was approved, the WMC compiled and submitted a Chemical Waste Disposal Request (CWDR) to FWO for assignment of container and manifest tracking numbers. All containers received a unique container number. Once the container and manifest tracking numbers were obtained from FWO, shipping documents were compiled and the transportation and disposal scheduled.

Wastes generated during the Phase I activities included large amounts of soil and debris, moderate volumes of storm and decontamination water, and small amounts of radioactive and mixed wastes, HE, barium nitrate, containers with unknown contents, ACM, personal protective equipment (PPE), and acetone. The waste characterization processes applied to each major waste stream are summarized in Table 2.2-2. Characterization activities are described in the Phase I report (LANL 2003, 76054).

Table 2.2-2
Summary of Phase I Waste Characterization Processes

Waste Stream	Characterization Process
Soils from MDA P	One composite sample was collected per 100 yd^3 pile. All samples were analyzed for TCLP metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), HE, radionuclides, and asbestos. A subset of samples was analyzed for reactive cyanide, reactive sulfide, organochlorine pesticides, polychlorinated biphenyls (PCBs), dioxins/furans, chlorinated herbicides, and pH.
Debris from MDA P – concrete	Debris was visually inspected after decontamination to verify that the alternative treatment standard for hazardous debris in 20.4.1.800 NMAC (40 CFR 268.45) was met.
Debris from MDA P – metal	Debris was tested for HE using spot tests and for radioactivity using screening/swipes.
Other MDA P wastes – containers with unknown contents	HAZCAT analysis was used to determine waste category.
Ash from HE burning, flashing	Containers were sampled and analyzed for TCLP metals.
ACM from MDA P	Waste was inspected by Asbestos Hazardous Emergency Response Act (AHERA)-certified inspector and given radiological survey.
Decontamination wastewater, stormwater	Samples collected from staging tank and analyzed for TCLP metals, VOCs, SVOCs, cyanide, HE, radionuclides, nitrates, sulfates, total dissolved solids, polynuclear aromatic hydrocarbons (PAHs), asbestos, organochlorine pesticides, PCBs, dioxins/furans, chlorinated herbicides, and pH.
PPE	Characterized using results of analyses of associated soil and debris samples.
Acetone from HE spot tests	Characterized by process knowledge.
Building debris from 387	Debris was tested for HE using spot tests and for radioactivity using screening/swipes.
Soil from 387	One composite sample per pile. All samples analyzed for TCLP metals, VOCs, SVOCs, HE, radionuclides, reactive cyanide, reactive sulfide, organochlorine pesticides, PCBs, dioxins/furans, chlorinated herbicides, and pH.

Table 2.2-2 (continued)

Waste Stream	Characterization Process
Waste lines from 387	Debris was tested for HE using spot tests and for radioactivity using screening/swipes.
Wastes from 16-016(c)-99	One composite sample per pile. All samples analyzed for TCLP metals, VOCs, SVOCs, HE, radionuclides, asbestos. Subset analyzed for reactive cyanide, reactive sulfide, organochlorine pesticides, PCBs, dioxins/furans, chlorinated herbicides, and pH.

2.2.6.3. Waste Disposition

Wastes streams generated during the MDA P Site Phase I activities were assigned one or more WPF numbers, and each container assigned one or more tracking numbers. Only natural rock was not considered a waste and did not receive a WPF number. Each WPF includes a description of the waste and all pertinent characterization information, including analytical data. Upon approval of a WPF, the WMC compiled and submitted a CWDR to the Laboratory's FWO for assignment of container and manifest tracking numbers. All containers received a unique container number. Shipping documents were compiled and the transportation and disposal scheduled upon receipt of the container and manifest tracking numbers from FWO. Table 2.2.3 summarizes the disposition of waste types generated during Phase I activities. More detailed information on the final disposition of each waste type, including disposal documentation records for all waste streams, is provided in the Phase I report (LANL 2003, 76054).

Table 2.2-3
Summary of Phase I Waste Disposition

Waste Type	Waste Disposition
Hazardous Wastes	
Soils	Shipped to off-site permitted TSD facility.
HE and related materials	Treated at on-site permitted treatment unit. Treatment residuals shipped to off-site permitted TSD facility.
Barium nitrate	Shipped to off-site permitted TSD facility.
Acetone	Transported to off-site permitted TSD facility.
Industrial Wastes	
Soils	Shipped to off-site permitted receiving facility.
Debris – metal (prior to June 2000)	Shipped to off-site recycling facility.
Debris – metal (after June 2000)	Shipped to off-site permitted receiving facility.
Debris – concrete	Shipped to off-site recycling facility or off-site permitted receiving facility.
Wastewater	
Decontamination water – non-HE-contaminated	Filtered to remove asbestos fibers. Applied on site for dust control.
Decontamination water – HE-contaminated	Filtered to remove asbestos fibers. Sent to on-site permitted wastewater treatment facility.
Stormwater	Filtered to remove asbestos fibers. Applied on site for dust control.

Table 2.2-3 (continued)

Waste Type	Waste Disposition
Radioactive wastes	Transported to on-site disposal facility.
Personal protective equipment	Disposed of with associated materials.
Miscellaneous waste	Transported to on-site waste management facility.

2.2.7 Demobilization and Site Stabilization

Demobilization activities included the removal of the staging area pads and the segregation pad constructed for the materials management. The liner on the segregation pad was removed and the soil beneath the liner was surveyed for barium. No breaks in the liner were observed and no contamination was found. Because the entire pad had been constructed from imported fill, the pad was removed and the soils transported to the 90s Line and staged for potential re-use during site reclamation. These soils were bermed and treated with a surfactant to control erosion and re-suspension. All other soil staging pads were excavated and the soils were disposed of.

Upon completion of the excavation operations, the project area was stabilized for erosion and sediment control. The southern area of the site had a relatively thick veneer (1 to 2 m) of soil and fill materials. Some of these residual unconsolidated deposits were left in place and the slopes regraded to reduce erosion. Slopes on the western, eastern, and southern parts of the project area were re-seeded with a seed mixture containing fast-germinating grasses and annuals for longer-term stabilization. Steep slopes on the margins of the east drainage were seeded and covered with a coconut-straw matting provided by the RRES Water Quality and Hydrology group (RRES-WQH, formerly ESH-18). Boulders and rocks that had been staged during the Phase I excavation and removal activities were used for riprap in areas requiring slope and sediment control. Along the western and eastern margins of MDA P, the drainages were lined with boulders. The lower part of the western drainage was lined with riprap for managing water from the adjacent watershed that impinged on the footprint of MDA P and made the West Access Road vulnerable to erosion. Along the middle and lower reaches of the east drainage, riprap was installed to collect sediment from the unconsolidated deposits near the former decontamination pad. The east runoff trench was left, unlined, to also collect sediment from this area. The remnant of the former run-on trench just north of former Flash Pad 387 was left to collect stormwater runoff and to distribute this to the lower east drainage. The Phase I report provides additional details on site conditions at the conclusion of the Phase I excavation and stabilization activities (LANL 2003, 76054).

2.2.8 Site Restoration

2.2.8.1 Current Status

Some interim stabilization and revegetation of the site was performed when field activities were completed in the spring of 2002. This occurred primarily along the interface with undisturbed areas on the eastern, southern and western boundaries of the site. Extensive contouring was also accomplished in the east drainage excavation. Matting, in conjunction with straw wattles and bales, was used to stabilize soil in these areas. These areas were then planted using a grass seed mixture recommended by the U. S. Forest Service (and used to reclaim areas damaged by the Cerro Grande Fire).

A riprap-armored trench was constructed along the western edge of the site to divert run-on from the adjacent hillside that had been burned off during the Cerro Grande Fire. Existing run-on trenches along

the eastern edge of the site are still in place, although the liners were removed as part of the final site clean up. Straw bales and wattles control erosion in areas that have not yet been reclaimed. These areas are managed per the MDA P and S-Site Storm Water Pollution Prevention Plans.

2.2.8.2 Planned Restoration

The planned site restoration may include the addition of clean backfill and topsoil on the relatively flat (<30% slope) area of exposed bedrock that was previously beneath the east and west lobes of MDA P. Approximately 5000 yd^3 of backfill has been staged for this purpose. After contouring, the soil will be stabilized using matting and the area will be planted with the grass seed mixture described above. Gamble oak, New Mexico locust, and other native shrubs and forbs have already begun to establish themselves here.

The northern portion of the site is too steep to reclaim and will be left as is. This area will resemble the adjoining cliff faces, and the corresponding elevations across the Cañon de Valle stream channel.

The MDA P Site is in a buffer zone for the Mexican spotted owl. Fieldwork cannot begin in this location until a nesting survey for this species has been completed. Site restoration will be completed, depending upon funding sources.

2.3 Phase II Focused Investigations

2.3.1 Introduction

The Phase II activities conducted at the MDA P Site had three major components: exploratory drilling to investigate the subsurface geophysical and geochemical regime of the bedrock; fracture survey and mapping to define the characteristics of the bedrock fractures at the site; and the final confirmation sampling and analysis. The drilling, geophysical, geochemical and fracture surveys were described in the Phase II closure investigation report (LANL 2003, 77423). The final confirmation sampling is described in section 2.4.

2.3.2 Exploratory Drilling

A total of six exploratory boreholes were drilled at the MDA P Site in August 2001. The objectives of the drilling were to provide:

- Continuous core for sample material to investigate the potential for residual contamination in the bedrock;
- Continuous core for lithologic and fracture descriptions of the bedrock beneath the MDA P Site;
- Open boreholes for geophysical measurements; and
- Open boreholes to measure potential water levels.

The original commitment was to drill four boreholes to approximately 30 ft in grid cells that were determined to have the highest potential for residual contamination at depth. Subsequent discussions with Laboratory and NMED personnel (LANL 2001, 70272) identified two boreholes to be drilled to a target depth of 10 ft below the level of the Cañon de Valle stream in locations where local drainage may have concentrated contaminants (grid cells 526 and 557). An error in the elevational survey, however, resulted in those two boreholes not reaching the target depth. Rather, the final depths of Boreholes 526 and 557 were approximately 60 and 70 ft, respectively, approximately the level of the Cañon de Valle

stream elevation. The other two boreholes were drilled in grid cells 516 and 554 to approximate depths of 32 and 96 ft, respectively. Although Boreholes 526 and 557 did not reach their target depths, the four boreholes as a group met the objectives of defining the vertical extent of residual contamination.

Boreholes 516 and 554 were drilled in the western portion of the MDA P Site footprint upon discovery of increased fracture density in that area, and served to characterize both the extent of contamination at depth and to investigate typical bedrock fracturing of the MDA P Site. Specifically, Borehole 516 was drilled to examine the potential for successful coring within the fracture zone and Borehole 554 was located adjacent to a potential fault of the fractured zone.

Two additional boreholes were placed to investigate the bedrock fracture regime outside of the MDA P footprint. These boreholes, located in grid cells 257 and 273, were drilled to approximately 159 and 146 ft below the surface, respectively. The two locations were chosen to represent areas with the lowest potential for residual contamination at depth, to provide further evidence of whether there was contamination at depth below the MDA P Site.

All boreholes were dry, with no water observed during or after drilling. All were abandoned in October 2001 by filling with grout.

2.3.3 Geophysical Logging

Borehole geophysical information was collected to provide measurements of the physical properties of the rocks and the fluids within them. Interpretation of geophysical data can be used to identify characteristics of flow in fractured bedrock, including alteration of the rocks as a result of those flows. At the MDA P Site, the objectives of the geophysical investigation were to identify characteristics of the fracture flow system, including specific zones of moisture and magnitude of flow associated with fractures and rubble zones observed in cores. Table 2.3-1 lists the geochemical analyses and the geophysical logging that were performed for each borehole. The results are discussed in this section. The Phase II closure investigation report (LANL 2003, 77423) provided the complete record of drilling and investigation methods and results, field boring logs lithologic field logs, and summary plots of borehole geophysics.

Table 2.3-1
Summary of Geophysical Logging and Geochemical Analysis Performed for Each MDA P Site Borehole

	Borehole No. 257	Borehole No. 273	Borehole No. 516[a]	Borehole No. 526	Borehole No. 554	Borehole No. 557
Final depth of borehole (ft)[b]	**158.7**	**145.8**	**32.0**	**59.4**	**96.5**	**69.5**
Geophysical Log Type						
Natural gamma	x	X	—[c]	x	x	x
Caliper	x	X	—	x	x	x
Electromagnetic conductivity	x	X	—	x	x	x
Neutron	x	X	—	x	—	x
Heat pulse flowmeter	x	X	—	x	x	—

Table 2.3-1 (continued)

	Borehole No. 257	Borehole No. 273	Borehole No. 516[a]	Borehole No. 526	Borehole No. 554	Borehole No. 557
Final depth of borehole (ft)[b]	**158.7**	**145.8**	**32.0**	**59.4**	**96.5**	**69.5**
Optical televiewer	x	X	—	x	x	x
Geochemical Analysis						
Anions[d]	—	X	—	x	x	—
Cations[e]	—	X	—	x	x	—

[a] Borehole 516 was drilled to investigate the viability of drilling in a fracture zone; no geophysical logging or geochemical analyses were performed in this borehole.

[b] Final depth reflects depth of borehole which remained open for geophysical logging.

[c] — = Analysis not performed.

[d] Anion suite includes bromide, chloride, fluoride, nitrate, nitrite, oxalate, phosphate, and sulfate.

[e] Cation suite includes barium, calcium, magnesium, potassium, and sodium.

Geochemistry analytical data were used to investigate whether borehole geochemistry (in particular, the presence of anions and cations) could be used to help interpret the geophysical results.

2.3.3.1 Borehole Geochemistry

Samples were collected from Boreholes 273, 526, and 554 and analyzed for cations (sodium, magnesium, potassium, calcium, and barium) and anions (bromide, oxalate, chloride, fluoride, nitrite, nitrate, phosphate, and sulfate) to investigate whether variations in the observed EM conductivity could be attributed to concentrations of ions through weathering or depositional processes. With the exception of barium in Borehole 526, all cation concentrations had similar patterns with depth.

Because barium and nitrate are potential vadose zone contaminants at the MDA P Site, an additional investigation was conducted to estimate the potential impact of barium and nitrate in the MDA P subsurface. Barium nitrate ($Ba[NO_3]_2$) is highly soluble, thus any significant flow of liquid water will dissociate the barium and nitrate, and the percolating water will cause relocation of the barium and nitrate to deeper parts of the vadose zone. When barium nitrate dissolves, the barium species in solution is dominantly Ba^{+2}, which tends to adsorb or form precipitates such as barium carbonate or barium sulfate (LANL 1998, 59730). Conversely, the two nitrate molecules released when barium nitrate dissolves are highly mobile anions (NO_3-). The barium profiles for Boreholes 273 and 526 show little indication of deep transport of barium. Nearly all values are less than 1 mg/kg and these values are likely controlled by the concentrations of naturally occurring barium in the tuff. The 0.3-ft sample from Borehole 526 did have a concentration that indicated some barium contamination. However, barium concentrations decreased below 2 ft to levels below tuff background, indicating minimal downward transport. Figure 2.3-2 shows the barium concentrations, with depth for all confirmation samples; sitewide concentrations below approximately 4 ft are near or below tuff background concentrations (LANL 1998, 59730).

2.3.4 Fracture Survey and Mapping

The objectives of the fracture characterization were to define the vertical and lateral variations in the frequency and distribution of fractures as they affect the potential to transmit water in the bedrock. The fractures were investigated by surface mapping, investigation of borehole cores, and in situ observations of fractures within the boreholes (LANL 2003, 77423).

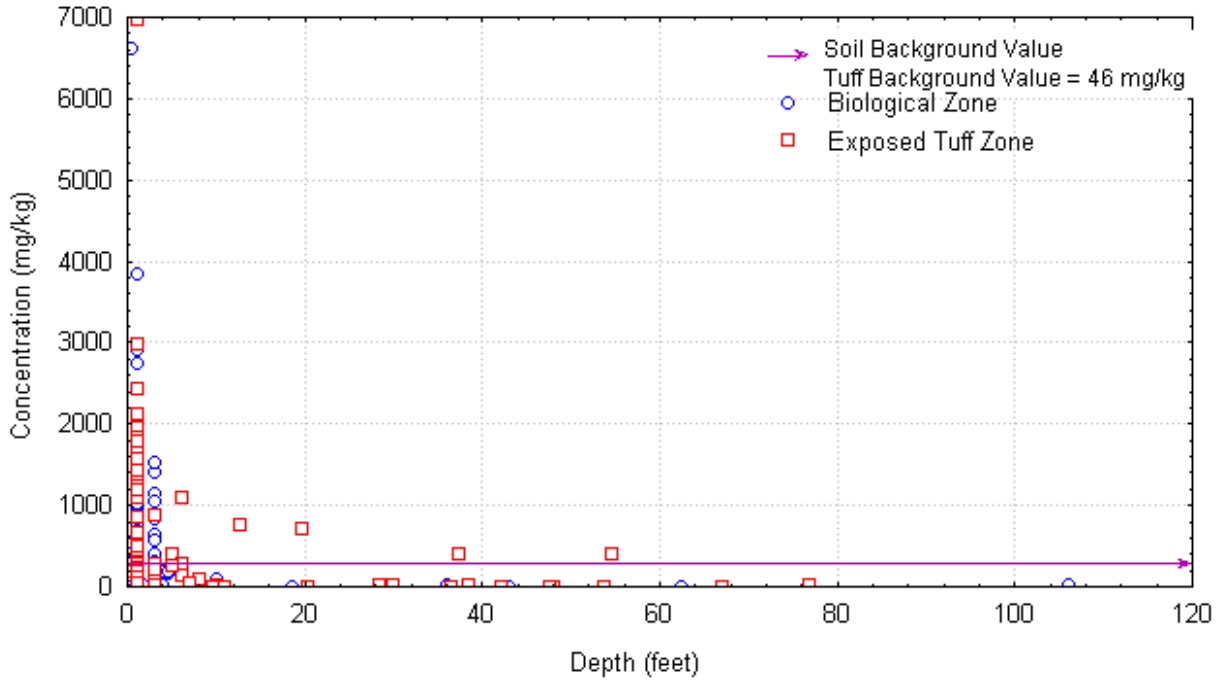

Figure 2.3-2. Barium concentrations with depth, as measured in the MDA P Site confirmation samples

2.3.5 Geologic Mapping

A geologic map of the excavated areas associated with the MDA P closure was compiled in July 2001 after the majority of contamination excavation was complete. For the MDA P closure and adjacent areas, five general mapping units were established, including bedrock, unconsolidated deposits, undisturbed deposits, alluvial, and post-excavation units emplaced for erosion control. The excavations of MDA P, Flash Pad 387, and SWMU 16-016(c)-99, as well as areas locally used for decontamination and materials staging, resulted in exposure of bedrock Units 3, 3T and 4l of the Tshirege Member of the Bandelier Tuff, from bottom to top, respectively. Unconsolidated units consisting of soils, alluvial and colluvial sediments, and gravels or fill materials used during the Phase I waste removal or placed afterward for erosion stabilization were present locally (LANL 2003, 77423).

2.3.5.1 Surface Fracture Characterization

Fracture mapping was conducted in August 2001. Eight traverse lines were established along the MDA P Site grid center markers. The statistical analysis of the preferred directions, apertures, and fracture densities indicated that the fracture set, as a whole, had a statistically significant north-northwest preferred orientation of N15 W26. Fracture dip angles varied from sub-horizontal to steep. Fracture density and aperture size increased across the MDA P Site from east to west. Fracture density was greater in the welded to poorly welded Tshirege Units 3 and 3T than in the nonwelded Tshirege Unit 4l, and ranged from 20 to 40 fractures per 100 ft. Fracture apertures in Tshirege Units 3 and 3T were as wide as 11 cm on the west side of the MDA P Site. In nonwelded Tshirege Unit 4l, apertures were generally 1 to 2 mm wide, though widths of approximately 50 mm were observed locally. Although no major faults were associated with the fracture zone on the west side, a small graben on the north side of Cañon de Valle appears to align with the zone of high aperture width and high fracture density. The spatial association of a series of small faults and elevated fracture density and fractures of large aperture

appear to indicate that a zone of diffuse structural deformation was present in the western part of MDA P that was attributed to deep-seated normal faulting (LANL 2003, 77423).

2.3.5.2 Fracture Characterization of Borehole Cores

The six boreholes provided cores for the recording of fracture occurrence with depth. Cores were examined using hand-specimen investigation methods for the presence and nature of natural fractures: frequency, dip, length, rubble zones, staining, and fracture-filling materials. Natural fractures and rubble zones were observed in all borehole cores. These were commonly associated with welded units, although both were present in the partially welded Unit 4l and the upper, partially welded portion of Unit 3. Many fractures were high-angle, but subhorizontal fractures were commonplace in the upper portions of boreholes, attributed to weathering and unloading. Fracture coatings were also observed and consisted of clays and black manganese oxides. Bright colors of the clays indicated that they were translocated from the surface. Clays tended to be darker, thicker, and more common towards the west of the MDA P Site than in the east. The apparent increase in clay thickness in the fracture zone on the west was attributable to the transport of suspended or colloidal clay particles, whereas the smaller fractures apertures to the east would inhibit such transport (LANL 2003, 77423).

2.3.5.3 Discussions of Geophysical and Geochemical Results

Correlations of the lithological observations, fracture characteristics, geophysical logs, and geochemical profile data were summarized in the Phase II closure investigation report (LANL 2003, 77423). The results are discussed here as they directly relate to the demonstration of clean closure for MDA P and Flash Pad 387 and the groundwater assessment for MDA P (section 3). The discussions that follow provide the summary interpretations for three distinct regimes within the MDA P Site based on topography and fracture-related characteristics: the eastern regime, as characterized by Borehole 526; the western regime, as characterized by Borehole 554; and the regime beneath the Flash Pad 387 at the watershed divide, characterized by Borehole 273.

2.3.5.3.1 Eastern Regime—Data Summary and Discussion

Borehole 526 represents the characteristics of the fracture regime beneath the eastern portion of the MDA P Site. Figure 2.3-3 shows the combined geophysical and geochemical results for Borehole 526. Borehole 526 was drilled to a depth of 59.4 ft (approximately the level of the Cañon de Valle stream elevation) from a beginning surface elevation of 7420 ft above msl. The borehole was dry during and after drilling. The lithologic data indicate that the underlying bedrock consists of a few feet of nonwelded Unit 4l, 10 ft of welded Unit 3T, and 40 ft of the partially welded Unit 3 that grades to approximately 8 ft of the welded portion. Fractures were observed throughout the core, but the fractures within a zone 40 to 45 ft below surface were correlated with the largest contributions to induced water flow.

Induced water flows were measured in Borehole 526 using an instrument designed by the US Geological Survey for low flows in fractured rock. The flow rates were measured by filling and maintaining a constant water level in the selected borehole. The flow-meter data also indicated that fractures between the surface and 24 ft below surface contributed little to water flow within the borehole. The last measurement of induced water flow at 55-ft depth was 0.03 gal. per minute (gpm), near the lower limit of the instrument. At depths of 36- to 52-ft bgs, a strong correlation exists among high EM conductivity, maximum caliper radius, and maximum concentrations of anions and sodium cations (LANL 2003, 77423).

These data indicated that an accumulation zone of soluble salts exists within the partially welded Unit 3 at 36 to 52 ft bgs, the bottom of which lies approximately 20 ft above the active stream channel. The high

EM conductivity measurements were attributed to the presence of high ionic-strength solutions within the rock matrix. Local areas of moisture paucity were represented by peaks of low EM conductivity superimposed on the broader high. Salts appeared to have penetrated the Unit 3 rock matrix and affected some weathering, as indicated by the caliper data. The EM conductivity lows were attributed to evaporation and local dry conditions. Thus, it was observed that salts may occur as aqueous solutions or precipitate minerals, depending on the actual moisture regime of the subsurface.

Smaller fractures, microfractures, and rock pores are known retention zones of residual moisture due to surface tension. Thus, the larger fractures appeared to serve as conduits of air flow, not of water flow, enhancing evaporation and the formation of precipitates. It is likely that the evaporation was facilitated by the interconnection of the subsurface fractures with those exposed at outcrops along the south wall of Cañon de Valle.

The salt accumulation zone was interpreted to be the result of the evaporation of percolated surface water that carried dissolved salts of nitrates and chlorides, the result of thousands of years of interaction of the fractured rock with the local climate. Thus, the subsurface of the eastern regime contains historic signatures (both geochemical and geophysical) of drying conditions, not of significant subsurface water flow.

2.3.5.3.2 Western Regime—Data Summary and Discussion

Borehole 554 represents the characteristics of the fracture regime beneath the western portion of the MDA P Site. Figure 2.3-4 shows the combined geophysical and geochemical results for Borehole 554. Borehole 554 was drilled to 96.5 ft below surface (approximately 36 ft below the level of the Cañon de Valle stream elevation) from a beginning elevation of 7422 ft above msl. The borehole was dry during and after drilling. The stratigraphic data indicate that the underlying bedrock consists of a few feet of nonwelded Unit 4l, 14 ft of welded Unit 3T, 34 ft of the partially welded Unit 3, and approximately 32 ft of welded Unit 3. Unit 4l thickens southward from Borehole 554 due to topography. In outcrop, Units 3 and 3T are locally intensely fractured and brecciated, with observed fracture apertures of 20 to 30 cm. Clay accumulations were common and typically 1 to 4 mm thick. Manganese oxides were scarce, although a thick accumulation occurred intergrown with the foliated clays in the high-angle fracture at 76 ft below surface.

The flow-meter data indicated that fractures above 35 ft below surface contribute little to water flow within the borehole and fractures within the zone 35 to 38 ft below surface were the largest contributors to induced water flow. This lower zone correlated strongly with high EM conductivity, maximum caliper radius, and maximum concentrations of anions. The high EM conductivity zone extended to a maximum depth of 50 ft where there was an increase in welding of Unit 3 and minimal caliper, anion, and water flow measurements. The last induced water flow measurement at 55 ft bgs indicated a flow rate of 0.20 gpm, an order of magnitude higher than the bottom of Borehole 526.

There was a general agreement in the results of the borehole geophysics results between the west and east regimes of the MDA P Site. The data from Borehole 554 indicate that an accumulation zone of soluble salts exists within the partially welded Unit 3 at 35 to 49 ft below surface, the bottom of which lies approximately 20 ft above the active stream channel. Fracture zones, rubble zones, and/or lost recovery zones are associated with the extent of the accumulation zone, as with Borehole 526. Apparent in Borehole 554 are minor EM conductivity peaks in addition to the primary peak of EM conductivity within the zone at 35 to 49 ft bgs. Shallow anomalies were observed at 21 and 25 ft below surface and a deeper anomaly from 78 to 90 ft below surface. The shallow anomalies do not appear to be associated with

observed fractures or high concentrations of anions. In contrast, the anomaly at 35 to 49 ft bgs was associated with both fractures and high anion concentrations.

The similarities of the soluble salt accumulation zones (particularly the extent and degree of accumulations at approximately 35 to 50 ft below surface) beneath the east and west regimes of the MDA P Site indicate that similar processes have been active over some period of geologic time. The fracture zone on the west side was observed to have greater fracture density and apertures, and thicker, more extensive clay accumulations, all of which indicated a greater ability to transmit water and sediment. These data indicated that the limiting factor is climate and annual precipitation, not the relative ability to transmit water, as indicated by the flow-meter data. Hence, the subsurface of the western regime of the MDA P Site contained historic signatures of drying conditions, not of significant subsurface water flow.

2.3.5.3.3 Flash Pad 387—Data Summary and Discussion

Borehole 273 represents the characteristics of the fracture regime beneath the Flash Pad 387 at the watershed divide. Figure 2.3-5 shows the combined geophysical and geochemical results for Borehole 273. Borehole 273 was drilled to 145.8 ft below surface (approximately 80 ft below the level of the Cañon de Valle stream elevation) from a beginning elevation of 7453 ft above msl. The borehole was dry during and after drilling. The stratigraphic data indicate that the underlying bedrock consists of 42 ft of nonwelded Unit 4l, approximately 9 ft of the densely welded Unit 3T, approximately 34 ft of poorly welded Unit 3, and approximately 35 ft of welded Unit 3 that grades to nonwelded Unit 3 with depth. Flow-meter measurements were not collected because of the influence of high flow rates at 125 ft below surface that exceeded the instrument capabilities. High EM conductivity was measured in two zones: 35 to 45 ft below surface and 65 to 90 ft below surface. In contrast to Boreholes 526 and 554, high zones of EM conductivity did not appear to correlate with caliper logs in the shallow zone, but did correlate with the deeper area of high EM conductivity at 55 to 85 ft below surface. The shallower zone of high EM conductivity in Borehole 273 was located across the welded contact of Units 4l and 3T, which was both overlain and underlain by fracture zones. The deeper zone of high EM conductivity, at depths of 62 and 80 ft bgs, occurred in the partially welded Unit 3, and correlated with the peak concentrations of sodium and chloride.

Borehole 273 data indicated that a broad zone of soluble salt accumulation was present from approximately 35 to 90 ft below surface within the partially welded Unit 3. The upper portion of the zone had a small increase in nitrate concentrations, but much of the zone exhibited high chloride and sodium concentrations. Local low values of chloride and sodium at 61 and 74 ft below surface were correlated with either a fracture zone or lost core, respectively, similar to results in Boreholes 526 and 554 at 45 ft below surface. As found with the other boreholes, the bottom of the accumulation zone was marked by the presence of welded tuff that indicated that the partially welded tuff matrix was acting as an absorbent medium. As with the other boreholes in the MDA P Site, the subsurface conditions beneath Flash Pad 387 contained historic signatures of drying conditions, not of significant subsurface water flow. Hence, the influence of the interconnection of fractures with the walls of Cañon de Valle appeared to extend to the watershed divide.

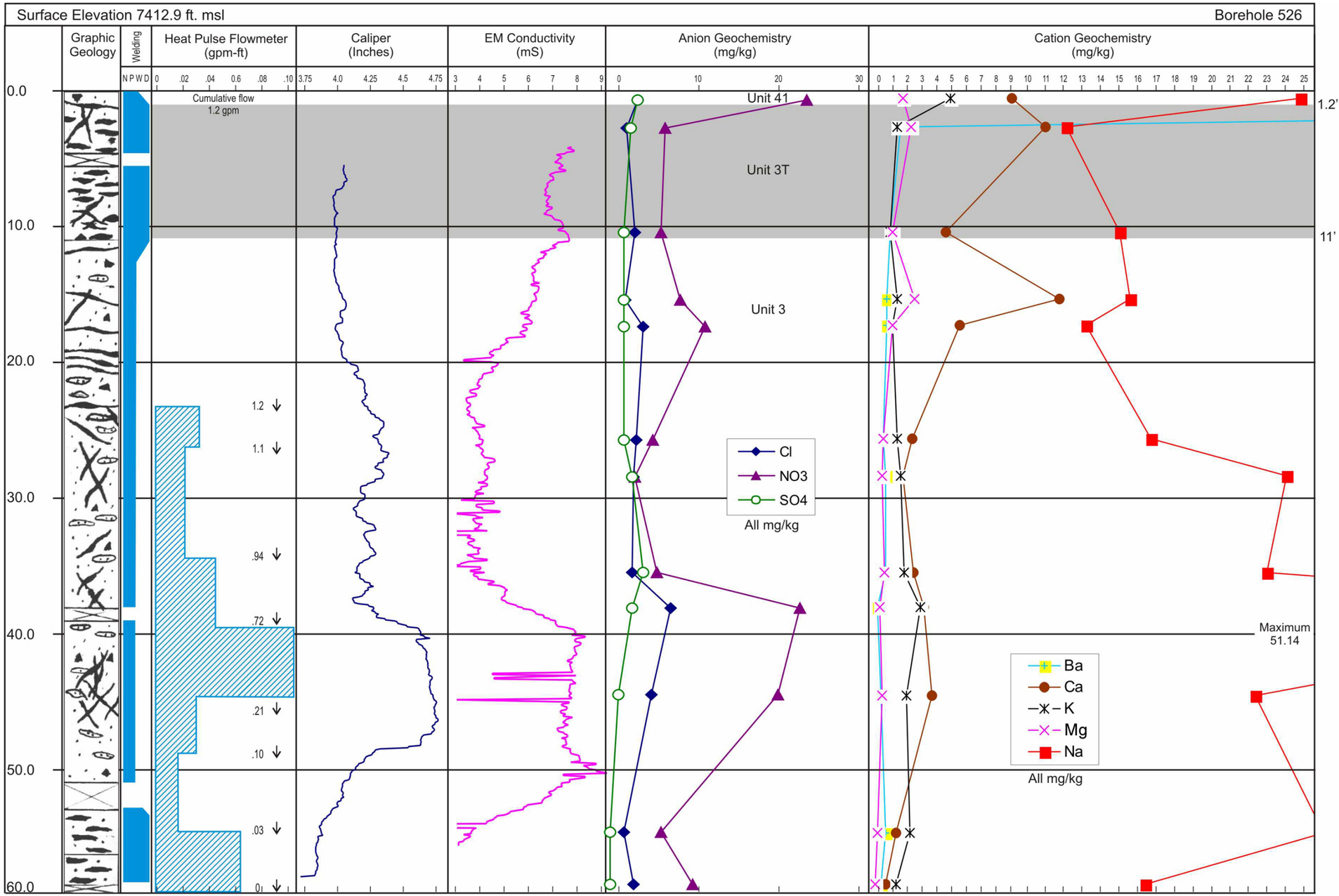

Figure 2.3-3. Empirical correlation diagram for Borehole 526, east side of the MDA P footprint

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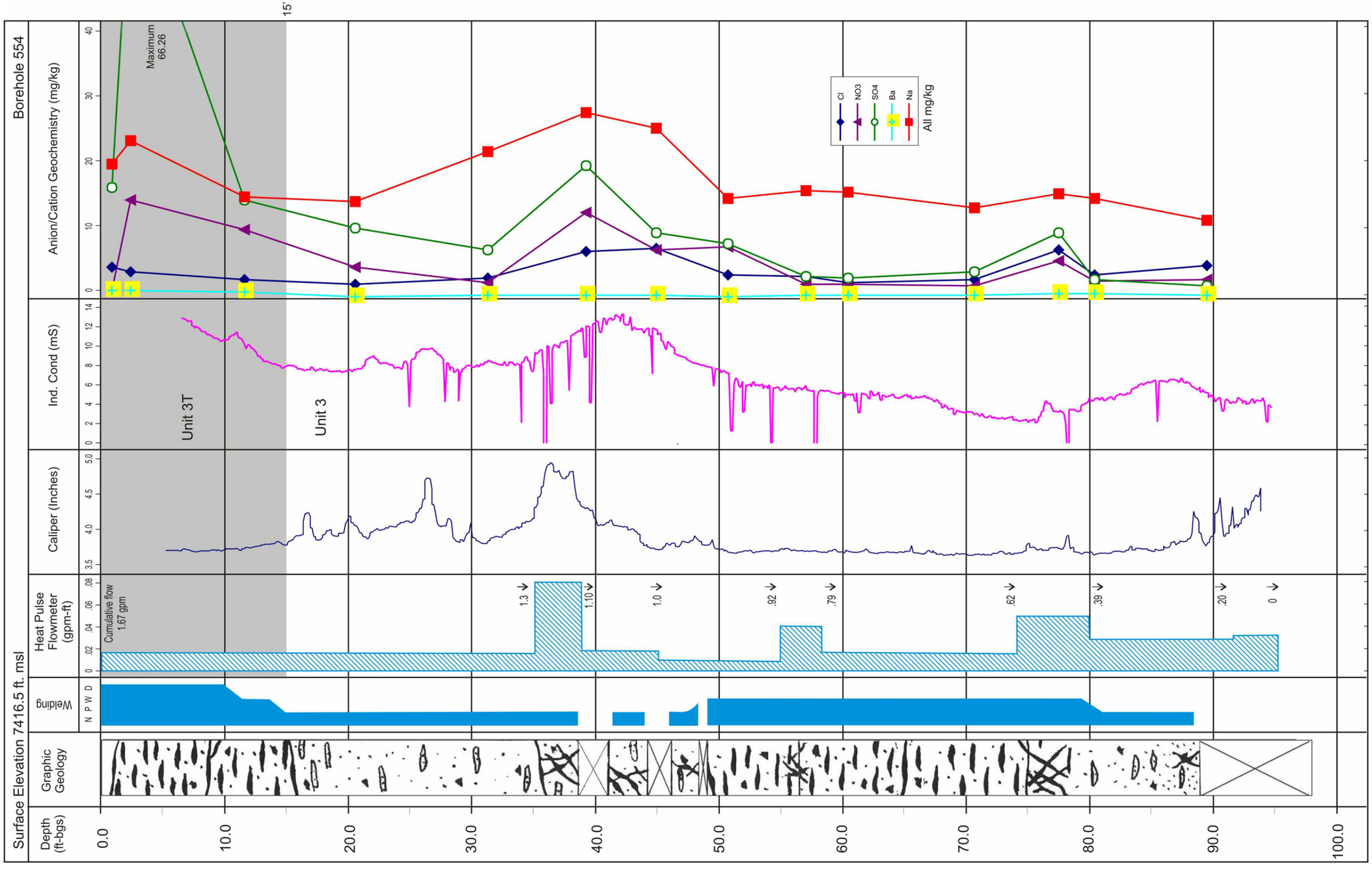

Figure 2.3-4. Empirical correlation diagram for Borehole 554, west side of the MDA P footprint

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2.4 Confirmation Sampling

Confirmation sampling within the MDA P Site was performed to confirm whether PRGs were met and to provide a basis for determining the potential risk to human and ecological receptors due to residual contamination remaining in the soil and tuff after the completion of the Phase I excavation and removal activities. Additional sampling included borehole sampling for the purposes of evaluating (1) the historical transport of contaminants through the bedrock underlying the MDA P Site, as determined by the sampling of cores for the same analytical suites as sampled in the surface soil and tuff and the sampling of borehole vapors; and (2) the potential for future transport through the vadose zone to groundwater, as determined by the focused geochemical and geophysical analysis of the boreholes, including the sampling for ionic species.

This section details the methods used for sample collection, the rationale for selecting confirmation sample locations, and the analytical suites sampled for in the confirmation samples. Data QA/QC measures, as relevant to the determination of data adequacy and data accuracy, are provided in Appendix B. The Phase II sampling and analyses, including the sampling of the boreholes, were detailed in the May 2002 NMED-approved closure plan modification (see Table 4-2 in LANL 2002, 73159) and are summarized in section 2.4.2.1. There are differences between the sampling indicated in Table 4-2 of the May 2002 modification and the final sampling as of January 2003. These differences represent slight discrepancies in Table 4-2 (less than 6% of the total samples collected for any given analyte group) and changes in sampling due to the additional excavation performed in September 2001, which were not captured in Table 4-2 of the May 2002 modification. Twelve samples were removed from the Phase II sample database because the locations from which these samples were taken were later excavated. Variances related to the Phase II confirmation sampling are summarized in section 2.4.4 and Appendix D.

2.4.1 Sample Collection Methods

Samples were collected in accordance with the SAP (LANL 1999, 63546). Approved ER Project SOPs were used for the locating of samples, sample collection, health and safety screening, sample shipping and storage, and maintenance of field records. These SOPs are listed in Table 2.4-1.

Table 2.4-1
Laboratory ER SOPs Used in the MDA P Site Phase I and Phase II Sampling

SOP Identifier	Title/Description
1.01	General Instructions for Field Investigations
1.02	Sample Container and Preservation
1.03	Handling, Packaging and shipping of Samples
1.04	Sample Control and Field Documentation
1.05 R1	Field Quality Control Samples
1.06 R2	Management of Environmental Restoration Project Wastes
1.07 R1	Operational Guidelines for Taking Soil and Water Samples in Explosives Areas
1.08	Field Decontamination of Drilling and Sampling Equipment
1.10 R1	Waste Characterization
1.12 R0	Field Site Closeout Checklist

Table 2.4-1 (continued)

SOP Identifier	Title/Description
2.01 R0	Surface Water Site Assessments
3.01	Land Surveying Procedures
6.03	Sampling for Volatile Organics
6.09	Spade and Scoop Method for Collection of Soil Samples
6.10	Hand Auger and Thin-Wall Tube Sampler
6.13 R2	Surface Water Sampling
6.15 R1	Coliwasa Samples for Liquids and Slurries
6.19 R1	Weighted Bottle Samples for Liquids and Slurries in Tanks
6.24	Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers
6.26	Core Barrel Sampling for Subsurface Earth Materials
6.28 R1	Chip Sampling of Porous Surfaces
6.29	Single-Stage Sampling for Surface Water Run-Off
4.01	Drilling Methods and Drill Site Management
4.04	General Borehole Logging
10.01 R1	Screening for PCBs in Soils
10.06	High Explosives Spot Test
10.08	Operation of the Field Portable XRF Instrument
10.10	Radiation Scoping Surveys
10.11	Soil Sample Field Screening to meet Radioactive Sample Shipping Requirements
12.02	Transportation, Receipt, and Admittance of Borehole Samples for the Sample Management Facility
15.15 R0	Sample Management Office Receiving and Shipping Analytical Samples

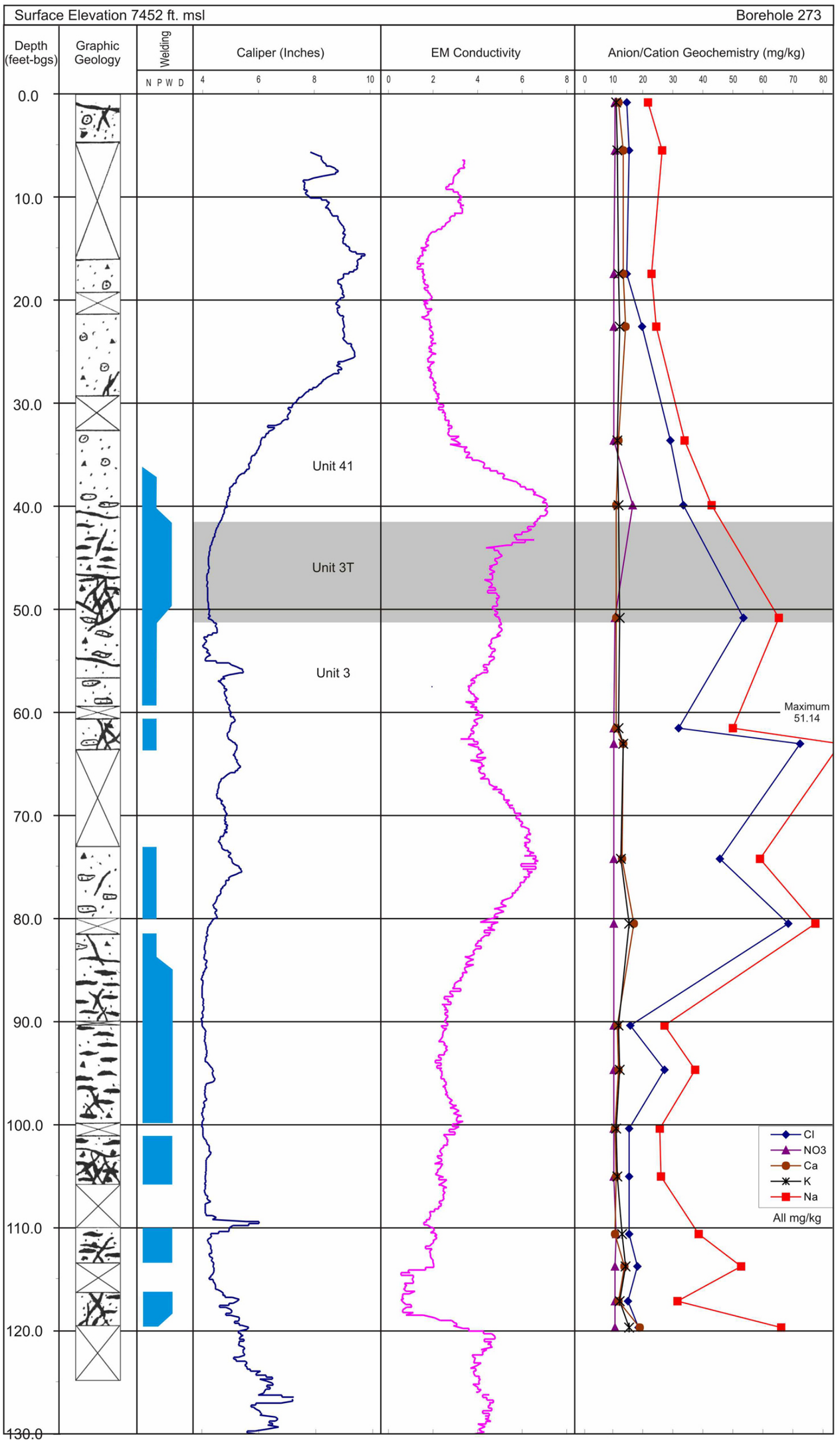

Figure 2.3-5. Empirical correlation diagram for Borehole 273, Flash Pad 387, at the watershed divide

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2.4.2 Sample Locations and Depths

2.4.2.1 Confirmation Samples

Sampling was performed to provide sufficient data for the determination of clean closure. Discrete grab samples were collected from the center of grid cells that were based on a 30- x 30-ft grid system laid across the MDA P Site. Each grid cell was given a unique number, which was used to identify the confirmation sample locations. Confirmation samples were collected at surface (defined here as 0 to 1 ft), subsurface (defined here as 2 to 3 ft), and deep subsurface (defined here as >3 ft) depths. A total of 200 grid cells were sampled from depths of 0.5 to 78 ft. The grid used for sampling is shown on Figure 1.4-2. Phase II sample locations are shown on Plate 2.

Additional sample locations beyond the original commitment in the SAP (LANL 1999, 63546) were selected using the following, tiered approach:

- grid cells with post-excavation RDX field-screening results exceeding 16 mg/kg;
- grid cells with post-excavation barium field-screening results exceeding 2000 mg/kg; and
- low-lying areas determined to have an increased potential for sediment deposition or areas with obvious deposition present.

Worker health and safety concerns were associated with the sampling of locations with slopes that exceeded 30%. Some grid centers identified at locations with slopes in excess of 30% were offset to locations within the given grid cells to areas with acceptable slopes (<30%). However, if no acceptable slopes occurred within a given grid cell, the sampling location was offset to an unsampled grid cell in close proximity with appropriate slope conditions. For the majority of the pre-determined sample locations with slopes greater than 30%, acceptable slope conditions existed within the grid cells, such that sampling in a proximal grid was not required.

The grid locations of the samples identified for analysis of organic chemicals followed the selection protocol outlined in LANL (2000, 67481): grid cells for which Phase I analytical sample results exceeded either 0.3 of the appropriate ecological screening levels (ESLs) or 0.1 of the appropriate human health SALs were also sampled in Phase II.

The locations of the final Phase II confirmation samples, as shown on Plate 2, were based on the original commitments made in the SAP (LANL 1999, 63546) and presented in revised Figure 2.1 in the response to the RSI (LANL 2000, 67481); subsequent deviations to the sample locations were presented in a letter (LANL 2001, 70252) and were approved by the NMED on May 30, 2002. Because of the NMED's approval, changes to the sample locations indicated in the letter (LANL 2001, 70252) are not presented as deviations; rather, only sample location changes summarized in section 2.4.4 are considered deviations to the approved Phase II sample locations.

More than 300 unique location and depth combinations are included in the confirmation sample database because many of the 200 grid cells identified for confirmation sampling had samples collected from more than one depth.

Table 2.4-2 presents the analytical suites, total number of confirmation samples in the May 2002 modification (LANL 2002, 73159), and total number of confirmation samples collected after all waste removal and sampling activities were completed (January 2003).

Table 2.4-2
MDA P Site Phase II Confirmation Sample Summary:
Analytical Suites and Total Number of Samples in Soil and Tuff

Analyte Type	Total Samples Reported in May 2002 Closure Plan Modification[a]	Final Total Soil and Tuff Samples (as of January 2003)	Total Duplicates Reported in May 2002 Closure Plan Modification	Final Total Duplicates (as of January 2003)
TAL metals	311	290	34	29
Hexavalent chromium	311	290	34	29
Mercury	311	290	34	29
Perchlorate	60	61	10	9
Reactive cyanide	5	3	0	0
Reactive sulfide	5	7	0	0
Total Cyanide	5	0	0	0
Dioxins/Furans	5	7	0	0
Herbicides (chlorinated)	5	7	0	0
HE	313	291	34	29
PCBs	5	7	0	0
Pesticides (organochlorine)	5	7	0	0
SVOCs	313	276	34	29
VOCs	23[b]	12[c]	1	1
Gamma spectroscopy	5	7	0	0
Gross alpha/gross beta	5 c	0	0	0
Isotopic uranium	7	7	0	0
Asbestos	5	7	0	0
pH	5	7	0	0

[a] Total of confirmation samples used in risk analysis: soil and tuff samples and borehole core samples.

[b] Includes 10 borehole VOC vapor samples.

[c] Includes 7 borehole VOC vapor samples.

2.4.2.2 Borehole Samples

The investigation of residual contamination at depth was accomplished with the drilling of four boreholes in grid cells 516, 526, 554, and 557 as discussed previously in section 2.3.2. A fifth borehole located in grid cell 273 was drilled to 145.8 ft for the primary purpose of geologic logging; however, analytical data derived from the sampling of Borehole 273 were included in the risk analysis (0–5 ft only), along with the sample results from Boreholes 516, 526, 554, and 557.

The five boreholes were sampled for TAL metals, hexavalent chromium, mercury, perchlorate, HE, SVOCs, and VOCs as summarized in Table 2.4-3. Appendix B presents all of the confirmation sample

results including the borehole data, and Tables 3.2.1-5, 3.2.1-10, 3.2.3-2, and 3.2.3-4 in Appendix A present the detected concentrations of inorganic chemicals above background and the detected concentrations of organic chemicals in the biological zone and exposed tuff zone. The sampling results for Boreholes 516, 554, and 273 show that inorganic chemical concentrations are detected above the Laboratory-wide BVs (LANL 1998, 59730) at less than 3 ft bgs. Copper and selenium are detected slightly above the BVs in deeper samples (5.0 mg/kg for copper versus a BV of 4.6 mg/kg and 0.32 mg/kg to 0.38 mg/kg versus a BV of 0.3 mg/kg). No organic chemicals are detected below 1 ft bgs in Boreholes 516, 554, and 273.

Table 2.4-3
MDA P Site Phase II Borehole Sample Summary: Analytical Suites and Total Number of Samples

Analyte Type	Total Borehole Samples Reported in May 2002 Closure Plan Modification	Final Total Borehole Samples (as of January 2003)
TAL metals	12	38
Hexavalent chromium	12	38
Mercury	12	38
Perchlorate	8	16
HE	12	39
SVOCs	8	24
VOCs	10[a]	12[b]

[a] VOCs referred to in May 2002 closure plan modification were for VOCs as vapors only and included two QA/QC samples.

[b] Includes samples for VOCs collected from borehole cores (5) and VOCs as vapors (7).

Sampling results for Boreholes 526 and 557 report inorganic chemical concentrations above the BVs at depth for antimony, barium, beryllium, cobalt, copper, and selenium; perchlorate is detected in these boreholes but does not have a BV. However, only barium, copper, and selenium are detected above BVs at greater than 3 ft bgs; perchlorate is detected below 3 ft bgs. Antimony is not detected above BV but had detection limits greater than the BV. Organic chemicals are also detected in Boreholes 526 and 557 (4-amino-2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, carbon disulfide, HMX, RDX, 1,3,5-trinitrobenzene, and 2,4,6-trinitrotoluene). Only 2-amino-4,6-dinitrotoluene, HMX, RDX, 1,3,5-trinitrobenzene, and 2,4,6-trinitrotoluene are detected below 3 ft bgs. Inorganic and organic chemical concentrations reported in the data tables in Appendixes A and B generally exhibit decreasing trends in concentration with depth in all boreholes; most concentrations are either below BV or undetected at total depth.

The results of the borehole VOC vapor sampling are included in this section, as additional information on potential contamination at depth. Eight borehole vapor samples from Boreholes 526, 554, and 557 were analyzed with SUMMA canisters for 62 VOC analytes. A minimum of two samples (plus one duplicate in Borehole 557) were collected from each borehole (as detailed in LANL 2001, 70252) (Table 2.4-4).

Table 2.4-4
VOC Vapor Samples in Boreholes, by Depth

Location ID[a]	Sample ID	Sample Depth (ft)
16-20526	0816-01-0268	26-28
16-20526	0816-01-0267	44-46
16-20554	0816-01-0283	37-39
16-20554[b]	0816-01-0277	76-78
16-20554[b]	0816-01-0284	76-78
16-20557	0816-01-0270	18-20
16-20557	0816-01-0269	54-56

[a] The final three digits identify the borehole.

[b] Borehole 554 was sampled on two dates at the 76- to 78-ft depth interval. These are considered unique samples, not duplicates.

Vapor sampling for VOCs was conducted on August 9 and October 10, 2001. Four types of QA samples were collected and analyzed, including duplicates: 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; two field (atmospheric) blank samples; and a performance evaluation sample/calibration gas sample taken from a tank of a certified gas mixture. The SUMMA canister sampling was performed using EPA Method TO-14 (gas chromatography/mass spectrometry) (EPA 1999, 70063) and collected according to LANL-ER-SOP-6.31, "Sampling Atmospheric and Sub-Atmospheric Air Sampling," using a downhole straddle packer. Laboratory QA for EPA Method TO-14 includes internal standards, surrogates, replicates, blanks, laboratory control samples, and reference standards. Before the sampling was performed, each depth was purged and monitored with field instruments until carbon dioxide levels stabilized at values representative of subsurface pore-gas conditions. Soil vapor was collected from 2-ft intervals of the borehole isolated by two, six-ft pneumatic packers. Soil vapor was first purged from the isolated zone with a 19-mm mercury vacuum until carbon dioxide concentrations stabilized to ensure formation air was being screened. The SUMMA canister samples were then collected and submitted for VOC analysis.

Table 2.4-5 summarizes the VOC analytical data, including number of analyses, number of detections, maximum and minimum values. Of the 62 VOCs included in the analysis, 24 VOCs were detected. The detected VOC analytes are summarized in Table 2.4-6, by borehole and sample ID.

Table 2.4-5
Summary of VOC Vapor Sample Analytical Results

Analyte	Number of Analyses[a]	Number of Detects[a]	Concentration Range (ppbv[b,c])
Acetone	7	7	20–5200
Benzene	7	0	0.84–[18]
Benzyl chloride	7	0	[0.84]–[18]
Bromodichloromethane	7	0	[3.40]–[70]
Bromoform	7	0	[3.40]–[70]
Bromomethane	7	0	[0.84]–[18]
Butadiene[1,3-]	7	0	[3.40]–[70]
Butanol[1-]	7	0	[8.40]–[180]
Butanone[2-]	7	6	[3.40]–[110]
Carbon disulfide	7	6	[3.50]–[70]
Carbon tetrachloride	7	4	[0.84]–24
Chlorobenzene	7	0	[0.84]–[18]
Chlorodibromomethane	7	0	[3.40]–[70]
Chlorodifluoromethane	7	0	[3.40]–[70]
Chloroethane	7	0	[0.84]–[18]
Chloroform	7	3	[0.86]–[18]
Chloromethane	7	0	[0.84]–[18]
Cyclohexane	7	0	[3.40]–[70]
Dibromoethane[1,2-]	7	0	[0.84]–[18]
Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	7	0	[0.84]–[18]
Dichlorobenzene[1,2-]	7	0	[0.84]–[18]
Dichlorobenzene[1,3-]	7	0	[0.84]–[18]
Dichlorobenzene[1,4-]	7	0	[0.84]–[18]
Dichlorodifluoromethane	7	3	[0.84]–[18]
Dichloroethane[1,1-]	7	0	[0.84]–[18]
Dichloroethane[1,2-]	7	1	[0.84]–[18]
Dichloroethene[1,1-]	7	0	[0.84]–[18]
Dichloroethene[trans-1,2-]	7	0	[3.40]–[70]
Dichloropropane[1,2-]	7	0	[0.84]–[18]
Dichloropropene[cis-1,3-]	7	0	[0.84]–[18]
Dichloropropene[trans-1,3-]	7	0	[0.84]–[18]

Table 2.4-5 (continued)

Analyte	Number of Analyses[a]	Number of Detects[a]	Concentration Range (ppbv[b,c])
Dioxane[1,4-]	7	0	[3.40]–[70]
Ethanol	7	5	[3.40]–[70]
Ethylbenzene	7	6	[0.88]–[18]
Ethyltoluene[4-]	7	1	[3.40]–[70]
Hexachlorobutadiene	7	0	[0.84]–[18]
Hexane	7	0	[3.40]–[70]
Hexanone[2-]	7	1	[3.40]–[70]
Methanol	7	0	[84]–[1800]
Methyl tert-butyl ether	7	0	[3.40]–[70]
Methyl-2-pentanone[4-]	7	0	[3.40]–[70]
Methylene chloride	7	1	[0.84]–48
n-Heptane	7	0	[3.40]–[70]
Propanol[2-]	7	4	[3.40]–2100
Propylene	7	1	[3.40]–[70]
Styrene	7	0	[0.84]–[18]
Tetrachloroethane[1,1,2,2-]	7	0	[0.84]–[18]
Tetrachloroethene	7	6	[0.88]–[18]
Tetrahydrofuran	7	0	[3.40]–[70]
Toluene	7	7	[0.88]–69
Trichloro-1,2,2-trifluoro-ethane[1,1,2-]	7	0	[0.84]–[18]
Trichlorobenzene[1,2,4-]	7	0	[0.84]–[18]
Trichloroethane[1,1,1-]	7	3	[0.84]–[18]
Trichloroethane[1,1,2-]	7	0	[0.84]–[18]
Trichloroethene	7	5	[0.86]–[18]
Trichlorofluoromethane	7	3	[0.84]–[18]
Trimethylbenzene[1,2,4-]	7	6	[0.88]–[18]
Trimethylbenzene[1,3,5-]	7	2	[0.86]–[18]
Vinyl acetate	7	0	[3.40]–[70]
Vinyl chloride	7	0	[0.84]–[18]
Xylene[1,2-]	7	6	[0.88]–[18]
Xylene[1,3-]+xylene[1,4-]	7	6	[0.88]–18

[a] QA/QC samples not included.
[b] ppbv = parts per billion by volume.
[c] Brackets indicate a nondetect.

Table 2.4-6
Detected VOCs in Borehole Vapor Samples

Analyte	Borehole Location	Sample ID	Depth (ft)	Sample Value (ppbv)
Acetone	526	0816-01-0268	26-28	300
		0816-01-0267	44-46	20
	554	0816-01-0283	37-39	29
		0816-01-0277	76-78	5200
		0816-01-0284	76-78	180
	557	0816-01-0270	18-20	70
		0816-01-0269	54-56	37
Butanone[2-]	526	0816-01-0268	26-28	11
	554	0816-01-0283	37-39	68
		0816-01-0277	76-78	110
		0816-01-0284	76-78	79
	557	0816-01-0270	18-20	26
		0816-01-0269	54-56	11
Carbon disulfide	526	0816-01-0268	26-28	51
		0816-01-0267	44-46	42
	554	0816-01-0283	37-39	3.60
		0816-01-0284	76-78	7.10
	557	0816-01-0270	18-20	12
		0816-01-0269	54-56	36
Carbon tetrachloride	526	0816-01-0268	26-28	0.97
		0816-01-0267	44-46	1.5
	557	0816-01-0270	18-20	1.10
		0816-01-0269	54-56	24
Chloroform	554	0816-01-0283	37-39	1.20
		0816-01-0284	76-78	1.5
	557	0816-01-0269	54-56	2.40

Table 2.4-6 (continued)

Analyte	Borehole Location	Sample ID	Depth (ft)	Sample Value (ppbv)
Dichlorodifluoromethane	526	0816-01-0268	26-28	4.5
		0816-01-0267	44-46	5.30
	557	0816-01-0269	54-56	1.30
Dichloroethane[1,2-]	526	0816-01-0267	44-46	1
Ethanol	526	0816-01-0268	26-28	7.20
		0816-01-0267	44-46	13
	554	0816-01-0284	76-78	3.8(J)[a]
	557	0816-01-0270	18-20	18
	557	0816-01-0269	54-56	6.70
Ethylbenzene	526	0816-01-0268	26-28	1.20
		0816-01-0267	44-46	1.20
	554	0816-01-0283	37-39	3.40
		0816-01-0284	76-78	4.5
	557	0816-01-0270	18-20	1.60
		0816-01-0269	54-56	1.20
Ethyltoluene[4-]	554	0816-01-0284	76-78	6.10
Hexanone[2-]	557	0816-01-0270	18-20	6
Methylene Chloride	526	0816-01-0267	44-46	48
Propanol[2-]	526	0816-01-0268	26-28	320
		0816-01-0267	44-46	5
	554	0816-01-0277	76-78	2,100
		0816-01-0284	76-78	17
Propylene	557	0816-01-0269	54-56	4.80
Tetrachloroethene	526	0816-01-0268	26-28	2.20
		0816-01-0267	44-46	2.5
	554	0816-01-0283	37-39	1.20
		0816-01-0284	76-78	1.40
	557	0816-01-0270	18-20	3.40
		0816-01-0269	54-56	1.90
Toluene	526	0816-01-0268	26-28	49
		0816-01-0267	44-48	19
	554	0816-01-0283	37-39	9.40
		0816-01-0277	76-78	18

Table 2.4-6 (continued)

Analyte	Borehole Location	Sample ID	Depth (ft)	Sample Value (ppbv)
Toluene (continued)		0816-01-0284	76-78	10
	557	0816-01-0270	18-20	69
		0816-01-0269	54-56	39
Trichloroethane[1,1,1-]	526	0816-01-0268	26-28	3.10
		0816-01-0267	44-46	5.80
	557	0816-01-0269	54-56	2.30
Trichloroethene	526	0816-01-0268	26-28	5.70
		0816-01-0267	44-46	11
	554	0816-01-0284	76-78	1.5
	557	0816-01-0270	18-20	7.40
		0816-01-0269	54-56	4.40
Trichlorofluoromethane	526	0816-01-0268	26-28	2.20
		0816-01-0267	44-46	2.60
	557	0816-01-0269	54-56	1.10
Trimethylbenzene[1,2,4-]	526	0816-01-0268	26-28	2
		0816-01-0267	44-46	1.70
	554	0816-01-0283	37-39	3.60
		0816-01-0284	76-78	6.90
	557	0816-01-0270	18-20	2.90
		0816-01-0269	54-56	2.10
Trimethylbenzene[1,3,5-]	554	0816-01-0283	37-39	1.30
		0816-01-0284	76-78	2.20
Xylene[1,2-]	526	0816-01-0268	26-28	2.20
		0816-01-0267	44-46	1.90
	554	0816-01-0283	37-39	7.20
		0816-01-0284	76-78	9.10
	557	0816-01-0270	18-20	2.60
		0816-01-0269	54-56	2.10
Xylene[1,3-]+xylene[1,4-]	526	0816-01-0268	26-28	5.30
		0816-01-0267	44-46	5
	554	0816-01-0283	37-39	14
		0816-01-0284	76-78	18

Table 2.4-6 (continued)

Analyte	Borehole Location	Sample ID	Depth (ft)	Sample Value (ppbv)
Xylene[1,3-]+xylene[1,4-] (continued)	557	0816-01-0270	18-20	6.60
		0816-01-0269	54-56	5.5

[a] J = estimated quantity.

VOC concentrations were generally detected in the ppbv range in each sample, with the exception of acetone and [2-]propanol, both detected in ppmv in sample 0816-01-0277. However, these two VOCs had substantially lower concentrations measured in the collocated sample (0816-01-0284). Detected compounds included trichloroethene, tetrachloroethene, benzene, toluene, ethylbenzene, and xylene (BTEX) components, acetone, and Freons. Several compounds were detected in the QA samples, including butanone and [2-]propanol.

Results of the borehole vapor sampling at MDA P indicate VOCs are present at very low concentrations in subsurface pore gas. The subsurface environment at MDA P is relatively dry (<20% moisture by volume) with limited organic content. Additionally, the VOCs detected at the site have relatively high vapor pressures. Given these factors, it is likely that these VOCs are restricted to the vapor phase and are not indicators of contamination of soil or tuff. In the absence of liquid water and organic material, these VOCs would not be present at detectable concentrations sorbed onto the tuff matrix.

The compounds detected in the vapor phase at the MDA P Site are indicative of those commonly associated with industrial waste. Furthermore, disposal and excavation activities at MDA P involved the use of heavy equipment, which likely introduced small amounts of petroleum products through exhaust and equipment leaks. Industrial waste was present on the surface for over fifty years at the site. Vapors from this material would have diffused into the underlying tuff at low concentrations and remain as residual pore gas contamination. Therefore, the vapor phase contaminants detected in pore gas in the boreholes at the MDA P Site are not unexpected and are consistent with known sources of contamination. VOCs as vapors in the boreholes are at trace levels and generally decrease with depth, indicating that contamination at depth does not occur.

2.4.3 Confirmation Sampling Results

The confirmation sample results from the MDA P Site are summarized for inorganic chemicals, radionuclides, and organic chemicals. The data review (comparison to background and evaluation of detection status) is presented in more detail in Appendix A, section 3.2. Following the comparison to background for inorganic chemicals, further evaluation was performed using statistical comparisons and box and whisker plots. The statistical analyses and graphical comparisons used in this assessment are detailed in Appendix A, section 3.2 and Attachment 2.

Ten inorganic chemicals in the biological zone soil exceeded their respective BVs: antimony, barium, cadmium, chromium, cobalt, copper, lead, manganese, silver, and zinc. Table 2.4-6 summarizes the inorganic chemical data. More detail is provided in Table 3.2.1-1 of Appendix A, including frequency of detection, range of concentrations measured in the confirmation samples, and a comparison of the concentrations of each analyte to the BVs for soil (LANL 1998, 59730). Following the BV comparisons, these 10 inorganic chemicals were further evaluated using statistical comparisons and box and whisker

plots (see Appendix A, section 3.2.1, Tables 3.2.1-2, 3.2.1-3, and 3.2.1-4 and Attachment 2). As a result, barium, copper, silver, cobalt, lead, and zinc were retained as COPCs in the biological zone soil. Appendix A, Table 3.2.1-5 presents the analytical results for all soil samples with detected inorganic chemical concentrations or detection limits exceeding BVs for the biological zone.

Sixteen inorganic chemicals in the biological zone tuff exceed their respective BVs: aluminum, antimony, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, nickel, selenium, silver, thallium, vanadium, and zinc. Table 2.4-7 summarizes the inorganic chemical data. More detail is provided in Appendix A, Table 3.2.1-1 including frequency of detection, range of concentrations measured in the confirmation samples, and a comparison of the concentrations of each analyte to the BVs for tuff (LANL 1998, 59730). Following the BV comparisons, these 16 inorganic chemicals are further evaluated using statistical comparisons and box and whisker plots (see Appendix A, section 3.2.1, Tables 3.2.1-2, 3.2.1-3, and Attachment 2). As a result, aluminum, antimony, barium, chromium, cobalt, copper, iron, lead, nickel, selenium, vanadium, and zinc are retained as COPCs in the biological zone tuff. Appendix A, Table 3.2.1-5 presents the analytical results for all tuff samples with detected inorganic chemical concentrations or detection limits exceeding BVs for the biological zone.

Nineteen inorganic chemicals in the exposed tuff zone exceed their respective BVs for tuff: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. Additionally, perchlorate, which does not have an associated BV, is retained as a COPC because it was detected. Table 2.4-8 summarizes the inorganic chemical data. More detail is provided in Table 3.2.1-6 of Appendix A, including frequency of detection, range of concentrations measured in the confirmation samples, and a comparison of the concentrations of each analyte to the BVs for tuff (LANL 1998, 59730). Following the BV comparisons, these 19 inorganic chemicals are further evaluated using statistical comparisons and box and whisker plots (see Appendix A, section 3.2.1, Tables 3.2.1-7, 3.2.1-8, and 3.2.1-9 and Attachment 2). As a result, aluminum, antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, vanadium, and zinc are retained as COPCs in the exposed zone tuff; perchlorate is also retained as a COPC because it was detected. Appendix A, Table 3.2.1-10 presents the analytical results for all samples with detected inorganic chemical concentrations or detection limits exceeding BVs in the exposed tuff zone.

Four radionuclides were detected in the soil samples from the biological zone: cesium-137, uranium-234, uranium-235, and uranium-238. None of these radionuclides were detected at activities exceeding the soil BVs or fallout values (LANL 1998, 59730). Three radionuclides were detected in the tuff samples from the exposed tuff zone: uranium-234, uranium-235, and uranium-238. None of these radionuclides were detected at activities exceeding the tuff BVs (LANL 1998, 59730). Table 2.4-9 summarizes the radionuclide data. More detail is provided in Appendix A, Tables 3.2.2-1 and 3.2.2-2 including frequency of detection, range of concentrations measured in the confirmation samples, and a comparison of the concentrations of each analyte to the BVs for soil or tuff (LANL 1998, 59730).

Nineteen organic chemicals were detected in one or more of the biological zone samples. However, 9 of these were detected in less than 5% of the samples and are eliminated as COPCs (EPA 1989, 08021); the remaining 10 organic chemicals were retained as COPCs for the biological zone: acetone, amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], Aroclor-1260, bis(2-ethylhexyl)phthalate, DDT[4,4'-] (dichlorodiphenyltrichloroethane), HMX (1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane), RDX (1,3,5-trinitro-1,3,5-triazacyclohexane), toluene, and trinitrotoluene[2,4,6-]. Table 2.4-10 summarizes the organic chemical data. More detail is provided in Appendix A, Table 3.2.3-1, including frequency of detection, range of concentrations measured in the confirmation samples, and the maximum estimated quantitation

limits (EQLs) for all detected organic chemicals. Samples with detected concentrations for the 10 organic COPCs are summarized in Appendix A, Table 3.2.3-2.

Sixteen organic chemicals were detected in one or more of the exposed tuff zone samples. However, 7 of the organic chemicals were detected in less than 5% of the samples and were eliminated as COPCs (EPA 1989, 08021); the remaining 9 organic chemicals were retained as COPCs for the exposed tuff zone: amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], bis(2-ethylhexyl)phthalate, carbon disulfide, HMX, RDX, toluene, trinitrobenzene[1,3,5-], and trinitrotoluene[2,4,6-]. Table 2.4-11 summarizes the organic chemical data. More detail is provided in Appendix A, Table 3.2.3-3, which summarizes the organic analytical data, including frequency of detection, range of concentrations measured in the confirmation samples, and the maximum EQLs for all detected organic chemicals. Samples with detected concentrations for the 9 organic COPCs are summarized in Appendix A, Table 3.2.3-4.

Table 2.4-7
Summary of Inorganic Chemical Results for the Biological Zone

Analyte	Media	Number of Analyses	Number of Detects	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Background Value (mg/kg)
Aluminum	Soil	71	71	2,630	19,900	29,900
Aluminum	Tuff	73	73	766	32,700	7,340
Antimony	Soil	71	17	[0.09][a]	2.9	0.83
Antimony	Tuff	73	3	[0.14]	1.2	0.5
Arsenic	Soil	71	66	[0.12]	4.8	8.17
Arsenic	Tuff	73	61	[0.12]	3.8	2.79
Barium	Soil	71	71	18.7	6,630	295
Barium	Tuff	73	73	9.3	2,920	46
Beryllium	Soil	71	71	0.27	1.8	1.83
Beryllium	Tuff	73	73	0.23	1.9	1.21
Cadmium	Soil	71	24	[0.01]	1.4	0.4
Cadmium	Tuff	73	33	[0.02]	0.80	1.63

Table 2.4-7 (continued)

Analyte	Media	Number of Analyses	Number of Detects	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Background Value (mg/kg)
Chromium	Soil	71	70	1.6	39.4	19.3
Chromium	Tuff	73	69	0.51	15.6	7.14
Cobalt	Soil	71	71	0.69	44.7	8.64
Cobalt	Tuff	73	70	0.41	41.3	3.14
Copper	Soil	71	71	0.68	36.8	14.7
Copper	Tuff	73	73	0.004	32.4	4.66
Iron	Soil	71	71	4,580	19,900	21,500
Iron	Tuff	73	73	6.47	22,500	14,500
Lead	Soil	71	71	3.8	61.5	22.3
Lead	Tuff	73	73	1.25	24.2	11.2
Manganese	Soil	71	71	30.9	1,290	671
Manganese	Tuff	73	73	44.7	456	482
Mercury	Soil	71	36	[0.2]	0.07	0.1
Mercury	Tuff	73	14	[0.0028]	0.061	0.1
Nickel	Soil	71	69	[1.3]	10.5	15.4
Nickel	Tuff	73	62	0.79	12.6	6.58
Selenium	Soil	71	33	[0.10]	0.48	1.52
Selenium	Tuff	73	48	0.13	0.74	0.3
Silver	Soil	71	16	[0.019]	15.8	1
Silver	Tuff	73	15	[0.035]	4.6	1
Thallium	Soil	71	30	[0.013]	[1.2]	0.73
Thallium	Tuff	73	25	[0.012]	1.2	1.1
Vanadium	Soil	71	70	[0.380]	29.3	36.6
Vanadium	Tuff	73	70	0.0038	26.4	17
Zinc	Soil	71	67	[9.4]	912	48.8
Zinc	Tuff	73	73	0.027	150	63.5

[a] Numbers in brackets are undetected results and the value reported is the estimated detection limit.

Table 2.4-8
Summary of Inorganic Chemical Results for the Exposed Tuff Zone

Analyte	Media	Number of Analyses	Number of Detects	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Background Value (mg/kg)
Aluminum	Tuff	146	146	656	28100	7,340
Antimony	Tuff	146	22	[0.02][a]	2.7	0.5
Arsenic	Tuff	146	120	[0.11]	7.2	2.79
Barium	Tuff	146	145	5.2	6,980	46
Beryllium	Tuff	146	146	0.25	3.3	1.21
Cadmium	Tuff	146	65	[0.015]	5.7	1.63
Chromium	Tuff	146	145	0.32	18.7	7.14
Cobalt	Tuff	146	144	0.35	151	3.14
Copper	Tuff	146	144	[0.94]	34	4.66
Iron	Tuff	146	146	4,130	20,600	14,500
Lead	Tuff	146	146	1.2	144	11.2
Manganese	Tuff	146	145	103	842	482
Mercury	Tuff	146	30	[0.0028]	0.22	0.1
Nickel	Tuff	146	132	0.78	13.2	6.58
Perchlorate	Tuff	33	7	[0.007]	[0.73]	No Value
Selenium	Tuff	146	88	0.12	1.4	0.3
Silver	Tuff	146	22	[0.04]	1.8	1
Thallium	Tuff	146	46	[0.012]	1.4	1.1
Vanadium	Tuff	146	140	[0.38]	36.7	17
Zinc	Tuff	146	146	23.1	118	63.5

[a] Numbers in brackets are undetected results and the value reported is the estimated detection limit.

Table 2.4-9
Summary of Radionuclide Results for the Biological Zone and Exposed Tuff Zone

Analyte	Media	Number of Analyses	Number of Detects	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Background Value (mg/kg)
Biological Zone						
Cesium-137	Soil	3	1	[-0.020][a]	0.55	1.65
Uranium-234	Soil	3	3	0.48	0.73	2.59
Uranium-235	Soil	5	2	[-0.63]	[0.31]	0.20
Uranium-238	Soil	3	3	0.51	0.85	2.29
Exposed Tuff Zone						
Uranium-234	Tuff	4	4	0.45	0.71	1.98
Uranium-235	Tuff	8	2	[-0.27]	0.068	0.09
Uranium-238	Tuff	4	4	0.374	0.51	1.93

[a] Numbers in brackets are undetected results and the value reported is the estimated detection limit.

Table 2.4-10
Summary of Organic Chemical Results for the Biological Zone

Analyte	Number of Analyses	Number of Detects	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)
Acetone	5	1	0.014	[0.026]
Amino-2,6-dinitrotoluene[4-]	145	18	0.063	0.98
Amino-4,6-dinitrotoluene[2-]	145	20	0.044	1.1
Aroclor-1260	3	1	[0.039][a]	0.061
Benzoic Acid[b]	139	3	0.1	[2.3]
Bis(2-ethylhexyl)phthalate	139	8	0.11	[0.47]
DDT[4,4'-]	3	1	[0.002]	0.0079
Dichlorobenzene[1,4-][b]	144	1	0.001	[0.47]
Dinitrobenzene[1,3-][b]	145	3	0.046	[1.4]
Dinitrotoluene[2,4-][b]	282	1	[0.08]	[1.4]
Dinitrotoluene[2,6-][b]	282	2	[0.08]	[1.4]
HMX	145	57	[0.08]	16
Methylnaphthalene[2-][b]	139	1	0.04	[0.47]
Nitrotoluene[3-][b]	145	1	[0.08]	[1.4]
Nitrotoluene[4-][b]	145	1	[0.08]	[1.4]
RDX	145	76	0.069	37
Tetryl[b]	144	1	[0.08]	[1.4]
Toluene	5	1	0.001	[0.007]
Trinitrotoluene[2,4,6-]	145	12	0.034	1.2

[a] Numbers in brackets are undetected results and the value reported is the estimated detection limit.

[b] Detected in less than 5% of the samples eliminated as a COPC.

Table 2.4-11
Summary of Organic Chemical Results for the Exposed Tuff Zone

Analyte	Number of Analyses	Number of Detects	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)
Amino-2,6-dinitrotoluene[4-]	143	20	0.049	0.55
Amino-4,6-dinitrotoluene[2-]	143	23	[2.5E-07][a]	0.882
Bis(2-ethylhexyl)phthalate	137	7	0.08	0.62
Carbon Disulfide	5	1	[0.005]	0.01
Di-n-butylphthalate	137	1	0.13	[0.43]
Dinitrobenzene[1,3-]	143	1	0.044	[0.33]
Dinitrotoluene[2,4-]	280	2	0.036	[0.43]
Dinitrotoluene[2,6-]	280	1	[0.08]	[0.43]
HMX	143	76	[0.08]	5.74

Table 2.4-11 (continued)

Analyte	Number of Analyses	Number of Detects	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)
Methylnaphthalene[2-]	137	1	0.058	[0.43]
Nitrotoluene[4-]	143	1	[0.08]	[0.33]
RDX	143	107	0.054	10.8
Tetryl	143	1	[0.08]	[0.33]
Toluene	5	2	0.001	[0.026]
Trinitrobenzene[1,3,5-]	143	8	0.047	0.36
Trinitrotoluene[2,4,6-]	143	10	0.029	0.48

[a] Numbers in brackets are undetected results and the value reported is the estimated detection limit.

All data collected for the Phase II confirmation sampling were validated in accordance with the requirements of the QA project plan (LANL 1996, 54609) and the Laboratory ER Project analytical services statement of work for contract laboratories (LANL 2000, 71233). Data QA/QC is summarized in Appendix B.

The data assessment determined that the data are of good quality and are sufficient for validating the demonstration of clean closure.

2.4.4 Phase II Variances

Several operational variances and deviations associated with the Phase II closure implementation activities for the MDA P Site were identified previously in a number of letters and/or Class I closure modification requests, as detailed in Appendix D; these changes were incorporated into the NMED-approved May 2002 request for closure plan modification (LANL 2002, 73159). Thus, all changes to the Phase II activities covered by the closure plan modification no longer represent deviations or variances, according to the definition of such changes in the MDA P closure plan (LANL 1995, 58713). Approved Phase II changes include changes related to the borehole investigations and changes to the Phase II sampling plan. With the exception of MDA P closure plan changes that may have also impacted the closure implementation of Flash Pad 387 due to the overlap in closure activities, no additional changes were identified for the Flash Pad 387 closure implementation. All changes that occurred in Phase II activities after May 2002 are considered variances that fall into one of two categories: (1) changes in sample locations, and (2) changes in analytical sampling.

2.4.4.1 Phase II Sample Location Changes

There were a number of changes to the Phase II sample locations, as committed to in May 2002 (LANL 2002, 73159) after the majority of the confirmation sampling activities had been completed (see Table 2.4-12). The changes to sampling locations included: additions, deletions, changes across grids, and changes within grids. The changes in sampling locations were primarily driven by (1) the commitment to sample in low-lying areas with increased potential for receiving deposition or in areas with obvious deposition occurring; and (2) the need to protect worker safety by avoiding steep slopes (>30%) during sampling.

Table 2.4-12
Phase II Sample Location Changes

Grid	Sample Depth (ft)	Notes
Deleted Phase II Sample Locations		
83	0–1	—
119	0–1	—
341	2–3	—
343	0–1	—
378	0–1	—
547	2–3	—
550	0–1	—
587	0–1	—
588	0–1	—
591	2–3	—
Added Phase II Sample Locations		
196	0–1	—
204	0–1	—
205	0–1	—
205	0–1	—
206	0–1	—
206D	0–1	—
238	0–1	—
239	0-11	—
240	0–1	—
241	0–1	—
242	0–1	—
271	0–1	—
271T	0–1	—
276	0–1	—
277E	0–1	—
278	0–1	—
278	0–1	—
314	0–1	—
340	0–1	—
340	2–3	—
344	3–4	—
348	0–1	—
373	0–1	—
375	9-10	—
376	0–1	—

Table 2.4-12 (continued)

Grid	Sample Depth (ft)	Notes
Added Phase II Sample Locations (continued)		
376A	0–1	—
387	0–1	—
413	0–1	—
454	0–1	—
624	0–1	—
625	0–1	—
625	2–3	—
661T	2–3	—
661T	6–7	—
667	0–1	—
669	0–1	—
670	0–1	—
702	0–1	—
702	2–3	—
702T	0–1	—
702T	4–5	—
706	0–1	—
741	2–3	—
741	5–6	—
742	0–1	—
742	2–3	—
Moved Phase II Sample Locations		
117	0–1	Moved to 153
153	0–1	Moved from 117
274	0–1	Moved from grid center
287	0–1	Moved from grid center
316	0–1	Moved from grid center
371	0–1	Moved from grid center
403	0–1	Moved to 404
404	0–1	Moved from 403
410	0–1	Moved to 411
411	0–1	Moved from 410
416	0–1	Moved from 417
417	0–1	Moved to 416
473	0–1	Moved to 474
474	0–0.5	Moved from 473
514	0–1	Moved from grid center

Table 2.4-12 (continued)

Grid	Sample Depth (ft)	Notes
Moved Phase II Sample Locations (continued)		
515	0–1	Moved from grid center
528	0–1	Moved from 564
564	0–1	Moved to 528
589	0–1	Moved to 590
590	0–1	Moved from 589
590	2–3	Moved from 589
652	0–0.5	Moved from 688
652	2–3	Moved from 688
688	0–0.5	Moved to 652
688	2–3	Moved to 652

The SAP (LANL 1999, 63546) and May 2002 modification (LANL 2002, 73159) detailed the collection of "baseline" samples to determine whether the Phase I activities may have introduced additional levels of residual contamination beyond the historic activities in the areas used for conducting Phase I activities (e.g., staging, decontamination, storage, and loading areas). However, the topsoil and unconsolidated materials in the majority of the staging areas were entirely removed during the Phase I activities. In other staging areas where removal was not complete, significant portions were excavated during Phase I and the remaining soil passed the field screening process. Thus, locations originally identified for baseline sampling were included within locations later considered for the Phase II confirmation sampling, obviating the need to separate baseline locations from confirmation sample locations.

The SAP (LANL 1999, 63546) defined a minimum number of sample locations based on "strata" (i.e., unique areas of concern within the MDA P Site boundaries), for a total of 179 locations. The purpose of this original sample design was to provide for an appropriate number of samples for which potential risk to receptors within each stratum could be evaluated. It was then proposed that the results of each stratum be compared to determine an appropriate level of grouping and thus, spatial scale, of the final risk analysis. This approach to the risk analysis was obviated by the decision to screen for potential risk at the MDA P Site with respect to the two, distinct regions of potential transport and receptor exposure (i.e., the biological zone and the exposed tuff zone, described in section 1.4) remaining at the site after the completion of the Phase I excavation and removal activities, as agreed upon by the Laboratory with the NMED and with EPA Region 6 personnel (LANL 2002, 73791).

Overall, the net change in the sample locations was a positive variance; that is, more grid locations were sampled than committed to in May 2002: 10 locations were "deleted"; 41 locations (some with more than one sample per location) were "added", 8 of which were "moved" from previously identified locations. Thus, a total of 23 locations were added to the confirmation sampling at the MDA P Site (41 additions - 8 moved from previously identified locations - 10 deleted locations). Within-grid moves from the grid centers occurred at 8 locations.

2.4.4.2 Phase II Sample Changes in Sample Numbers

The confirmation sampling by analytical suite, as committed to and as performed, is summarized in Table 2.4-2 and Table 2.4-3. Table 2.4-2 shows the number of samples for some analytical suites (notably inorganic chemicals, HE, and SVOCs) is less than indicated in the May 2002 modification, while other chemicals have more samples than indicated in the May 2002 modification. However, the differences in the sample numbers from May 2002 to the preparation of this closure certification report represent slight discrepancies in Table 4-2 of the May 2002 modification (less than 6% of the total samples collected for any given analyte group) and changes in sampling due to the additional excavation and removal activities in the eastern drainage that occurred after May 2002. Samples in the eastern drainage area that were used as confirmation samples prior to May 2002 became Phase I characterization samples after May 2002 because of the additional excavation and removal activities in the drainage. Overall, twelve samples were removed from the Phase II sample database because the locations from which these samples were collected were later excavated. Thus, a reduction in number of confirmation samples does not indicate a reduction in the ability to characterize the residual contamination at the MDA P Site because the sampling changes beyond May 2002 were driven by additional removal and sampling performed at the site as a result of the initial confirmation sample results. The changes in the numbers of confirmation samples collected at the MDA P Site do not affect the ability to evaluate risk and, therefore, determine clean closure.

2.5 Risk Assessments for the MDA P Site

2.5.1 Introduction

The human health and ecological risk assessments summarized in this section are performed to confirm that the requirements for clean closure and corrective action at the MDA P Site are met. The risk assessment approach was delineated in the NMED-approved SAP for the MDA P Site units (LANL 1999, 63546). The analysis of the Phase II confirmation sample data in the context of potential human health and ecological risk is the focus of this section, the details of which are provided in Appendix A.

Potential risks to both human and ecological receptors from residual contamination are evaluated for the MDA P Site. The screening assessments performed for the human and ecological receptors consist of four components: scoping, screening evaluation, uncertainty analysis and/or problem formulation, and interpretation of results. The human health screening assessment is performed using the approach presented in the “Installation Work Plan for Environmental Restoration Program” (LANL 1998, 62060) and in LANL (2002, 72639). The ecological screening assessment is performed using the methodology presented in “Screening Level Ecological Risk Assessment Methods” (LANL 1999, 64783). For all inorganic and organic COPCs that do not pass the initial human health and ecological screening assessments, additional analysis and evaluation is provided.

2.5.2 Conceptual Site Model

This section summarizes the conceptual model of COPC release, transport, and potential exposure to human and ecological receptors at the MDA P Site. The conceptual model is discussed in more detail in Appendix A, section 3.3.

The current, post-excavation MDA P Site is comprised of two distinct zones: an “exposed tuff zone” and a “biological zone” (see Photograph 1.4-2, Photograph 1.4-3, and Figure 1.4-2). The location of MDA P exists almost exclusively within the exposed tuff zone, though the very southern tip of the east lobe is within the biological zone. The location of Flash Pad 387 exists within an area that has been restored and

reseeded and lies entirely within the biological zone. The location of consolidated SWMU 16-016(c)-99 exists within both the exposed tuff and biological zones. The boundaries of the biological and exposed tuff zones and the boundaries of the units within the MDA P Site are shown on Figure 1.4-2.

2.5.2.1 Potential Releases and Transport

The primary mechanism of past releases of chemicals at the MDA P Site is related to the former material disposal operations conducted at the site. Contamination of surface soils and tuff at the site occurred through transport and dispersion from the contaminated debris and soil generated and accumulated during the operations at the MDA P Site. Additional releases potentially occurred via leaching through the landfill contents and surface water runoff from the MDA P Site to the Cañon de Valle stream channel, located downgradient (north) of the MDA P Site.

Soil and tuff are the contaminated media within the boundaries of the MDA P Site associated with past releases. The majority of COPCs identified for both the exposed tuff and biological zones are in soil and tuff at depths less than 5 ft. Surface water does not currently exist at the site and excavation and removal activities resulted in the elimination of all potential near-saturated and ponded water sources at the surface, eliminating surface water as a medium of concern within the boundaries of the MDA P Site. Run-on is directed away from the site into two, adjacent watersheds, using natural and engineered landscape features. Runoff of precipitation that falls within the boundaries of the MDA P Site is generally diverted to the west and east of the site, into channels that terminate in Cañon de Valle. Large precipitation events may cause breaching of the diversion channels and result in sheet flow across the surface of the site, terminating also in Cañon de Valle. Groundwater is also ruled out as a contaminated medium underneath the MDA P Site because contamination beneath the site does not extend to approximately 700 ft bgs (potential perched aquifer) or the regional aquifer at approximately 1200 ft bgs.

Surface soils have been removed from the exposed tuff zone, which has also been denuded of all mature, native vegetation. Because there are currently no areas for ponding or with near-saturated conditions within the exposed tuff zone, the current conditions promote runoff and inhibit infiltration. Also, because the residual contamination is limited to the tuff, transport from the exposed tuff zone is controlled primarily by the slow rate of weathering of the tuff. The soils in the biological zone are approximately 2 to 5 ft deep (though in some locations, soils may exceed 5 ft) and are inhabited by grasses and plants typical of successional or transitional areas that have been subjected to some kind of disturbance. Erosion of the topsoil that remains at the site within the biological zone was mitigated by the implementation of BMPs by the Laboratory, including slope stabilization and erosion control measures. Transport of residual contamination from the biological zone to Cañon de Valle is still possible through surface water runoff, though the presence of topsoil, plant cover, and the BMP features tend to promote infiltration of water over runoff, making sediment runoff a minor transport pathway for the biological zone.

Natural, physiographic boundaries (terrain constraints) limit the lateral extent of both past and future transport. The off-site transport of contaminants is constrained by drainage channels to the east and west of the site and the upgradient road to the south, such that all run-on and runoff is directed to Cañon de Valle. Because the Phase II confirmation samples cover the majority of the MDA P Site, including locations beyond the historic and current natural boundaries of the site, the lateral extent of residual contamination related to the MDA P Site has been sufficiently defined; i.e., locations subject to potential contamination from either historic use or historic transport processes have been appropriately captured by the confirmation sampling. Additionally, because the depth of the confirmation sampling extends well below the residual contamination in the soil and tuff of the MDA P Site, the vertical extent of contamination is sufficiently defined.

2.5.2.2 Potential Exposure to Human and Ecological Receptors

Potential, complete exposure pathways from COPCs in surface soil and tuff include inhalation of fugitive dust and direct exposure to soil and tuff via dermal contact or incidental ingestion. Potential exposure pathways due to COPCs in subsurface soil and tuff would be complete only if contaminated soil or tuff were excavated and brought to the surface, in which case the potential exposure pathways would be similar to surface soil exposures. Weathering of tuff is the only viable natural process that may result in the exposure of receptors to COPCs in tuff; because of the slow rate of weathering expected for tuff, exposure to COPCs in this medium is negligible.

Because no surface water currently exists at the site and excavation activities resulted in the elimination of all potential near-saturated and ponded water sources at the surface, potential human health exposure pathways due to surface water (dermal and ingestion) are incomplete and are not evaluated. Groundwater is eliminated as a potentially contaminated medium underneath the MDA P Site because no surface-to-groundwater pathway exists. Thus, pathways to the regional aquifer, which is located approximately 1200 ft below the site, are incomplete and are not evaluated.

The exposed tuff zone currently contains surface anomalies (e.g., depressions or cracks in the tuff) that provide isolated and discontinuous microsites with a tendency to accrete fine materials/deposits that can become microhabitats for plants. Thus, some isolated plants can be found growing within the exposed tuff zone. Use of the exposed tuff zone for foraging or other activities by the animal receptors that may potentially inhabit areas proximal to the MDA P Site is not expected.

As agreed upon by the Laboratory with the NMED and EPA Region 6 (LANL 2002, 73791), the exposed tuff area of the site does not require a quantitative ecological risk assessment including generation and review of hazard quotients (HQs). The “preferred approach is a qualitative ecological risk assessment” consisting of a written discussion documenting that the various exposure pathways are not complete in this area of the site. In summary, COPCs in the tuff are generally immobilized and become available to receptors only as a function of the slow rates of weathering of the tuff. Vegetation, though present in some microsites, is sparse and does not have contact with COPCs to the degree that population-level effects occur. Also, the vegetation is not present in sufficient quantities to result in substantial uptake through the food chain and it is unlikely that use or foraging by ecological receptors occurs because of the unsuitable habitat. Therefore, the contact that wildlife receptors might have with COPCs in the exposed tuff zone does not drive population-level effects in the wildlife receptors. Thus, there are no complete pathways in the exposed tuff zone and the exposure of receptors to COPCs in this zone is not evaluated quantitatively.

The remaining area of the MDA P Site footprint, which is yet undisturbed or has been reseeded/reclaimed, currently supports grasses and plants that may be used as forage by ecological receptors. The relatively shallow depth of the soil in the reclaimed footprint area (an average depth of approximately 2 ft, though as deep as approximately 5 ft in some locations near the east and west perimeters of the site) precludes deep-rooted plants and all but investigative burrowing activities by fossorial mammals (see Ecological Scoping Checklist, Attachment 1 to Appendix A). Complete exposure pathways for ecological receptors to COPCs in the surface soil and tuff in the biological zone include: uptake by plants; ingestion and dermal pathways for animal receptors; and potential food web transfer.

As with the exposure pathways for human receptors, pathways related to the exposure of ecological receptors to COPCs in surface water at the site are incomplete because no surface water currently exists at the site and excavation activities resulted in the elimination of all potential near-saturated and ponded water sources at the surface. Additionally, groundwater is eliminated as a potentially contaminated

medium underneath the MDA P Site because no surface-to-groundwater pathway exists; thus, pathways to the regional aquifer, which is located approximately 1200 ft below the site, are incomplete for ecological receptors at the MDA P Site.

2.5.3 Screening Assessment Summaries

As detailed in Appendix A, screening assessments are performed for all inorganic COPCs that are determined to be greater than background concentrations (LANL 1998, 59730) in the confirmation sample data sets for the biological and exposed tuff zones. Organic chemicals detected in more than 5% of the confirmation samples (EPA 1989, 08021) are designated COPCs, and evaluated for potential risk to human and ecological receptors. No radionuclides are identified as COPCs for the MDA P Site based on a comparison of detected radionuclide activities to the Laboratory BVs. For the biological zone, the background comparison divides the data into samples taken from soil and those taken from tuff because the BVs are matrix-specific. No such division is necessary for the samples collected from the exposed tuff zone because all samples are designated as tuff. The Phase II confirmation samples, as used in the risk assessments (i.e., biological vs. exposed tuff and soil matrix vs. tuff), are shown in Figure 2.5-1. The sample locations on Figure 2.5-1 are shown in the center of the grids from which they were collected because the assumption in the sample collection methodology and the risk assessments is that the entire grid cell is represented/characterized by the within-grid samples.

The COPCs identified for the MDA P Site, for both the biological zone and the exposed tuff zone, are summarized in Appendix A, Table 3.2.4-1. The inorganic chemicals are categorized by matrix type for the biological zone because the BVs used to determine COPCs are matrix-specific.

A total of 16 inorganic chemicals are retained as COPCs for further evaluation for the MDA P Site. Six inorganic chemicals are identified as COPCs for the biological zone soil (barium, cobalt, copper, lead, silver, and zinc). Twelve inorganic chemicals are identified as COPCs for the biological zone tuff (aluminum, antimony, barium, chromium, cobalt, copper, iron, lead, nickel, selenium, vanadium, and zinc). Fifteen inorganic chemicals are identified as COPCs for the exposed tuff zone (aluminum, antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, perchlorate, selenium, vanadium, and zinc).

A total of 12 organic chemicals are retained as COPCs for further evaluation for the MDA P Site. Ten organic chemicals are identified as COPCs for the biological zone (acetone, amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], Aroclor-1260, bis(2-ethylhexyl)phthalate, DDT[4,4'-], HMX, RDX, toluene, and trinitrotoluene[2,4,6-]). Nine organic chemicals are identified as COPCs for the exposed tuff zone (amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], bis(2-ethylhexyl)phthalate, carbon disulfide, HMX, RDX, toluene, trinitrobenzene[1,3,5-], and trinitrotoluene[2,4,6-]).

No radionuclides are identified as COPCs for the MDA P Site.

2.5.3.1 Human Health Screening Analysis

The MDA P Site exists within the active, operational area of TA-16 and lies entirely on DOE land. The site is isolated from public access by a security fence and security checkpoints. Based on the current and proposed future land use, the site will remain under Laboratory control and will continue to be used for industrial purposes. Potential human exposure pathways include inhalation of airborne particles, incidental ingestion of surface soil or tuff, and dermal contact with surface soil or tuff. The potential on-site receptors for both current and reasonably foreseeable future land use are Laboratory employees, for both industrial and recreational land uses. However, for this screening assessment, residential land use is assumed, to support closure certification and corrective action decisions.

The screening assessment is a comparison of COPC concentrations with SALs. SALs were calculated based on the methodology provided in Appendix C of the approved IWP (LANL 1998, 62060) and LANL (2002, 72639). The methodology is based on guidance from EPA Region 6 and NMED (EPA 2001, 71466; NMED 2000, 68554). The SALs used in the screening evaluation reflect a residential exposure scenario, assuming exposure for 24 hr/day for 350 days/year. The SAL comparison is presented separately for noncarcinogenic and carcinogenic chemicals. The SALs for noncarcinogens are based on a hazard quotient (HQ) of 1.0. SALs for carcinogens are based on a target cancer risk of 10^{-6}. The comparison is based on the 95% upper confidence limit (UCL) of the mean concentration of each COPC, as measured in samples collected from 0 to 5 ft. The statistical evaluations are provided in Appendix A, section 3.2. If a chemical is a COPC for either zone (biological or exposed tuff), it is assumed to be a COPC for the entire MDA P Site. Thus, the data sets defining the 95% UCL concentrations for comparison to human health SALs include all sample locations and both soil and tuff matrices, regardless of whether the samples were from the biological or exposed tuff zone.

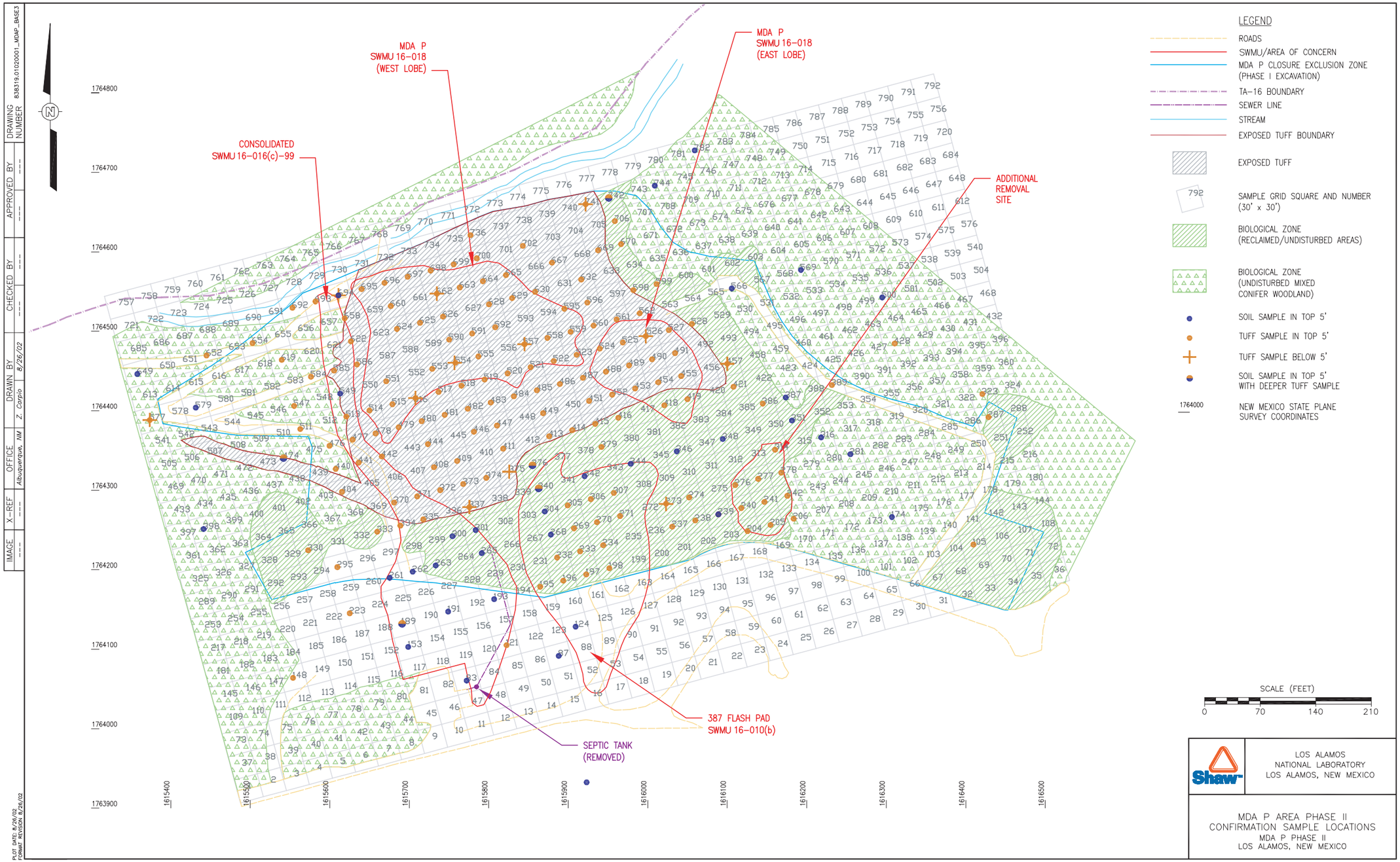

Figure 2.5-1. MDA P Site Phase II sample locations used in the risk assessment

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2.5.3.1.1 Screening Results

Barium and iron are the only noncarcinogens for which the 95% UCL concentrations exceed the 0.1 SAL (Table 2.5-2). The sum of the ratio of each COPC (calculated as the 95% UCL concentration divided by the respective SAL; i.e., the hazard index [HI]) was less than unity (0.8). This indicates that a potential human health hazard is not expected from exposure to co-located noncarcinogenic COPCs at the MDA P Site.

None of the carcinogenic COPCs have a 95% UCL concentration above their respective SALs (Table 2.5-3) and are less than the NMED target risk level of 10^{-5} (NMED 2000, 68554). The cumulative cancer risk for the entire site was 6×10^{-7}. Therefore, exposure in the MDA P Site does not result in a potential unacceptable risk to human receptors.

Table 2.5-2
Comparison of Noncarcinogenic COPCs with SALs (0–5 ft)

Analyte	95% UCL[a] (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Inorganic Chemicals			
Aluminum	6050	7400	74,000
Antimony	0.41	3	30
Barium	**534**[b]	520	5200
Beryllium	0.83	15	150

Table 2.5-2 (continued)

Analyte	95% UCL[a] (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Inorganic Chemicals (continued)			
Cobalt	5.35	450	4500
Copper	6.71	280	2800
Iron	**10,335**	2300	23,000
Lead	9.67	40	400
Mercury	0.02	0.65	6.5
Nickel	4.50	150	1500
Perchlorate	0.03	0.78	7.8
Selenium	0.25	38	380
Silver	0.54	38	380
Vanadium	9.52	53	530
Zinc	49.0	2300	23,000
Organic Chemicals			
Acetone	0.10	160	1600
Amino-2,6-dinitrotoluene[4-][c]	0.15	6.1	61
Amino-4,6-dinitrotoluene[2-][c]	0.16	6.1	61
Aroclor-1260	0.034[d]	0.11	1.1
Carbon disulfide	0.01	36	360
HMX	0.95	310	3100
Toluene	0.005	18	180
Trinitrobenzene[1,3,5-]	0.14	180	1800

[a] 95% UCL = 95% upper confidence limit of the mean.
[b] Values in bold indicate SAL or 0.1 SAL exceeded by 95% UCL.
[c] 2,6-Dinitrotoluene SAL was used as a surrogate (EPA 2001, 71466).
[d] Data set had <10 samples; 95% UCL could not be calculated; maximum value used.

Table 2.5-3
Comparison of Carcinogenic COPCs with SALs (0–5 ft)

Analyte	95% UCL[a] (mg/kg)	SAL (mg/kg)
Aroclor-1260	0.034[b]	0.22
Bis(2-ethylhexyl)phthalate	0.20	35
Chromium, total	5.28	210
DDT[4,4'-]	0.0035[b]	1.7
RDX	1.89	4.1
Trinitrotoluene[2,4,6-]	0.14	16

[a] 95% UCL = 95% upper confidence limit of the mean.

[b] Data set had <10 samples; 95% UCL could not be calculated; maximum value used.

An additional human health risk analysis is performed to account for potential exposure to a limited area of high COPC concentrations. A residential lot of 5400 ft^2 (~600 m^2) is used to represent the limited potential exposure area. A residential lot is selected for both the biological and exposed tuff zones to be consistent with the locations of highest residual barium concentrations (the risk driver for the site). Figure 2.5-2 shows the barium contour and lot layouts for the additional human health risk analysis. The inorganic chemical concentrations are compared to the corresponding BVs for each residential lot. Inorganic chemicals less than the BVs are not evaluated for each lot. Organic chemicals that were not detected within a lot are not evaluated for that lot.

Among the noncarcinogenic COPCs in the biological zone residential lot, only barium has a 95% UCL concentration greater than one-tenth the respective SAL but less than the SAL (Table 2.5-4), similar to the initial screening results. The sum of the ratio of each COPC exposure calculated as the 95% UCL concentration divided by the respective SAL is less than unity (0.4), indicating that a human health hazard is not expected from exposure to co-located noncarcinogenic COPCs in the biological zone lot.

One of the carcinogenic COPCs (RDX) has a 95% UCL concentration above the SAL (Table 2.5-5). The cumulative cancer risk from exposure to carcinogenic COPCs in the biological zone residential lot is approximately 4×10^{-6}, which is less than NMED's target risk level of 10^{-5} (NMED 2000, 68554). Therefore, the residential lot in the biological zone does not pose a potential unacceptable risk to human receptors.

Table 2.5-4
SAL Comparison to 95% UCL Concentrations of Noncarcinogens—
Biological Zone: 5400 ft^2 Residential Lot (0–5 ft)

Analyte	95% UCL[a] (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Inorganic Chemicals			
Barium	**1584**[b]	520	5200
Copper	12.73	280	2800
Lead	21.8	40	400
Selenium	0.31	38	380
Silver	0.68	38	380
Zinc	58.6	2300	23,000
Organic Chemicals			
Amino-2,6-dinitrotoluene[4-][c]	0.51	6.1	61
Amino-4,6-dinitrotoluene[2-][c]	0.55	6.1	61
HMX	8.03	310	3100

[a] 95% UCL = 95% upper confidence limit of the mean.

[b] Values in bold indicate SAL or 0.1 SAL exceeded by 95% UCL.

[c] 2,6-Dinitrotoluene SAL was used as a surrogate (EPA 2001, 71466).

Table 2.5-5
SAL Comparison to 95% UCL Concentrations of Carcinogens—
Biological Zone 5400 ft ^{2} Residential Lot (0–5 ft)

Analyte	95% UCL[a] (mg/kg)	SAL (mg/kg)
Bis(2-ethylhexyl)phthalate	0.26	35
RDX	**17.7**[b]	4.4
Trinitrotoluene[2,4,6-]	0.27	16

[a] 95% UCL = 95% upper confidence limit of the mean.
[b] Values in bold indicate SAL exceeded by the 95% UCL.

Among the noncarcinogenic COPCs in the exposed tuff zone residential lot, aluminum, barium, and iron have 95% UCL concentrations greater than one-tenth their respective SALs (Table 2.5-6). The sum of the ratio of each COPC exposure calculated as the 95% UCL concentration divided by the respective SAL slightly exceeded unity (1.7). However, approximately one-half of the sum is due to iron, which is an essential nutrient. The iron 95% UCL concentration (16,404 mg/kg) is less than the maximum tuff background concentration (19,500 mg/kg) and slightly above the tuff BV of 14,500 mg/kg (LANL 1998, 59730). None of the noncarcinogenic COPCs exceed the SAL at the 95% UCL concentration.

RDX is the only carcinogenic COPC with a 95% UCL concentration above its respective SAL (Table 2.5-7). The cumulative cancer risk from exposure to carcinogenic COPCs for the exposed tuff zone residential lot is 1.2×10^{-6}, which is less than NMED's target risk level of 10^{-5} (NMED 2000, 68554). Therefore, the residential lot for the exposed tuff zone does not pose a potential unacceptable risk to human receptors.

Table 2.5-6
SAL Comparison to 95% UCL Concentrations of Noncarcinogens in
Exposed Tuff Zone, 5400 ft^2 Residential Lot (0–5 ft)

Analyte	95% UCL (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)
Aluminum	**10,415**[a]	74,000	7400
Amino-2,6-dinitrotoluene[4-][b]	0.27	61	6.1
Amino-4,6-dinitrotoluene[2-][b]	0.34	61	6.1
Antimony	0.50	30	3
Barium	**3834**	5200	520
Beryllium	1.75	150	15
Cobalt	45.6	4500	450
Copper	6.9	2800	280
HMX	1.6	3100	310
Iron	**16,404**	23,000	2300
Nickel	5.68	1500	150
Selenium	0.49	380	38
Trinitrobenzene[1,3,5-]	0.1	1800	180
Vanadium	14.4	530	53
Zinc	50.7	23,000	2300

[a] Values in bold indicate SAL or 0.1 SAL exceeded by 95% UCL.
[b] 2,6-Dinitrotoluene SAL was used as a surrogate (EPA 2001, 71466).

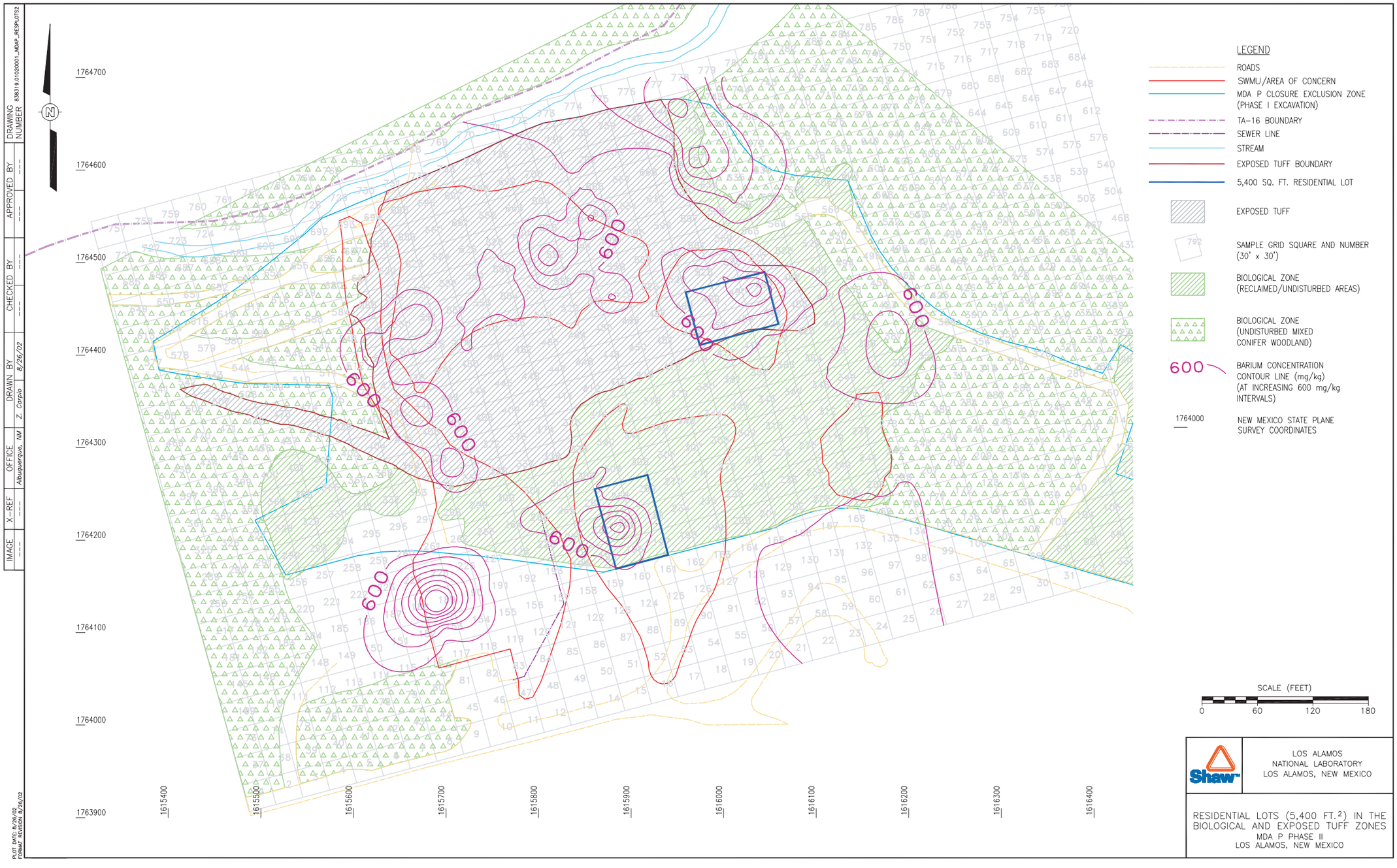

Figure 2.5-2. Residential lots (5400 ft^2) in the biological and exposed tuff zones

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Table 2.5-7
SAL Comparison to 95% UCL Concentrations of Carcinogens in Exposed Tuff Zone 5400 ft^2 Residential Lot (0–5 ft)

Analyte	95% UCL (mg/kg)	SAL (mg/kg)
Chromium	7.8	210
RDX	**5.63**[a]	4.4
Trinitrotoluene[2,4,6-]	0.15	16

[a] Values in bold indicate SAL exceeded by 95% UCL.

PRG Comparison of SAL Exceedances. The MDA P closure plan (LANL 1995, 58713) indicated that the closure certification report would provide a "PRG comparison of the Phase II grid confirmatory analytical results that exceeded SALs." The intent of this comparison is to determine whether the operational PRGs had been met during Phase I excavation and removal activities, even if SALs were exceeded in some samples. Some samples exceeded the SALs of the two chemicals for which operational PRGs were used to determine cleanup levels during Phase I: barium and RDX. The operational PRG of 2000 mg/kg for barium was exceeded in four grid cells (006, 232, 670, 742), and the operational PRG of 16 mg/kg for RDX was exceeded in three grid cells (232, 306, and 670). However, the risk screening results presented indicate that residual concentrations of barium and RDX, both for the site as a whole and smaller areas with elevated barium or RDX concentrations, do not present a potential unacceptable risk to human health.

2.5.3.1.2 Uncertainty Analysis

The analysis presented in the human health screening assessments is subject to varying degrees and kinds of uncertainty. Aspects of data evaluation and COPC identification, exposure assessment, toxicity assessment, and the additive approach all contribute to uncertainties in the risk assessment process.

(a) Data Evaluation and COPC Identification Process

A primary uncertainty associated with the COPC identification process (as presented in Appendix A) is the possibility that a chemical may be inappropriately identified as a COPC. It is unlikely that inorganic chemicals are inappropriately excluded as COPCs because the only detected inorganic chemicals excluded are those determined to be less than the associated BV or those with data sets not significantly different than background. Aluminum and iron in the exposed tuff zone residential lot and iron in the site-wide comparison have 95% UCL concentrations greater than 0.1 of the respective SAL, but less than the SAL. Concentrations measured in soil and tuff at the MDA P Site for these two inorganic chemicals are not a potential risk for human health for two reasons: (1) the high values for these inorganic chemicals are in the tuff and are, thus, unavailable for exposure; and (2) the 95% UCL concentrations are within the range of soil and tuff background concentrations (LANL 1998, 59730), indicating that exposure to site-wide or residential lot concentrations is similar to background. Also, iron is an essential nutrient for which concentrations in soil would need to be substantially higher than background before they become a concern to human health. Thus, HI values calculated for the whole area and the residential lots are primarily due to barium and are less than 1.0.

It is unlikely that organic chemicals are inappropriately excluded as COPCs because the only detected organic chemicals not retained for analysis are those that were detected in less than 5% of the confirmation samples, per EPA guidance (EPA 1989, 08021).

Uncertainties associated with the organic and inorganic chemical data include sampling errors, laboratory analysis errors, and data analysis errors. For the MDA P Site, these uncertainties are expected to have little effect on the results even though many detected concentrations of organic COPCs were qualified J, indicating that the values are less than EQLs and can only be estimated.

(b) Exposure Assessment

Three main uncertainties are identified in the exposure assessment process:

1. *Identification of Receptors*. The human health screening evaluation is a conservative comparison of the 95% UCL concentration with SALs based upon a residential land-use scenario. To the degree that actual activity patterns are not represented by those activities assumed by the residential land-use scenario, uncertainties are introduced in the assessment. Because the potentially exposed individual is an industrial worker, the screening assessment based on a residential scenario overestimates the exposure and, therefore, the potential hazard and risk to human receptors. If, however, future land use becomes residential, the assessment appropriately addresses potential human health risks.

2. *Exposure Pathway Assumptions*. A number of assumptions are made relative to exposure pathways, including: input parameters, whether or not a given pathway is complete, the actual media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with EPA-approved parameters and default values (EPA 2001, 71466). When several upper-bound values (as are found in EPA 2001, 71466) are combined to estimate exposure for any one pathway, the resulting risk can exceed the 99th percentile of "expected risk" and therefore, exceed (overestimate) the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and cause exposure in the same manner as if they were in soil overestimates the potential risk to receptors. Therefore, the HI of 1.7 is an overestimation of the potential hazard at the site within the exposed tuff zone.

3. *Derivation of Exposure Point Concentrations*. Some uncertainty is introduced in the concentration aggregation of data for estimating the representative COPC concentrations (95% UCL) at the site. Risk from a single location or area with relatively high COPC concentrations may be "diluted" by using a representative, site-wide value. This is considered the single, largest uncertainty that may result in the underestimation of potential risk to human receptors. Thus, an additional analysis based on locations with high concentrations of barium (the only COPC to exceed 0.1 SAL in both zones) is performed to address this uncertainty. The use of the 95% UCL is intended to provide a protective, upper bound (e.g., conservative) on the average COPC concentration at the site, which is more likely to lead to an overestimation of the concentration representative of average exposure to a COPC across the entire site.

(c) Toxicity Assessment

The primary uncertainty associated with the SALs is related to the derivation of toxicity values used in their calculation. EPA toxicity values (reference doses [RfDs] and slope factors [SFs]) are used to derive the SALs used in this risk screening assessment (EPA 2001, 70109; EPA 1997, 58968). Uncertainties are identified in three areas with respect to the toxicity values: (1) extrapolation from animals to humans, (2) extrapolation from one route of exposure to another route of exposure, and (3) individual variability in the human population.

1. *Extrapolation from Animals to Humans*. The SFs and RfDs are often determined based on extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. The EPA takes into account differences in body weight, surface

area, and pharmacokinetic relationships between animals and humans to address these uncertainties in the dose-response relationship; however, conservatism is usually incorporated in each of these steps, resulting in the overestimation of potential risk.

2. *Extrapolation from One Route of Exposure to Another Route of Exposure*. The SFs and RfDs often contain extrapolations from one route of exposure to another that result in additional conservatisms in the risk calculations. For example, an extrapolation from the oral route to the inhalation and/or the dermal route was used in this assessment (EPA 2001, 71466) and differences between the two exposure pathways contribute to the uncertainty in the estimation of potential risk at this site.

3. *Individual Variability in the Human Population*. For noncarcinogenic effects, the degree of variability in human physical characteristics is important both in determining the risks that can be expected at low exposures and in defining the no-observed-adverse-effect level (NOAEL). The NOAEL uncertainty factor approach incorporates a 10-fold factor to reflect individual variability within the human population that can contribute to uncertainty in the risk assessment; this factor of 10 is generally considered to result in a conservative estimate of risk to noncarcinogenic COPCs.

(d) Additive Approach

For noncarcinogens, the effects of exposure to multiple chemicals are generally unknown and possible interactions could be synergistic or antagonistic, resulting in either an overestimation or underestimation of the potential risk. Additionally, RfDs used in the risk calculations typically are not based on the same endpoints with respect to severity, effects, or target organs. Therefore, the potential for noncarcinogenic effects can be overestimated for individual COPCs that act by different mechanisms and on different target organs but are addressed additively.

2.5.3.1.3 Interpretation of Results

Overall, the uncertainties associated with the evaluation of human health risks to residual concentrations of COPCs in the soil and tuff of the MDA P Site overestimate potential risk to human receptors. A detailed analysis of risk from exposure at locations with high concentrations of barium (the main risk driver at the site), indicate that no potential unacceptable risk to human health exists in either the biological or exposed tuff zone.

The noncarcinogenic HI values range from 0.8 (site-wide) to 1.7 (exposed tuff zone) based on 95% UCL concentrations; none of the individual COPCs exceeded an HQ of 1.0. Approximately half of the HI of 1.7 (0.7) results from iron, which is an essential nutrient and has a 95% UCL within the range of background concentrations. In addition, COPCs in this lot are in the tuff, so exposure is unlikely; the HI for the exposed tuff zone residential lot overestimates the potential hazard to receptors. Given the uncertainties and the overestimation of the hazard, the HIs for the site and for the residential lots do not exceed NMED's target HI of 1.0 (NMED 2000, 68554) and do not pose a potential hazard to human health.

Concentrations of carcinogenic COPCs are less than their respective SALs. The incremental excess cancer risk range from 6×10^{-7} (site-wide risk) to 4×10^{-6} (residential lot risk). The risk levels are below the NMED target cancer risk level of 10^{-5} (NMED 2000, 68554). Therefore, the site as a whole and the residential lots within each zone do not pose a potential unacceptable risk to human health.

2.5.3.2 Human Health Assessment Summary

The analysis of potential human health risk from the MDA P Site COPCs provides strong evidence that there are no adverse effects from residual concentrations of COPCs. Multiple conservatisms were used in the human health risk assessment that, in combination, lead to overestimations of potential risk, rather

than underestimations. The key assumption/uncertainty that may have resulted in an underestimation of potential risk was the use of site-wide COPC concentrations (95% UCLs) to evaluate risk. However, a detailed analysis of potential risk from exposure at locations representing residential lots with high concentrations of barium (the main risk driver for human health at the site) did not change the initial results based on side-wide concentrations—that there are no adverse effects to human receptors from residual concentrations of COPCs at the MDA P Site.

A detailed human health risk analysis is not required for the MDA P Site because the screening results indicate that there are no potential unacceptable human health risks due to the residual concentrations of COPCs in soil and tuff at the MDA P Site.

2.5.3.3 Ecological Screening Analysis

Because potentially complete exposure pathways exist for COPCs in the biological zone, the following eight terrestrial receptors are evaluated quantitatively in the ecological screening assessment for the biological zone, representing several feeding guilds and trophic levels:

- a plant,
- soil-dwelling invertebrates (represented by the earthworm),
- deer mouse (mammalian omnivore),
- vagrant shrew (mammalian insectivore),
- desert cottontail (mammalian herbivore),
- fox (mammalian carnivore),
- American robin (avian insectivore, omnivore, and herbivore), and
- American kestrel (avian insectivore and carnivore); a surrogate for avian threatened and endangered (T&E) species.

Of the terrestrial receptors evaluated, only the vagrant shrew is not expected to be of concern for the MDA P Site because it requires free water for survival—a medium that does not exist at the site and that has been eliminated from consideration as a potential exposure medium for the MDA P Site footprint. However, because the shrew represents the insectivorous feeding guild for mammals, which is not specifically represented by any of the other terrestrial receptors, the shrew was retained for the MDA P Site screening assessment.

As described in section 2.5.2.2, a quantitative analysis of ecological risk is not performed for the exposed tuff zone, as agreed upon with the NMED and EPA Region 6 (LANL 2002, 73791). The basis for this approach is that exposure pathways are incomplete in this area of the site.

2.5.3.3.1 Screening Results

The screening assessment is a comparison of 95% UCL concentrations with ESLs for each COPC, resulting in a HQ. The comparison is based on the 95% UCL of the mean concentration of each COPC identified for the biological zone, as measured in soil and tuff samples taken from 0 to 5 ft. The higher the contaminant levels relative to the ESLs, the higher the potential risk to receptors; conversely, the higher the ESLs relative to the contaminant levels, the lower the potential risk to receptors. HQs greater than 0.3 are identified as chemicals of potential ecological concern (COPECs) requiring additional evaluation (LANL 1999, 64783). The hazard index (HI) is the sum of HQs; an HI greater than 1.0 is considered an indication of potential adverse impacts to a given receptor from exposure to multiple chemicals at a site.

The HQ/HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential of overlooking possible COPECs at the site (LANL 1999, 64783).

ESLs are obtained from the Laboratory's ECORISK database version 1.4 (LANL 2002, 72802), as presented in Appendix A, Table 4.3.2-1. All COPCs identified for the biological zone, with the exception of nickel and lead, require further evaluation because one or more HQ exceed 0.3 or because no ESL is available for one or more of the receptors for a given COPC (Table 2.5-8). Nickel and lead are eliminated as COPECs because all receptors have an associated ESL and all HQs are less than 0.3. All other chemicals are discussed in detail below in the problem formulation.

As presented in Table 2.5-8, HI values for the terrestrial receptors range from 1.75 for the top carnivore American kestrel to 464 for the plant. Per EPA guidance (EPA 2000, 73306), aluminum "is identified as a COPC only at sites where the soil pH is less than 5.5." pH levels measured in confirmation samples from the MDA P Site range from 5.8 to 7.4 in tuff and 6.8 to 7.6 in soil, indicating that aluminum at the MDA P Site is unavailable to ecological receptors. With aluminum eliminated, barium and cobalt are the primary contributors to the HI values for each receptor, while vanadium and DDT[4,4] also contribute to the HI for some receptors.

2.5.3.3.2 Problem Formulation

This section provides an evaluation of the initial screening assessment results in the context of assumptions and conservatisms used in the screening process, in order to determine whether or not the results are ecologically meaningful and if additional analysis is required beyond the screening assessment. Table 2.5-8 shows the COPCs that fail the initial screening.

(a) Inorganic COPCs

A number of the HQs determined for inorganic chemicals are not ecologically meaningful estimations of potential risk because the ESLs are below the soil and tuff BVs. Therefore, the HQ/HI analysis was performed again after removing ESLs below the associated soil BV from the analysis (Table 2.5-9, see "NC" entries). All of the inorganic COPCs, except for barium, have seven or fewer detections in soil above the soil BV, indicating that the residual concentrations of inorganic chemicals in the biological zone are in the tuff and are inaccessible to receptors. In addition, the 95% UCL concentrations determined for all inorganic COPCs, except for barium, cobalt, and copper, are within the range of the background concentrations for soil and tuff, indicating that exposure to the representative site concentrations for inorganic COPCs is similar to background. As a result, the majority of the inorganic COPCs (except barium) are not retained as COPECs.

Table 2.5-8
HQ/HI Summary for COPCs in Biological Zone

Analyte	95% UCL[a] 0–5 ft (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Antimony	4.10E-01	**8.20E+00**[b]	—[c]	—	—	—	—	—	6.61E-02	**4.14E-01**	**7.19E-01**	4.20E-03
Barium	6.56E+02	**6.56E+00**	—	**2.50E+00**	**1.73E+00**	**6.56E-01**	1.43E-02	**3.86E-01**	**1.93E+01**	**1.46E+02**	**2.73E+02**	**1.56E+00**
Chromium	5.95E+00	**2.48E+00**	**4.25E+00**	1.29E-02	1.08E-02	8.80E-03	5.00E-04	1.10E-03	7.00E-04	2.80E-03	8.50E-03	3.00E-04
Cobalt	4.18E+00	**1.67E+01**	—	**8.20E+01**	**4.50E+01**	**9.09E+00**	**6.97E-01**	**1.10E+01**	**8.36E-01**	**2.20E+01**	**4.59E+01**	**4.18E-01**
Copper	7.60E+00	**7.60E-01**	**5.85E-01**	1.96E-02	2.45E-02	2.92E-02	3.00E-04	2.30E-03	2.53E-02	4.47E-02	4.47E-02	9.00E-04
Iron	1.02E+04	—	—	—	—	—	—	—	—	—	—	—
Lead	1.04E+01	2.31E-02	5.20E-03	1.89E-01	1.44E-01	1.04E-01	3.90E-03	2.08E-02	1.12E-02	4.73E-02	1.04E-01	2.30E-03
Nickel	4.65E+00	2.33E-01	4.65E-02	4.70E-03	3.90E-03	2.90E-03	1.00E-04	4.90E-04	5.91E-04	2.20E-03	5.19E-03	2.00E-04
Selenium	2.40E-01	**2.40E+00**	3.12E-02	2.18E-01	1.20E-01	2.40E-02	1.70E-03	2.86E-02	4.40E-03	1.26E-01	2.64E-01	2.20E-03
Silver	7.00E-01	**1.40E+01**	—	5.00E-02	3.68E-02	2.33E-02	2.93E-04	7.03E-03	**1.35E+00**	**5.00E+00**	**7.69E+00**	5.00E-02
Vanadium	1.02E+01	**4.08E+02**	—	**3.64E+00**	**2.00E+00**	**3.64E-01**	2.00E-02	**4.86E-01**	1.29E-02	**5.10E-01**	**1.06E+00**	6.78E-03
Zinc	5.37E+01	**5.37+00**	1.54E-01	**5.54-01**	**4.13E-01**	2.56E-01	1.10E-02	8.14E-02	4.89E-02	6.40E-05	7.57E-05	2.99E-05
Acetone	1.40E-02	—	—	3.33E-07	3.33E-06	6.36E-06	2.50E-09	4.52E-08	3.26E-03	3.68E-03	3.78E-04	—
Amino-2,6-dinitrotoluene[4-]	1.80E-01	2.25E-03	—	—	—	—	—	—	3.10E-02	5.00E-02	3.16E-02	1.94E-04
Amino-4,6-dinitrotoluene[2-]	1.82E-01	2.28E-03	—	—	—	—	—	—	2.17E-02	3.43E-02	2.19E-02	1.40E-04
Aroclor-1260	6.1E-02[d]	—	—	1.39E-01	7.09E-02	4.07E-03	2.77E-02	3.39E-02	9.24E-05	6.10E-03	1.22E-02	1.91E-03
Bis(2-ethylhexyl)phthalate	2.00E-01	—	—	2.00E-01	1.05E-01	8.70E-03	1.18E-01	8.70E-02	5.56E-05	3.28E-03	6.67E-03	3.13E-03
DDT[4,4'-]	7.9E-03[d]	2.14E-03	—	**3.04E+00**	**1.52E+00**	6.58E-02	**8.59E-01**	**8.49E-01**	3.95E-05	3.76E-03	7.90E-03	1.72E-03
HMX	1.33E+00	—	2.66E-03	—	—	—	—	—	2.61E-02	3.09E-02	5.12E-03	3.59E-05
RDX	2.37E+00	2.37E-02	4.74E-03	—	—	—	—	—	2.16E-01	2.58E-01	7.18E-02	4.82E-04

Table 2.5-8 (continued)

Analyte	95% UCL 0–5[a] (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Toluene	3.30E-03	1.65E-05	—	—	—	—	—	—	2.06E-05	4.52E-05	4.71E-05	2.75E-07
Trinitro-toluene[2,4,6-]	1.80E-01	2.57E-01	2.57E-01	—	—	—	—	—	2.34E-03	3.40E-03	1.80E-03	1.13E-05
HI		**4.64E+02**	**5.34E+00**	**9.29E+01**	**5.11E+01**	**1.06E+01**	**1.75E+00**	**1.30E+01**	**2.19E+01**	**1.74E+02**	**3.29E+02**	**2.05E+00**

[a] 95% UCL = 95% upper confidence limit of the mean.
[b] Value in bold indicates HQ > 0.3 or an HI > 1.0.
[c] — = ESL not available.
[d] 95% UCL could not be calculated; maximum detection was used.

Table 2.5-9
HQ/HI Summary of COPCs with Elimination of ESLs Less Than Background—Biological Zone

Analyte	95% UCL[a] (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Inorganic Chemicals												
Antimony	4.10E-01	NC[b]	—[c]	—	—	—	—	—	6.61E-02	**4.14E-01**[d]	NC	4.27E-03
Barium	6.56E+02	NC	—	NC	**1.72E+00**	**6.56E-01**	1.43E-02	**3.86E-01**	NC	NC	NC	**1.56E+00**
Chromium	5.95E+00	NC	NC	1.29E-02	1.08E-02	8.75E-03	4.58E-04	1.12E-03	7.44E-04	2.83E-03	8.50E-03	3.31E-04
Cobalt	4.18E+00	NC	—	NC	NC	NC	NC	NC	NC	NC	NC	**4.18E-01**
Copper	7.60E+00	NC	NC	1.95E-02	2.45E-02	2.92E-02	3.45E-04	2.30E-03	2.53E-02	4.47E-02	4.47E-02	8.54E-04
Iron	1.02E+04	—	—	—	—	—	—	—	—	—	—	—
Selenium	2.40E-01	NC	3.12E-02	NC	1.20E-01	2.40E-02	1.74E-03	2.86E-02	4.36E-03	1.26E-01	2.64E-01	2.18E-03
Silver	7.00E-01	NC	—	5.00E-02	3.68E-02	2.33E-02	2.92E-04	7.00E-03	NC	NC	NC	5.00E-02
Vanadium	1.02E+01	NC	—	NC	NC	NC	2.00E-02	NC	1.29E-02	NC	NC	6.80E-03
Zinc	5.37E+01	NC	1.54E-01	**5.54E-01**	**4.13E-01**	2.56E-01	1.10E-02	8.14E-02	4.89E-02	6.40E-05	7.57E-05	2.99E-05

Table 2.5-9 (continued)

Analyte	95% UCL[a] (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Organic Chemicals												
Acetone	1.40E-02	—	—	3.33E-07	3.33E-06	6.36E-06	2.50E-09	4.52E-08	3.26E-03	3.68E-03	3.78E-04	—
Amino-2,6-dinitrotoluene[4-]	1.80E-01	2.25E-03	—	—	—	—	—	—	3.10E-02	5.00E-02	3.16E-02	1.94E-04
Amino-4,6-dinitrotoluene[2-]	1.82E-01	2.28E-03	—	—	—	—	—	—	2.17E-02	3.43E-02	2.19E-02	1.40E-04
Aroclor-1260	6.1E-02[e]	—	—	1.39E-01	7.09E-02	4.07E-03	2.77E-02	3.39E-02	9.24E-05	6.10E-03	1.22E-02	1.91E-03
Bis(2-ethylhexyl)phthalate	2.00E-01	—	—	2.00E-01	1.05E-01	8.70E-03	1.18E-01	8.70E-02	5.56E-05	3.28E-03	6.67E-03	3.13E-03
DDT[4,4'-]	7.9E-03[e]	2.14E-03	—	**3.04E+00**	**1.52E+00**	6.58E-02	**8.59E-01**	**8.49E-01**	3.95E-05	3.76E-03	7.90E-03	1.72E-03
HMX	1.33E+00	—	2.66E-03	—	—	—	—	—	2.61E-02	3.09E-02	5.12E-03	3.59E-05
RDX	2.37E+00	2.37E-02	4.74E-03	—	—	—	—	—	2.15E-01	2.38E-01	7.18E-02	4.84E-04
Toluene	3.30E-03	1.65E-05	—	—	—	—	—	—	2.06E-05	4.52E-05	4.71E-05	2.75E-07
Trinitrotoluene[2,4,6-]	1.80E-01	2.57E-01	2.57E-01	—	—	—	—	—	2.34E-03	3.40E-03	1.80E-03	1.13E-05
HI		2.88E-01	4.49E-01	**4.01E+00**	**4.03E+00**	**1.08E+00**	**1.05E+00**	**1.48E+00**	4.58E-01	**9.77E-01**	4.76E-01	**2.05E+00**

[a] 95% UCL = 95% upper confidence limit of the mean.

[b] NC = HQ not calculated because the ESL is < the BV.

[c] — = ESL not available.

[d] Bold indicates HQ > 0.3 or an HI > 1.0.

[e] 95% UCL could not be calculated; maximum detection was used.

(b) Organic COPECs

Table 2.5-8 shows DDT[4,4'-] is the only organic chemical that fails the initial screening because of HQs greater than 0.3 (for the insectivorous and omnivorous robin and both kestrels). However, DDT[4,4'-] was detected in only one soil sample and had HQs of 3.0 or less, which are not expected to result in adverse population-level effects to the robin or kestrel. Therefore, DDT [4,4'-] is not retained as a COPEC for the biological zone.

Three organic chemicals (acetone, Aroclor-1260, and bis[2-ethylhexyl]phthalate) have ESLs for most or all of the wildlife receptors and all HQs are less than 0.3. Furthermore, these COPCs were detected in only one sample (acetone and Aroclor-1260) or eight samples (bis[2-ethylhexyl]phthalate). Because of the low number of detected concentrations, these COPCs are not expected to drive adverse population-level effects. All detected concentrations for these COPCs are at or below the maximum EQLs, indicating that only trace concentrations are present at the site. Although there are no ESLs for these COPCs for plants and invertebrates, the plants at the site are healthy. Because these organic chemicals are infrequently detected at low concentrations, and HQs for receptors with ESLs are less than 0.3, acetone, Aroclor-1260, and bis[2-ethylhexyl]phthalate are not retained as COPECs.

The remaining organic COPCs (amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], HMX, RDX, toluene, trinitrotoluene[2,4,6-]) have mammalian ESLs, but are lacking ESLs for the avian receptors and may also lack an ESL for either the plant or invertebrate. All HQs for the mammalian receptors are less than 0.3, and in many cases are at least an order of magnitude lower than 0.3; thus, there is no further evaluation warranted for the mammalian receptors. The plants observed at the site during a recent site visit (August 28, 2002) appeared healthy and no observable adverse effects to the flora were noted, indicating that plants are not being adversely affected by residual concentrations of COPCs in the biological zone and that no additional evaluations are required for the plants. If a ten-fold uncertainty factor were applied to the available mammalian ESLs and used to estimate avian HQs, the resulting HQs would be less than 1.0 for all avian receptors except for potential exposure to RDX, where the resulting HQs are greater than 1.0 but less than 5.0. Lastly, except for RDX, which was detected across the site in both soil and tuff, there are a limited number of detections of organic chemicals in soil, indicating that the residual concentrations of these organic chemicals in the biological zone are in the tuff. Because of the low number of detected concentrations in soil and given the time required for the weathering of the tuff to become an exposure medium for receptors, these organic chemicals in tuff are not expected to cause adverse population-level effects.

(c) Problem Formulation Summary

The COPECs barium and RDX warrant further site-specific evaluation in an ecological risk assessment. All other inorganic and organic chemicals identified as COPCs are eliminated as COPECs for the MDA P Site. COPCs in the tuff are not of concern for the receptors at the MDA P Site or in Cañon de Valle because the exposure pathways are incomplete. Future exposures to COPECs in tuff are directly related to the rate of weathering, which is slow and not likely to result in adverse ecological impacts.

Barium is retained for additional assessment because HQs indicate potential risk to all ecological receptors except the kestrel top carnivore (the surrogate for avian T&E receptors). RDX is also recommended for additional analysis because the avian receptors lack ESLs and estimated HQs based on assumptions related to available mammalian ESLs indicate that the potential risk to avian receptors could not be definitively eliminated.

2.5.3.4 Ecological Assessment Summary

Because the MDA P Site has been disturbed by the removal of contaminated waste, soil, and tuff, the site either does not have any suitable habitat for ecological receptors or is in the process of being re-established. Cañon de Valle has comparable COPECs at similar or higher concentrations than detected at the MDA P Site and is used to illustrate whether residual contaminant concentrations may pose potential adverse ecological effects at the MDA P Site.

The contaminant signatures and inventories in Cañon de Valle are expected to be the worst-case condition because the MDA P Site has been excavated and other sources of contaminant discharges to the canyon have been eliminated/remediated. Because of the source removal/remediation activities, contaminant concentrations will decline and inventories will dissipate with the continued influence of hydrologic processes in the canyon, thereby further decreasing potential ecological impacts from residual contamination at the MDA P Site. More details of the ecological assessment are provided in Appendix A.

The ecological assessment considers terrestrial effects for the MDA P Site and aquatic and terrestrial effects in the canyon. The data used to support this assessment include

- post-excavation Phase II confirmation sample data for the MDA P Site;
- sediment profile data collected in 1996 for the active channel in Cañon de Valle;
- overbank samples collected for the fluvial geomorphology characterization in 1999;
- water samples collected from April 1994 to March 1999;
- small mammal population and contaminant body burden data collected in 2001;
- sediment toxicity test results collected in 2001; and
- synoptic benthic macro-invertebrate community data collected in 1996 and 1997.

The data sources are subset to assess the MDA P Site impacts where these data extend substantially beyond the area of influence for the MDA P Site or where the data show concentration trends in the canyon that are not relevant to the MDA P Site.

The MDA P Site is one of several historic contaminant sources to Cañon de Valle and is not the dominant source. The 260 outfall [SWMU 16-021(c)-99] is the dominant source of contaminants for the canyon (LANL 1998, 59891). Additionally, MDA R (SWMU 16-019) and the silver outfall (SWMU 16-020), up-canyon from the MDA P Site, are also contributors of contaminants. Figures 2.5-3 and 2.5-4 show the down-canyon profile of barium concentrations for the overbank soils and the active channel sediments, including the location of the MDA P Site, downgradient of the 260 outfall. The zero distance is the location of the 260 outfall. The overbank plot shows five locations with elevated concentrations of barium between the 260 outfall and the MDA P Site. All the other overbank data show a lack of trend with location in the canyon. The active channel sediment plot includes a locally smoothed line fit to approximate and average barium concentration with location in the canyon. The active channel shows a barium concentration decline below the MDA P Site. Both plots show higher barium concentrations up-gradient of the MDA P Site reach. These plots indicate that the MDA P Site has not been, nor currently is, a major contributor of barium to the canyon. Other COPCs have similar patterns.

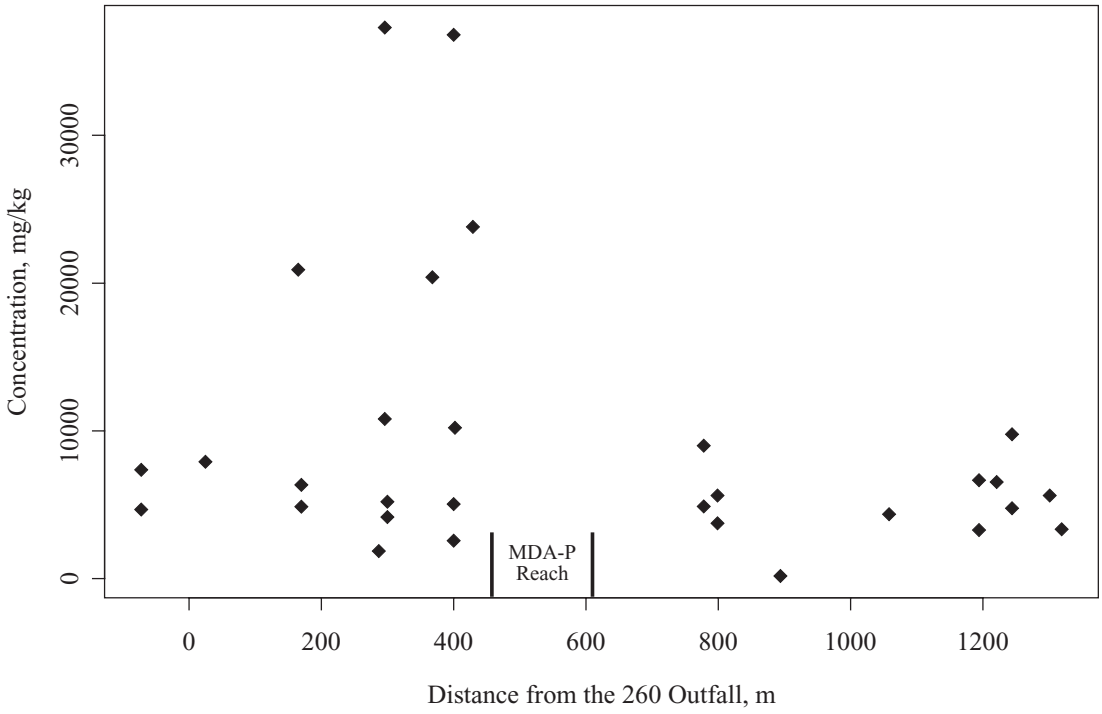


Figure 2.5-3. Down-canyon profile of barium concentrations for the overbank soils

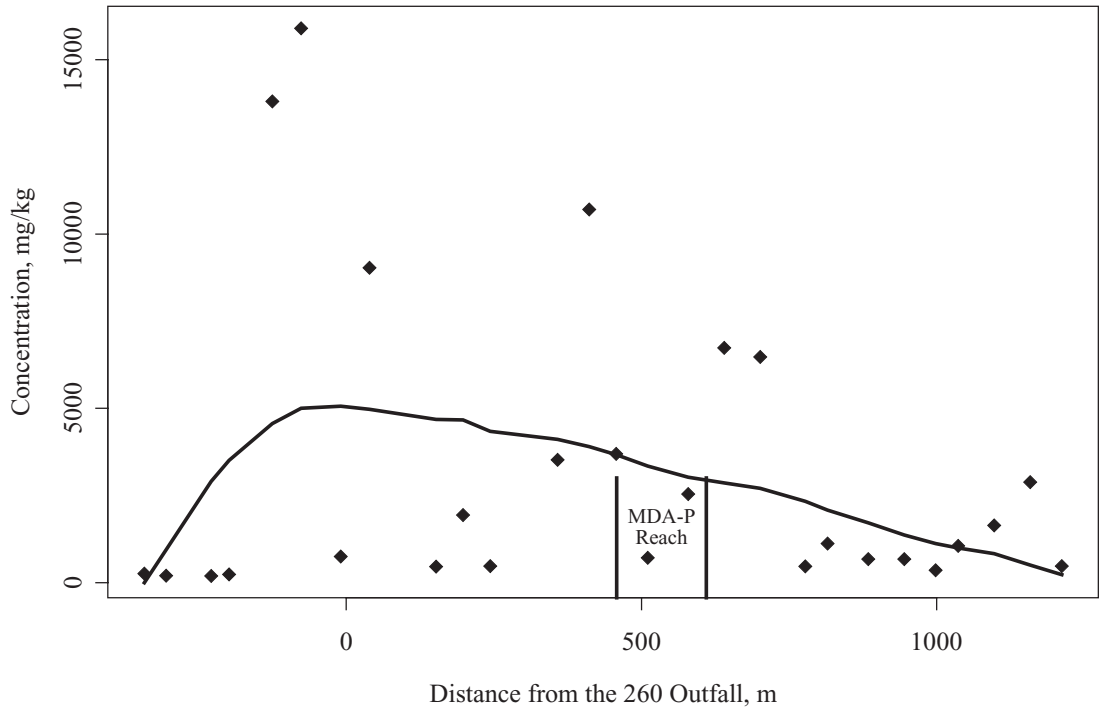


Figure 2.5-4. Down-canyon profile of barium concentrations for the active channel sediments

The COPC concentration patterns, as represented by the barium plots, indicate that ecological investigations for adverse effects in Cañon de Valle that include the reach below the MDA P Site are also useful for evaluating historic effects from the MDA P Site.

2.5.3.4.1 Identification of COPECs for Cañon de Valle Receptors

The identification of Cañon de Valle COPECs for terrestrial and aquatic receptors is described in Appendix A, section 5.3.2 and are summarized below.

- Six COPECs were identified in overbank soils that exceed the ESLs for terrestrial receptors: barium, silver, lead, copper, HMX, and RDX.
- Six COPECs were identified in water that exceeded the ESLs for aquatic receptors: aluminum, barium, cadmium, cobalt, manganese, and silver.
- Ten COPECs were identified in active channel sediments that exceeded the ESLs for aquatic receptors: barium, cobalt, copper, lead, silver, thallium, vanadium, di-n-butylphthalate, HMX, and RDX.

2.5.3.4.2 Cañon de Valle Field Studies Introduction

The environmental values, or assessment endpoints, to be protected for Cañon de Valle consist of features of the canyon relative to the surrounding landscape and the resident threatened species. Cañon de Valle is one of many canyons incised into the Pajarito Plateau. This canyon has a perennial spring and an alluvial seep in the vicinity of the TA-16 facilities. The presence of water in the canyon is ecologically important to the viability of many species in this semi-arid environment. Additionally, the canyon supports a multi-leveled overstory of mixed conifer, aspen, and oak, with grasses and forbs on overbanks and terraces. The combination of perennial water and diverse vegetation make the canyon a relatively attractive location for endemic fauna. The Mexican spotted owl, a threatened species, has a nesting site down-canyon from the MDA P Site and is likely to hunt in the canyon.

The following assessment endpoints were addressed in the focused Cañon de Valle assessment:

- community viability of small mammals as an indication of contaminant impacts upon maximally exposed taxa across trophic levels and foraging guilds in the terrestrial environment;
- contaminant concentrations in the food web as an indication of potential impacts to carnivores, including the Mexican spotted owl, a resident threatened species in the canyon, below the MDA P Site; and
- capacity of the perennial reach of the canyon to support an aquatic community as an indication of the extent to which contaminants have impaired sediment and water quality.

The specific measures of effects used to assess small mammal community viability and food web contaminant concentrations are

- number of small mammal species,
- population density estimates of small mammals,
- reproductive status classes for each small mammal species,
- small mammal body weights, and
- small mammal contaminant body burdens.

The specific measures of effects used to assess the capacity of the canyon's aquatic system to support an aquatic community are

- number of benthic macro-invertebrate species,
- presence of sensitive species,
- benthic macro-invertebrate community metrics,
- *Chironomus tentans* toxicity test survival, and
- *C. tentans* toxicity test growth.

(a) Terrestrial Study

Small mammal community is a practical choice for biota sampling for adverse terrestrial effects in Cañon de Valle. Small mammals reside in the canyon year-round and the populations are sufficiently abundant to provide multiple individuals for population estimates and to determine the amounts of contaminants taken up and stored by individuals in their body tissues, i.e., contaminant body burdens. Additionally, small mammals are dominant prey species for the carnivores active in the canyon, including the Mexican spotted owl. Contaminant body burden data from small mammals provides the information necessary to make direct estimates of contaminant intake by carnivores, obviating most of the assumptions in contaminant transfer models. Small mammals were collected from Cañon de Valle and Pajarito Canyon, the latter being a reference (i.e., uncontaminated) location. Pajarito Canyon was selected as the reference canyon based on its similarity to Cañon de Valle with respect to topography, elevation, water presence and quantity, vegetation, and burn severity from the Cerro Grande Fire in 2000. Trapping was conducted during May 2001 and again in September to October 2001. The lines of evidence evaluated are number of species, body weight, reproductive status classes for each species, population density estimates, and contaminant body burdens.

The trophic level of a small mammal species generally influences the rate of accumulation of contaminants relative to soil concentrations. Sample et al. (1998, 72726) found that bioaccumulation is highest in insectivores and lowest in herbivores. Three endpoint species under consideration are the mountain cottontail (an herbivore), the deer mouse (an omnivore), and the dusky shrew (an insectivore). Based upon home range, the potential for bioaccumulation, and prey size preferences of the Mexican spotted owl, the dusky shrew and deer mouse populations are best suited for assessing contaminant transfers to top carnivores. Given the propensity for higher body burdens, these species are also likely to elicit population responses to COPECs if such responses are occurring. If necessary, the differences in diet between the two mammals can be used to differentiate body burdens associated with trophic levels. Finally, the reproductive rate of these species is such that individuals removed for analysis will be quickly replaced within the populations and negative consequences to the food chain from sampling are very unlikely. The body burden data are used to compare COPEC concentrations between Cañon de Valle and the reference canyon and to estimate the dose of COPECs to the Mexican spotted owl. Individuals were sacrificed for body burden analysis and samples were submitted to the analytical laboratory for analysis of HE and TAL metals. The details of the calculated minimum detection limits for estimating risk relevant doses to the Mexican spotted owl are provided in "Cañon de Valle Terrestrial Ecological Risk Assessment Pilot, Steps Four and Five: Study Design and Implementation Plan" (Tardiff 2002, 73764).

The terrestrial study data indicate that both the number of species (Table 2.5-10) and the population densities (Table 2.5-11) of small mammals are greater in Cañon de Valle than in the reference (i.e., uncontaminated) site, Pajarito Canyon. The dusky shrew, selected as a study species, was not trapped on any of the field collection/trapping dates. Additionally, Cañon de Valle consistently had more

reproductive status classes than Pajarito Canyon (Table 2.5-10). These results indicate that the contaminant inventories in Cañon de Valle are not adversely affecting the small mammal community.

A comparison of body weights, by species, shows no differences between the canyons except for brush mice when the sexes are combined. However, this difference in weights is associated with a relatively large number of non-reproductive individuals in Cañon de Valle and indicates that the brush mouse population in Cañon de Valle is more active with regard to reproduction because Cañon de Valle has more individuals transitioning from juvenile to reproductive status.

Figure 2.5-5 shows box plots of deer mouse body burden data, with a cursor line representing the Mexican spotted owl ESL. The analysis of contaminant body burdens for small mammals show that the whole-mouse concentrations (of barium, copper, lead, silver, HMX, and RDX) are well below ESLs for the Mexican spotted owl. These data indicate that the contaminant inventories in Cañon de Valle are not posing a food chain risk to the owl.

(b) Aquatic Study

Synoptic benthic macro-invertebrate surveys and toxicity testing with *Chironomus tentans* were selected for assessing adverse effects in the Cañon de Valle aquatic system. The study design is summarized below and fully described in "Cañon de Valle Aquatic Ecological Risk Assessment Pilot, Steps Four, Five, and Six: Study Design and Implementation Plan" (Tardiff 2003, 73730).

(b1) Biotic Survey

Cañon de Valle is somewhat limited in survey options for aquatic resources because it is a very small stream that does not support fish. The lack of fish is due to the perennial reach being disconnected from any larger body of water and its small dimensions (average width 50 cm, average depth 7 cm), and lack of sufficient pool cover to protect fish populations from freezing and drought.

The benthic macro-invertebrate community is an appropriate option for a synoptic survey. The species in this community reside in or on sediments, are continually exposed to the contaminants in the water column, and they feed on detritus and microorganisms. The consumption of microorganisms incorporates food chain effects into the macro-invertebrate exposures. This community was surveyed in 1996 and 1997 and was shown to be well-developed in Cañon de Valle (NMED 1999, 73769). These data are used to assess community effects in Cañon de Valle relative to the reference stream reaches on the Pajarito Plateau.

A synoptic survey of benthic macro-invertebrates was conducted for riffle habitat in Cañon de Valle, Pajarito Canyon, Los Alamos Canyon, and Guaje Canyon. The latter three canyon reaches are reference streams. The lines of evidence evaluated are number of species, presence of sensitive species, and comparisons of community metrics between the two canyons. Three taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT), generally considered to be sensitive to pollutants, were measured in the canyons. Their presence at a site indicates that if pollution is present, it is most likely at low levels. The second metric consists of the ratio of EPT to EPT plus the Chironomids. Chironomidae is one of the taxonomic families of true flies. They are typically tolerant of pollution-impacted conditions. If they dominate the assemblage of taxa for a site, then the site may warrant evaluation for pollution impacts. The third metric is the community tolerance dominance quotient (CTDq) from the biotic community index of Winget and Mangum (1979, 75926). For the first two metrics, larger values indicate better site quality. For the CTDq, lower values indicated better site quality.

Table 2.5-10
Cañon de Valle Small Mammal Trapping Results for Spring and Fall 2001,
Number of Individuals by Species and Reproductive Status

	Juvenile Female	Juvenile Male	Pregnant Female	Lactating Female	Non-Reproductive Female	Non-Scrotal Male	Scrotal Male	Totals
Spring 2001								
Cañon de Valle								
Deer Mouse[a]	2		1	2	3	5	8	21
Montane Vole[b]				1		3		4
Totals	2		1	3	3	8	8	25
Pajarito Canyon								
Deer Mouse					2	2	4	8
Montane Vole							1	1
Totals					2	2	5	9
Fall 2001								
Cañon de Valle								
Deer Mouse	6	3		3	6	5	2	25
Brush Mouse[c]			1	1	7	8		17
Pinyon Mouse[d]					1			1
Western Harvest Mouse[e]	2	2	2	1	2	3		12
Wood Rat[f]						4		4
Totals	8	5	3	5	16	20	2	59
Pajarito Canyon								
Deer Mouse		2	2	1	5	6	1	17
Brush Mouse			1	1	3	2	1	8
Wood Rat				1		1	1	3
Totals		2	3	3	8	9	3	28

[a] *Peromyscus maniculatus*.

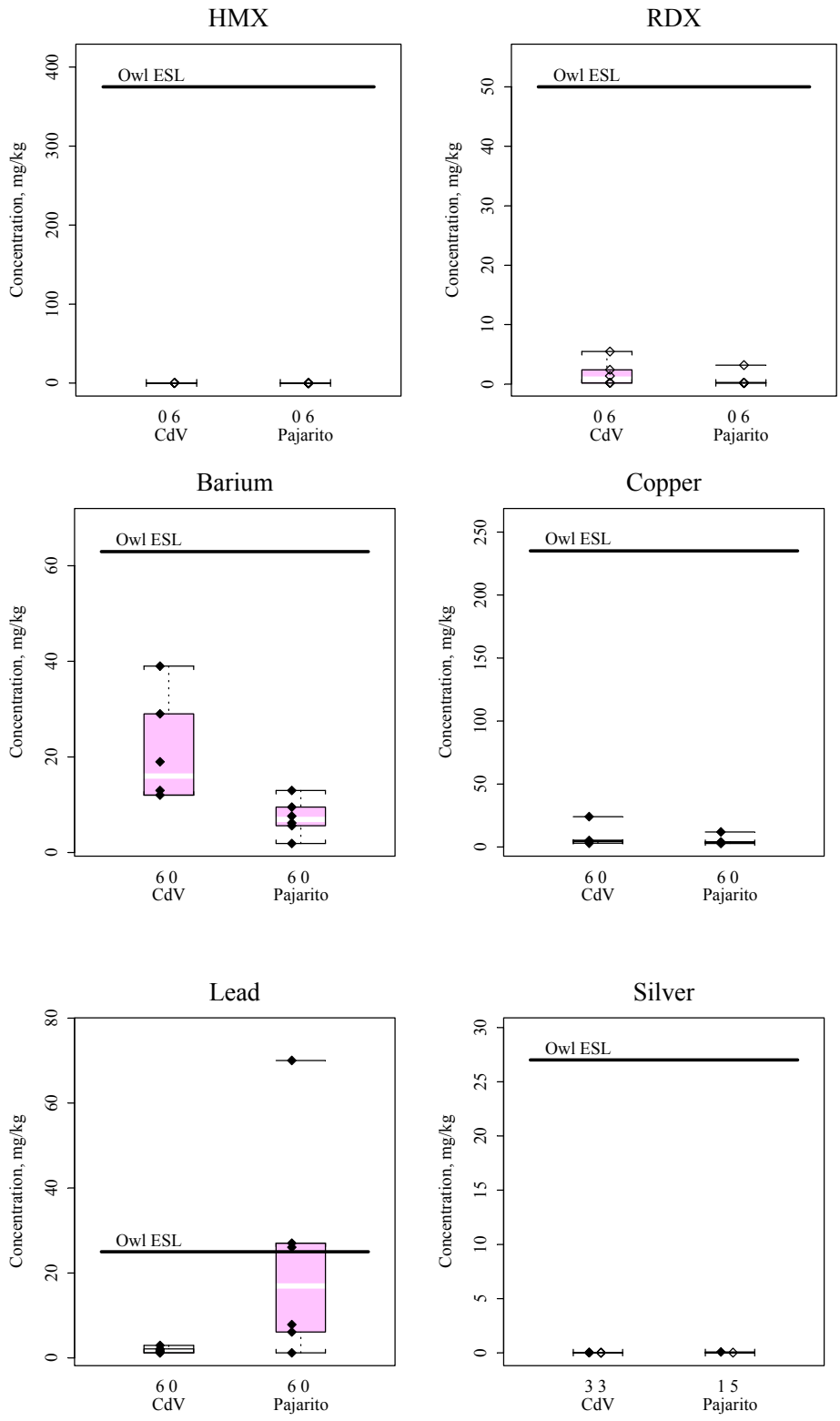
[b] *Microtus montanus*.

[c] *Peromyscus boylii*.

[d] *Peromyscus truei.*

[e] *Reithrodontomys megalotis*.

[f] *Neotama mexicana*.



Numbers above data groups are detects (solid symbol) and nondetects (open symbol)

Figure 2.5-5. Deer mouse contaminant body burdens

Table 2.5-11
Deer Mouse Population Density Estimates by Trapping Grid and Season

Location	Spring 2001 individuals/ha (95% CI[a])	Fall 2001 individuals/ha (95% CI)
Cañon de Valle, Upper Grid	10.5 (4)	NA[b]
Cañon de Valle, Lower Grid	24 (9)	144 (66)
Pajarito Canyon, Upper Grid	7.1 (3.8)	11.3 (7.5)
Pajarito Canyon, Lower Grid	9.1 (4.1)	18.7 (8)

[a] CI = confidence level.

[b] NA = not applicable; population density not calculated because new capture data are nonlinear (5,4,8,6). See text for explanation.

The benthic macro-invertebrate study results show that the total number of benthic macro-invertebrate taxa in Cañon de Valle (33) is within the range of values for the three reference reaches (25 to 42): Pajarito, Guaje, and upper Los Alamos Canyons. Sensitive species are present in Cañon de Valle, with the total number of sensitive species (EPT = 6) being lower than in the reference reaches (EPT = 10, 16, and 18) (Table 2.5-12). This result corresponds to the comparisons of community metrics for the reaches. The EPA Rapid Bioassessment Protocol (EPA 1999, 73728) characterizes a community metric reference comparison of >79% as "full support" and a reference comparison of 70-79% as "full support, impacts observed." The Cañon de Valle community metric score of 81% is slightly above the cut-off for impacted streams (79%) when compared to Pajarito Canyon, the most similar reference stream. There are two possible sources of these differences. First, the scraper community is substantially reduced in Cañon de Valle primarily because of a lack of habitat to support that feeding strategy rather than contaminant impacts. When the community metrics are summed without the scraper community metric, Cañon de Valle has a community metric score of 90% relative to Pajarito Canyon. The second source of differences between Cañon de Valle and the references reaches is stream size. Cañon de Valle is the smallest of the streams and it is common for smaller streams to have fewer taxa. Thus, the difference in the community metric scores of Cañon de Valle and Pajarito Canyon is not due to contaminants in Cañon de Valle, but is attributed to the lack of habitat in Cañon de Valle to support a scraper community and the smaller size of the stream.

(b2) Toxicity Test

Two general approaches are available for conducting toxicity tests: the use of water column test organisms or sediment-dwelling test organisms. Given the nature of the aquatic system in Cañon de Valle, organisms that live in sediments are more representative of contaminant exposures to endemic biota than are water column organisms.

The midge, *C. tentans*, is a toxicity test organism that is well-documented for its toxic responses to contaminants, widely used in toxicity testing, and is reared from laboratory populations. Additionally, the genus Chironomus is present in Cañon de Valle. A cursory literature review provided in ASTM (1995, 73729) indicates that the test species, *C. tentans*, was among the most sensitive of 24 species evaluated with Great Lakes sediments. In various studies, the midge tended to be less sensitive than *Hyalella azteca* for some metals and equivalent to or more sensitive than *H. azteca* for pesticides. A study by DeFoe and Ankley (1998, 73783) showed that the sensitivity of the *C. tentans* 10-day test is greatly increased by measuring growth in addition to survival. While a single species cannot represent the toxic responses for all the members of the community, *C. tentans* is related to the Cañon de Valle aquatic

community and appears to have contaminant sensitivities that can indicate whether adverse effects are present.

Sediment samples were collected in Cañon de Valle and Starmer's Gulch for toxicity testing with *C. tentans* using the EPA 10-day survival and growth protocol with daily static renewal using site water (EPA 2000, 73776). The lines of evidence evaluated are survival and growth of the test organisms (Pacific Ecorisk 2001, 73775).

Table 2.5-12
Sensitive Species Metrics for Cañon de Valle Relative to Three Reference Sites

	Cañon de Valle, 2.6	Los Alamos Canyon, 13.0	Pajarito Canyon, 9.0	Guaje Canyon, 10.0
EPT[a]	6	18	10	16
EPT/EPT + Chironomids	0.66	0.25	0.84	0.90
CDTq[b]	91.0	71.4	80.0	62.0

[a] EPT = Ephemeroptera, plecoptera, and trichoptera.
[b] CDTq = Community tolerance dominance quotient.

The sediment toxicity test results show that the Cañon de Valle reach above MDA P is impacted relative to the reference site in Starmer's Gulch, but that the reach potentially influenced by the MDA P Site is not impacted (Table 2.5-13). Survival of the test organisms was higher below the MDA P Site (86.25% survival) than above it (68.75% survival), relative to Starmer's Gulch (82.5% survival). Similarly, the comparisons of larval growth showed impacts above the MDA P Site reach (mean ash-free dry weight of 0.38 mg/individual) but not below (mean ash-free dry weight of 0.4 mg/ individual), relative to Starmer's Gulch (mean ash-free dry weight of 0.44 mg/individual).

Table 2.5-13
Data Summaries of Sediment and
Water Toxicity Testing with *Chironomus tentans*

Group	Minimum	1st Quarter	Median	Mean	3rd Quarter	Maximum
Percent Survival Data Summaries Starting number is 10 individuals per replicate, with 8 replicates per site						
Starmer's Gulch	60	77.5	90	82.5	90	90
Above MDA P	30	60.0	75	68.75	80	90
Below MDA P	70	80.0	90	86.25	90	100
Growth Data Summaries Ash-free dry weight, mg/individual, based upon surviving individuals						
Starmer's Gulch	0.34	0.43	0.44	0.4356	0.46	0.52
Above MDA P	0.34	0.35	0.37	0.3756	0.38	0.44
Below MDA P	0.35	0.37	0.39	0.3956	0.40	0.50

2.5.3.4.3 MDA P Site and Cañon de Valle COPC Concentration Comparisons

Two COPECs in the MDA P Site biological zone soil are carried forward for ecological risk assessment: barium and RDX, both of which are present at elevated concentrations in the Cañon de Valle soils and

sediments. The ecological risk assessment approach for these contaminants in MDA P Site soils is to compare their concentrations to the Cañon de Valle concentrations. The result of the ecological risk assessment for Cañon de Valle, presented above, is a determination of no adverse effects in the vicinity of the MDA P Site. If the COPEC concentrations for the MDA P Site footprint soils are less than, or not different from, the Cañon de Valle soils, then a determination of no adverse effects is supported for the MDA P Site soils.

Contaminant concentration data for the MDA P Site soils are compared to Cañon de Valle overbank soils and are presented in Table 2.5-14 and Table 2.5-15. All of the statistical comparisons between Cañon de Valle and the MDA P Site are not significant ($p > 0.05$), except for aluminum and cadmium. Where the tests are not significant, the concentrations in the MDA P Site soils are equivalent to or less than the concentrations in Cañon de Valle. Aluminum in MDA P Site soils is higher than in the canyon soil. Per EPA guidance (EPA 2000, 73306) aluminum is a COPEC only for sites with a soil pH of less than 5.5. The pH range of the MDA P soils is 6.8 to 7.6. Based upon this criterion, aluminum is not a COPEC. Cadmium concentrations are also higher for the MDA P soils than for Cañon de Valle. Cadmium is eliminated from further consideration because 22 of the 23 detected values are less than the soil BV of 0.4 mg/kg (LANL 1998, 59730). The single value that exceeds the BV is 1.4 mg/kg, which is within the range of background concentrations, 0.2 mg/kg to 2.6 mg/kg (LANL 1998, 59730), indicating that cadmium is unlikely to pose adverse population-level effects to ecological receptors.

2.5.3.4.4 Uncertainty Analysis

The major source of uncertainty associated with this assessment is that the terrestrial and sediment toxicity evaluations were conducted during a multi-year drought and within a year of the Cerro Grande Fire. Drought is one stressor and is likely to increase the potential of detecting an adverse effect that could be associated with contaminants. Fire effects often result in increased small mammal populations associated with increased ground vegetation. If contaminant uptake and food chain transfers were a source of population effects, then post-fire environments should increase the likelihood of detecting these effects.

Ecological screening assessments are subject to uncertainties through the use of laboratory toxicology studies to develop “no effect” contaminant concentrations. Laboratory studies use chemical forms of contaminants and exposure mechanisms that are often not representative when compared to environmental conditions. Additionally, laboratory studies are often conducted with single contaminants. The result of combinations of contaminants is largely unknown. The results presented for Cañon de Valle are based upon field studies and laboratory toxicity studies with field-collected media from the canyon containing multiple contaminants. This approach obviates the usual difficulties of extrapolating laboratory data to field settings.

Another major uncertainty associated with this assessment is the adequacy of sample coverage to support descriptions of the contaminant signatures at the site. In this assessment, the MDA P Site soils in the biological zone are characterized with 71 samples collected in a grid pattern and were often biased towards locations where contaminant concentrations were suspected of being elevated (e.g., locations that receive focused infiltration or runoff). The overbank soils sampled in Cañon de Valle were collected as part of the geomorphic characterization of contaminants in the canyon and were biased towards areas likely to have elevated contaminant concentrations in order to conservatively characterize the canyon. The combination of these two data sets for this analysis provides an abundant basis for the conclusion of no adverse effects to the Cañon de Valle or MDA P Site ecological receptors from residual COPC concentrations at the MDA P Site.

Table 2.5-14
Data Summaries of Detected Values for MDA P Site Soils and Cañon de Valle Overbank Soils

	Minimum	1st Quarter	Median	Mean	3rd Quarter	Maximum	Detects
MDA P Site Soils							
Barium	18.7	120	200.5	538.7	503	6630	70
RDX	0.069	0.2625	0.73	3.176	2.125	37	36
Aluminum	2630	5542	7305	7926	9750	19900	70
Cadmium	0.04	0.0665	0.087	0.1545	0.12	1.4	23
Cobalt	0.69	2.125	3.35	3.954	4.075	44.7	70
Copper	0.68	3.9	5.1	7.373	8.275	36.8	70
HMX	0.118	0.5725	1.05	2.828	2.425	16	32
Lead	3.8	8.325	10.45	12.18	13.87	61.5	70
Manganese	30.9	179	225	257.6	298.8	1290	70
Silver	0.099	0.165	0.73	2.146	1.5	15.8	15
Vanadium	2.9	8.3	12.2	12.89	15.3	29.3	69
Cañon de Valle Overbank Soils							
Barium	184	4430	5620	9264	9575	37300	30
RDX	0.16	0.32	0.49	0.8833	0.72	5.5	21
Aluminum	3030	4312	5370	5316	6332	8880	30
Cadmium	0.06	0.085	0.22	0.309	0.4075	1.1	10
Cobalt	1.50	4.175	5.30	6.703	7.3	17.5	30
Copper	3.30	14.3	24.55	26.53	29.4	139	30
HMX	0.19	0.8	1.60	16.47	12	290	27
Lead	7.60	28.18	36.30	35.59	44.50	65.9	30
Manganese	75.2	278.8	341	341	378.50	980	30
Silver	0.63	2.675	3.60	5.478	8.050	14.9	28
Vanadium	8.90	11.98	14.3	14.35	15.7	21.2	30

Table 2.5-15
Statistical Comparisons of Cañon de Valle COPECs to MDA P Site Soils

COPEC	Gehan Test p-value	Quantile Test p-value
Aluminum	0.00005	0.0021
Barium	1.0	1.0
Cadmium	*	0.033
Cobalt	1.0	1.0
Copper	1.0	1.0
HMX	*	1.0
Lead	1.0	1.0
Manganese	1.0	1.0
RDX	*	1.0
Silver	*	1.0
Vanadium	1.0	0.99

*Insufficent number of detects for the statistical test.

2.5.3.5 Ecological Assessment Summary

The ecological risk assessment for the terrestrial and aquatic systems in Cañon de Valle found that there is no empirical evidence of adverse effects associated with the MDA P Site. Both the terrestrial and aquatic studies indicate that ecological receptors in the canyon are not being adversely affected by contaminants in the soils and sediments of the canyon. Comparisons of the MDA P Site soil COPEC concentrations to Cañon de Valle contaminant concentrations show that barium and RDX are not statistically different between the two locations. The lack of adverse ecological effects in Cañon de Valle from these contaminants is strong evidence that there are no effects due to these contaminants in the biological zone soils at the MDA P Site. The concentrations of other Cañon de Valle COPECs in the MDA P Site soils do not pose a threat of adverse effects because they do not differ from (or are lower than) the overbank soil concentrations for the canyon. This conclusion is valid for the MDA P Site soils in their present location and also in the event that they are transported into the canyon in the future because the current contaminant concentrations in the canyon exceed those that may be transported from the MDA P Site in the future. These lines of evidence indicate that residual contamination from the MDA P Site does not pose a threat to the environment.

3.0 ASSESSMENT OF IMPACT TO GROUNDWATER

3.1 Introduction and Regulatory Requirements

This section provides the basis for the Laboratory's request to NMED for a determination that a post-closure permit for groundwater monitoring at MDA P is not required because

- the MDA P closure meets the standards for closure by removal or decontamination in 20.4.1.600 NMAC, 265.111 and 265.258(a), and
- in accordance with 20.4.1.500 NMAC, 264.90(c)(1), the requirements for groundwater monitoring for regulated units specified in 264.91 – 264.100 do not apply if, after closure of the regulated

unit, all waste, waste residues, contaminated containment system components, and contaminated subsoils are removed or decontaminated at closure

These requirements apply specifically to MDA P, not Flash Pad 387 or SWMU 16-016(c)-99, because of MDA P's unique status as a land-based unit.

To demonstrate clean closure, the owner/operator of the closing unit must establish that hazardous constituents that may remain in place after clean closure do not represent a threat to human health or the environment (52 FR 8706, 3/19/87). With respect to groundwater, sufficient amounts of soil must be removed to ensure that any contribution of hazardous constituents to groundwater do not and will not exceed protective levels. In addition, the adequacy of clean closure is measured at the potential point of exposure to hazardous constituents, assumed to be directly at or within the unit boundary for all media, including groundwater (52 FR 8707, 3/19/87). Per 20.4.1.500 NMAC, 264.95, the *point of compliance* for groundwater monitoring is "a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units." The *waste management area* is the limit projected in the horizontal plane of the area on which waste was placed during the active life of the regulated unit. For the purposes of demonstrating clean closure, the unit boundary for all routes of exposure for the MDA P waste management area is shown on Plate 1. The point of compliance for MDA P is the MDA P waste management area boundary within the MDA P Site. The area of study in the Phase II investigations encompassed what constitutes the point of compliance for exposure to hazardous constituents via a pathway to groundwater.

As detailed in section 2 of this report, the Laboratory has met the closure by removal and decontamination standards set forth in 20.4.1.600 NMAC, 265.111 and 265.258(a). No waste, waste residues, contaminated containment system components, or contaminated subsoils remain within the waste management area boundary. As discussed in section 2.1, the term "waste residues" refers to any hazardous constituents derived from hazardous wastes that are present in the environment at or above levels of human health or environmental concern (53 FR 9944, 3/28/88). "Contaminated subsoils," in the context of closure of waste piles by removal and decontamination, is interpreted to mean any materials that may have been contaminated by hazardous wastes managed in the unit (53 FR 9944, 3/28/88).

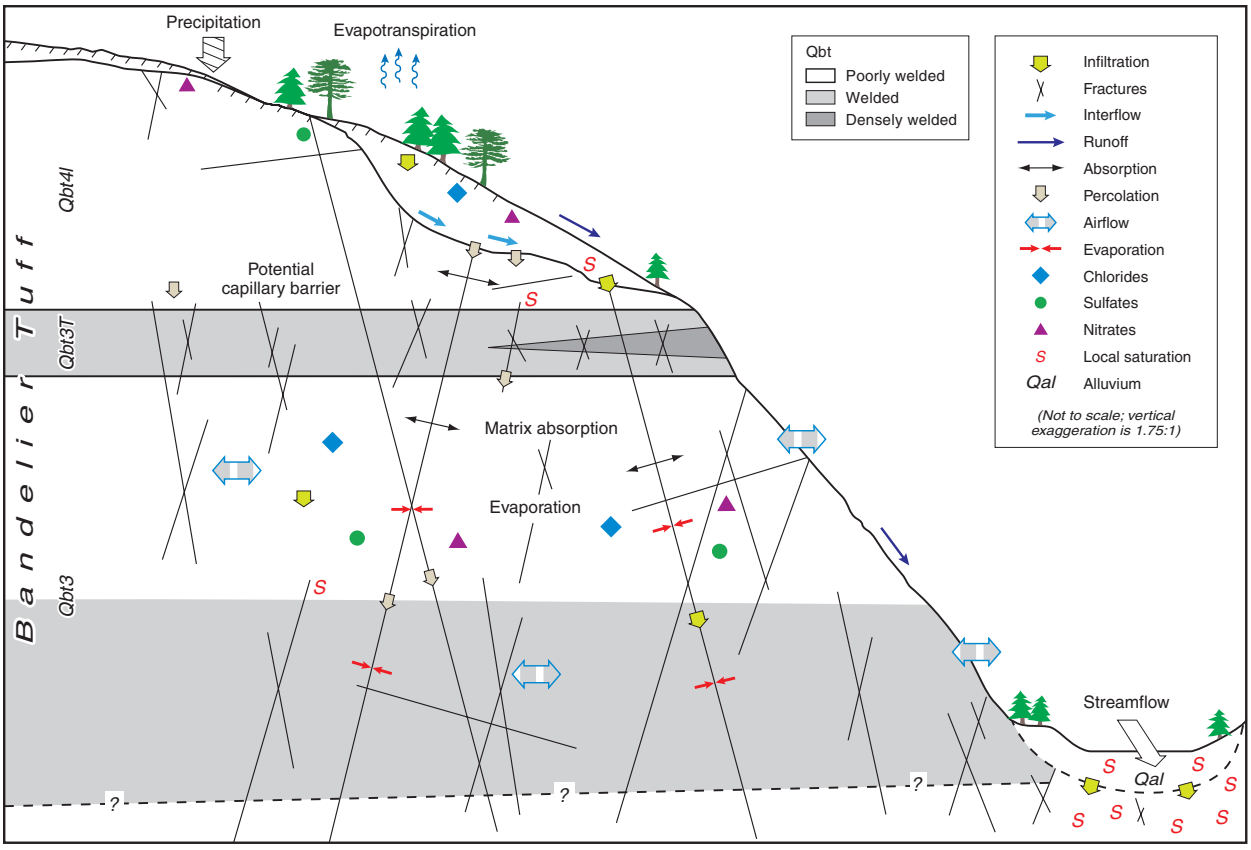
This section discusses the transport pathways and the potential for residual hazardous constituents to migrate to groundwater. It also discusses whether or not post-closure groundwater monitoring at MDA P is necessary. The information in this section is intended to satisfy requirements for determining potential exposure to hazardous constituents via groundwater at the point of compliance, as defined earlier in this section. However, because the closure performance standard in 20.4.1.600 NMAC, 265.111 also requires that the potential for post-closure escape of residual hazardous constituents to surface water be addressed, relevant information pertaining to surface water pathways is included here.

3.2 Conceptual Model of the Bedrock Fracture Flow System at MDA P

The MDA P Site is located within a small, open watershed with no springs or other natural, perennial sources of water on the south rim of Cañon de Valle. The Site lies in a transition zone where fracture density and fracture aperture decrease from west to east. The site is underlain by welded to nonwelded Units 3 and 4 of the Bandelier Tuff. The partially to densely welded Units 3 and 3T form the cliffs and benches of the canyon walls, and the nonwelded Unit 4l forms the gentle slopes from the topographic bench southward to the surface of the former Flash Pad 387 at the watershed divide. The climate is semi-arid. Precipitation as snowfall or rainfall in the watershed provides ephemeral runoff to two arroyos that provide hydrologic boundaries on the east and west margins of the Site. Direct precipitation is the only source of surface water transport within the interior portion of the Site. Current conditions promote runoff

and inhibit infiltration, as a north-south trending man-made trench bisects the eastern exposed tuff region and diverts overland flow to the east arroyo.

From the empirical data presented in section 2.3, a conceptual model was developed that states that the fracture flow system is unsaturated, with local infiltration of precipitation and downward percolation, but dominated by matrix absorption and evaporation (Figure 3.2-1). The latter processes result in an accumulation zone of nitrate, chloride, and sulfate salts at 30- to 90-ft depths below the current land surface in the partially welded Unit 3. The salts are believed to be the result of dissolution of surface salts and redistribution in the subsurface through percolation and evaporation. The zone is apparent in all boreholes and is located entirely above the stream level of Cañon de Valle. It is believed that evaporation is promoted by connection of the fracture system with the atmosphere near the canyon walls. Pressure changes are propagated through the fracture system in response to barometric pressure changes, a process recognized at many other arid and semi-arid sites across the western United States and the Pajarito Plateau. Hence, the larger fractures promote exchange of atmospheric gases; the smaller fractures promote retention of moisture and provide the initial paths of rewetting. The data in this report support the hypothesis by Neeper and Gilkeson (1996, 56025) and Newman (1996, 59372) that the process of moisture removal from within the mesa by evaporation forms a hydraulic barrier. Thus, vapor phase transport is the dominant subsurface mechanism for moisture transport. The zone of salt accumulation is believed to represent the response of the fracture system to the semi-arid climate and probably required thousands of years to develop.



Source: Shaw_Rev. for MDA P Area Closure Certification Report; Annex III, Phase II; 012703; cf

Figure 3.2-1. Conceptual model of the bedrock fracture flow system at MDA P (LANL 2003, 77423)

3.3 Discussion of Groundwater Transport Pathways at MDA P

There are three major routes for potential transport of residual hazardous constituents at MDA P to groundwater and perennial surface water (Figure 3.2-1). The first route is by deep downward transport through the MDA P subsurface to a possible perched saturated zone located approximately 700 ft below MDA P and to the regional aquifer that is about 1200 ft below the MDA P Site. The 700-ft zone is inferred based on its presence at monitoring well R-25 (Broxton et al. 2002, 72640), but not likely to be present underneath MDA P. The second route for potential hazardous constituent transport is via a combination of downward and northward lateral transport through the MDA P subsurface into the alluvial aquifer/surface water system of Cañon de Valle. The third route for potential transport is by overland flow directly into Cañon de Valle. Although no support for significant transport via any of these 3 pathways has been identified, each of these routes is discussed in more detail below.

The first route for potential contaminant transport to groundwater from MDA P is deep downward transport by percolation. The four main factors controlling the downward transport route to the deep aquifer systems are (1) the quantity of precipitation that the site receives, (2) the amount of evapotranspiration, (3) the hydraulic properties and conditions of the tuff matrix, and (4) the hydraulic properties and conditions in fractures in the tuff (which are closely related to the matrix properties). The chemical characteristics of the different residual hazardous constituents will also control the rate of transport, but these are minor compared to the hydrologic controls.

MDA P has a semiarid climate, which means that annual potential evapotranspiration is greater than annual precipitation. Thus, downward flow is limited because evapotranspiration removes most or all annual precipitation through the top and canyon walls of MDA P. For example, MDA P receives an annual average of approximately 19.7 in. of precipitation, and evaporation rates are about 65 in./yr (Bowen, 1990 06899).The low downward flux at MDA P is also supported by consideration of hydraulic properties and conditions in the field. Data collected from historic and recent boreholes at MDA P (section 2.3) do not show any evidence of subsurface saturation. Water contents from the nearby monitoring well R-25 (Broxton et al. 2002, 72640), and Boreholes 16-02667 and 16-02668 (LANL 2003, 77965), typically had gravimetric water contents in the Tshirege Member of less than 15%; similar values are reported in the boreholes at MDA P (557, 554, 526, 516). Such low water contents not only indicate unsaturated flow conditions, but also indicate low unsaturated hydraulic conductivity values. At these water contents, hydraulic conductivities can be as low as 10^{-11} ft/s, which severely limit downward flow and transport (D.B. Stephens and Associates 1999, 76886). Moreover, the salt accumulation zone, present in the 30- to 90-ft depth interval in the MDA P Site boreholes is an indicator of extremely low downward water flux (e.g., less than one-tenth of an inch/yr). Recent studies (Scanlon et al. 2003, 77966; Walvoord et al. 2002, 77967) indicate that this represents a zone where no downward recharge has occurred over thousands of years. The chloride concentrations from the MDA P boreholes (section 2.3) are similar to those observed in monitoring well R-25 and the SWSC borehole (16-0267), both of which indicate no recharge over the last 1000 years or longer (Broxton et al. 2002, 72640; LANL 2003, 77423; LANL 1998, 59891; LANL 2003, 77965). Based on the physical data, vapor-phase transport is deemed the dominant subsurface mechanism for moisture transport. Thus, it is unlikely that substantial downward transport by percolation of residual hazardous constituents to deep aquifer systems occurs at MDA P.

Fractures are a concern because of the potential for fast preferential transport. While this has been shown to be important at other locations on the TA-16 mesa (LANL 2003, 77965) long-term ponded surface water conditions were present. Ponded conditions are not present at MDA P and, as a result of the Phase I activities, the MDA P Site has been engineered to prevent ponding now and in the future. It is unlikely that fractures would act as fast pathways to the deep groundwater systems. Additional evidence supporting this transport model is based on increased chloride content that coincides with fractures or

fracture zones. If fractures were historically acting as fast pathways, the salt concentrations in the fractures would be noticeably lower than detected because these highly soluble salts would have been flushed into the deeper of the bedrock. In other words, the presence of salt accumulation in the fractures indicates that little water has moved through the fracture systems. Transport of residual hazardous constituents to the deeper aquifer system would only occur if the current balance between precipitation and evapotranspiration were altered through a long-term change in hydrology (e.g., resulting from climate change or anthropogenic discharges). Based on the existent and expected long-term hydrologic conditions, post-closure groundwater monitoring beneath MDA P is not warranted.

The second route for potential hazardous constituent transport is via a combination of downward and northward lateral transport through the MDA P subsurface into the alluvial aquifer/surface water system of Cañon de Valle (Figure 3.2-1). This is not a viable pathway because, as discussed above, downward moisture flux at MDA P is minimal. In addition, none of the boreholes at the MDA P Site detected a saturated zone at or above the elevation of Cañon de Valle. This lack of borehole water indicates that saturated conditions along the Cañon de Valle stream do not extend laterally to produce a continuous perched water table beneath MDA P. MDA P lies on a geologic transition from a graben structure to the west and a bedrock promontory to the east. There is strong evidence that geologic features in MDA P differ from those in adjacent areas, such that perched water, found as ephemeral saturated “ribbons” in the subsurface west and southwest of MDA P (at approximately 100–200 ft bgs) and manifest in SWSC, Burning Ground, and Martin Springs (LANL 1998, 59891), is not present beneath MDA P. This transport model is also supported by the lack of any springs or seeps at the base of MDA P and by the lack of water encountered in Borehole 554, which is located adjacent to a potential bounding fault where perched water would likely have been observed, were it present. Additionally, historical data collected at MDA P found no evidence of saturated conditions in the vadose zone beneath the site (LANL 1995, 58713). This includes five boreholes drilled in 1988 on and around MDA P and nine shallow boreholes drilled along the north face of MDA P at the level of Cañon de Valle. Thus, there is no evidence for a fast lateral subsurface connection to the canyon. Any lateral transport is limited by the low water contents and low hydraulic conductivities of the bedrock, as described above, for the downward transport pathway.

The third route for potential transport is by overland flow directly into Cañon de Valle. Some overland flow from the site occurs. However, permanent, passive site engineering controls are in place that reduce the potential contributing area for runoff and minimize the volume of overland flow that can be generated. Ephemeral runoff is currently directed to two arroyos that provide hydrologic boundaries on the east and west margins of the site. Grading and terracing of the site also reduced the potential for any residual dissolved and/or sediment-bound hazardous constituents to enter the canyon. Historical sediment and geomorphological studies and sampling in Cañon de Valle indicated that, even prior to implementation of site engineering controls and source removal, there was little impact from MDA P due to overland flow (LANL 2003, 77965). Based on the source-term removal and the engineered runoff controls, future overland flow inputs are not likely to be of concern.

In addition to the conditions discussed above, the decreasing concentrations (mostly below background or undetected) of residual hazardous constituents at depth in the subsurface support the determination that post-closure groundwater monitoring at MDA P is not warranted. The confirmation sampling was performed in accordance with the NMED-approved MDA P closure plan (LANL 1995, 58713) and subsequent modifications (LANL 1999, 63546; LANL 2002, 73159). The MDA P closure plan committed to addressing this question by measuring concentrations of hazardous constituents in the vadose zone using the Phase II confirmation analytical results of near surface soil and tuff and borehole core and vapor samples. Soil/tuff sampling results and vadose zone VOC data demonstrate that no substantial migration of contaminants into the subsurface has occurred beneath MDA P.

The VOC pore gas sampling results report several VOCs detected in one or more samples. The detected concentrations are primarily in the ppbv range and generally show a decrease in concentrations with depth (Table 2.4-6). However, because the VOCs are detected at trace concentrations at depth there may be little or no change in concentration for some VOCs to total depth of the borehole. The subsurface environment beneath MDA P is relatively dry, has limited organic content, and the VOCs detected have relatively high vapor pressure. In addition, the potential source term for VOCs has been removed. As a result of these conditions, VOCs are restricted to the vapor phase, have no source for releasing additional VOCs, and have no hydraulic gradient to facilitate migration. Therefore, the VOCs will remain at trace levels and will not be transported vertically and encounter groundwater beneath MDA P.

Analytical results of the soil and tuff matrices report concentrations of contaminants that do not pose a potential unacceptable risk to human and ecological receptors (section 2.5 and Appendix A). The majority of the residual contamination following removal activities is in the top 5 ft of the soil and tuff. Because concentrations decrease with depth, the lower concentrations also do not pose a potential unacceptable risk to human and ecological receptors. The data also indicate that concentrations of contaminants have not accumulated in the subsurface beneath MDA P. The lack of a source term, the unsaturated conditions, and the zone of accumulation beneath MDA P further inhibits any vertical migration of the residual contamination to the deep groundwater. Therefore, the removal of nearly all hazardous constituents from within the MDA P waste management area during the closure process and the demonstration that residual concentrations do not pose a potential unacceptable risk to human and ecological receptors support the conclusion that post-closure groundwater monitoring beneath MDA P is not required.

3.4 Discussion of Needs for Post-closure Monitoring

The conceptual model and pathway discussions support the Laboratory's request for a determination that a post-closure permit for groundwater monitoring at MDA P is not required. The analytical and geochemical data demonstrate that the potential for transport of residual hazardous constituents from MDA P to groundwater is mitigated because:

- the Laboratory successfully completed closure by removal and as a result, the residual hazardous constituent concentrations at MDA P are below levels that pose a potential unacceptable risk to human and ecological receptors;
- the residual hazardous constituent concentrations at MDA P are confined primarily to the upper 5 ft of the soil and tuff;
- the vadose zone properties beneath MDA P limit the potential subsurface transport of contaminants to a depth no greater than the accumulation zone (30 to 90 ft bgs) due to evapotranspiration;
- the transport of residual hazardous constituents from MDA P in the surface soils and tuff to alluvial and perched systems outside the unit boundaries (e.g., in Cañon de Valle) is limited by the lack of viable surface and subsurface water transport mechanisms; and
- the thickness of the vadose zone (i.e., approximately 1200 ft to the regional aquifer) and the low hydraulic conductivities of the vadose zone strongly limit potential transport to the deep groundwater.

4.0 CONCLUSIONS

Clean closure and NFA requirements for the MDA P Site units [MDA P, Flash Pad 387, and consolidated SWMU 16-016(c)-99] are met.

- The contents of MDA P, including waste residues and structures, were removed and/or decontaminated, and disposed of in accordance with all applicable procedures, plans, and regulations. All contaminated containment system components, contaminated subsoils, and structures and equipment contaminated with waste were removed and/or decontaminated. All equipment and structures associated with closure operations were decontaminated, reclaimed, recycled, or disposed. Only soils and tuff containing residual levels of hazardous constituents determined to pose no current or future potential unacceptable risk to human or ecological receptors remain in place.

- The Flash Pad 387 structure and potentially contaminated underlying material were removed and/or decontaminated, and disposed of in accordance with all applicable procedures, plans, and regulations. All contaminated containment system components, contaminated subsoils, and structures and equipment contaminated with waste were removed and/or decontaminated. All equipment and structures associated with closure operations were decontaminated, reclaimed, recycled, or disposed. Only soils and tuff containing residual levels of hazardous constituents determined to pose no current or future potential unacceptable risk to human or ecological receptors remain in place.

- SWMU 16-016(c)-99 was characterized and remediated in accordance with the approved VCA plan and all applicable regulations. Only soils and tuff containing residual levels of hazardous constituents determined to pose no current or future potential unacceptable risk to human or ecological receptors remain in place.

- Waste management was conducted in accordance with the approved closure plans, the VCA plan, and applicable regulations. All contaminated equipment, structures, soils, and other wastes generated as a result of closure/remediation activities were properly characterized, managed, decontaminated, and/or disposed.

- Confirmation sampling results were used to demonstrate that the operational PRGs were successful in guiding soil and debris removal activities at the MDA P Site; for the isolated locations that have residual concentrations of barium or RDX above the operational PRGs, the risk assessment results indicate there is no current or future potential unacceptable risk to human or ecological receptors from the residual concentrations that have been left in place.

- Confirmation sampling provide sufficient data for the human health and ecological risk assessments. The confirmation data adequately determine the horizontal extent of residual COPC concentrations at the site, as the sampling extended beyond the boundaries of excavation and beyond the natural hydrologic barriers that limit potential horizontal transport to the area between the east and west drainages. The confirmation data adequately determine the vertical extent of COPC concentrations in the subsurface soils and tuff at the site, as adequate data at depth were taken to conclude that only residual levels of COPC concentrations exist at depth and the majority of the depth sample results were either not detected or were detected at concentrations below established BVs and/or acceptable risk levels.

- Data collected from borehole geophysical and geochemical studies and the fracture characterization study, including the boreholes drilled along the MDA P unit boundary, indicate that there is no surface-to-groundwater pathway at the MDA P Site.
- Risk assessment results demonstrate that the remaining soils and tuff at the site containing residual hazardous constituents pose no unacceptable current or future potential unacceptable risk to human and ecological receptors.

Together, these factors satisfy the facility closure performance standard for MDA P and Flash Pad 387 (20.4.1.600 NMAC, 265.115); the unit-specific closure performance standard for MDA P [20.4.1.600 NMAC, 265.258(a)]; and the unit-specific closure performance standard for Flash Pad 387 (20.4.1.600 NMAC, 265.381). Therefore, the Laboratory submits this demonstration of clean closure at MDA P and Flash Pad 387 and requests determination from NMED that further remediation or post-closure monitoring is not warranted. Additionally, these factors satisfy the NFA criterion for SWMU 16-016(c)-99, which requires that the SWMU has been characterized or remediated in accordance with applicable state or federal regulations and that the available data indicate that chemicals of concern are either not present or are present at concentrations that pose no potential unacceptable risk to human or ecological receptors under projected future land use.

5.0 CERTIFICATIONS

This section provides the independent registered professional engineer certifications attesting that the closure activities for MDA P and Flash Pad 387 have been performed in accordance with the approved closure plans. Also provided is the owner/operator certification as required by 20.4.1.600 NMAC, 265.115.

5.1 Independent Registered Professional Engineer's Certification

Closure Certification - MDA P

This certification was prepared in accordance with generally accepted professional engineering principles and practice pursuant to the requirements of 20.4.1.600 NMAC, Section 265.115, for an independent registered P.E. certification. These services have been performed with the care and skill ordinarily exercised by members of the profession practicing under similar conditions at the same time and in the same or in a similar locality. We make no other warranty either expressed or implied. The finding and certification are based on reviewing the contents, and implementation of, the following documents:

- Material Disposal Area P closure plan, revision 0 (LANL 1995, 58713), approved by NMED on February 20, 1997; and
- Revised closure plan modification request (LANL 2002, 73159), approved by NMED on May 30, 2002.

With the signature and seal below, I certify that, except for the variances presented in section 2.4.4 and Appendix D, the closure of the TA-16 Material Disposal Area P was conducted substantially in accordance with the NMED-approved closure plan and associated modification. The information presented in this report is, to the best of my knowledge and belief, true, accurate, and complete.

Respectfully,

Shaw Environmental, Inc.

P. Scott den Baars, P.E.
New Mexico Registered Professional Engineer No. 10653
Expires: December 31, 2003
Date: _____

Closure Certification—Flash Pad 387

This certification was prepared in accordance with generally accepted professional engineering principles and practice pursuant to the requirements of 20.4.1.600 NMAC, Section 265.115, for an independent registered P.E. certification. These services have been performed with the care and skill ordinarily exercised by members of the profession practicing under similar conditions at the same time and in the same or in a similar locality. We make no other warranty either expressed or implied. The finding and certification are based on reviewing the contents, and implementation of, the following document:

- Flash Pad 387 closure plan (LANL 1999, 63547), approved by NMED on July 7, 2002; and
- Revised closure plan modification request (LANL 2002, 73159), approved by NMED on May 30, 2002.

With the signature and seal below, I certify that, except for the variances presented in section 2.4.4 and Appendix D, the closure of the TA-16-387 Flash Pad was conducted substantially in accordance with the NMED-approved closure plan and associated modification. The information presented in this report is, to the best of my knowledge and belief, true, accurate, and complete.

Respectfully,

Shaw Environmental, Inc.

P. Scott den Baars, P.E.
New Mexico Registered Professional Engineer No. 10653
Expires: December 31, 2003
Date: _____

5.2 Owner/Operator Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, 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 violations.

Document title:

Material Disposal Area P Site Closure Certification Report

_____ _____

James L. Holt Date Signed

Associate Director, Operations
Los Alamos National Laboratory
Operator

_____ _____

Ralph E. Erickson Date Signed

Director, Los Alamos Site Operations
US Department of Energy
National Nuclear Security Administration
Owner

6.0 REFERENCES

The following list includes all documents cited in the main body of this report. The parenthetical information following each reference provides the author, publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the RRES-RS Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the RRES-RS project reference library titled "Reference Set for Operable Unit 1082."

Copies of the reference library are maintained at the NMED Hazardous Waste Bureau; the DOE Los Alamos Site Office; the US Environmental Protection Agency, Region 6; and RRES-RS. This library is a living collection of documents that was developed to ensure that the administrative authority has all material needed to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

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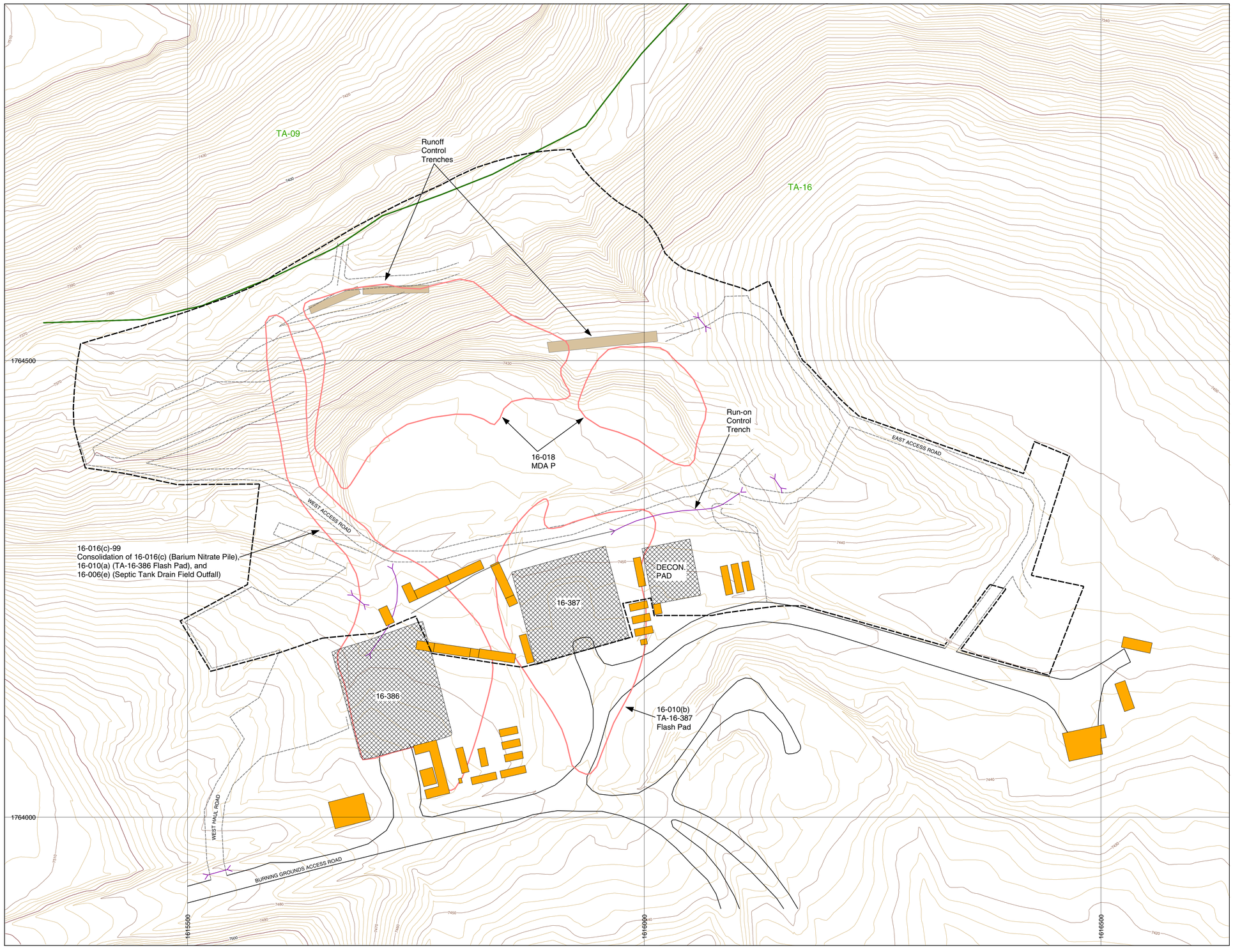
MDA P Site: Plate 1



- Contour, 2 foot
- Contour, 10 foot
- Contour, 100 foot
- Culvert
- Area of Contamination—MDA P Site Boundary
- Road, Dirt
- Road, Paved
- Solid Waste Management Unit (SWMU) Boundary
- Boundary, TA
- Burn Pad
- Structure
- Trench

Topography represents ground surface prior to closure removal activities

DATA SOURCES FOR PLOT: 200578

Title; Owner; Pub Date; Intended Scale; (ER ID); (GISLab ID)

1991 Hypsography (100ft); Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (00800-0001)

1991 Hypsography (10ft); Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (00798-0001)

1991 Hypsography (20ft); Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (00799-0001)

1991 Hypsography (2ft); Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (00797-0001)

Boundary, TA; Los Alamos National Laboratory, FWO; Unknown; Unknown; (Unknown); (NA)

Burn Pads, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

Culverts as built 20000202, client supplied; Los Alamos National Laboratory, ER; 20021210; 1:600; (NA); (Unknown)

Drainage as of 20000202, client supplied; Los Alamos National Laboratory, ER; 20021210; 1:600; (NA); (Unknown)

Exclusion Zone as of 20000202, client supplied; Los Alamos National Laboratory, ER; 20021210; 1:600; (NA); (Unknown)

MDA P SWMU Boundaries, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

Roads, Dirt, as built 20000202, client supplied; Los Alamos National Laboratory, ER; 20021210; 1:600; (NA); (Unknown)

Roads, Paved, as built 20000202, client supplied; Los Alamos National Laboratory, ER; 20021210; 1:600; (NA); (Unknown)

Structures as built 20000202, client supplied; Los Alamos National Laboratory, ER; 20021210; 1:600; (NA); (Unknown)

Trenches as built 20000202, client supplied; Los Alamos National Laboratory, ER; 20021210; 1:600; (NA); (Unknown)

GISLab
Los Alamos National Laboratory

RRES

Cartography by: Doug Walther

Date: January 28, 2003 M#: 200578

N

State Plane Coordinate System, New Mexico Central Zone, 1983 North American Datum. Units Feet.

Grid displays New Mexico State Plane coordinates in feet.

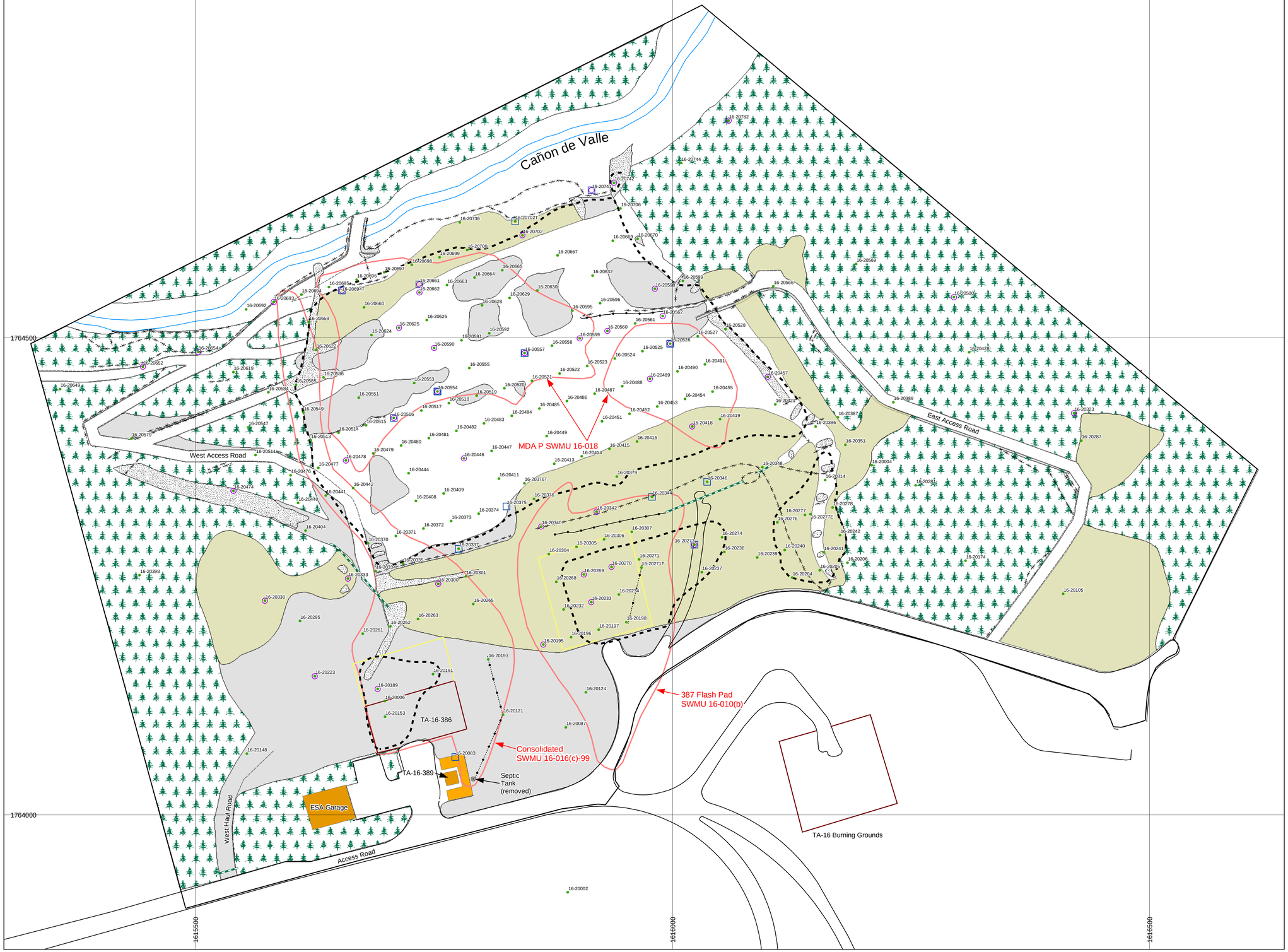
1:600

0 50 100 150 200
Feet

0 15 30 45
Meters

Work performed on behalf of RRES-R, Los Alamos National Laboratory, Los Alamos, NM, 87545.

Confirmation Sample Locations: Plate 2



- Boundary of Mapped Area
- Culvert
- Fence, Current
- Fence, Removed
- Stream Channel Boundary
- Trench Buried by Fill (exposed by excavation)
- Trench, Remnant Exposed
- Limit of Excavation
- Road, Dirt
- Road, Paved
- Solid Waste Management Unit (SWMU) Boundary
- Straw Bales or Waddles for Erosion Control

Building/Storage Areas

- Active Facility or Structure
- Revetment at Building 389

Results of Erosion Stabilization

- Rip Rap
- Reclaimed Area, Seeded, Straw Crimp

Unconsolidated Deposits

- Unconsolidation Undifferentiated
- Forest Floor Soils/Undisturbed
- Septic Tank (removed)

Sampling Locations

- Excavation or Borehole
- Subsurface
- Surface

DATA SOURCES FOR PLOT: 200575

Title; Owner; Pub Date; Intended Scale; (ER ID); (GISLab ID)

MDA P Dirt Roads, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Erosion Control (straw bales and waddles), client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Excavation Areas, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Line Features (trenches, culverts, stream channel, fences, boundary of mapped area), client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Location Ids with Depth, client supplied; Los Alamos National Laboratory, ER; 16-Sept-2002; Unknown; (NA); (Unknown)

MDA P Reclaimed Areas, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Rip Rap, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Septic Tank (removed), client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown, (NA); (Unknown)

MDA P Structures, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P SWMU Boundaries, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Unconsolidated Undifferentiated Deposit Areas, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

MDA P Undistrubed Areas, client supplied; Los Alamos National Laboratory, ER; Unknown; Unknown; (NA); (Unknown)

Roads, surfaced; Los Alamos National Laboratory, FWO; Unknown; Unknown; (Unknown); (00907-0002)

Roads, unsurfaced; Los Alamos National Laboratory, FWO; Unknown; Unknown; (Unknown); (00908-0002)

GISLab
Los Alamos National Laboratory

RRES

Cartography by: Doug Walther

Date: January 24, 2003 M#: 200575

N

State Plane Coordinate System, New Mexico Central Zone, 1983 North American Datum. Units Feet.

Grid displays New Mexico State Plane coordinates in feet.

1:600

0 50 100 150 200
Feet

0 15 30 45
Meters

Work performed on behalf of RRES-R, Los Alamos National Laboratory, Los Alamos, NM, 87545.

LA-UR-03-8046
ER2003-0643

Material Disposal Area P Site Closure Certification Report

October 2003

Responsible project leader:

William Criswell		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

Appendix A

Human Health and Ecological Risk Assessments
for the MDA P Site

TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF ACRONYMS

BMP	Best Management Practice(s)
BV	background value
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
Cr^{+6}	hexavalent chromium
CTDq	community tolerance dominance quotient
DDT	dichlorodiphenyltrichloroethane
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, and Trichoptera
EQL	estimated quantitation limit
ESL	ecological screening level
HE	high explosive(s)
HI	hazard index
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
HPF	heat pulse flowmeter
HQ	hazard quotient
IWP	Installation Work Plan
LANL	Los Alamos National Laboratory
MDA	Material Disposal Area
mg/kg-d	milligram(s) per kilogram per day
NMED	New Mexico Environment Department
NOAEL	no-observed-adverse-effect level
PCB	polychlorinated biphenyls
RDX	1,3,5-trinitro-1,3,5-triazacyclohexane
RfD	reference dose
SAL	screening action level
SAP	sampling and analysis plan
SF	slope factor
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
T&E	threatened and endangered
TA	Technical Area
TAL	target analyte list
UCL	upper confidence limit
UNM	University of New Mexico
VCA	voluntary corrective action
VOC	volatile organic compound
WRS	Wilcoxon Rank Sum

1.0 INTRODUCTION

The human health and ecological risk assessment analyses detailed in this appendix have been performed to support the Final Closure Certification of the Solid Waste Management Units (SWMUs) associated with the Material Disposal Area (MDA) P. The MDA P Site is comprised of the following areas of concern within Los Alamos National Laboratory's (LANL's) Technical Area (TA)-16 Burning Grounds High Explosives (HE) Exclusion Area: MDA P Waste Pile (SWMU 16-018), the TA-16-387 Flash Pad (SWMU 16-016[b]), the TA-16-386 Flash Pad (SWMU 16-010[a]), a former barium nitrate pile (SWMU 16-016[c]), and an operational septic tank (SWMU 16-006[e]). The first two SWMUs are designated Resource Conservation and Recovery Act Interim Storage units, for which closure requirements must be demonstrated. The latter 3 SWMUs are consolidated into a single SWMU, designated SWMU 16-016(c)-99 (LANL 1999, 63546) and sometimes referred to as the Burning Grounds North, and are being investigated under LANL's Voluntary Corrective Action (VCA) program. Excavation and clean-up activities (Phase I) for all SWMUs within the MDA P Site were conducted simultaneously; likewise, the risk assessments supporting closure and corrective action of the various SWMUs are also being conducted collectively. This approach was delineated in the New Mexico Environment Department (NMED)-approved sampling and analysis plan (SAP) for the MDA P Site (LANL 1999, 63546). Confirmation sampling activities were conducted as part of the MDA P Site Phase II investigation. The detailed analysis of the Phase II sample data in the context of potential human health and ecological risk is the focus of this appendix.

Potential adverse effects to both human health and ecological receptors are evaluated for the residual contamination at the MDA P Site. The screening assessments performed for the human and ecological receptors consist of four components: scoping, screening evaluation, problem formulation, and interpretation of results. The human health screening assessment was performed using the approach presented in the Installation Work Plan (IWP) (LANL 1998, 62060) and LANL (2002, 72639). The ecological screening assessment was performed using the methodology documented in "Screening Level Ecological Risk Assessment Methods" (LANL 1999, 64783). For all inorganic and organic chemicals of potential concern (COPCs) that do not pass the initial human health and ecological screening assessments, additional analysis and evaluation is provided.

This appendix is organized as follows:

- **Section 1, Introduction**: describes the objectives of, and approach to, the human health and ecological risk assessments following Phase I excavation and clean-up activities and Phase II confirmation sampling and analysis.
- **Section 2, Environmental Setting**: describes the general setting, geology, groundwater and surface water, meteorology and climate, biology, and current site conditions of the MDA P Site.
- **Section 3, Confirmation Data Analysis**: provides a detailed evaluation of the Phase II confirmation data, including the screening of site COPC concentrations against established LANL-wide background values (BVs).
- **Section 4, Site Screening Assessments**: provides the screening of the potential human health and ecological risks to residual concentrations of chemicals at the MDA P Site.
- **Section 5, Ecological Risk Assessment for Cañon de Valle**: details the Cañon de Valle risk assessment, with an emphasis on the potential risk to Cañon de Valle ecological receptors due to the historical and potential future transport of COPCs to the canyon from the MDA P Site.

Additional supporting documentation is provided as attachments:

- **Attachment 1, Ecological Scoping Checklist**: provides details of the general site setting, ecology, and surface hydrology, as observed during a site visit, August 28, 2002.
- **Attachment 2, Statistical Calculations, Analyses, and Plots**: provides documentation related to the statistical analyses performed for supporting the risk assessment process and conclusions.

Note: The figures, tables, and attachments called out in this appendix have been inserted after their respective tabs at the end of this appendix.

2.0 ENVIRONMENTAL SETTING

This section briefly introduces the environmental setting of the MDA P Site, including a summary of the geology, groundwater and surface water, meteorology and climate, biology, and current post-excavation condition of the site.

2.1 General Site Setting

LANL is a 43 square mile facility located in north-central New Mexico, approximately 60 miles northeast of Albuquerque and 20 miles northwest of Santa Fe. LANL lies on the Pajarito Plateau, which consists of fingerlike mesas separated by deep canyons that contain ephemeral and intermittent streams generally oriented west to east. The mesa tops of the Pajarito Plateau range in elevation from approximately 6,200-7,800 feet above mean sea level. The eastern portion of the plateau stands approximately 300-900 feet above the Rio Grande River.

The MDA P Site is located at the LANL TA-16 Burning Grounds, within the HE Exclusion Area (Figure 2.1-1). The individual SWMUs at the MDA P Site are shown in Figure 2.1-2. The TA-16 Burning Grounds are located within a broad topographic saddle on an east-trending mesa. The MDA P Site is located on the north side of the Burning Grounds within a small, open watershed that drains to a small tributary of Water Canyon called Cañon de Valle. The saddle runs between two topographic hills to the east and west and at its lowest point is at an elevation of approximately 7,450 feet. TA-16 is located entirely on land operated by the U.S. Department of Energy (DOE) and is isolated from public access by security fencing and security checkpoints.

2.2 Geology

Major eruptions in the Jemez Mountains and the surrounding area occurred about 1.2 to 1.6 million years ago and this volcanism is reflected in the geology of the Pajarito Plateau. Pertinent stratigraphic units (from youngest to oldest) are: the Bandelier Tuff, Puye Conglomerate, and Precambrian basement rocks (Broxton et al. 2002, 72640). Bandelier Tuff, which includes ash fall, ash fall pumice, and rhyolite tuff, forms most of the finger-like mesas and ranges from more than 1,000-feet thick in the western part of the plateau to approximately 260 feet in the eastern plateau. The Bandelier Tuff is an ignimbrite sequence formed by widespread deposition and consolidation of ash flows, pyroclastic material, and includes welded tuff and non-welded but recrystallized ash flows. The degree of welding in the Bandelier Tuff increases westward across the plateau. Greater welding in the tuff reduces the porosity and capillary size of the pores and is likely a strong influence on transmissivity properties. The Puye Conglomerate is composed of fanglomerate that is interbedded with volcanic deposits. At TA-16, the Bandelier Tuff is unsaturated and is approximately 844 feet thick; the Puye Conglomerate is more than 1090 feet thick; and the thickness of the Precambrian rocks is unknown (Broxton et al. 2002, 72640).

The Phase II activities included a focused geophysical and geochemical study for characterizing the surface and subsurface fractures at the site. The following measurements were taken in a series of

boreholes drilled at the site: natural gamma levels, borehole diameters, electromagnetic conductivity, neutron logs, heat-pulse flowmeter (HPF), and borehole imaging. The study results indicate that the west side of the MDA P footprint displays the following features: a series of small faults, a small graben, elevated fracture density and larger apertures in Bandelier Tuff Units 3 and 3T. The eastside has fewer fractures and overall smaller apertures. HPF data have demonstrated that fractures in the westside are capable of transmitting larger volumes of water to the subsurface under saturated conditions than fractures in the eastside, though saturated conditions are not presented in the MDA P Site, as discussed in section 2.3.

2.3 Groundwater

Groundwater flow through the unsaturated fractured rock is affected by lithologic and structural characteristics, including porosity, degree of welding, density and fracture apertures, infiltration, percolation, precipitation, evaporation, and runoff. The only aquifer of the Pajarito Plateau capable of supplying municipal or industrial water lies in the Santa Fe Group and Puye Formation. The regional aquifer at the MDA P Site is approximately 1200 feet below the surface. Findings of the MDA P Phase II focused geochemical study indicate that continuous saturated conditions, as are observed along the Cañon de Valle stream, do not extend laterally to produce a continuous, perched water table beneath the MDA P Site. The Phase II focused study findings also show the fracture systems in the eastside do not appear to be capable of conducting water to the subsurface. The fractures in the westside, however, are capable of transmitting water only under saturated conditions. In the unsaturated conditions that are prevalent in this area, the fractures serve to enhance air movement and, thus, evaporation of water that may infiltrate from the surface. Surface-to-groundwater hydrologic connection will only be possible if, in the future, saturated conditions from a perennial source of water exist to alter the current balance between percolation and evaporation in the subsurface.

2.4 Surface Water

There are no perennial water sources within the MDA P watershed. Currently, run-on is directed away from the site into two, adjacent watersheds, using natural and engineered landscape features; the bar ditch along the north side of the access road leading from the west into the Burning Grounds is diverted through a culvert to the drainage south of the saddle. Runoff of precipitation that falls within the boundaries of the MDA P Site is generally diverted to the west and east of the site, into channels/ephemeral drainages that ultimately terminate in Cañon de Valle; overland flow from the former 387 Flash Pad in the northern portion of the site is currently diverted through a remnant of the MDA P run-on trench to an ephemeral drainage east of the landfill footprint. Large precipitation events may cause breaching of the diversion channels and result in significant sheet flow across the surface of the site, ultimately terminating in Cañon de Valle. Cañon de Valle is fed continuously from upstream springs and has perennial flow across the "reach" (the canyon area directly downgradient) of the MDA P Site.

2.5 Meteorology and Climate

The Los Alamos area has a temperate mountain climate with four distinct seasons. Generally, spring is dry and windy, summer begins warm and dry through June and is followed by a 2-month rainy season. The fall weather is cooler and drier than the summer. During the winter, snow covers the ground for approximately two months. The dry atmosphere promotes rapid nighttime cooling near the ground. Summer daytime temperatures range from 21 to 31ºC (70 to 88ºF) and 10 to 15ºC (50 to 59ºF) during the nighttime; winter daytime temperatures range from 1 to 10ºC (30 to 50ºF) and -9 to -4ºC (15 to 25ºF) during the nighttime (Bowen 1990, 06899). The average annual precipitation is 48 centimeters (cm) (19 inches [in.]), which includes both rain and water equivalent of frozen precipitation, generally distributed as snowfall. Due to the eastward slope of the Pajarito Plateau terrain, a large east-to-west gradient in

precipitation exists across the plateau; the eastern flanks of the Jemez Mountains can receive up to 13 cm (5.1 in.) more precipitation annually than the western portions of the plateau.

2.6 Biology

This section provides a summary of the biota at LANL, as presented in "Screening Level Ecological Risk Assessment Methods" (LANL 1999, 64783), which can be consulted for additional information.

The mean elevation at TA-16 is approximately 7450 feet and the overstory vegetative cover type is a mixed conifer forest, specifically Rocky Mountain montane mixed conifer forest. Mixed conifer forests are typically found between 6,900 and 10,500 feet in elevation, are blended with ponderosa pine communities, and may extend to lower elevations on north-facing canyon slopes. Douglas fir and white fir (*Abies concolor*) are the typical overstory dominant tree species in mixed conifer forests. Limber pine (*Pinus flexilis*) can also be found in mixed conifer forests, particularly on rocky ridgelines.

Understory vegetation includes shrub species such as, big sagebrush (*Artemisia tridentata*), wax currant (*Ribes cerceum*), four-wing saltbush (*Atriplex canescens*), currant (*Ribes* sp.), and mountain mahogany (*Cercocarpus betuloides*). Other common understory plants are blue grama grass (*Bouteloua gracilis*), prickly pear cactus (*Opuntia* spp.), snake weed (*Gutierrezia microcephala* and *Gutierrezia sarothrae*), pinque (*Hymenoxys richardsonii*), wild chrysanthemum (*Bahia dissecta*), leafy golden aster (*Chrysopsis filiosa*), purple horned-toothed moss (*Ceratadon purpureus*), several lichen species, three-awn grass (*Aristida* spp.), bottlebrush squirreltail (*Sitanion hystrix*), bluegrass (*Poa* spp.), and false tarragon (*Artemisia dracunculus*).

A variety of fauna, including insects, reptiles, mammals, and birds inhabit the area. Harvester ants are the most abundant insects. Commonly found reptiles include fence lizards (*Sceloporous undulates*), Plateau striped whiptails (*Cnemidophorus velux*), gopher snakes (*Pituophis melanoleucus*), and garter snakes (*Thamnophilis elegans*). Mammals inhabiting the LANL area include bobcat (*Lynx rufus baileyi*), mountain lion (*Felis concolor*), mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus nelsoni*), black bear (*Ursus americanus amblyceps*), coyote (*Canis latrans*), fox (*Urocyon cinereoargenteus scottii*), and a number of rodent species. A wide variety of bird species, such as raptors and songbirds, are found at LANL. The Mexican spotted owl (*Strix occidentalis lucida*) is a threatened species resident in Cañon de Valle, downgradient of the MDA P Site.

2.7 Current Site Conditions

The current, post-excavation MDA P Site is comprised of two distinct zones: an "exposed tuff zone" and a "biological zone" (Photographs 2.7-1, 2.7-2, and Figure 2.7-1). Photograph 2.7-1 shows the MDA P Site as excavation activities were being completed: the middle area of the site is the flat portion of the exposed tuff zone, in front of which is the unconsolidated tuff area that slopes steeply towards the Cañon de Valle; the uppermost portion of the site is the now-restored and reseeded area called the biological zone (shown in the photograph with soil piles in the right half of the site). Photograph 2.7-2 is a recent (October 2002) photograph of the site, showing the restored/revegetated areas in green surrounding the exposed tuff zone; particularly evident is the steep slope transitioning from the biological zone (towards the left of the excavation area, adjacent to the forest boundary). Figure 2.7-1 shows the SWMU boundaries and the extent of the biological and exposed tuff zones within the MDA P Site. Additional photographs of the current site condition are provided in Appendix C to this certification report.

The biological zone consists of undisturbed or reclaimed areas (~5.1 acres of the nearly 9.25 acre site), which essentially border the main excavation area to the south, east, and west. The reclaimed areas within

the MDA P Site have approximately 2 feet of topsoil, though the soils in some locations near the east and west perimeters of the site can be as deep as approximately 5 feet. The reclaimed areas have thriving plant communities that are composed primarily of grasses and ruderal species representative of successional or transitional areas. Undisturbed areas outside the MDA P Site footprint contain deeper soils (up to 5 feet on average, with deeper soils possible) that support mature vegetation (including deeper rooted shrubs and trees that are typical of the Rocky Mountain montane mixed conifer vegetation type). Evidence of animal activity (tracks and scat of small and large mammals) was observed in the biological zone during a recent site visit (August 28, 2002; see Ecological Checklist, Attachment 1).

The exposed tuff zone consists of a single, large, and continuous area of exposed tuff (~4.25 acres of consolidated tuff or unconsolidated tuff with large boulders) from which the topsoil was removed during the Phase I excavation activities. In contrast to the biological zone, the exposed tuff zone is largely bereft of plants and supports little or no animal activity. Each zone is considered separately in the risk assessment analysis because of the large differences in transport mechanisms and receptor exposure pathways between the two zones.

3.0 CONFIRMATION DATA ANALYSIS

3.1 Introduction

Analytical suites included in the Phase II confirmation samples that are relevant to the risk assessment analyses include: target analyte list (TAL) metals (herein referred to as inorganics); organic chemicals (HE compounds; semivolatile organic compounds [SVOCs]; volatile organic compounds [VOCs]; dioxins/furans; herbicides; pesticides; polychlorinated biphenyls [PCBs]); and radionuclides (cesium-137, uranium-234, uranium-235, and uranium-238). Table 3.1-1 summarizes the total number of Phase II confirmation samples used in the risk assessments by analyte group, including the division of samples into the biological and exposed tuff zone. The total number of Phase II confirmation samples collected for each analytical suite is summarized in Table 2.4-2 of the certification report. The data quality analysis of the Phase II confirmation samples, including a description of data qualifiers pertinent to the confirmation samples used in the risk assessment analyses, is provided in Appendix B of this report.

Samples from the biological zone are categorized as “soil” or “tuff” in the data evaluation. The designation of the matrix type, as determined at the time of sampling, was retained, with the exception that samples designated as “fill” are treated as “soil.” All samples from the exposed tuff zone are treated as “tuff,” regardless of the matrix type designated by the sampling team at the time of sample collection; this decision was made after the site visit by the risk assessment team (August 28, 2002), during which it was observed that the fine material that remains at the exposed tuff zone (apparent in surface anomalies, e.g., depressions or cracks in the tuff, that provide isolated and discontinuous microsites with a tendency to accrete fine materials/deposits) is unconsolidated tuff. This approach was agreed upon by LANL with the NMED and EPA Region 6 (LANL 2002, 73791).

A site map showing the locations of all Phase II final confirmation samples, the sample location grid, the extent of the biological and exposed tuff zones, and other features of the MDA P Site is provided as Figure 3.1-1. The biological zone includes all samples outside of the contiguous exposed tuff zone area.

3.2 Evaluation of Data

This section summarizes the comparison of the confirmation samples at the MDA P Site to LANL BVs for inorganics and radionuclides (LANL 1998, 59730). Also provided is a presentation of the organic

chemicals detected in confirmation samples at the MDA P Site. The statistical analyses and calculations used in this assessment are detailed in Attachment 2 to this appendix.

3.2.1 Inorganic Chemical Comparison with Background

Biological Zone-- Soil

Ten of the 21 inorganic chemicals sampled for in the biological zone soil exceeded their respective BVs: antimony, barium, cadmium, chromium, cobalt, copper, lead, manganese, silver, and zinc. Table 3.2.1-1 summarizes the inorganic analytical data for the biological zone, including frequency of detection, range of concentrations measured in the confirmation samples, and a comparison of the concentrations of each analyte to the BVs determined for LANL soil (LANL 1998, 59730). Only 19 inorganic chemicals are listed in Table 3.2.1-1; because hexavalent chromium (Cr^{6+}) and perchlorate were not detected in any of the confirmation samples taken in the biological zone soil and were eliminated as COPCs. Essential macro-nutrients, such as calcium, magnesium, potassium, and sodium are not used to determine potential risk to receptors.

Box-and-whisker plots in Attachment 2 to this appendix (Figures B-1 through B-19) show the distribution of the background data sets relative to the distributions of the confirmation sample data sets. The box-and-whisker plots provide for a qualitative, visual comparison that can be used to clearly identify the following four cases:

1) Inorganic chemical concentrations in the confirmation samples that are all below the BV (e.g., aluminum in soil; Attachment 2, Figure B-1a). These inorganic chemicals are eliminated as COPCs based on the data comparisons;
2) Confirmation samples with inorganic chemical concentrations that exceed the BV and/or the maximum concentrations of the background data sets (e.g., aluminum in tuff; Attachment 2, Figure B-1a). These inorganic chemicals were preliminarily identified as COPCs based on the data comparisons;
3) Chemicals with median concentrations and/or data ranges that appear to be similar between the confirmation and background data sets, and the BV is exceeded by some confirmation samples (e.g., lead in soil; Attachment 2, Figure B-11a). These chemicals were preliminarily identified as COPCs; and
4) Chemicals with median concentrations and/or data ranges that are dissimilar between the confirmation and background data sets (e.g., barium in soil and tuff; Attachment 2, Figure B-4a).

Two statistical tests were used to determine whether the 10 inorganic chemicals preliminarily identified as COPCs in soil (Table 3.2.1-1) could be eliminated because the confirmation data sets are not statistically different from the background data sets.

The statistical tests used were a Wilcoxon Rank Sum (WRS) Test and a quantile test for comparisons of the distributions. Details of these statistical tests, including assumptions and methodology, are provided in Attachment 2. The WRS Test is a nonparametric distribution test of the hypothesis that samples within two data sets were taken from distributions with the same medians, i.e., it tests whether the background data and the confirmation data are similar. The quantile analysis is a nonparametric distribution evaluation of the differences in the upper tails of the distributions, i.e., it tests whether the upper end of the confirmation data set is similar to the upper end of the background data set. By using two tests, a COPC that fails the WRS Test because of a limited number of relatively high concentrations when compared to background, may pass the quantile test and be eliminated as a COPC for the site. The quantile test can also be used to determine whether a data set with a low median relative to background

and some exceedances of the BV is statistically different from the background data set. The quantile test is useful for detecting differences in the upper tails of the two data sets (in other words, to identify areas of elevated concentrations at a site). The two distributions within a test are assumed to possess the same variance. The quantile test is a test of the null hypothesis that the site data are not different from the background data, with respect to the upper tails of the distributions. One disadvantages of the quantile test is that it is not sensitive to the magnitude of the outliers (i.e., cadmium and zinc passed the quantile test with a single high concentration relative to background).

Inorganics were eliminated as COPCs for the following reasons:

- The maximum concentration in the confirmation samples was less than the corresponding BV.
- The distribution comparison passed for both the WRS and quantile test;
- The analyte failed the WRS test due to the fact that the site median was statistically different than background but was at a lower concentration and the distribution passed the quantile test; and
- The analyte passed the WRS test but failed the quantile test due to a very limited number of detection(s) greater than the BV.

Results of the WRS statistical comparisons of the 10 inorganic chemicals preliminarily identified as COPCs in soil (Table 3.2.1-1) are presented in Table 3.2.1-2. A significance level (p-value) of 0.05 was used to determine differences in the data sets; a p-value >0.05 indicates the data sets are not statistically different at a 95% confidence level. Two COPCs for the biological zone soil (copper and zinc) had distributions of the confirmation sample data sets that were not significantly different than the background data sets. The box-and-whisker plot comparisons support these results; for copper and zinc, which passed the WRS Test, the medians of the confirmation and the background data sets are quite similar (Attachment 2, Figures B-9a and B-19a, respectively). Results of the subsequent quantile distribution comparisons are presented in Table 3.2.1-3. Of the 10 inorganic chemicals, 8 passed the quantile test for the biological zone soil (antimony, cadmium, chromium, cobalt, lead, manganese, thallium, and zinc). The box-and-whisker plot comparisons indicate that there are limited numbers of concentrations detected above the BVs and the upper tails of the distributions are similar to those of the background data sets (Attachment 2, Figures B-2a, B-6a, B-7a, B-8a, B-11a, B-12a, B-17a, and B-19a, respectively). The results of the biological zone soil distribution comparison are summarized in Table 3.2.1-4. Note that silver could not be eliminated as a COPC based on the distribution comparison tests because a soil background data set for silver is not available. Thus, three inorganic chemicals were retained as soil COPCs for the biological zone based on the statistical analyses: barium, copper, and silver. Cobalt, lead, and zinc were retained as COPCs in the biological zone, regardless of the outcome of the statistical analyses, because they had one or more samples that exceeded soil or tuff background concentrations by several factors or more.

Table 3.2.1-5 presents the analytical results for all soil samples with detected inorganic chemical concentrations or detection limits exceeding BVs for the biological zone. Figures showing grid locations with samples greater than background were generated for the entire MDA P Site for all inorganic chemicals detected above background and are discussed in the context of the nature and extent of residual concentrations of chemicals at the MDA P Site (section 3.4).

Biological Zone—Tuff

Sixteen of the 20 inorganic chemicals sampled for in the biological zone tuff exceeded their respective BVs: aluminum, antimony, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, nickel,

selenium, silver, thallium, vanadium, and zinc. Table 3.2.1-1 summarizes the inorganic analytical data for the biological zone tuff, including frequency of detection, range of concentrations measured in the confirmation samples, and comparison of the concentrations of each analyte to the BVs determined for LANL tuff (LANL 1998, 59730). Cr^{+6} was not detected in any of the confirmation samples and is not listed in Table 3.2.1-1. Perchlorate was not sampled for in tuff. Essential macro-nutrients, such as calcium, magnesium, and potassium, are not used to determine potential risk to receptors.

Box-and-whisker plots in Attachment 2 (Figures B-1 through B-19) show the distributions of the background data sets relative to the distributions of the confirmation sample data sets. As with the soil confirmation samples, two statistical tests were performed to determine whether the 16 inorganic chemicals preliminarily identified as COPCs in tuff could be eliminated because the confirmation data sets were not statistically different from the background data sets.

Results of the WRS distribution comparisons of the 16 inorganic chemicals preliminarily identified as COPCs in tuff are presented in Table 3.2.1-2. Of the 16 inorganic chemicals, four COPCs for the biological tuff zone (arsenic, beryllium, lead, and zinc) had distributions of the confirmation sample data sets that were not significantly different from the background data sets. The box-and-whisker plot comparisons for arsenic, beryllium, lead, and zinc (Attachment 2, Figures B-3a, B-5a, B-11a, and B19a, respectively) support these results, as the medians of the confirmation data sets and the background data sets are quite similar. Results of the quantile distribution comparisons of the 16 inorganic chemicals are presented in Table 3.2.1-3. Of the 16 inorganic chemicals, 9 were eliminated as COPCs for the biological zone tuff, based on the quantile test (arsenic, beryllium, chromium, cobalt, iron, silver, thallium, vanadium, and zinc). The box-and-whisker plots support these conclusions, as iron, silver, and thallium have a limited number of concentrations above the BVs and the upper tails of the distributions are similar to those of the background data sets (Attachment 2, Figures B-10a, B-16a, and B-17a, respectively). Thus, eleven inorganic chemicals were retained as COPCs for the biological zone tuff: aluminum, antimony, barium, chromium, cobalt, copper, iron, lead, nickel, selenium, and vanadium. The results of the biological zone distribution comparison are summarized in Table 3.2.1-4. Cobalt, lead, and zinc were retained as COPCs in the biological zone, regardless of the outcome of the statistical analyses, because they had one or more samples that exceeded soil or tuff background concentrations by several factors or more.

Table 3.2.1-5 presents the analytical results for all tuff samples with detected inorganic chemical concentrations or detection limits exceeding BVs for the biological zone. Figures showing grid locations with samples greater than background were generated for the entire MDA P Site for all inorganic chemicals detected above background and are discussed in the context of the nature and extent of residual concentrations of chemicals at the MDA P Site (section 3.4).

Exposed Tuff Zone

Nineteen of the 21 inorganic chemicals sampled for in the exposed tuff zone exceeded their respective BVs for tuff: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. Additionally, perchlorate, which was analyzed for in 33 samples does not have an associated BV and was retained as a COPC because it was detected in seven samples. Cr^{+6} was eliminated as a COPC because it was not detected. Table 3.2.1-6 summarizes the inorganic analytical data for the exposed tuff zone, including frequency of detection, range of concentrations measured in the confirmation samples, and comparison of the concentrations of each analyte to the BVs determined for tuff (LANL 1998, 59730).

Box-and-whisker plots in Attachment 2 (Figures B-1 through B-19) show the distributions of the background data sets relative to the distributions of the confirmation sample data sets. As with the confirmation samples in the biological zone, two statistical tests were performed to determine whether the 19 inorganic chemicals above BVs could be eliminated because the confirmation data sets were not statistically different from the background data sets.

Results of the WRS Test distribution comparisons of the 19 inorganic chemicals preliminarily identified as COPCs in the exposed tuff zone are presented in Table 3.2.1-7. Of the 19 inorganic chemicals, two COPCs for the exposed tuff zone (arsenic and lead) had distributions of the confirmation sample data sets that were not significantly different from the background data sets. The box-and-whisker plot comparisons support these results; for arsenic and lead, which were removed based on the WRS Test, the medians of the confirmation and the background data sets are quite similar (Attachment 2, Figures B-3b and B-11b, respectively). Results of the subsequent quantile distribution comparisons of the 19 inorganic chemicals are presented in Table 3.2.1-8. Of these 19 inorganics, 6 could be eliminated as COPCs for the exposed tuff zone. For the inorganic chemicals eliminated as COPCs based on the quantile comparison, there are a limited number of concentrations above the BVs and the upper tails of the distributions are similar to those of the background data sets (Attachment 2, Figures B-6b, B-12b, B-16b, B-17b, and B-19b, respectively). Thus, 15 inorganic chemicals were retained as COPCs for the exposed tuff zone: aluminum, antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, vanadium, and zinc; perchlorate was also retained as a COPC because it was detected and lacks a BV. The results of the exposed tuff zone distribution comparison are summarized in Table 3.2.1-9.

Table 3.2.1-10 presents the analytical results for all samples with detected inorganic chemical concentrations or detection limits exceeding BVs in the exposed tuff zone. Figures showing grid locations with samples greater than background were generated for the entire MDA P Site for all inorganic chemicals detected above background and are discussed in the context of the nature and extent of residual concentrations of chemicals at the MDA P Site (section 3.4).

3.2.2 Radionuclide Comparison with Background Values

Biological Zone—Soil

Four radionuclides that might be associated with historical operations at the MDA P Site were detected in the soil samples from the biological zone, for which 3 to 5 samples were taken: cesium-137, uranium-234, uranium-235, and uranium-238. However, none of these were detected at activities exceeding the soil BVs or fallout values (LANL 1998, 59730). Table 3.2.2-1 summarizes the radiochemical analytical data, including frequency of detection, established BVs, and range of activities measured in the confirmation samples for all detected radionuclides.

Biological Zone—Tuff

No radionuclides were sampled for in the biological zone tuff.

Exposed Tuff Zone

Three radionuclides that might be associated with historical operations at the MDA P Site were detected in the tuff samples from the exposed tuff zone: uranium-234, uranium-235, and uranium-238. However, none of these radionuclides were detected at activities exceeding the soil BVs. Table 3.2.2-2 summarizes the radiochemical analytical data, including frequency of detection, established BVs, and range of activities measured in the confirmation samples for all detected radionuclides.

3.2.3 Evaluation of Organic Chemicals

Organic chemicals do not have background data for soil or tuff. The identification of organic COPCs is based upon whether a chemical is detected or not in the confirmation samples and does not require that the samples be separated by media type. Thus, all confirmation samples from the biological zone were grouped together for determining organic COPCs. Organic chemicals that were detected in less than 5% of the confirmation samples were eliminated as COPCs, per U.S. Environmental Protection Agency (EPA) guidance (EPA 1989, 08021).

Biological Zone

Nineteen organic chemicals were detected in one or more of the biological zone samples. However, 9 of these were detected in less than 5% of the samples and were eliminated as COPCs (EPA 1989, 08021); the remaining 10 organic chemicals were retained as COPCs for the biological zone: acetone, amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], Aroclor-1260, bis(2-ethylhexyl)phthalate, DDT[4,4'-] (dichlorodiphenyltrichloroethane), HMX (1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane), RDX (1,3,5-trinitro-1,3,5-triazacyclohexane), toluene, and trinitrotoluene[2,4,6-]. Table 3.2.3-1 summarizes the organic analytical data, including frequency of detection, range of concentrations measured in the confirmation samples, and the maximum estimated quantitation limits (EQLs) for all detected organic chemicals. Samples with detected concentrations for the 10 organic COPCs are summarized in Table 3.2.3-2. Figures showing grid locations with detections of organic chemicals retained as COPCs were generated for the entire MDA P Site and are discussed in the context of the nature and extent of residual concentrations of chemicals at the MDA P Site (section 3.4).

Exposed Tuff Zone

Sixteen organic chemicals were detected in one or more of the exposed tuff zone samples. However, 7 of the organic chemicals were detected in less than 5% of the samples and were eliminated as COPCs (EPA 1989, 08021); the remaining 9 organic chemicals were retained as COPCs for the exposed tuff zone: amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], bis(2-ethylhexyl)phthalate, carbon disulfide, HMX, RDX, toluene, trinitrobenzene[1,3,5-], and trinitrotoluene[2,4,6-]. Table 3.2.3-3 summarizes the organic analytical data, including frequency of detection, range of concentrations measured in the confirmation samples, and the maximum EQLs for all detected organic chemicals. Samples with detected concentrations for the 9 organic COPCs are summarized in Table 3.2.3-4. Figures showing grid locations with detections of organic chemicals retained as COPCs were generated for the entire MDA P Site and are discussed in the context of the nature and extent of residual concentrations of chemicals at the MDA P Site (section 3.4).

3.2.4 Summary of COPCs for the MDA P Site

The COPCs identified for the MDA P Site, for both the biological zone and the exposed tuff zone, are summarized in Table 3.2.4-1. The inorganic chemicals are categorized by matrix type for the biological zone because the BVs used to determine COPCs are matrix-specific.

A total of 16 inorganic chemicals were retained as COPCs for further evaluation for the MDA P Site. Six inorganic chemicals were identified as COPCs for the biological zone soil (barium, cobalt, copper, lead, silver, and zinc). Twelve inorganic chemicals were identified as COPCs for the biological zone tuff (aluminum, antimony, barium, chromium, cobalt, copper, iron, lead, nickel, selenium, vanadium, and zinc). Fifteen inorganic chemicals were identified as COPCs for the exposed tuff zone (aluminum, antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, perchlorate, selenium, vanadium, and zinc).

A total of 12 organic chemicals were retained as COPCs for further evaluation for the MDA P Site. Ten organic chemicals were identified as COPCs for the biological zone (acetone, amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], Aroclor-1260, bis(2-ethylhexyl)phthalate, DDT[4,4'-], HMX, RDX, toluene, and trinitrotoluene[2,4,6-]). Nine organic chemicals were identified as COPCs for the exposed tuff zone (amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], bis(2-ethylhexyl)phthalate, carbon disulfide, HMX, RDX, toluene, trinitrobenzene[1,3,5-], and trinitrotoluene[2,4,6-]).

No radionuclides were identified as COPCs for the MDA P Site.

3.3 Conceptual Site Model

This section provides the framework for the conceptual model of COPC release, transport, and potential exposure to human and ecological receptors that may be impacted by residual contamination at the MDA P Site. Key elements of the conceptual model that are summarized include the following:

- Current site conditions;
- Past releases that are known, or are assumed, to have occurred at the MDA P Site;
- Identification of contaminated media based on past releases and transport mechanisms that previously operated at the site;
- Identification of contaminated media based on residual contamination and transport mechanisms that currently operate at the site;
- Identification of exposure pathways for potential human and ecological receptors to COPCs remaining within the MDA P Site footprint; and
- Identification of exposure pathways for potential ecological receptors due to current and historical transport of MDA P COPCs to Cañon de Valle.

Past Releases

The primary mechanism of past releases of chemicals at the MDA P Site is related to the former material disposal operations conducted at the site. Contamination of surface soils and tuff occurred through transport and dispersion from the contaminated debris and soil generated and accumulated during the operations at the MDA P Site. Additional releases likely occurred via leaching through the landfill contents and surface water runoff from the MDA P Site to the Cañon de Valle channel, located downgradient of the MDA P Site.

Contaminated Media—Past Releases

Soil and tuff are the contaminated media within the boundaries of the MDA P Site associated with past releases. The majority of COPCs identified for both the exposed tuff and biological zones are in soil and tuff at depths less than 5 feet. Surface water does not currently exist at the site and excavation and removal activities resulted in the elimination of all potential near-saturated and ponded water sources at the surface, eliminating surface water as a medium of concern within the boundaries of the MDA P Site. Groundwater is also ruled out as a potentially contaminated medium underneath the MDA P Site and contamination beneath the site does not extend to the depth of the regional aquifer (1200 feet). This is consistent with the findings of the Phase II focused geochemical study, which indicate that saturated conditions, as are observed along the Cañon de Valle stream, do not extend laterally to produce a continuous perched water table beneath the MDA P Site (LANL 2003, 77423). Also, the depth to the regional aquifer (1200 feet) precludes deep transport of residual contamination near the surface under unsaturated conditions. The soil-to-groundwater pathway would be complete only if the surface hydrology changed such that ponded water was available to provide a hydraulic head for moving contaminants to groundwater; this scenario is ruled out for the site because of the lack of potential surface water sources at the site. Past releases that may have occurred via surface water runoff from the MDA P

Site to the downgradient Cañon de Valle might have contributed to contamination of the sediments and surface water of the stream.

Contaminated Media—Current Conditions

As described for past releases, the only contaminated media currently within the boundaries of the MDA P Site are soil and tuff, for which the residual contamination is largely limited to depths less than 5 feet. Surface water within the boundaries of the MDA P Site and groundwater beneath the MDA P Site are not impacted by the residual contamination in the soil and tuff under current conditions. Currently, run-on is directed away from the site into two, adjacent watersheds, using natural and engineered landscape features. Runoff of precipitation that falls within the boundaries of the MDA P Site is generally diverted to the west and east of the site, into channels that terminate in Cañon de Valle. Large precipitation events may cause breaching of the diversion channels and result in sheet flow across the surface of the site, terminating in the Cañon de Valle.

Potential transport from the exposed tuff zone differs from that of the biological zone and the impact of transport from each zone is considered separately in the risk screening evaluations. Surface soils have been removed from the exposed tuff zone, which has also been denuded of all mature, native vegetation. Because there are currently no areas for ponding or with near-saturated conditions within the exposed tuff zone, the current conditions promote runoff and inhibit infiltration. Also, because the residual contamination is limited to the tuff, transport from the site is controlled primarily by the extremely slow rate of weathering of the tuff. Thus, while movement of contaminants via runoff is the most important transport mechanism from the exposed tuff zone, the actual rate of transport is directly proportional to the rate of weathering of the tuff; the weathering process of the tuff is best described in the context of geologic time (1000s of years), indicating that off-site transfer is negligible. Exposure of receptors in Cañon de Valle to residual contamination from the exposed tuff zone is also negligible.

Outside, and surrounding, the exposed tuff zone is the biological zone, which includes undisturbed locations or previously disturbed locations that have been reseeded/reclaimed. The soils in the biological zone are approximately 2 to 5 feet deep (though in some locations, soils may exceed 5 feet) and are inhabited by grasses and plants typical of successional or transitional areas that have been subjected to some kind of disturbance. Erosion of the topsoil that remains at the site within the biological zone has been mitigated by the implementation of Best Management Practices (BMPs), including slope stabilization and erosion control measures. Transport of residual contamination from the biological zone to Cañon de Valle is still possible through surface water runoff, though the presence of topsoil, plant cover, and the BMP features tend to promote infiltration of water within the surface soil, making runoff a minor transport pathway for the biological zone.

Natural, physiographic boundaries (terrain constraints) limit the lateral extent of both past and future transport. The off-site transport of contaminants is constrained by drainage channels to the east and west of the site and the up-gradient road to the south, such that all run-on and runoff is directed to Cañon de Valle. Because the Phase II confirmation samples cover the majority of the MDA P Site, including locations beyond the historic and current natural boundaries of the site, the lateral extent of residual contamination related to the MDA P Site has been sufficiently defined; in other words, locations subject to potential contamination from either historic use or transport processes have been appropriately captured by the confirmation sampling. Additionally, because the depth of the confirmation sampling extends well below the residual contamination in the soil and tuff, the vertical extent of contamination has been sufficiently defined; in other words, locations subject to potential contamination from either historic use or historic transport processes have been captured by the confirmation sampling. The ecological

impacts due to the transport of COPCs to the canyon are evaluated in a focused risk assessment for Cañon de Valle receptors (section 5.0).

Exposure Pathways—Human Receptors

Potential, complete exposure pathways from COPCs in surface soil and tuff include inhalation of fugitive dust and direct exposure to soil and tuff via dermal contact or incidental ingestion. Potential exposure pathways due to COPCs in subsurface soil and tuff would be complete only if contaminated soil or tuff were excavated and brought to the surface, in which case the potential exposure pathways would be similar to surface soil exposures. Weathering of tuff is the only viable natural process that may result in the exposure of receptors to COPCs in tuff; because of the slow rate of weathering expected for tuff, exposure to COPCs in tuff is negligible. This assessment assumes that a reasonable depth of exposure is 0 to 5 feet in soil; for consistency, 5 feet is also assumed to be the depth of exposure for tuff. This is conservative because 1) COPCs in tuff will cause exposure only as weathering occurs, and 2) the highest COPC concentrations are in samples within the top few feet of soil. Also, this is reasonable because the assumed 5-foot depth of exposure captures the average depth of soil and, thus, exposure to COPCs in soil at the site. Typically, potential risk to human receptors is determined based on exposure to COPCs in the top 10 feet of soil. For the MDA P Site, the majority of the samples are in the top 5 feet and those few COPCs below 5 feet are at lower concentrations. Thus, the exclusion of deeper samples results in a more conservative assessment because the 95% UCL concentrations based on the samples within the 0- to 5-foot interval are not "diluted" by the lower concentrations of the deeper samples.

Because no surface water currently exists at the site and excavation activities resulted in the elimination of all potential near-saturated and ponded water sources at the surface, potential human health exposure pathways due to surface water (dermal and ingestion) are incomplete and are not evaluated. Likewise, groundwater is ruled out as a potentially contaminated medium underneath the MDA P Site because no surface-to-groundwater pathways exist. Thus, pathways to the regional aquifer, which is located approximately 1,200 feet below the site, are incomplete are not evaluated.

Exposure Pathways—Ecological Receptors

The exposed tuff zone currently contains surface anomalies (e.g., depressions or cracks in the tuff) that provide isolated and discontinuous microsites with a tendency to accrete fine materials/deposits that can become microhabitats for plants. Thus, some isolated plants are growing within the exposed tuff zone. Use of the exposed tuff zone for foraging or other activities is not expected by animal receptors that may potentially inhabit areas proximal to the MDA P Site. This assessment assumes that a reasonable depth of exposure is 0 to 5 feet. As with the human health exposure, this is conservative because the highest COPC concentrations are in samples within the top few feet of soil and reasonable because this captures the average depth of soil and, thus, exposure to soil at the site. Exposure of ecological receptors to COPCs in tuff is expected to be minor because of the slow rate of the weathering of the tuff.

The remaining area of the MDA P Site footprint, which is yet undisturbed or has been reseeded/reclaimed, currently supports grasses and plants that may be used as forage items by ecological receptors. The shallow depth of the soil in the reclaimed footprint area (an average depth of approximately 2 feet, though as deep as approximately 5 feet in some locations near the east and west perimeters of the site) precludes deep-rooted plants and all but investigative burrowing activities by fossorial mammals, as detailed in the Ecological Scoping Checklist (Attachment 1). Complete exposure pathways for ecological receptors to COPCs in the surface soil and tuff in the biological zone include: uptake by plants; dermal and ingestion pathways for animal receptors; and potential food web transfer because of dermal and ingestion uptake by animal receptors. As discussed previously, this assessment assumes that a reasonable depth of exposure is 0 to 5 feet, regardless of the media type (soil or tuff).

Undisturbed areas outside the MDA P Site footprint contain deeper soils (up to 5 feet and deeper) that supports mature vegetation (including deeper rooted shrubs and trees that are typical of the Rocky Mountain montane mixed conifer forest vegetation type). Significant habitat use by ecological receptors can be expected in these outlying areas, including foraging, nesting, and the development of established burrow systems (vs. investigative burrows within the reclaimed portions of the MDA P footprint) by fossorial mammals. Complete exposure pathways for ecological receptors to COPCs in the surface soil and tuff in the biologically viable areas outside the MDA P footprint include: uptake by plants and dermal and ingestion pathways for animal receptors; and potential food web transfer because of dermal and ingestion uptake by animal receptors. This assessment assumes that a reasonable depth of exposure is 0 to 5 feet, regardless of the media type (soil or tuff) and the exposure to COPCs in tuff is low because of the slow rate of the weathering of the tuff. The assessment of potential ecological risk to receptors in the outlying, undisturbed areas was combined with that for the biological zone within the MDA P footprint because of the similarity of the exposure pathways for ecological receptors and the site-related COPCs.

As with the exposure pathways for human receptors, pathways related to the exposure of ecological receptors to COPCs in surface water at the site are incomplete because no surface water currently exists at the site and excavation activities resulted in the elimination of all potential near-saturated and ponded water sources at the surface. Additionally, groundwater is ruled out as a potentially contaminated medium underneath the MDA P Site; thus, pathways to the regional aquifer, which is located approximately 1,200 feet below the site, are incomplete for ecological receptors at the MDA P Site.

3.4 Nature and Extent of Contamination

Figures with detailed information on the location of inorganic chemicals detected above background (Figures 3.3.2-1 through 3.3.2-13) and detected organic chemicals (Figures 3.3-14 through 3.3.2-19) are provided for those chemicals with more than 10 samples to be plotted as a pictoral description of the extent of residual contamination at the MDA P Site. These figures indicate whether a given sample was from the biological or exposed tuff zone, as well as the matrix type and depth of that sample. Sample locations are identified by Sample Identification numbers and concentrations for each sample are provided in tabular form on each figure. Samples mapped in the figures sometimes appear to be clusters. However, because the sample grids are 30 feet to a side, the actual degree of "clustering" may be misleading on a given figure; in other words, what appear as clusters may actually be isolated locations with concentrations higher than the BV, due to the scale of the sample grid. If a particular analyte had 50 or more sample locations to be displayed, the concentrations are not shown in a table on the figure, but are provided instead as contours. Because the majority of the inorganic chemical concentrations greater than BVs and detected organic chemical concentrations were in the upper surface (0 to 5 feet) of the soil and tuff at the site, all analytical data from 0 to 1 foot were contoured to display the surface concentrations for a given COPC. Contouring was done using Surfer 7.02 software (Surfer 2002, 73768); the default griding method was used (Kriging) and the contours were highly smoothed. The contour intervals were adjusted to fit the grid size of the Phase II sample locations.

The confirmation data adequately determined the horizontal extent of residual COPC concentrations at the site, as the sampling extended beyond the boundaries of excavation and beyond the natural hydrologic barriers that limit potential horizontal transport to the area between the east and west drainages.

Inorganic Chemicals

Each of the inorganic COPCs appears to have a unique spatial pattern of the locations that exceed BVs. Some inorganic COPCs appear to be wide-spread and others are very limited in the extent of residual contamination at the site; some COPCs appear to be clustered, while others have what appear to be random distributions. In general, the residual concentrations of inorganic chemicals are concentrated near,

and within, the boundaries of the former SWMUs (the area of the excavation and removal activities) and therefore, there are generally decreasing trends laterally. Note that the observed trends in the lateral extent of residual contamination may be more an artifact of the extensive excavation activities performed at the site than historic transport of contaminants from the landfill contents to the soil and tuff.

Organic Chemicals

In contrast to the inorganic COPCs, the organic COPCs appear to have spatial patterns of locations with detections that are closely related to the previous site-related activities at the MDA P Site. Some organic COPCs are more ubiquitous than others, but most tend to follow a pattern that can be explained by the historical site uses of the MDA P Site. In general, the residual concentrations of organic chemicals are concentrated near, and within, the boundaries of the former SWMUs (the area of the excavation and removal activities) and therefore, there are generally decreasing trends laterally. Note that the observed trends in the lateral extent of residual contamination may be more an artifact of the extensive excavation activities performed at the site than historic transport of contaminants from the landfill contents to the soil and tuff.

3.5 Depth of Contamination

The investigation of residual contamination at depth was accomplished with the drilling of four boreholes in grid cells 516, 526, 554, and 557. The original commitment was to drill four boreholes to approximately 30 feet in grid cells that were determined to have the highest potential for residual contamination at depth. Subsequent discussions with LANL and NMED personnel determined that two boreholes would be drilled in locations where local drainage may have concentrated contaminants (grid cells 526 and 557) to a target depth of 10 feet below the level of the Cañon de Valle stream; an error in the elevational survey resulted in the two boreholes not reaching the target depth and the final depths of boreholes 526 and 557 reached the approximate elevation of the Cañon de Valle stream. The remaining two boreholes were drilled in grid cells 516 and 554 to depths of 32 and 100 feet, respectively. Although boreholes 526 and 557 did not reach their target depths, the four boreholes, as a group, met the objectives of defining the extent of residual contamination at depth because the vertical extent could be defined by the deep subsurface sampling analytical results. A fifth borehole located in grid cell 273 was drilled to 170 feet for the primary purpose of geologic logging; analytical data derived from the sampling of borehole 273 were included in the analysis of contamination at depth.

The main purpose of the Phase II confirmation samples collected at depth was to identify whether potential site-related COPC concentrations decrease with depth. All COPCs identified for the biological and exposed tuff zones (Table 3.2.4-1) are examined with respect to the distribution of concentrations with depth (Attachment 2, Figures B-20 through B-47). Figures of the inorganic chemical concentrations with depth (Attachment 2, Figures B-20 through B-35) show data for both zones, with no additional detail on whether an individual data point is from tuff or soil or whether it is a detection or a detection limit (such information is available in the box-and-whisker plots in Attachment 2 to this appendix). Figures of the organic chemical concentrations with depth (Attachment 2, Figures B-36 through B-47) do not distinguish between the two zones, but do indicate whether a given data point is a detection or a detection limit.

The confirmation data adequately determined the vertical extent of COPC concentrations in the subsurface soils and tuff at the site, as adequate data at depth were taken to conclude that only residual levels of COPC concentrations exist at depth and the majority of the depth sample results were either not detected or were detected at concentrations below established BVs.

Inorganic Chemicals

The majority of the inorganics identified as COPCs for the biological zone were due to exceedances of BVs for tuff. With very few exceptions, the soil and tuff samples exceeding the BVs in the biological zone and the samples exceeding BVs in the exposed tuff zone were taken between the surface and 4 feet. In general, below 4 feet, the concentrations decrease to background.

Organic Chemicals

In contrast to the inorganic COPCs, the organics were identified as COPCs due to detections in both soil and tuff, with three exceptions: Aroclor-1260, DDT[4,4'-], and toluene were retained as COPCs based on detection in a single soil sample. With few exceptions, all organic detections are from samples taken between the surface and 4 feet. Beyond this, the majority of organic COPCs are not detected and the isolated detections that do occur are at or below the maximum EQL, indicating that residual site-related concentrations of organic COPCs do not exist at depth.

4.0 SITE SCREENING ASSESSMENTS

4.1 Introduction

Potential adverse effects to both human and ecological receptors are evaluated for the residual contamination at the MDA P Site. The human health screening assessment was performed according to the approach in the NMED-approved IWP (LANL 1998, 62060) and LANL (2002, 72639). The ecological screening assessment was performed in accordance with the methodology presented in "Screening Level Ecological Risk Assessment Methods" (LANL 1999, 64783).

4.2 Human Health Screening Assessment

A human health screening assessment was used to determine if concentrations of COPCs defined in section 3.2 might result in potential unacceptable risk to human receptors.

4.2.1 Scoping

The MDA P Site exists within the active, operational area of TA-16 and lies entirely on DOE land. The site is isolated from public access by a security fence and security checkpoints. Based on the current and proposed future land use, the site will remain under LANL control and will continue to be used for industrial purposes. Potential human exposure pathways include inhalation of airborne particles or vapors, incidental ingestion of surface soil or tuff, and dermal contact with surface soil or tuff (section 3.3). The potential on-site receptors for both current and future land use will continue to be LANL employees, including both industrial and recreational land uses. However, this screening assessment assumed residential land use to support closure certification and corrective action decisions.

4.2.2 Screening Evaluation

The screening assessment is a comparison of COPC concentrations with screening action levels (SALs). The comparison was based on the 95% upper confidence limit (95% UCL) of the mean concentration of each COPC at MDA P, as presented in the approved SAP (LANL 1999, 63546). If a chemical was a COPC for either zone (biological and exposed tuff), it was assumed to be a COPC for the entire MDA P Site. The derivation and calculation of the 95% UCL values is described in Attachment 2. This assessment assumes a 0- to 5-foot depth of exposure in soil and tuff.

Summary statistics for the COPCs identified at the MDA P Site are presented in Tables 4.2.2-1 (human health) and 4.2.2-2 (ecological screening).

Even though land use at the site is industrial, the SALs used in the screening evaluation reflect a residential exposure scenario, assuming exposure for 24 hours/day for 350 days/year (NMED 2000, 68554; EPA 2001, 71466). The SAL comparison is presented separately for noncarcinogenic and carcinogenic chemicals. The SALs for noncarcinogens are based on a hazard quotient (HQ) of 1.0; SALs for carcinogens are based on a target cancer risk of 10^{-6}. The 95% UCL concentration of each COPC was compared to its corresponding SAL for carcinogens, and 0.1 the SAL for noncarcinogens. The SAL comparisons are presented in Table 4.2.2-3 (noncarcinogens) and Table 4.2.2-4 (carcinogens).

The noncarcinogens identified in the data review (section 3.2) were aluminum, antimony, barium, beryllium, cobalt, copper, iron, lead, mercury, nickel, perchlorate, selenium, silver, vanadium, zinc, acetone, Aroclor-1260, amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], carbon disulfide, HMX, toluene, and trinitrobenzene[1,3,5-]. Among the noncarcinogenic COPCs, only barium and iron had a 95% UCL of the mean concentration greater than one-tenth the respective SAL (Table 4.2.2-3). The sum of the ratio of each COPC exposure calculated as the 95% UCL concentration divided by the respective SAL (i.e., the hazard index [HI]) was less than unity (0.8). This indicates that a human health hazard is not expected from exposure to co-located noncarcinogenic COPCs.

The carcinogens identified in the data review (section 3.2) were Aroclor-1260, bis(2-ethylhexyl)phthalate, chromium, DDT[4,4'-], RDX, and trinitrotoluene[2,4,6-]. None of the carcinogenic COPCs had a 95% UCL concentration above the respective SAL (Table 4.2.2-4), and were less than the NMED target risk level of 10^{-5} (NMED 2000, 68554). The cumulative cancer risk for the entire site was $6x10^{-7}$. Therefore, exposure in the MDA P Site does not result in an unacceptable risk to human receptors.

4.2.3 Additional Human Health Risk Analysis

An additional human health risk analysis was performed to account for potential exposure to a limited area of elevated COPC concentrations. A residential lot of 5400 square feet (~600 square meters) was used to represent the limited potential exposure area. A residential lot was selected for both the biological and exposed tuff zones to be consistent with the locations of high barium concentrations (see Figure 4.2.3-1), because barium was the primary risk driver for both zones. For the biological zone, a single high detection of barium in grid 189 was measured. The barium concentration in this grid was 6,630 mg/kg, which results in an HQ of 1.3. However this barium concentration was within the range of the other concentration evaluated in the residential lots. In addition, there were a limited number of analytical samples within the area of this grid. Therefore, grid 189 was not evaluated as a potential residential lot. There is some residual HE left on site (primarily RDX and HMX). However, because concentrations for the HE COPCs are below the SALs when evaluating MDA P as a whole, the additional analysis focused on barium as the primary COPC for human health. Although the screening analysis determined iron to be a potential risk driver, iron is an essential nutrient and is not expected to create toxicity concerns unless the site concentrations are substantially higher than background; because the 95% UCL concentrations of 10,349 milligrams per kilogram (mg/kg) are within the range of background data (maximum of 19,500 mg/kg), exposure to iron at the MDA P Site is similar to background. Figure 4.2.3-1 shows the barium contour (with locations of relatively high concentrations) and lot layout for the additional human health risk analysis. The lots do not perfectly overlay the contours due to a couple of factors:

- The available analytical data within the grids, and
- The magnitude of the barium concentrations of the nearby grids.

In general, an effort was made to maximize the number of grids with confirmation samples and high barium concentrations.

The inorganic chemical concentrations were compared to the corresponding BV for each residential lot. Inorganic chemicals that were not greater than the BVs were not evaluated for each lot. Organics that were undetected within a lot were also not evaluated. The calculation of the 95 % UCL concentration was identical to the methodology summarized in Attachment 2. Summary statistics for the data sets used for the COPCs identified in the two residential lots are presented in Tables 4.2.3-1 and 4.2.3-2.

Among the noncarcinogenic COPCs in the biological zone residential lot, only barium had a 95% UCL concentration greater than one-tenth the respective SAL but less than the SAL (Table 4.2.3-3), similar to the initial screening results. The sum of the ratio of each COPC exposure calculated as the 95% UCL concentration divided by the respective SAL was less than unity (0.4), indicating that a human health hazard is not expected from exposure to co-located noncarcinogenic COPCs in the biological zone lot.

Only RDX had a 95% UCL concentration slightly above the SAL (Table 4.2.3-4). The cumulative excess cancer risk from exposure to carcinogenic COPCs in the biological zone residential lot was approximately $4x10^{-6}$, which is less than NMED's target risk level of 10^{-5} (NMED 2000, 68554). Therefore, the residential lot in the biological zone does not pose an unacceptable risk to human receptors.

Among the noncarcinogenic COPCs in the exposed tuff zone residential lot, only aluminum, barium, and iron had 95% UCL concentrations greater than one-tenth their respective SALs (Table 4.2.3-5). The sum of the ratio of each COPC exposure calculated as the 95% UCL concentration divided by the respective SAL also slightly exceeded unity (1.7). However, approximately 1/2 of this is due to iron, which is an essential nutrient and is similar to background (95% UCL is less than maximum background concentration of 19,500 mg/kg (LANL 1998, 59730). None of the noncarcinogenic COPCs exceeded the SAL for the 95% UCL concentration.

RDX was the only carcinogenic COPC with a 95% UCL concentration slightly above its respective SAL (Table 4.2.3-6). The cumulative cancer risk from exposure to carcinogenic COPCs for the residential lot in the exposed tuff zone was approximately $1.2x10^{-6}$, which is less than NMED's target risk level of 10^{-5} (NMED 2000, 68554). Therefore, the residential lot for the exposed tuff zone does not pose an unacceptable risk to human receptors.

Evaluation of the residential lots did not change the area-wide results of the screening assessment, although the noncarcinogenic risk increased slightly within the exposed tuff zone lot (from 0.8 to 1.7). Therefore, the site as a whole and the residential lots within each zone do not pose a potential hazard to human health, even with the conservative exposure assumptions used.

4.2.4 Uncertainty Analysis

The analysis presented in this human health screening assessment is subject to varying degrees and kinds of uncertainty. Aspects of data evaluation and COPC identification, exposure assessment, toxicity assessment, and the additive approach all contribute to uncertainties in the risk assessment process.

4.2.4.1 Data Evaluation and COPC Identification Process

A primary uncertainty associated with the COPC identification process is the possibility that a chemical may be inappropriately identified as a COPC. It is unlikely that inorganic chemicals were inappropriately excluded as COPCs because the only detected inorganic chemicals excluded were those determined to be below the associated BV or those with data sets not significantly different than background. Aluminum and iron in the exposed tuff zone residential lot and iron in the site-wide comparison had 95% UCL concentrations greater than 0.1 of the respective SAL, but less than the SAL. Concentration measured in

soil and tuff at the MDA P Site for these two inorganic chemicals are not considered a concern for human health for two reasons: 1) the high values for these inorganic chemicals are in the tuff and are, thus, unavailable for exposure; and 2) the 95% UCL concentrations are within the range of soil and tuff background concentrations (LANL 1998, 59730), indicating that exposure to site-wide or residential lot concentrations is similar to background. Also, iron is an essential nutrient for which concentrations in soil would need to be substantially higher than background before they become a concern to human health. Thus, HI values calculated for the whole area and the residential lots are primarily due to barium and are less than 1.0.

It is unlikely that organic chemicals were inappropriately excluded as COPCs because the only detected organic chemicals not retained for analysis were those that were detected in less than 5% of the confirmation samples.

Uncertainties associated with the inorganic and organic chemical data include sampling errors, laboratory analysis errors, and data analysis errors. For the MDA P Site, these uncertainties are expected to have little effect on the results even though many detected concentrations of organic COPCs were qualified J, indicating that the values were less than EQLs and could only be estimated.

4.2.4.2 Exposure Assessment

Three main uncertainties were identified in the exposure assessment process.

1) *Identification of Receptors*. The human health screening evaluation is a conservative comparison of the 95% UCL concentration with SALs based upon a residential land-use scenario. To the degree that actual activity patterns are not represented by those activities assumed by the residential land-use scenario, uncertainties are introduced in the assessment. Because the potentially exposed individual is an industrial worker, the screening assessment based on a residential scenario overestimates the exposure and, therefore, the potential hazard and risk to human receptors. The same is true if the receptor is a recreational user (e.g., hiker, jogger, etc.). If, however, future land use becomes residential, the assessment appropriately addresses potential human health risks.
2) *Exposure Pathway Assumptions*. A number of assumptions are made relative to exposure pathways, including: input parameters, whether or not a given pathway is complete, the contaminated media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with EPA-approved parameters and default values (EPA 2001, 71466). When several upper-bound values (as are found in EPA 2001, 71466) are combined to estimate exposure for any one pathway, the resulting risk can exceed the 99th percentile of "expected risk" and therefore, exceed (overestimate) the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and cause exposure in the same manner as if they were in soil overestimates the potential risk to receptors. Therefore, the HI of 1.7 is an overestimation of the potential hazard at the site within the exposed tuff zone.
3) *Derivation of Exposure Point Concentrations*. Some uncertainty is introduced in the concentration aggregation of data for estimating the representative COPC concentrations (95% UCL) at the site. Risk from a single location or area with relatively high COPC concentrations may be "diluted" by using a representative, site-wide value. Thus, an additional analysis based on locations of high concentrations of barium (the only COPC to exceed 0.1 SAL in both zones) was performed to address this uncertainty. The use of the 95% UCL is intended to provide a protective, upper bound (e.g., conservative) on the average COPC concentration at the site, which is more likely to lead to an overestimation of the concentration representative of average exposure to a COPC across the entire site.

4.2.4.3 Toxicity Assessment

The primary uncertainty associated with the SALs is related to the derivation of toxicity values used in their calculation. EPA toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SALs used in this risk screening assessment (EPA 2001, 70109; EPA 1997, 58968). Uncertainties were identified in three areas with respect to the toxicity values: 1) extrapolation from animals to humans, 2) extrapolation from one route of exposure to another route of exposure, and 3) individual variability in the human population.

1) *Extrapolation from Animals to Humans*. The SFs and RfDs are often determined based on extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. The EPA takes into account differences in body weight, surface area, and pharmacokinetic relationships between animals and humans to address these uncertainties in the dose-response relationship; however, conservatism is usually incorporated in each of these steps, resulting in the overestimation of potential risk.
2) *Extrapolation from One Route of Exposure to Another Route of Exposure*. The SFs and RfDs often contain extrapolations from one route of exposure to another that result in additional conservatisms in the risk calculations. For example, an extrapolation from the oral route to the inhalation and/or the dermal route was used in this assessment (EPA 2001, 71466) and differences between the two exposure pathways contribute to the uncertainty in the estimation of potential risk at this site.
3) *Individual Variability in the Human Population*. For noncarcinogenic effects, the degree of variability in human physical characteristics is important both in determining the risks that can be expected at low exposures and in defining the no-observed-adverse-effect level (NOAEL). The NOAEL uncertainty factor approach incorporates a 10-fold factor to reflect individual variability within the human population that can contribute to uncertainty in the risk assessment; this factor of 10 is generally considered to result in a conservative estimate of risk to noncarcinogenic COPCs.

4.2.4.4 Additive Approach

For noncarcinogens, the effects of exposure to multiple chemicals are generally unknown and possible interactions could be synergistic or antagonistic, resulting in either an overestimation or underestimation of the potential risk. Additionally, RfDs used in the risk calculations typically are not based on the same endpoints with respect to severity, effects, or target organs. Therefore, the potential for noncarcinogenic effects can be overestimated for individual COPCs that act by different mechanisms and on different target organs but are addressed additively.

4.2.5 Interpretation of Results

Overall, the uncertainties associated with the evaluation of human health risks to residual concentrations of COPCs in the soil and tuff of the MDA P Site overestimate potential risk to human receptors. A detailed analysis of risk due to exposure at locations with high concentrations of barium (the main risk driver at the site) indicate that there is no potential, unacceptable risk to human health in either the biological or exposed tuff zone.

The noncarcinogenic HI values ranged from 0.8 (site-wide) to 1.7 (exposed tuff zone) based on 95% UCL concentrations; none of the individual COPCs exceeded a HQ of 1.0. Approximately half of the HI of 1.7 (0.7) is due to iron, which is an essential nutrient and has a 95% UCL within the range of background concentrations. In addition, COPCs in this lot are in the tuff so exposure is unlikely; the HI for the exposed tuff zone residential lot overestimates the potential hazard to receptors. Given the uncertainties and the overestimation of the hazard, the HIs for the site and for the residential lots do not exceed NMED's target HI of 1.0 (NMED 2000, 68554) and do not pose a potential hazard to human health.

Concentrations of carcinogenic COPCs were less than their respective SALs. The incremental excess cancer risk ranged from $6x10^{-7}$ (site-wide) to $4x10^{-6}$ (residential lot). The risk levels are below the NMED target cancer risk level of 10^{-6} (NMED 2000, 68554). Therefore, the site as a whole and the residential lots within each zone do not pose a potential unacceptable risk to human health.

4.3 Ecological Screening Assessment

The footprint of the MDA P Site is located on the TA-16 mesa and canyon slope directly adjacent to, and south of, Cañon de Valle in the vicinity of a perennial reach of the stream channel within the canyon. The Conceptual Site Model (section 3.3) indicates that the primary transport of COPCs from the MDA P Site to the canyon occurs via hydrologic processes and potentially affects the canyon's terrestrial and aquatic habitats. Thus, the assessment of potential ecological risk is designed to evaluate potential risk to receptors from residual COPC concentrations at the MDA P Site as well as potential risk to ecological receptors in the Cañon de Valle.

The assessment of ecological risk for the MDA P Site is composed of the scoping evaluation, which defines the focus of the screening assessment. The screening assessment assesses potential risk to ecological receptors at the MDA P Site based on residual COPC concentrations measured in the Phase II confirmation samples. The screening assessment concludes with a problem formulation, which evaluates constituents of potential ecological concern (COPECs) identified in the screening evaluation based on site-specific information and an analysis of the screening results within the context of established background concentrations. The third part of the assessment is a focused ecological risk assessment of the COPECs carried forward from the problem formulation that evaluates adverse effects in Cañon de Valle from historic contaminant transport into the canyon to both aquatic and terrestrial receptors. The focused evaluation integrates the effects of the multiple contaminant sources to canyon receptors, in addition to the effects from MDA P Site COPCs.

4.3.1 Scoping

The scoping evaluation provides the ecological framework for the screening assessment. Scoping establishes the breadth and focus of the ecological screening process and is based on the ecological scoping checklist (Attachment 1) and the Conceptual Site Model (section 3.3).

An ecological scoping checklist (Attachment 1 of this appendix) was completed prior to the start of the assessment of potential risk to ecological receptors at the MDA P Site. A site visit (August 28, 2002) was conducted in conjunction with the completion of the ecological scoping checklist. One of the objectives of the visit was to confirm that the risk assessment approach, which was defined prior to the Phase I excavation, was reasonable for the post-excavation conditions (LANL 1999, 64783).

As described in section 3.3 (Conceptual Site Model), the MDA P Site is composed of two distinct zones: 1) an exposed tuff zone that is largely bereft of plants and for which little or no evidence of animal activity was observed during the site visit, and 2) a biological zone that has topsoil and is populated by

either successional/transitional plant species (grasses and herbaceous plants and forbs) in the areas disturbed during the Phase I excavation or mature, native vegetation typical of the Rocky Mountain mixed conifer vegetative type in the undisturbed areas of the MDA P Site. Evidence that the biological zone is used by both small mammals (e.g., soil mounding by burrowing mammals) and large mammals (e.g., tracks and scat) was noted during the site visit.

As agreed upon by LANL with the NMED and EPA Region 6 (LANL 2002, 73791), the "exposed tuff area of the site doesn't need a quantitative ecological risk assessment including generation and review of hazard quotients" and the "preferred approach is a qualitative ecological risk assessment" consisting of a written discussion documenting that the various exposure pathways are not complete in this area of the site. COPCs in the tuff are generally immobile and become available to receptors only as a function of the slow rates of weathering of the tuff. Vegetation, though present in some microsites, is sparse and not expected to have contact with COPCs to the degree that population-level effects would occur from this limited exposure to COPCs in the exposed tuff zone. Also, the vegetation is not present in sufficient quantities to result in uptake through the food chain combined with the unlikely scenario of use or foraging by ecological receptors because of the unsuitable habitat. Therefore, the contact that wildlife receptors might have with COPCs in the exposed tuff zone does not drive population-level effects in the wildlife receptors. Thus, the exposure of receptors to COPCs in the exposed tuff zone is not evaluated quantitatively in this assessment.

Because potentially complete pathways exist for exposure to COPCs in the biological zone, the following terrestrial receptors were evaluated quantitatively in this screening assessment for the biological zone, representing several feeding guilds and trophic levels:

- plants,
- soil-dwelling invertebrates (represented by the earthworm),
- deer mouse (mammalian omnivore),
- vagrant shrew (mammalian insectivore),
- desert cottontail (mammalian herbivore),
- fox (mammalian carnivore),
- American robin (avian insectivore, omnivore, and herbivore), and
- American kestrel (avian insectivore and carnivore); surrogate for avian threatened and endangered (T&E) species.

Of the terrestrial receptors being evaluated, only the vagrant shrew is not expected to be of concern for the MDA P Site because it requires free water for survival—a medium that does not exist at the site and that has been eliminated from consideration as a potential exposure medium for the MDA P Site footprint. However, because the shrew represents the insectivorous feeding guild for mammals, which is not specifically represented by any of the other terrestrial receptors, the shrew was retained and evaluated in the MDA P Site screening assessment.

4.3.2 Screening Evaluation

The ecological screening evaluation identifies COPECs and is based primarily on the comparison of representative COPC concentrations (95% UCL concentrations) at the site to ecological screening levels (ESLs). This comparison is summarized in the calculation of HQs for each COPC and screening receptor.

The hazard quotient (HQ) is defined as the ratio of the representative contaminant concentration in the exposure medium being investigated to the dose that has been determined to be potentially acceptable to a given ecological receptor. The higher the contaminant levels relative to the ESLs, the higher the potential

risk to receptors; conversely, the higher the ESLs relative to the contaminant levels, the lower the potential risk to receptors. HQs greater than 0.3 are identified as COPECs requiring additional evaluation (LANL 1999, 64783). The HI is the sum of HQs; an HI greater than 1.0 is considered an indication of potential adverse impacts to a given receptor from exposure to multiple chemicals at a site. Additionally, chemicals without associated ESLs are retained as COPECs and require further evaluation. The HQ/HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential of overlooking possible COPECs at the site.

The calculation of representative COPC concentrations is presented in Attachment 2. ESLs were obtained from LANL's ECORISK database version 1.4 (LANL 2002, 72802), as presented in Table 4.3.2-1.

HQ Summary for Ecological Screening Assessment

All COPCs identified for the biological zone, with the exception of lead and nickel, were identified as chemicals requiring further evaluation because one or more HQ exceeded 0.3 or because there was no ESL available for one or more of the receptors for a given COPC (Table 4.3.2-2). Nickel and lead were eliminated as COPECs because all receptors had an associated ESL and all HQs were less than 0.3. All other chemicals are discussed in detail below in the Problem Formulation.

As presented in Table 4.3.2-2, HI values for the terrestrial receptors range from 1.75 for the top carnivore American kestrel to 464 for the plant. Per EPA guidance (EPA 2000, 73306), aluminum "is identified as a COPC only at sites where the soil pH is less than 5.5." pH levels measured in confirmation samples form the MDA P Site range from 5.8 to 7.4 in tuff and 6.8 to 7.6 in soil, indicating that aluminum at the MDA P Site is unavailable to ecological receptors. With aluminum eliminated, barium and cobalt are the largest contributors to the HI values for each receptor, while vanadium and DDT[4,4'-] also contribute to the HI for some receptors.

4.3.3 Problem Formulation

This section provides an evaluation of the screening assessment results in the context of assumptions and conservatisms used in the screening process, in order to determine whether or not the results are ecologically meaningful and if additional analysis is required. Table 4.3.2-2 shows the COPCs that failed the screening against ESLs.

Inorganic COPCs

A number of the HQs determined for inorganic COPCs are not meaningful estimations of potential risk because the ESLs are below the soil and tuff BVs. In addition, the 95% UCL concentrations, determined for all the inorganic COPCs except for barium, copper, and cobalt, are within the range of the background data sets for soil, indicating that the exposure of receptors to the representative site concentrations of inorganic chemicals is similar to background. Thus, the HQ/HI analysis was performed a second time after removing ESLs below the associated soil BV from the analysis (Table 4.3.2-3, see "NC" entries). The majority of the inorganic COPCs (except antimony, barium, and cobalt) are eliminated as COPECs because the elevated HQs were based on ESLs that were less than BVs. Furthermore, all of the inorganic COPCs (except for barium) have 7 or fewer detections in soil above the soil BV, indicating that the residual concentrations of inorganic chemicals in the biological zone are in the tuff and are unavailable to receptors. As a result, the majority of the inorganic COPCs (except barium) are not retained as COPECs.

COPC concentrations in tuff are eliminated from further consideration because the contaminants are absorbed into the porous rock matrix. Exposure pathways to receptors are incomplete. Plant exposure to COPCs in tuff is limited to the fractures near the surface, which does not produce sufficient biomass to

support an herbivore population. Consequently, the contaminants in tuff are unavailable to receptors and cannot cause adverse population-level effects. Although weathering of the tuff will eventually release these contaminants, the COPC concentrations will be similar to or less than the soil concentrations.

Organic COPCs

Table 4.3.2-2 shows DDT[4,4'-] was the only organic COPC that failed the screen because of an HQ greater than 0.3 (for the insectivorous and omnivorous robin and both kestrels). However, DDT[4,4'-] was detected in only one soil sample and had HQs of 3.0 or less, which are not expected to result in adverse population-level effects to the robin or kestrel. Therefore, DDT[4,4'-] is eliminated as a COPEC.

Three organic COPCs (acetone, Aroclor-1260, and bis[2-ethylhexyl]phthalate) had ESLs for most or all of the wildlife receptors and all HQs were less than 0.3. Furthermore, these COPCs were detected in only one sample (acetone and Aroclor-1260) or 8 samples (bis[2-ethylhexyl]phthalate). Because of the low numbers of detected concentrations, these COPCs are not expected to cause adverse population-level effects. All detected concentrations measured for these COPCs were at or below the maximum EQLs, indicating that only trace concentrations are present at the site. Although there are no ESLs for these COPCs for plants and invertebrates, the plants at the site are healthy. Because these organic chemicals are infrequently detected at low concentrations, and HQs for receptors with ESLs are less than 0.3, acetone, Aroclor-1260, and bis(2-ethylhexyl)phthalate are not retained as COPECs.

The remaining organic chemicals (amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], HMX, RDX, toluene, and trinitrotoluene[2,4,6-]) have mammalian ESLs, but are lacking ESLs for the avian receptors and may also lack an ESL for either the plant or invertebrate. All HQs for the mammalian receptors are less than 0.3, and in many cases are at least an order of magnitude lower than 0.3; thus, there is no further evaluation warranted for the mammalian receptors. The plants observed at the site are healthy and no observable adverse effects to the flora were noted during the August 28, 2002, site visit, indicating that plants are not being adversely affected by residual concentrations of COPCs in the biological zone and that no additional evaluations are required for the plants. If a ten-fold uncertainty factor were applied to the available mammalian ESLs and used to estimate avian HQs, then depending on the surrogate ESL used for a given receptor/COPC combination, the resulting HQs would be less than 1.0 for all avian receptors except for RDX, where the resulting HQs are greater than 1.0 but less than 5.0. Lastly, except for RDX that was detected across the site in both soil and tuff, there are infrequent detections of organic chemicals in soil, indicating that the residual concentrations of these organic chemicals in the biological zone are in the tuff. Because of the low number of detected concentrations in soil and given the time required for the weathering of the tuff to become an exposure medium for receptors, these organic COPCs (except for RDX) in tuff are not expected to cause adverse population-level effects.

Problem Statement for the Ecological Risk Assessment

The COPECs barium and RDX warrant further site-specific evaluation in an ecological risk assessment. All other inorganic and organic analytes are eliminated as COPECs for the MDA P Site. COPCs in the tuff are not of concern for the receptors at the MDA P Site or in Cañon de Valle because the exposure pathways are incomplete. Future exposures to COPCs in the tuff are directly related to the rate of weathering, which is slow and not likely to result in adverse ecological impacts.

Barium is retained for additional analysis because HQs based on the representative site concentration indicated potential risk to all ecological receptors except the kestrel top carnivore (the surrogate for avian T&E receptors). RDX is also recommended for additional analysis because the avian receptors lack ESLs

and estimated HQs based on assumptions related to available mammalian ESLs indicated that potential risk to avian receptors could not be definitively eliminated.

5.0 ECOLOGICAL RISK ASSESSMENT FOR THE MDA P SITE

5.1 Introduction

The ecological risk assessment was performed to address the two COPECs that could not be eliminated from the screening analysis for the MDA P Site: barium and RDX. This assessment uses the results of the Cañon de Valle ecological risk assessment to address the potential adverse effects from these COPECs. This section includes a revisit of the conceptual site model developed for the screening assessment, a summary of the Cañon de Valle study results as they relate to the transport of barium and RDX to the canyon and the subsequent exposure of both aquatic and terrestrial receptors, and an interpretation of the results.

5.2 Conceptual Site Model

5.2.1 Historic Transport From the MDA P Site

As presented in section 3.3, the conceptual site model for the MDA P Site includes the potential for exposure to ecological receptors in Cañon de Valle due to releases of contaminants from the MDA P Site. Historic releases to Cañon de Valle from the MDA P Site include the off-site transport of COPCs via surface erosion and the potential leaching of water through the landfill contents to surface water and sediments. To the extent that contaminants were transported to the canyon from the MDA P Site prior to the source removal, the historic contaminant signatures in the canyon from the MDA P Site may not correspond with residual COPC concentrations identified in the Phase II confirmation samples, though the primary contaminants (barium and HE compounds, including RDX) are common to both. Consequently, the ecological risk assessment of Cañon de Valle in support of the MDA P Site closure certification and corrective action includes all the COPECs that were identified in the canyon, including barium and RDX.

The MDA P Site is one of several historic contaminant sources to Cañon de Valle and is not the dominant source. The 260 outfall (SWMU 16-021[c]-99) is identified as the dominant source of contaminants for the canyon (Phase II RFI for Potential Release Site 16-021[c]). Additionally, MDA-R (SWMU 16-019) and the Silver Outfall (SWMU 16-020), up-canyon from the MDA P Site are contributors of contaminants to the canyon. Figures 5.2.1-1 and 5.2.1-2 show the down-canyon profile of barium concentrations for the overbank soils and the active channel sediments. The location of the MDA P Site is also shown for each plot. The zero distance is the location of the 260 outfall. The overbank plot shows five relatively high barium concentrations between the 260 outfall and the MDA P Site. All the other overbank data show a lack of trend with location in the canyon. The active channel sediment plot includes a locally smoothed line fit to approximate and average barium concentration with location in the canyon. The active channel shows a general barium concentration decline below the MDA P Site. Both plots show higher barium concentrations up-gradient of the MDA P Site. These plots support the assertion that the MDA P Site has not been nor currently is a major contributor of barium to the canyon. Other COPCs have similar patterns.

The COPC concentration patterns, as represented by the barium plots, indicate that ecological investigations for adverse effects in Cañon de Valle that include the MDA P Site reach are also useful for evaluating historic effects from the MDA P Site.

The current adverse ecological effects determined for the Cañon de Valle receptors represent risk from the historic loading of COPECs into the Cañon de Valle system. These present-day contaminant signatures

and inventories are expected to be the worst-case condition because the MDA P Site has been excavated and other sources of contaminant discharges to the canyon have been eliminated. With time, concentrations will decline and inventories will dissipate with the continued influence of hydrologic processes in the canyon. Because of the historic transport of COPECs to the canyon, the conceptual site model for the MDA P Site is expanded to include potential ecological receptors associated with the both the terrestrial and aquatic systems of Cañon de Valle.

5.2.2 Cañon de Valle Conceptual Site Model

Effluent discharges from TA-16, including the 260 outfall (SWMU 16-021(c)-99), silver outfall (SWMU 16-020), Building 16-540 (steam plant), roof drains, and parking lot runoff all served to augment the surface flow in Cañon de Valle and to transport contaminants into the natural systems of the canyon. Data from media samples collected in the canyon show HE and metals, especially barium, to be present in surface water, alluvial groundwater, soils and sediments.

With the elimination of discharges from the 260 outfall in November 1996 and the steam plant in January 1997, the aquatic regime of the canyon is receding to pre-laboratory conditions. During the drought of year 2000 Burning Ground Spring (up-gradient of the MDA P Site) continued to flow but the rest of the canyon was mostly dry. Flow from SWSC Spring (also up-gradient of the MDA P Site) ceased in the fall of 2001 and has yet to recover as of this writing. It is unknown whether the loss of flow in SWSC Spring is because of the drought or because the spring was induced by 260 outfall effluent.

A geomorphic survey and map has been completed for 2500 meters (m) of the canyon from the silver outfall (SWMU 16-020) to below the MDA P Site. The canyon bottom averages 23 m in width over the mapped reach and generally intersects a cliff-forming unit of the Bandelier tuff to the north and a colluvial slope to the south. This is characteristic of many east-west trending canyons of the Pajarito Plateau. The distinction between soil and sediment in this report is a matter of location relative to the active channel of the canyon. Sediment refers to material in the active channel of the canyon, while soil refers to overbank and floodplain sediment deposits as well as the terraces, fans, and colluvial slopes. Soil samples collected as part of the geomorphic investigation were analyzed for metals and HE.

The overbanks that are influenced by contaminant transport and deposition average 6 m in width and consist of sorted fine material. The highest concentrations of COPECs are in units that have been deposited since LANL commenced operations. The geomorphic mapping approach distinguishes two overbank units and a floodplain unit that has been impacted by LANL contaminants. They are designated as *c2* and *c3* for the overbanks and *f1* for the floodplain. The active channel is poorly sorted indicating that transport in the system tends to occur under higher energy and short duration events. These events do not provide conditions that sort the transported material into deposits with different particle sizes. The balance of the canyon bottom area, nominally 75%, is made up of Quaternary terraces. These features are abandoned by channel incision and no longer experience flood flows. The distribution of contaminant concentrations across the geomorphic feature types is presented in Figure 5.2.2-1.

Vegetation in the canyon from the silver outfall to Peter Seep (up-gradient of the MDA P Site) consists largely of a closed canopy mixed conifer stand. Ground vegetation in this reach is sparse. Vegetation over the next kilometer is a mosaic of closed canopy areas with sparse ground cover and open canopy areas with dense grasses and forbs. The reach that bounds the toe of the MDA P Site is open and densely vegetated with groundcover. Other locations up canyon that are similar to this reach are the SWSC Cut, and Burning Ground Spring. About 100 m below the MDA P Site, the overstory vegetation opens up and the canyon bottom widens, resulting in dense groundcover and understory vegetation dominated by

Gambel Oak. The overbanks that are heavily vegetated with grasses and forbs are effectively armored against erosive forces during flood flows.

The problem formulation phase of the ecological risk assessment pilot for Cañon de Valle identified potential adverse impacts to aquatic, riparian and terrestrial systems in the canyon, as discussed further in section 5.3.

5.3 Ecological Risk Assessment Approach

The footprint of the MDA P Site is located on the TA-16 mesa and canyon slope directly adjacent to, and south of, Cañon de Valle in the vicinity of a perennial reach of the stream within the canyon. The Conceptual Site Model (section 3.3) indicates that the primary transport of COPCs from the MDA P Site to the canyon occurs via hydrologic processes and potentially affects the canyon's terrestrial and aquatic habitats. Thus, the assessment of potential ecological risk is designed to evaluate risk to receptors from residual COPC concentrations at the MDA P Site as well as risk to ecological receptors in the Cañon de Valle.

As discussed in section 4.3, the ecological risk assessment for the MDA P Site is composed of three elements. The first and second elements define the scope of the assessment and assess potential ecological risk to COPC concentrations remaining within the MDA P Site boundaries. The third element is the focus of this section, which is comprised of a focused ecological risk assessment of the COPECs carried forward from the problem formulation in steps one and two that evaluates adverse effects in Cañon de Valle from historic contaminant transport into the canyon to both aquatic and terrestrial receptors. This focused evaluation integrates the effects of the multiple contaminant sources to canyon receptors, in addition to the effects from MDA P Site COPCs.

The remainder of this section defines the scope of the assessment of Cañon de Valle receptors relative to MDA P Site COPCs and summarizes previous Cañon de Valle assessment results in order to provide the framework for the additional assessment activities performed in Cañon de Valle that are being used to support the Closure Certification of the MDA P Site.

5.3.1 Scope of the Assessment

The areal extent of this assessment includes the footprint of the former the MDA P Site and the terrestrial and aquatic habitats in Cañon de Valle that could be affected by historic (or future) contaminant transport from the MDA P Site. The assessment considers terrestrial effects for the former facility and aquatic and terrestrial effects in the canyon. The data used to support this assessment are:

- Post-excavation Phase II confirmation sample data for the MDA P Site;
- Sediment profile data collected in 1996 for the active channel in Cañon de Valle;
- Overbank samples collected for the fluvial geomorphology characterization in 1999;
- Water samples collected from April 1994 to March 1999;
- Small mammal population and contaminant body burden data collected in 2001;
- Sediment toxicity testing results collected in 2001; and
- Synoptic benthic macro-invertebrate community data collected in 1996 and 1997.

The data sources were subset to assess the MDA P Site impacts where these data extend substantially beyond the area of influence for the MDA P Site or where the data show concentration trends in the canyon that are not relevant to this facility.

5.3.2 Cañon de Valle Problem Formulation Results Summary

The problem formulation phase of the ecological risk assessment for Cañon de Valle identified potential adverse impacts to aquatic, riparian and terrestrial systems in the canyon. The results of that analysis are summarized in Table 5.3.2-1. The natural resources investigations to collect evidence of adverse effects are described in "Cañon de Valle Terrestrial Ecological Risk Assessment Pilot, Steps Four and Five: Study Design and Implementation Plan" (Tardiff 2002, 73764) and "Cañon de Valle Aquatic Ecological Risk Assessment Pilot, ERA-S Steps Four and Five: Study Design and Implementation Plan" (Tardiff 2003, 73730).

The screening ecological risk assessment methodology developed for LANL (LANL 1999, 64783) was used to identify COPECs for the Cañon de Valle, as was done for the MDA P Site terrestrial receptors. The initial risk assessment screen compared measured COPC concentrations (in soil, water, and sediment) to receptor-specific ESLs to determine HQs for Cañon de Valle receptors (Tables 5.3.2-1, 5.3.2-2, 5.3.2-3, and 5.3.2-4). HQs are provided for the minimum, maximum, and the 95% UCL median concentrations for detected values. The UCL on the median is used instead of the UCL on the mean because it better represents the middle of the data when the data are highly skewed or there are non-detects. The three HQs for each COPEC are an indication of the extent to which the site data exceed a given ESL.

5.3.2.1 Terrestrial System

The problem formulation assessment identified six COPECs in overbank soils that exceed the screening ESLs: barium, silver, lead, copper, HMX, and RDX. Summary information for HQs with minimum, maximum and the 95% UCL median concentrations are provided in Table 5.3.2-2. This table shows that copper and lead have a full complement of eleven screening values; barium and silver are missing the invertebrate endpoint: RDX is missing six endpoints; and HMX is missing seven endpoints. Endpoints are missing because toxicology studies have not been included in LANL's Ecorisk database for these contaminants. In some cases, such as avian endpoints for HMX and RDX, extensive searches of the literature have yet to identify relevant studies. This is consistent with Talmage et al. (1999, 63021), which states that no subchronic or chronic feeding studies of HE compounds were found for avian species.

Table 5.3.2-2 shows great variability in the extent to which the COPECs exceed screening values. A single screening endpoint value was exceeded by the maximum RDX concentration with an HQ of 1.1. An HQ of 1.1 would typically be acceptable and the COPEC dropped from further consideration. RDX is carried forward because of the large number of unavailable screening values. In contrast to RDX, all barium screening endpoint values were exceeded by the maximum concentration and four of those endpoint values were exceeded by the minimum concentration. The highest HQ for barium is 1,600.

5.3.2.2 Aquatic System

The problem formulation assessment identified six COPECs in water and ten COPECs in sediment that exceed screening ESLs (LANL 2000, 67822). The details of the COPEC comparisons to ESLs are provided in Table 5.3.2-3 for water and Table 5.3.2-4 for sediments. The water COPECs are aluminum, barium, cadmium, cobalt, manganese, and silver. Each of the water COPECs has the full complement of nine screening endpoints. The sediment COPECs are barium, cobalt, copper, lead, silver, thallium, vanadium, di-n-butylphthalate (DNBP), HMX, and RDX. The sediment COPECs are missing 8 of the possible 30 COPEC:endpoint pairs. The three COPECs in common for water and sediment are barium, cobalt, and silver. HMX and RDX are included as COPECs for active channel sediment because ESLs are not available for the swallow and aquatic community.

The screening value exceedances for cadmium, cobalt, manganese, and silver in water are associated with generic aquatic community criteria (LANL 2000, 67822). These criteria originate from a variety of sources including laboratory toxicity studies (60 FR 56; and 20.6.4 NMAC "Standards for Interstate and Intrastate Surface Waters"). The aquatic community endpoint is designed to be protective of the resource, not predictive of potential adverse effects. Hence, they are conservative values based upon species assemblages that do not necessarily populate the canyon aquatic system. The screening value exceedances for aluminum and barium include the aquatic community endpoint and mammalian wildlife drinking water pathway. The wildlife drinking water exceedances for aluminum are associated with alluvial groundwater and range in HQ from 1 to 2.2, based on the 95 % UCL median concentration. The barium wildlife drinking water exceedances are associated with surface water and alluvial water and range in HQs from 1.3 to 2.7, also based on the 95% UCL median concentration. Given the assumptions, uncertainties, and conservatisms built into the drinking water pathway these HQs are not different from the screening values.

The sediment endpoint exceedances include the generic sediment community endpoint, the little brown bat, and the violet-green swallow. The bat and swallow endpoints for sediment are based upon wildlife models where exposure of the receptor to contaminants in sediments occurs through ingestion of emergent aquatic insects. The sediment aquatic community endpoint is derived from a variety of studies including freshwater and marine sediments and organisms. These studies may not be relevant to Cañon de Valle. However, they are useful as general indicators of contaminant concentrations that warrant further consideration.

5.3.2.3 Conclusions from the Problem Formulation

The potential for adverse effects to the terrestrial system from barium and HMX in soil is indicated by the large HQs for the concentrations of these contaminants. The lack of screening information regarding HMX and RDX for the avian and invertebrate endpoints leaves a gap in the information for making risk-based decisions regarding residual concentrations of site-specific COPCs.

The screening assessment results for the aquatic system show large HQs for contaminants in water and sediment associated the aquatic community, and for bat and swallow via the emergent insect pathway. Additionally, the lack of screening values for RDX and HMX in sediments leaves questions regarding the potential effects of these two contaminants that are present in the canyon system. The bat and swallow results require considerations of the extent to which populations of these receptors can be supported by the emergent insects from the canyon. Given the limited extent of these resources, it is very unlikely that adverse effects to bats or insectivorous birds are realized.

The possible terrestrial effects from barium and HMX, the generic aquatic community results, and the lack of information for HE in terrestrial and aquatic receptors indicates that an empirical study to assess adverse effects in Cañon de Valle is needed.

5.4 Assessment Endpoints

The environmental values, or assessment endpoints, to be protected for Cañon de Valle and the MDA P Site consist of features of the canyon relative to the surrounding landscape and the resident threatened species. Cañon de Valle is one of many canyons incised into the Pajarito Plateau. This canyon has a perennial spring and an alluvial seep in the vicinity of the TA-16 facilities. The presence of water in the canyon is ecologically important to the viability of many species in this semi-arid environment. Additionally, the canyon supports a multi-leveled overstory of mixed conifer, aspen and oak with grasses and forbs on overbanks and terraces. The combination of perennial water and diverse vegetation make the

canyon a relatively attractive location for endemic fauna. The Mexican spotted owl has a nesting site down-canyon from the MDA P Site and is likely to hunt in the canyon.

Specific assessment endpoints that were addressed with measures of effects are:

- Community viability of small mammals as an indication of contaminant impacts upon maximally exposed taxa across trophic levels and foraging guilds in the terrestrial environment.
- Contaminant concentrations in the food web as an indication of potential impacts to carnivores including the Mexican spotted owl, a resident threatened species in the canyon.
- The capacity of the perennial reach of the canyon to support an aquatic community as an indication of the extent to which contaminants have impaired sediment and water quality.

5.4.1 Terrestrial Study Design

The screening ecological risk assessment methodology uses eleven terrestrial biotic screening endpoints. They are kestrel as carnivore, kestrel as omnivore, robin as herbivore, robin as omnivore, robin as insectivore, desert cottontail, deer mouse, fox, shrew, soil invertebrate, and plant. The rationale for selecting the small mammal community for assessing adverse effects in Cañon de Valle is summarized below and fully described in "Cañon de Valle Terrestrial Ecological Risk Assessment Pilot, Steps Four and Five: Study Design and Implementation Plan" (Tardiff 2002, 73764).

Small mammal community is a practical choice for biota sampling for adverse terrestrial effects in Cañon de Valle. Small mammals reside in the canyon year-around and the populations are sufficiently abundant to provide multiple individuals for population estimates and to determine the amounts of contaminants taken up and stored by individuals in their body tissues through soil ingestion and food web transfers, i.e., contaminant body burdens. Additionally, small mammals are a dominant prey species for the carnivores active in the canyon, including the Mexican spotted owl. Contaminant body burden data from small mammals provides the information necessary to make direct estimates of contaminant intake by carnivores, obviating most of the assumptions in contaminant transfer models.

The trophic level of a small mammal species generally influences the rate of accumulation of contaminants relative to soil concentrations. Sample, et al. (1998, 72726) found that bioaccumulation is highest in insectivores and lowest in herbivores. Three endpoint species under consideration are: mountain cottontail (an herbivore), deer mouse (an omnivore), and dusky shrew (an insectivore). Based upon home range, the potential for bioaccumulation, and prey size preferences of the Mexican spotted owl, the dusky shrew and deer mouse populations are best suited for assessing contaminant transfers to top carnivores. Given the propensity for higher body burdens, these species are also likely to elicit population responses to COPECs if such responses are occurring. If necessary, the differences in diet between the two mammals can be used to differentiate body burdens associated with trophic levels. Finally, the reproductive rate of these species is such that individuals removed for analysis will be quickly replaced within the populations and negative consequences to the food chain from sampling are very unlikely.

5.4.1.1 Terrestrial Measures of Effects

Small mammal community metrics and body burdens were collected for Cañon de Valle and Pajarito Canyon, the latter being a reference (i.e., uncontaminated) location. The lines of evidence evaluated are number of species, body weight, reproductive status classes for each species, population density estimates, and contaminant body burdens.

5.4.1.2 Field Study Synopsis

Small Mammal Population Estimates

Small mammal trapping arrays were established in Cañon de Valle and Pajarito Canyon. Trapping was conducted during May 2001 and again in September to October 2001. Pajarito Canyon was selected as the reference canyon based on its similarity to Cañon de Valle with respect to topography, elevation, water presence and quantity, vegetation, and burn severity from the Cerro Grande fire in 2000. Each array for a canyon consisted of two 5-by-20 grids with ten-m spacing between traps. Each grid had a footprint of 40 m x 190 m. The two grids were separated by a minimum of 100 m to prevent trapping competition for individuals. Two Sherman live traps were located at each of 80 (4 x 20) intersections. The line of traps closest to the creek had a pitfall trap paired with a Sherman live trap at each intersection (1 x 20). The double trap configuration at each grid node was used to equalize the trapping effort between the locations adjacent to the creek where pitfall traps and live traps were combined with grid locations away from the creek. This was necessary for generating population estimates that are unbiased for location.

The trap lines followed the lay of the land using the stream channel as the baseline. The live traps were baited to attract herbivores and omnivores. Insectivores, such as shrews, typically do not respond to bait but are usually caught in pitfall traps. In the late afternoon, Sherman traps were opened and baited. Bait was a mixture of peanut butter and sweet feed (molasses coated horse feed). Pitfall traps were also opened in the afternoon. The traps were checked early in the morning. Traps that had not been tripped by animals were then closed and all tripped traps were collected for animal processing.

Animals collected on nights 1 through 3 were weighed and measured (body length, tail length, hind foot length, and ear length). Sex and species were determined. Reproductive status was recorded, and the trap number was noted. The animals were also ear tagged and then released. Animal characteristics were recorded only on the first day of capture for each individual. Each day trap number and ear tag numbers were recorded for all animals captured or recaptured. After the fourth night of trapping, all information on new captures was recorded and any recaptures were noted. The dusky shrew, selected as a study species, was not trapped on any of the field collection/trapping dates. Because of the low number of captures in the spring, all species but deer mice (*Peromyscus maniculatus*) were released. During spring sampling, blood samples (from the interorbital region) for Hantavirus screening were obtained from deer mice only. In the fall, blood samples from brush mice (*Peromyscus boylli*), deer mice, and wood rats *(Neotoma mexicana)* were obtained for Hantavirus screening. All other species were released after capture. The University of New Mexico (UNM) Medical School performed all of the screening. All target species were euthanized on the last day of trapping during each trapping session. Only animals that screened negative for Hantavirus were analyzed for contaminants.

Population densities were estimated using Leslie's regression method (Seber 1982, 72730) applied to each grid where daily total numbers of captures were plotted against the cumulative daily captures. Confidence intervals were calculated at 95% using the general method (Seber 1982, 72730). Mean percent daily capture rates were calculated and compared to 1993 data where similar sites were trapped (Raymer and Biggs 1994, 56038). Species composition of each canyon was determined as well as a comparison of sex ratios, reproductive stages, and mean weights. Parametric and nonparametric analysis of variance were performed on weights to test for differences between the grids. However, because of the low capture numbers and the differences in the amount of captures within the four grids, the statistical results are primarily descriptive.

Body Burden Analysis

On the final night of live trapping, individuals of the relevant species were sacrificed for body burden analysis. Blood samples were collected from all specimens and screened for Hantavirus by UNM in accordance with their standard operating procedures for this analysis. Negative Hantavirus screening results are necessary prior to shipping the whole body samples to the analytical laboratory for body burden analysis. Each sample submitted for chemical analysis of whole body burden had a live weight of 15 grams (g) or more to provide sufficient material for analysis. The body burden data are used to compare COPEC concentrations between Cañon de Valle and the reference canyon and to estimate the dose of COPECs to the Mexican spotted owl.

Samples were submitted to the analytical laboratory for the analysis of HE and TAL metals. The details of the calculated minimum detection limits for estimating risk relevant doses to the Mexican spotted owl are provided in "Cañon de Valle Terrestrial Ecological Risk Assessment Pilot Steps Four and Five: Study Design and Implementation Plan" (Tardiff 2002, 73764).

5.4.2 Aquatic Study Design

The screening ecological risk assessment methodology for aquatic systems uses twelve biotic screening endpoints. They are generic aquatic community; generic sediment community; drinking water exposure pathway for kestrel, robin, swallow, bat, cottontail, deer mouse, shrew, fox; and emergent aquatic insect prey pathway for bat and swallow.

5.4.2.1 Aquatic Measures of Effects

Synoptic benthic macro-invertebrate surveys and toxicity testing with *Chironomus tentans* were selected for assessing adverse effects in the Cañon de Valle aquatic system. The study design is summarized below and fully described in "Cañon de Valle Aquatic Ecological Risk Assessment Pilot, Steps Four, Five and Six: Study Design and Implementation Plan" (Tardiff 2003, 73730).

Biotic Survey

Cañon de Valle is somewhat limited in survey options for aquatic resources because it is a very small stream that does not support fish. The lack of fish is due to the perennial reach being disconnected from any larger body of water and its small dimensions (average width 50 cm, average depth 7 cm), and lack of sufficient pool cover to protect fish populations from freezing and drought.

The benthic macro-invertebrate community is an appropriate option for a synoptic survey. The species in this community reside in or on sediments, are continually exposed to the contaminants in the water column, and they feed on detritus and microorganisms. The consumption of microorganisms incorporates food chain effects into the macro-invertebrate exposures. This community was surveyed in 1996 and 1997 and was shown to be well-developed in Cañon de Valle (NMED 1999, 73769). These data are used to assess community effects in Cañon de Valle relative to the reference stream reaches on the Pajarito Plateau.

A synoptic survey of benthic macro-invertebrates was conducted for riffle habitat in Cañon de Valle, Pajarito Canyon, Los Alamos Canyon, and Guaje Canyon. The latter three canyon reaches are reference streams. The lines of evidence evaluated are number of species, presence of sensitive species, and comparisons of community metrics between the two canyons.

Toxicity Test

Two general approaches are available for conducting toxicity tests: the use of water column test organisms or sediment-dwelling test organisms. Given the nature of the aquatic system in Cañon de Valle, organisms that live in sediments are more representative of contaminant exposures to endemic biota than are water column organisms.

The midge, *C. tentans*, is a toxicity test organism that is well-documented for its toxic responses to contaminants, widely used in toxicity testing, and is reared from laboratory populations. Additionally, the genus *Chironomus* is present in Cañon de Valle. A cursory literature review provided in ASTM (1995, 73729) indicates that the test species, *C. tentans,* was among the most sensitive of 24 species evaluated with Great Lakes sediments. In various studies, the midge tended to be less sensitive than the amphipod *Hyalella azteca* for some metals and equivalent to or more sensitive than *H. azteca* for pesticides. A study by DeFoe and Ankley (1998, 73783) showed that the sensitivity of the *C. tentans* 10-day test is greatly increased by measuring growth in addition to survival. While a single species cannot represent the toxic responses for all the members of the community, *C. tentans* is related to the Cañon de Valle aquatic community and appears to have contaminant sensitivities that can indicate whether adverse effects are present.

Sediment samples were collected in Cañon de Valle and Starmer's Gulch for toxicity testing with *C. tentans* using the EPA 10-day survival and growth protocol with daily static renewal using site water (EPA 2000, 73776). The lines of evidence evaluated are survival and growth of the test organisms (Pacific Ecorisk 2001, 73775).

5.4.2.2 Field Study Synopsis

Benthic Macro-invertebrate Survey

Benthic macro-invertebrate samples were collected in Cañon de Valle below the MDA P Site using a modified Hess sampler (EPA 1999, 73728). The samples were preserved in the field and sorted in a laboratory by NMED personnel. Similar samples were collected in Los Alamos Canyon above the reservoir, Guaje Canyon, and Pajarito Canyon. All sampling was conducted in 1996 and 1997, prior to the Cerro Grande fire. Taxonomic identifications were provided by J. Jacobi, with chironomid identifications provided by D. McGuire. Data for number of species, species densities and relative abundances were used to calculate comparative community metrics. A summary of the metric comparisons between Cañon de Valle and Los Alamos Canyon are provided in (NMED 1999, 73769). The comparisons to upper Guaje Canyon and upper Pajarito Canyon are documented in NMED presentation materials regarding macro-invertebrates (NMED 1998, 73772).

Toxicity Testing

Toxicity testing with *C. tentans* was conducted in accordance with the EPA Protocol 100.2 (EPA 2000, 73776). Survival and growth was measured for each of the eight replicates for each site and control. Three sets of sediment and water samples were collected for this assessment. Two locations were above and below the reach of Cañon de Valle that bounds the MDA P Site and the third location, Starmer's Gulch, is a reference location. The testing protocol starts with ten third instar larvae in each exposure vessel and exposes them to the site sediments for 10 days. The overlying water in the test vessels is replaced each day. Site water and sediment was used for each location in order to incorporate any toxicity associated with either media in the test results. At the completion of the test, the number of surviving larvae are counted for each replicate and the surviving larvae are dried, ashed, and the ash-free dry weight is determined. Ash-free weight is a better indicator of growth because it removes that component of larval weight due to gut contents. This is especially important when the amount of organic matter in sediment

samples differs among the sites. Highly organic sediments have a lower specific gravity than mineral sediments, resulting in a downward bias in dry-weight based growth for larvae from organic sediments.

5.5 Field Study Results

5.5.1 Terrestrial Measures of Effects

Five measures of effects were described in the study design section. They are

- Number of small mammal species,
- Population density estimates,
- Reproductive status classes for each species,
- Body weights, and

5.5.1.1 Number of Small Mammal Species and Density Estimates

The spring trapping was conducted from May 21 through May 24, 2001 in Cañon de Valle and Pajarito Canyon. Two species were captured in both canyons: deer mouse and Montane vole (*Microtus montanus*). The numbers of individuals for each species, by canyon were 21 deer mice and 4 Montane voles in Cañon de Valle and 8 deer mice and 1 Montane vole for Pajarito Canyon.

The autumn small mammal trapping was conducted from September 25 through September 28, 2001. This campaign produced five species in Cañon de Valle and three species in Pajarito Canyon for the same trapping effort as the spring campaign. The species, numbers of individuals and reproductive status classes for the spring and fall are provided in Table 5.5.1-1.

Population densities for deer mice were estimated for each trapping grid in both canyons. The results are presented in Table 5.5.1-2. Densities were estimated using Leslie's regression method (Seber 1982, 72730) applied to each grid where daily total numbers of captures were plotted against the cumulative daily captures. Confidence intervals were calculated at 95% using the general method (Seber 1982, 72730). Low capture numbers and some trapping mortality resulted in violating some of the assumptions for the density estimation technique. Consequently, the results may be biased high. However, the density estimates are meaningful for relative comparisons among the trapping grids.

A population density estimate is not provided for the upper trapping grid in Cañon de Valle for the autumn data. The new-capture numbers for deer mice for that period and grid are 5, 4, 8, and 6 individuals for each of the four nights. Density estimation techniques assume that there are a finite number of individuals in a small mammal population and consequently the number of new captures (individuals not previously caught and tagged) each night will decline over the trapping period. If trapping were to continue for a sufficient number of nights, eventually all individuals would be caught at least once and no new captures would be possible. This assumption necessarily depends upon no recruitment of individuals from outside the population area, and a trapping period duration that is not impacted by births or mortality. The higher numbers of new-captures on the third and fourth trapping nights produce a nonsensical density estimate with the Leslie regression technique; other estimation methods would produce similar results.

5.5.1.2 Reproductive Status Classes

The seven reproductive status classes used in this investigation are juvenile female, juvenile male, pregnant female, lactating female, non-reproductive female, non-scrotal male and scrotal male. Table 5.5.1-1 presents reproductive status classes for each of the species collected in the spring and fall trapping campaigns. Cañon de Valle had six reproductive classes in the spring and seven classes in the fall.

Pajarito Canyon had three reproductive classes in the spring and six classes in the fall. The lower number of reproductive classes in Pajarito Canyon correspond with the lower number of individuals caught in that canyon.

5.5.1.3 Body Weights

Body weights of new captures were collected during the trapping campaigns. These data were used to determine whether there are differences in body weights that might be associated with contaminants in Cañon de Valle. For each species, the data were categorized by canyon of origin and sex of the individuals. Sex was used as a category to identify systematic sex-linked differences in weight that could mask differences due to contaminants if the sexes were combined. Weight data were investigated for deer mice in the spring and fall, and for brush mice and wood rats in the fall. Other species either had insufficient numbers for both canyons or were captured in only one canyon.

Data summaries for small mammal weights, by species and sex, and statistical testing results are presented in Tables 5.5.1-3(a, b). Juvenile weights were excluded from these summaries and statistical analyses because weight is one of many ways in which juveniles are unstable. Two statistical methods were used for each data set. The Kruskal-Wallis is a nonparametric test for comparing multiple groups of data using ranks. The results of this test are robust against the data not being normally distributed or the variances being unequal. The result of a parametric analysis of variance is also provided. The four data sets (Cañon de Valle males, Cañon de Valle females, Pajarito Canyon males, and Pajarito Canyon females) showed no differences in body weights between the canyons or sexes. The results are presented as "Four Groups" in Tables 5.5.1-3(a, b). Testing of the four groups is not shown for the wood rat data because of insufficient sample numbers.

The data were also assembled into two groups, Cañon de Valle and Pajarito Canyon, with the sexes combined. These results are presented in Table 5.5.1-3b as "Two Groups" in the statistical testing results for each species. All of these comparisons are not significant, with the exception of the Kruskal-Wallis test for the brush mouse weights. In this case, the Kruskal-Wallis test has a p-value of 0.024 and the analysis of variance has a p-value of 0.074. Figure 5.5.1-1 shows the weight data for the brush mouse, by canyon, sex and reproductive status.

All the brush mouse body weights are within normal weight ranges for this species. The lower weights in Cañon de Valle are associated with the non-reproductive females and the non-scrotal males. These two classes are individuals in transition between the juvenile class and the sexually mature adult classes. In both cases, the individuals have the pelage of adults but have yet to become sexually mature. These two classes characteristically show large variations in body weight, depending upon where individuals are in their maturation. A change in pelage and the onset of adult status typically occurs by the time an individual weighs approximately 11 g. Brush mouse adults frequently weigh over 20 g, as seen in Figure 5.5.1-1. Because the differences in weight between the canyons are due to differences in transitional reproductive status classes, the statistical difference is not biologically meaningful.

5.5.1.4 Contaminant Body Burdens

Six deer mice were collected in each of Cañon de Valle and Pajarito Canyon for contaminant body burden analysis during the spring 2001 trapping campaign. The analyses were conducted on whole-mouse subsamples in order to represent the dose to the Mexican spotted owl. Each mouse was analyzed for TAL metals and HE.

5.5.1.5 Estimated ESLs for the Mexican Spotted Owl

The NOAEL concentrations for the Mexican spotted owl were developed for each of the six terrestrial COPECs. For ecological risk screening, the NOAEL is used as the ESL. Toxicity reference values (TRVs) were used for each of the chemicals for avian or mammalian carnivore receptors. The TRV is the dose in milligrams (mg) of the chemical in food or water per kilogram (kg) of receptor body weight per day (mg/kg-d) that results in a NOAEL. The TRVs are obtained from laboratory studies and require scaling equations in order to apply the information to other receptors such as wildlife. Avian TRVs were used for the metals. As noted earlier, avian toxicity studies for HE have not been published. Consequently, mammalian TRVs were used to develop HE NOAELs for the owl.

Two factors, in addition to TRVs, are necessary for calculating Mexican spotted owl NOAELs: body weight and rate of food consumption. The Mexican spotted owl's average body weight is 600 g, (Dunning 1993, 73795). An estimated daily food consumption rate was developed using two approaches. A daily food consumption rate of 42 g for a 600 g bird was computed using the Nagy equation for "all birds" (Nagy 1987, 62782), as provided in the Wildlife Exposure Factors Handbook (EPA 1993, 59384). This value has a food dry weight per live bird body weight basis.

The Wildlife Exposure Factors Handbook (EPA 1993, 59384) also provides life history information, including daily food intake rates, for four raptors. They are kestrel, red-tail hawk, osprey, and bald eagle. A regression of food consumption rate versus body weight for these species provides an intake estimate of 0.2 body weight per day for the owl. The value of 0.2 is equivalent to a consumption rate of 120 g per day for a 600 g owl. This value has a food fresh weight per live bird body weight basis. The ratio of 42 g dry weight to 120 g fresh weight (0.35) closely approximates the typical factor of 0.3 for converting fresh weight to dry weight. The 120 g fresh weight value is used to calculate required quantitation limits because it relates directly to the owl consumption rate. Table 5.5.1-4 provides the TRVs and the calculated NOAELs for each of the COPECs.

Figure 5.5.1-2 shows boxplots of the deer mouse body burden data, by COPEC, for each canyon. Each plot also has a cursor line that represents the Mexican spotted owl ESL. The data are presented as filled symbols for detects and open symbols for non-detects. All of the Cañon de Valle data are below their respective ESLs. All the HE results were non-detects. Barium showed elevated values relative to Pajarito Canyon with the highest value being 24 mg/kg, which is below the Mexican spotted owl ESL of 63 mg/kg. Two lead values from Pajarito Canyon exceeded the ESL; there are no apparent problems with the laboratory data and the reason for these high values has not been determined.

5.5.2 Aquatic Measures of Effects

Five measures of effects were described in the study design section. They are

- Number of benthic macro-invertebrate species,
- Presence of sensitive species,
- Benthic macro-invertebrate community metrics,
- *C. tentans* toxicity test survival, and
- *C. tentans* toxicity test growth.

5.5.2.1 Number of Benthic Macro-invertebrate Species

Thirty-three taxa of benthic fauna were collected in Cañon de Valle. Most of the taxa were identified to species. Some of the dipterans could only be identified to genus. Pajarito Canyon, the most similar

reference site to Cañon de Valle, had 25 taxa, upper Los Alamos Canyon had 42 taxa, and Guaje Canyon had 26 taxa.

5.5.2.2 Presence of Sensitive Species

Three metrics are available to assess sensitive species. One is the number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). These orders are generally considered to be sensitive to pollutants and their presence at a site indicates that if pollution is present, it is most likely at low levels. The second metric consists of the ratio of EPT to EPT plus the Chironomids. *Chironomidae* is one of the taxonomic families of true flies. They are typically tolerant of pollution-impacted conditions. If they dominate the assemblage of taxa for a site, then the site warrants evaluation for pollution impacts. The third metric is the community tolerance dominance quotient (CTDq) from the biotic community index of Winget and Mangum (1979, 75926). For the first two metrics, larger values indicate better site quality. For the CTDq, lower values indicated better site quality.

Table 5.5.2-1 presents the values of these metrics for Cañon de Valle and each of the three reference sites.

5.5.2.3 Benthic macro-invertebrate community metrics

A total of eleven community metrics were computed by Ralph Ford-Schmid with NMED-OB to assess the benthic macro-invertebrate community quality of Cañon de Valle relative to reference sites. Using Pajarito Canyon as the reference site, Cañon de Valle had a relative score of 81%. Comparisons to upper Los Alamos and Guaje Canyons were 70% and 73%, respectively. These values generally indicate little or no impact of pollutants to the benthic invertebrate community structure. The EPA Rapid Bioassessment Protocol (EPA 1999, 73728) characterizes a reference comparison of >79% as "full support" and a reference comparison of 70-79% as "full support, impacts observed."

Two sources of community variability that these metrics do not control for are the relative size of the streams and the availability of fauna to colonize the sites. Cañon de Valle is the smallest of the streams and would be expected to have a smaller invertebrate community. Additionally, all of these streams are headwater, or first order, streams. First order streams are generally known for large variations in their species assemblages. The primary reason ascribed to this phenomenon is the reduced availability of colonizing species. An additional challenge to colonizing headwater streams with invertebrates on the Pajarito Plateau is that all of these streams are disconnected from the Rio Grande.

An evaluation of the eleven metrics that are aggregated to support the inter-stream comparisons shows that Cañon de Valle has very low numbers of taxa in the scraper feeding guild relative to the other streams. The feeding strategy for this guild is to harvest ("scrape") periphytic algae and associated organisms from mineral and organic surfaces. The character of the Cañon de Valle streambed is unsorted coarse to fine sand with areas of emergent vegetation and higher concentrations of clays, silts and organic matter. Larger stable surfaces that could support the propagation of periphytic films are largely lacking in this stream. There may be insufficient energy in the stream flow to scour finer materials and to establish cobble-dominated riffles. When the community index is aggregated without the scraper community score, (ten metrics instead of eleven), Cañon de Valle scores 90% relative to Pajarito Canyon, 78.6% relative to upper Los Alamos Canyon and 81.5% relative to Guaje Canyon. These values indicate that the presence of contaminants in Cañon de Valle is not causing a displacement in the benthic macro-invertebrate community structure.

5.5.2.4 C. tentans Toxicity Test

Site sampling to support toxicity testing was conducted on September 21, 2001. The data discussed in this section are a subset of the data generated by the sampling and testing campaign for the Cañon de Valle assessment. The three locations used to support this assessment are above the MDA P Site and below Burning Ground Spring, 80 m below the MDA P Site, and the Starmer's Gulch reference site.

The toxicity testing laboratory conducted two additional sets of replicates to support the data interpretation. A laboratory control, using standard reference sediment and laboratory water, was provided to assess any impacts associated with the laboratory environment or materials and a reference toxicant test was performed to ascertain whether the test organisms responded to toxicants in a predictable manner. The full data report contains these results (Pacific Ecorisk 2001, 73775).

Survival

The sediment and site water from Starmer's Gulch had 82.5 % survival for the eight replicates. This is the uncontaminated reference site. The site above the MDA P Site had 68.75 % survival and the site below the MDA P Site had 86.25 % survival. Statistical analysis was performed to compare the sites using two statistical methods. The WRS Test is a nonparametric method that is not influenced by unequal variances or skew in the data. When the data depart from normality and equal variances the WRS Test is better able to discriminate differences than the Student's t test. The Student's t test was also conducted to assess any differences in interpretation of the data that could be attributed to the choice of test. The results and data summaries are presented in Table 5.5.2-2(a, b). The testing site above the MDA P Site is significantly different from the reference site and the site below the MDA P Site is not different from the reference site. These results indicate that Cañon de Valle is impacted relative to the reference site, but that the MDA P Site is not a contributor to that impact.

Growth

The growth data from the toxicity test show that there is some response to site conditions associated with Cañon de Valle relative to Starmer's Gulch. The mean ash-free dry weight for Starmer's Gulch is 0.44 mg/individual. The mean weights for above the MDA P Site and below the MDA P Site are 0.38 mg/individual and 0.4 mg/individual, respectively. Consistent with the survival results, growth of individuals above the MDA P Site was more impacted than the growth of individuals below the MDA P Site. Statistical analyses of these data were performed in the same manner as described for the survival data. The results are presented in Table 5.5.2-2(a, b) along with data summaries. Starmer's Gulch, the reference site, is statistically different from the site above the MDA P Site. The site below the MDA P Site is not statistically different from Starmer's Gulch. Based upon these results, there is a Cañon de Valle induced impact to the growth measurement endpoint relative to Starmer's Gulch. The difference in growth response between the sites above and below the MDA P Site indicates that the MDA P Site is not contributing to this impact.

5.6 Cañon de Valle Risk Characterization

Information has been presented to evaluate potential ecological risks to the terrestrial and aquatic systems in Cañon de Valle. The terrestrial lines of evidence compare small mammal populations and contaminant body burdens between Cañon de Valle and upper Pajarito Canyon (a reference site). The aquatic lines of evidence are derived from two data sources. One is a comparison benthic macro-invertebrate communities between Cañon de Valle and three reference canyons. The other data source is sediment toxicity testing with *C. tentans* for samples collected above and below the MDA P Site and the reference location in Starmer's Gulch.

5.6.1 Terrestrial Assessment

The terrestrial results show that the number of species and the population densities are both greater in Cañon de Valle than in the reference site. Additionally, Cañon de Valle consistently had more reproductive status classes than Pajarito Canyon. This evidence indicates that the contaminant inventories in Cañon de Valle are not adversely affecting the small mammal community.

A comparison of body weights, by species, shows no differences between the canyons except for brush mice when the sexes are combined. As shown in Figure 5.5.1-1 and described in the text, this difference in weights is associated with a relatively large number of non-reproductive individuals in Cañon de Valle. The difference in weights actually indicates the brush mouse population in Cañon de Valle is more active with regard to reproduction because the canyon has more individuals transitioning from juvenile to reproductive status.

The analysis of contaminant body burdens for small mammals show that the whole-mouse concentrations are well below ESLs for the Mexican spotted owl. These data indicate that the contaminant inventories in Cañon de Valle are not posing a food chain risk to the owl.

5.6.2 Aquatic Assessment

The benthic macro-invertebrate lines of evidence show that the total number of benthic macro-invertebrate taxa in Cañon de Valle (33) is within the range of values for the three reference reaches (25 to 42). Sensitive species are present in the canyon, with the total number of sensitive species being lower than in the reference reaches. This result corresponds to the comparisons of community metrics for the reaches, summarized below. The Cañon de Valle score of 81% is slightly above the cut-off for impacted streams (79%) when compared to Pajarito Canyon, the most similar reference stream. There are two possible sources of these differences. First, the scraper community is substantially reduced in Cañon de Valle. The primary reason is probably a lack of habitat to support that feeding strategy. When the community metrics are summed without the scraper community metric, Cañon de Valle scores 90% relative to Pajarito Canyon. The second source of differences between Cañon de Valle and the references reaches is stream size. Cañon de Valle is the smallest of the streams. It is common for smaller streams to have fewer taxa. Thus, the difference in the community metric scores of Cañon de Valle and Pajarito Canyon is not due to contaminants in Cañon de Valle, but is attributed to the lack of habitat in Cañon de Valle to support a scraper community and the smaller size of the stream.

The sediment toxicity testing lines of evidence show that Cañon de Valle is impacted relative to the reference site in Starmer's Gulch, but that the reach potentially influenced by the MDA P Site is not contributing to that impact. Survival for the test organisms was higher below the MDA P Site than above it. Similarly, the comparisons of larval growth showed impacts above the MDA P Site reach but not below.

5.6.3 Conclusions

The conclusions of the ecological risk assessment for the terrestrial and aquatic systems in Cañon de Valle are that while the contaminant concentrations in the canyon exceed ESLs for both systems, there is no empirical evidence of adverse effects associated with the MDA P Site. These lines of evidence, in combination with the overall appearance of the canyon, indicate that mitigations and/or monitoring are not warranted in the vicinity of the MDA P Site.

5.6.4 Uncertainty Analysis

The major source of uncertainty associated with this assessment is that the terrestrial and sediment toxicity evaluations were conducted during a multi-year drought and within a year of the Cerro Grande fire. The results of the investigations may differ during wetter periods, but the potential impacts of contaminants in the environment are not likely to be increased. Individual and population effects are typically the consequence of multiple stressors. Drought is one stressor and is likely to increase the potential of detecting an adverse effect that could be associated with contaminants. Fire effects often result in increased small mammal populations associated with increased ground vegetation. If contaminant uptake and food chain transfers were a source of population effects, then post-fire environments should increase the likelihood of these effects.

Ecological screening assessments are subject to uncertainties through the use of laboratory toxicology studies to develop no effects contaminant concentrations. Laboratory studies use chemical forms of contaminants and exposure mechanisms that are often conservative when compared to environmental conditions. Additionally, laboratory studies are often conducted with single contaminants. The result of combinations of contaminants is largely unknown. The results presented for Cañon de Valle are based upon field studies and laboratory toxicity studies with field-collected media from the canyon containing multiple contaminants. This approach obviates the usual difficulties of extrapolating laboratory data to field settings.

The calculations of exposure concentrations for the Mexican spotted owl for RDX and HMX were based upon mammal TRVs. This is because data were not available in the literature for avian exposures to these COPCs. The Department of the Army has very recently published results of exposure studies for RDX and HMX using Northern Bobwhite quail (*Colinus virginianus*) (Salis and Holdsworth 2001, 73780; USACHPPM 2001, 73781). The TRV for RDX is 8.7 mg/kg-d. This value is in good agreement with the rat TRV of 10 mg/kg-d, indicating that the calculated Mexican spotted owl ESL for RDX is representative. A similar study was conducted for HMX. No TRV is published because exposure of quail to HMX did not result in mortality or morbidity in sub-chronic studies with doses up to 10,000 mg/kg HMX in food. These results indicate that the mouse TRV of 75 mg/kg-d is a conservative proxy for avian effects and protective of the Mexican spotted owl.

Another uncertainty associated with this assessment is the adequacy of sample coverage to support descriptions of the contaminant signatures at a site. In this particular assessment, the MDA P soils were characterized with 46 samples collected in a grid pattern. The overbank soils sample in Cañon de Valle were collected as part of the geomorphic characterization of contaminants in the canyon. These latter samples were biased towards areas likely to have high contaminant concentrations in order to conservatively characterize the canyon. The combination of these two data sets for this analysis provides a strong basis for the conclusion of no adverse effects to the Cañon de Valle receptors from residual COPC concentrations at the MDA P Site.

5.7 Comparisons of COPEC Concentrations for the MDA P Site to Cañon de Valle Soils

Two COPECs in MDA P Site biological zone soil were carried forward for ecological risk assessment. They are barium and RDX. Both of these contaminants are present in the Cañon de Valle soils. The ecological risk assessment approach for these contaminants in the MDA P Site soils is to compare their concentrations to the Cañon de Valle concentrations. The results of the ecological risk assessment for Cañon de Valle, presented above, is a determination of no adverse effects in the vicinity of the MDA P Site. If the COPEC concentrations for the MDA P Site footprints soils are less than, or not different from, the Cañon de Valle soils, then the determination of no adverse effects is supported for the MDA P Site soils.

Contaminant concentration data for the MDA P Site soils were compared to Cañon de Valle overbank soils using a Gehan test for differences between medians and a Quantile test for differences in the upper 20% of the data values. The combination of these two tests evaluates the differences in the centers of the data and the highest concentrations of the data. Data summaries for barium and RDX are presented in Table 5.7-1, along with the data for other COPECs in Cañon de Valle. Statistical comparisons for all the Cañon de Valle COPECs were performed in order to assess the consequences of soil transport from the MDA P Site footprint to the canyon. The results of the comparisons are presented in Table 5.7-2.

All of the statistical comparisons between Cañon de Valle and the MDA P Site in Table 5.7-2 are not significant, except for aluminum and cadmium. Where the tests are not significant, the concentrations in the MDA P Site soils are equivalent to or less than the concentrations in Cañon de Valle. The maximum concentration of barium (the main risk driver for the MDA P Site) is much lower (6980 mg/kg) than the maximum concentration measured in the canyon (37,300 mg/kg). Aluminum in MDA P Site soils is higher than in the canyon soil. Per EPA guidance (EPA 2000, 73306) aluminum is a COPEC only for sites with a soil pH of less than 5.5 because of pH values greater than 5.5, aluminum is unavailable. The pH range of the MDA P soils is 6.8 to 7.6. Based upon this criterion, aluminum is eliminated from further consideration. Cadmium concentrations are also higher for the MDA P soils that for Cañon de Valle. Cadmium is eliminated from further consideration because 22 of the 23 detected values are less than the soil BV of 0.4 mg/kg (LANL 1998, 59730). The single value that exceeds the BV is 1.4 mg/kg, which is within the range of background concentrations (LANL 1998, 59730), indicating that cadmium is unlikely to cause a population-level effect to ecological receptors.

5.7.1 Risk Characterization

Comparisons of the MDA P Site soil COPEC concentrations to Cañon de Valle contaminant concentrations show that the COPECs barium and RDX are not different between the two locations. The lack of adverse effects in Cañon de Valle from these contaminants is strong evidence that there are no effects due to these contaminants in the MDA P Site soils of the biological zone. This conclusion is valid for the MDA P Site soils in their present location and also in the event that they are transported into the canyon in the future. The concentrations of other Cañon de Valle COPECs in the MDA P Site soils do not pose a threat of adverse effects because they are not different from the overbank soil concentrations for the canyon.

5.7.2 Conclusions

Based upon this assessment, further actions to mitigate/monitor contaminant concentrations in the MDA P Site soils are not warranted. There are no impacts to ecological receptors due to residual concentrations of chemicals in soil and tuff at the MDA P Site.

Tables

LIST OF TABLES

Table 3.1-1
Summary of MDA P Site Phase II Confirmation Samples Used in the Risk Assessment

Analyte Group	Number of Samples	
	Biological Zone	Exposed Tuff Zone
Inorganic Chemicals		
TAL Metals	143	146
Chromium (VI)	143	146
Mercury	143	146
Perchlorate	27	33
Organic Chemicals		
VOCs	5	5
SVOCs	138	137
PCBs	3	4
HE	144	143
Dioxins/Furans	3	4
Pesticides	3	4
Herbicides	3	4
Radionuclides		
Gamma Spec.	3	4
Uranium Isotopes	3	4
Other		
pH	3	4

Table 3.2.1-1
Frequency of Detected Inorganic Chemicals Above Background-Biological Zone

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	BV (mg/kg)	Frequency of Detects above BV	Frequency of Nondetects above BV
Aluminum	Soil	71	71	2,630 to 19,900	29,900	0/71	0/71
Aluminum	Tuff	73	73	766 to 32,700	7,340	6/73	0/73
Antimony	Soil	71	17	[0.09] to 2.90	0.83	1/71	23/71
Antimony	Tuff	73	3	[0.14] to 1.20	0.5	1/73	41/73
Arsenic	Soil	71	66	[0.12] to 4.80	8.17	0/71	0/71
Arsenic	Tuff	73	61	[0.12] to 3.80	2.79	4/73	0/73
Barium	Soil	71	71	18.7 to 6,630	295	28/71	0/71
Barium	Tuff	73	73	9.30 to 2,920	46	45/73	0/73
Beryllium	Soil	71	71	0.27 to 1.80	1.83	0/71	0/71
Beryllium	Tuff	73	73	0.23 to 1.90	1.21	7/73	0/73
Cadmium	Soil	71	24	[0.01] to 1.40	0.4	1/71	4/71
Cadmium	Tuff	73	33	[0.02] to 0.80	1.63	0/73	0/73
Chromium	Soil	71	70	1.6 to 39.4	19.3	1/71	0/71
Chromium	Tuff	73	69	0.51 to 15.6	7.14	8/73	0/73
Cobalt	Soil	71	71	0.690 to 44.7	8.64	4/71	0/71
Cobalt	Tuff	73	70	0.41 to 41.3	3.14	9/73	0/73
Copper	Soil	71	71	0.68 to 36.8	14.7	6/71	0/71
Copper	Tuff	73	73	0.004 to 32.4	4.66	19/73	0/73
Iron	Soil	71	71	4,580 to 19,900	21,500	0/71	0/71
Iron	Tuff	73	73	6.47 to 22,500	14,500	4/73	0/73
Lead	Soil	71	71	3.80 to 61.5	22.3	5/71	0/71
Lead	Tuff	73	73	1.25 to 24.20	11.2	8/73	0/73
Manganese	Soil	71	71	30.90 to 1,290	671	1/71	0/71
Manganese	Tuff	73	73	44.7 to 456	482	0/73	0/73
Mercury	Soil	71	36	[0.2] to 0.07	0.1	0/71	0/71
Mercury	Tuff	73	14	[0.0028] to 0.0610	0.1	0/73	0/73
Nickel	Soil	71	69	[1.3] to 10.5	15.4	0/71	0/71
Nickel	Tuff	73	62	0.79 to 12.6	6.58	8/73	0/73
Selenium	Soil	71	33	[0.10] to 0.480	1.52	0/71	0/71
Selenium	Tuff	73	48	0.13 to 0.74	0.3	21/73	2/73
Silver	Soil	71	16	[0.019] to 15.8	1	7/71	3/71
Silver	Tuff	73	15	[0.035] to 4.60	1	2/73	1/73
Thallium	Soil	71	30	[0.0130] to [1.2]	0.73	0/71	3/71
Thallium	Tuff	73	25	[0.012] to 1.2	1.1	1/73	1/73
Vanadium	Soil	71	70	[0.380] to 29.3	36.6	0/71	0/71
Vanadium	Tuff	73	70	0.0038 to 26.4	17	2/73	0/73

Refer to footnotes at end of table.

Table 3.2.1-1 (Concluded)
Frequency of Detected Inorganic Chemicals Above Background-Biological Zone

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	BV (mg/kg)	Frequency of Detects above BV	Frequency of Nondetects above BV
Zinc	Soil	71	67	[9.4] to 912	48.8	7/71	0/71
Zinc	Tuff	73	73	0.027 to 150	63.5	2/73	0/73

BV = Background value.
COPC = Chemical of potential concern.
mg/kg = Milligram(s) per kilogram.
[ ] = Non-detect.

Table 3.2.1-2
Wilcoxon Rank Sum Test Distribution Comparison Results of Inorganics with Maximum Values Greater than Background: Confirmation Data Sets vs. Background Data Sets-Biological Zone

Analyte	Media	Valid N for Background Data Set	Valid N for MDA P Data Set	Adjusted p-Level[a]	Pass/Fail Test[a]
Aluminum	Tuff	62	73	0.000	Fail
Antimony	Soil	135	71	0.000	Fail
Antimony	Tuff	63	73	0.000	Fail
Arsenic	Tuff	63	73	0.753	Pass
Barium	Soil	173	71	0.000	Fail
Barium	Tuff	62	73	0.000	Fail
Beryllium	Tuff	63	73	0.263	Pass
Cadmium	Soil	39	71	0.000	Fail
Chromium	Soil	173	71	0.000	Fail
Chromium	Tuff	63	73	0.000	Fail
Cobalt	Soil	131	71	0.000	Fail
Cobalt	Tuff	11	73	0.005	Fail
Copper	Soil	174	71	0.405	Pass
Copper	Tuff	63	73	0.000	Fail
Iron	Tuff	63	73	0.000	Fail
Lead	Soil	173	71	0.017	Fail
Lead	Tuff	62	73	0.691	Pass
Manganese	Soil	173	71	0.000	Fail
Nickel	Tuff	62	73	0.000	Fail
Selenium	Tuff	14	73	0.000	Fail
Silver	Soil	---	---	---	---
Silver	Tuff	63	73	0.000	Fail
Thallium	Soil	173	71	0.000	Fail
Thallium	Tuff	63	73	0.000	Fail
Vanadium	Tuff	63	73	0.001	Fail
Zinc	Soil	172	71	0.945	Pass
Zinc	Tuff	63	73	0.743	Pass

[a]p-Level $\geq$ 0.05 = Pass, indicating the distributions are not statistically different at the 95% confidence level.
MDA P = Material Disposal Area P.
N = Number of samples.
--- = Background data set not available.

Table 3.2.1-3
Quantile Test Results for Soil and Tuff-Biological Zone

Analyte	Media	Valid N for Background Data Set	Valid N for MDA P Data Set	Table k[a]	Observed k	Pass/Fail Test[b]
Aluminum	Tuff	62	73	5	6	Fail
Antimony	Soil	135	71	5	1	Pass
Antimony	Tuff	63	73	5	43	Fail
Arsenic	Tuff	63	73	5	0	Pass
Barium	Soil	173	71	5	20	Fail
Barium	Tuff	62	73	5	45	Fail
Beryllium	Tuff	63	73	5	1	Pass
Cadmium	Soil	39	71	5	0	Pass
Chromium	Soil	173	71	5	1	Pass
Chromium	Tuff	63	73	5	1	Pass
Cobalt	Soil	131	71	5	3	Pass
Cobalt	Tuff	11	73	19	9	Pass
Copper	Soil	173	71	5	6	Fail
Copper	Tuff	63	73	5	14	Fail
Iron	Tuff	63	73	5	1	Pass
Lead	Soil	173	71	5	2	Pass
Lead	Tuff	62	73	5	8	Fail
Manganese	Soil	173	71	5	1	Pass
Nickel	Tuff	62	73	5	8	Fail
Selenium	Tuff	14	73	15	55	Fail
Silver	Soil	---	---	---	---	---
Silver	Tuff	63	73	5	1	Pass
Thallium	Soil	173	71	5	3	Pass
Thallium	Tuff	63	73	5	0	Pass
Vanadium	Tuff	63	73	5	1	Pass
Zinc	Soil	172	71	5	2	Pass
Zinc	Tuff	63	73	5	2	Pass

[a]EPA 1994.
[b]Pass = Quantile test determined the background and MDA P data set distribution upper tails are not different.
k = Exceedance of site data.
N = Number of samples.
-- = Background data set not available.

Table 3.2.1-4
Background Test Matrix Table - Biological Zone

Analyte	Media	Above/Below BV	Wilcoxon Rank Sum Pass/Fail	Quantile Pass/Fail	COPC?
Aluminum	Soil	Below	---	---	No
Aluminum	Tuff	Above	Fail	Fail	Yes
Antimony	Soil	Above	Fail	Pass	No[a]
Antimony	Tuff	Above	Fail	Fail	Yes
Arsenic	Soil	Below	---	---	No
Arsenic	Tuff	Above	Pass	Pass	No
Barium	Soil	Above	Fail	Fail	Yes
Barium	Tuff	Above	Fail	Fail	Yes
Beryllium	Soil	Below	---	---	No
Beryllium	Tuff	Above	Pass	Pass	No
Cadmium	Soil	Above	Fail	Pass	No[a]
Cadmium	Tuff	Below	---	---	No
Chromium	Soil	Above	Fail	Pass	No[a]
Chromium	Tuff	Above	Fail	Pass	Yes
Cobalt	Soil	Above	Fail	Pass	No[a]
Cobalt	Tuff	Above	Fail	Pass	Yes
Copper	Soil	Above	Pass	Fail	Yes
Copper	Tuff	Above	Fail	Fail	Yes
Iron	Soil	Below	---	---	No
Iron	Tuff	Above	Fail	Pass	Yes
Lead	Soil	Above	Fail	Pass	No[a]
Lead	Tuff	Above	Pass	Fail	Yes
Manganese	Soil	Above	Fail	Pass	No[a]
Manganese	Tuff	Below	---	---	No
Nickel	Soil	Below	---	---	No
Nickel	Tuff	Above	Fail	Fail	Yes
Selenium	Soil	Below	---	---	No
Selenium	Tuff	Above	Fail	Fail	Yes
Silver	Soil	Above	NA	NA	Yes[c]
Silver	Tuff	Above	Fail	Pass	No[b]
Thallium	Soil	Above	Fail	Pass	No[a]
Thallium	Tuff	Above	Fail	Pass	No[a]
Vanadium	Soil	Below	---	---	No
Vanadium	Tuff	Above	Fail	Pass	Yes
Zinc	Soil	Above	Pass	Pass	No
Zinc	Tuff	Above	Pass	Pass	No

[a]WRS failed due to the fact that the site median was statistically less than the background median.
[b]One hit greater than maximum background.
[c]Background data set unavailable for statistical comparison tests.
--- = Statistical analysis not required because BV was not exceeded.

Table 3.2.1-5
Inorganic COPCs: Samples Greater than Background-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Aluminum	16-20195	0816-01-0206	8,540	Tuff	2-3
Aluminum	16-20323	0816-01-0039	10,200	Tuff	2-3
Aluminum	16-20295	0816-01-0072	13,300	Tuff	0-1
Aluminum	16-20105	0816-01-0027	14,400	Tuff	0-1
Aluminum	16-20223	0816-01-0083	17,400	Tuff	2-3
Aluminum	16-20223	0816-01-0082	32,700	Tuff	0-0.5
Antimony	16-20323	0816-01-0040	0.80 (UJ)	Tuff	0-0.5
Antimony	16-20376	0816-01-0232	0.82 (U)	Tuff	0-1
Antimony	16-20598	0816-01-0265	0.85 (UJ)	Tuff	0-1
Antimony	16-20706	0816-01-0323	0.86 (U)	Tuff	0-1
Antimony	16-20306	0816-01-0033	0.86 (U)	Tuff	0-1
Antimony	16-20511	0816-01-0100	0.87 (UJ)	Tuff	0-1
Antimony	16-20307	0816-01-0034	0.87 (U)	Tuff	0-1
Antimony	16-20598	0816-01-0266	0.88 (UJ)	Tuff	2-3
Antimony	16-20237	0816-01-0037	0.88 (U)	Tuff	0-1
Antimony	16-20323	0816-01-0039	0.89 (UJ)	Tuff	2-3
Antimony	16-20457	0816-01-0226	0.90 (UJ)	Tuff	0-1
Antimony	16-20334	0816-01-0235	0.91 (UJ)	Tuff	0-1
Antimony	16-20195	0816-01-0206	0.92 (U)	Tuff	2-3
Antimony	16-20223	0816-01-0083	0.93 (UJ)	Tuff	2-3
Antimony	16-20305	0816-01-0035	0.94 (U)	Tuff	0-1
Antimony	16-20457	0816-01-0227	0.95 (U)	Tuff	24-36
Antimony	16-20274	0816-01-0029	0.96 (U)	Tuff	0-1
Antimony	16-20223	0816-01-0082	0.97 (UJ)	Tuff	0-0.5
Antimony	16-20295	0816-01-0072	0.97 (UJ)	Tuff	0-1
Antimony	16-20419	0816-01-0244	0.98 (UJ)	Tuff	0-1
Antimony	16-20528	0816-01-0190	0.98 (U)	Tuff	0-1
Antimony	16-20273	0816-01-0032	0.99 (U)	Tuff	2-3
Antimony	16-20189	0816-01-0247	1.00 (UJ)	Tuff	2-3
Antimony	16-20198	0816-01-0114	1.00 (UJ)	Tuff	0-1
Antimony	16-20234	0816-01-0115	1.00 (UJ)	Tuff	0-1
Antimony	16-20269	0816-01-0061	1.00 (U)	Tuff	0-1
Antimony	16-20269	0816-01-0062	1.00 (U)	Tuff	2-3
Antimony	16-20273	0816-01-0031	1.00 (U)	Tuff	0-1
Antimony	16-20287	0816-01-0028	1.00 (U)	Tuff	0-1
Antimony	16-20330	0816-01-0110	1.00 (UJ)	Tuff	0-1
Antimony	16-20330	0816-01-0111	1.00 (UJ)	Tuff	2-3
Antimony	16-20333	0816-01-0091	1.00 (UJ)	Tuff	0-1
Antimony	16-20333	0816-01-0093	1.00 (UJ)	Tuff	2-3

Refer to footnotes at end of table.

Table 3.2.1-5 (Continued)
Inorganic COPCs: Samples Greater than Background-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Antimony	16-20415	0816-01-0245	1.00 (UJ)	Tuff	0-1
Antimony	16-20416	0816-01-0246	1.00 (UJ)	Tuff	0-1
Antimony	16-20418	0816-01-0242	1.00 (UJ)	Tuff	0-1
Antimony	16-20418	0816-01-0243	1.00 (UJ)	Tuff	2-3
Antimony	16-20105	0816-01-0027	1.1 (U)	Tuff	0-1
Antimony	16-20121	0816-01-0097	1.1 (U)	Tuff	0-1
Antimony	16-20389	0816-01-0030	1.1 (U)	Tuff	0-1
Antimony	16-20193	0816-01-0059	1.10 (U)	Tuff	0-1
Antimony	16-20421	0816-01-0217	1.2 (J)	Tuff	0-1
Barium	16-20330	0816-01-0110	52	Tuff	0-1
Barium	16-20105	0816-01-0027	52.6	Tuff	0-1
Barium	16-20295	0816-01-0072	54.6 (J-)	Tuff	0-1
Barium	16-20195	0816-01-0206	69.8	Tuff	2-3
Barium	16-20270	0816-01-0138	71.1	Tuff	2-3
Barium	16-20242	RE16-02-44951	81.2	Tuff	0-1
Barium	16-20528	0816-01-0190	84	Tuff	0-1
Barium	16-20274	0816-01-0029	85.7	Tuff	0-1
Barium	16-20277	RE16-02-44953	105	Tuff	0-1
Barium	16-20278	RE16-02-44944	113	Tuff	0-1
Barium	16-20598	0816-01-0265	116	Tuff	0-1
Barium	16-20269	0816-01-0061	123	Tuff	0-1
Barium	16-20205	RE16-02-44945	136	Tuff	0-1
Barium	16-20205	RE16-02-44946	136	Tuff	0-1
Barium	16-20323	0816-01-0039	158	Tuff	2-3
Barium	16-20223	0816-01-0083	161 (J-)	Tuff	2-3
Barium	16-20386	0816-01-0360	196	Tuff	0-1
Barium	16-20323	0816-01-0040	201 (J)	Tuff	0-0.5
Barium	16-20234	0816-01-0115	263	Tuff	0-1
Barium	16-20197	0816-01-0120	264	Tuff	0-1
Barium	16-20692	0816-01-0086	266 (J-)	Tuff	0-1
Barium	16-20271	0816-01-0140	274	Tuff	0-1
Barium	16-20223	0816-01-0082	280 (J-)	Tuff	0-0.5
Barium	16-20198	0816-01-0114	326	Tuff	0-1
Barium	16-20334	0816-01-0235	335	Tuff	0-1
Barium	16-20278	0816-01-0359	342	Tuff	0-1
Barium	16-20270	0816-01-0136	376	Tuff	0-1
Barium	16-20706	0816-01-0323	384	Tuff	0-1
Barium	16-20307	0816-01-0034	428	Tuff	0-1
Barium	16-20276	RE16-02-44952	439	Tuff	0-1

Refer to footnotes at end of table.

Table 3.2.1-5 (Continued)
Inorganic COPCs: Samples Greater than Background-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Barium	16-20206	RE16-02-44950	463	Tuff	0-1
Barium	16-20305	0816-01-0035	606	Tuff	0-1
Barium	16-20233	0816-01-0122	640	Tuff	2-3
Barium	16-20457	0816-01-0226	652	Tuff	0-1
Barium	16-20233	0816-01-0121	674	Tuff	0-1
Barium	16-20419	0816-01-0244	686 (J)	Tuff	0-1
Barium	16-20418	0816-01-0243	840 (J)	Tuff	2-3
Barium	16-20418	0816-01-0242	996 (J)	Tuff	0-1
Barium	16-20241	0816-01-0357	1,030	Tuff	0-1
Barium	16-20189	0816-01-0147	1,040	Tuff	0-1
Barium	16-20189	0816-01-0148	1,160	Tuff	2-3
Barium	16-20599	RE16-02-45443	1,170 (J-)	Tuff	0-1
Barium	16-20196	0816-01-0130	1,250	Tuff	0-1
Barium	16-20306	0816-01-0033	1,310	Tuff	0-1
Barium	16-20189	0816-01-0247	1,400 (J)	Tuff	2-3
Barium	16-20670	RE16-02-45436	2,920 (J-)	Tuff	0-1
Barium	16-20002	0816-01-0294	310	Soil	0-0.5
Barium	16-20694	0816-01-0253	323	Soil	2-3
Barium	16-20195	0816-01-0205	335 (J)	Soil	0-1
Barium	16-20262	0816-01-0105	354	Soil	0-1
Barium	16-20268	RE16-02-45437	358 (J-)	Soil	0-1
Barium	16-20191	0816-01-0046	394	Soil	0-1
Barium	16-20300	0816-01-0187	398 (J+)	Soil	2-3
Barium	16-20174	0816-01-0047	473	Soil	0-1
Barium	16-20694	0816-01-0058	473	Soil	0-1
Barium	16-20376	0816-01-0164	513 (J+)	Soil	0-1
Barium	16-20238	RE16-02-44948	527	Soil	0-1
Barium	16-20004	0816-01-0293	558	Soil	0-0.5
Barium	16-20348	0816-01-0214	588	Soil	0-1
Barium	16-20314	0816-01-0354	651	Soil	0-1
Barium	16-20304	0816-01-0036	696	Soil	0-1
Barium	16-20153	0816-01-0262	789 (J+)	Soil	0-1
Barium	16-20265	0816-01-0107	921	Soil	0-1
Barium	16-20342	0816-01-0180	983	Soil	0-1
Barium	16-20340	0816-01-0176	1,060	Soil	2-3
Barium	16-20549	0816-01-0215	1,320	Soil	0-1
Barium	16-20742	RE16-02-45441	1,440	Soil	2-3
Barium	16-20742	RE16-02-45442	1,540 (J-)	Soil	2-3
Barium	16-20351	0816-01-0050	1,540	Soil	0-1
Barium	16-20387	0816-01-0161	1,730	Soil	0-1

Refer to footnotes at end of table.

Table 3.2.1-5 (Continued)
Inorganic COPCs: Samples Greater than Background-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Barium	16-20240	0816-01-0352	1,700	Soil	0-1
Barium	16-20742	RE16-02-45439	2,750 (J-)	Soil	0-1
Barium	16-20232	RE16-02-45438	3,850 (J-)	Soil	0-1
Barium	16-20006	0816-01-0289	6,630	Soil	0-0.5
Chromium	16-20457	0816-01-0226	7.3 (J)	Tuff	0-1
Chromium	16-20670	RE16-02-45436	7.5	Tuff	0-1
Chromium	16-20105	0816-01-0027	7.9	Tuff	0-1
Chromium	16-20121	0816-01-0097	8.2	Tuff	0-1
Chromium	16-20223	0816-01-0083	10	Tuff	2-3
Chromium	16-20376	0816-01-0232	10.1 (J)	Tuff	0-1
Chromium	16-20295	0816-01-0072	12.1	Tuff	0-1
Chromium	16-20223	0816-01-0082	15.6	Tuff	0-0.5
Cobalt	16-20189	0816-01-0247	3.3 (J)	Tuff	2-3
Cobalt	16-20599	RE16-02-45443	3.7	Tuff	0-1
Cobalt	16-20457	0816-01-0226	3.7 (J)	Tuff	0-1
Cobalt	16-20223	0816-01-0082	4.1 (J)	Tuff	0-0.5
Cobalt	16-20105	0816-01-0027	4.4 (J)	Tuff	0-1
Cobalt	16-20205	RE16-02-44945	5.6 (J-)	Tuff	0-1
Cobalt	16-20205	RE16-02-44946	5.9 (J-)	Tuff	0-1
Cobalt	16-20204	RE16-02-44943	21.7 (J-)	Tuff	0-1
Cobalt	16-20242	RE16-02-44951	41.3 (J-)	Tuff	0-1
Cobalt	16-20742	RE16-02-45441	25	Soil	2-3
Copper	16-20273	RE16-02-46406	5.0 (J)	Tuff	42.4-42.9
Copper	16-20189	0816-01-0148	5.2	Tuff	2-3
Copper	16-20323	0816-01-0039	5.4	Tuff	2-3
Copper	16-20242	RE16-02-44951	5.5	Tuff	0-1
Copper	16-20233	0816-01-0122	5.7	Tuff	2-3
Copper	16-20223	0816-01-0083	6.7	Tuff	2-3
Copper	16-20295	0816-01-0072	7.4	Tuff	0-1
Copper	16-20599	RE16-02-45443	8.5	Tuff	0-1
Copper	16-20305	0816-01-0035	10.4	Tuff	0-1
Copper	16-20223	0816-01-0082	10.5	Tuff	0-0.5
Copper	16-20196	0816-01-0130	11.2	Tuff	0-1
Copper	16-20274	0816-01-0029	16.2	Tuff	0-1
Copper	16-20306	0816-01-0033	19.4	Tuff	0-1
Copper	16-20376	0816-01-0232	22.2	Tuff	0-1
Copper	16-20105	0816-01-0027	22.8	Tuff	0-1
Copper	16-20670	RE16-02-45436	23.4	Tuff	0-1
Copper	16-20307	0816-01-0034	25.5	Tuff	0-1

Refer to footnotes at end of table.

Table 3.2.1-5 (Continued)
Inorganic COPCs: Samples Greater than Background-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Copper	16-20334	0816-01-0235	25.6	Tuff	0-1
Copper	16-20237	0816-01-0037	32.4	Tuff	0-1
Copper	16-20694	0816-01-0253	18.8	Soil	2-3
Copper	16-20387	0816-01-0161	20.70	Soil	0-1
Copper	16-20340	0816-01-0176	21.8 (J)	Soil	2-3
Copper	16-20232	RE16-02-45438	28.9	Soil	0-1
Copper	16-20124	0816-01-0063	29.40	Soil	0-1
Copper	16-20304	0816-01-0036	36.80	Soil	0-1
Iron	16-20105	0816-01-0027	15,300	Tuff	0-1
Iron	16-20223	0816-01-0083	16,900	Tuff	2-3
Iron	16-20295	0816-01-0072	17,200	Tuff	0-1
Iron	16-20223	0816-01-0082	22,500	Tuff	0-0.5
Lead	16-20273	0816-01-0032	13.20	Tuff	2-3
Lead	16-20196	0816-01-0130	13.50	Tuff	0-1
Lead	16-20274	0816-01-0029	19.40	Tuff	0-1
Lead	16-20223	0816-01-0082	19.70	Tuff	0-0.5
Lead	16-20306	0816-01-0033	22.20	Tuff	0-1
Lead	16-20237	0816-01-0037	23.50	Tuff	0-1
Lead	16-20670	RE16-02-45436	24.10	Tuff	0-1
Lead	16-20105	0816-01-0027	24.20	Tuff	0-1
Nickel	16-20274	0816-01-0029	7.2	Tuff	0-1
Nickel	16-20307	0816-01-0034	7.3	Tuff	0-1
Nickel	16-20223	0816-01-0083	8.3	Tuff	2-3
Nickel	16-20376	0816-01-0232	8.8	Tuff	0-1
Nickel	16-20237	0816-01-0037	8.9	Tuff	0-1
Nickel	16-20105	0816-01-0027	10.3	Tuff	0-1
Nickel	16-20295	0816-01-0072	11.3	Tuff	0-1
Nickel	16-20223	0816-01-0082	12.6	Tuff	0-0.5
Selenium	16-20323	0816-01-0039	0.32 (U)	Tuff	2-3
Selenium	16-20273	RE16-02-45791	0.33	Tuff	0.9-1.7
Selenium	16-20277	RE16-02-44953	0.33	Tuff	0-1
Selenium	16-20278	RE16-02-44944	0.33	Tuff	0-1
Selenium	16-20269	0816-01-0061	0.33 (U)	Tuff	0-1
Selenium	16-20306	0816-01-0033	0.34 (J)	Tuff	0-1
Selenium	16-20241	0816-01-0357	0.35	Tuff	0-1
Selenium	16-20189	0816-01-0247	0.35 (J-)	Tuff	2-3
Selenium	16-20457	0816-01-0227	0.35 (J-)	Tuff	24-36
Selenium	16-20237	0816-01-0037	0.37 (J)	Tuff	0-1
Selenium	16-20389	0816-01-0030	0.37 (J)	Tuff	0-1

Refer to footnotes at end of table.

Table 3.2.1-5 (Concluded)
Inorganic COPCs: Samples Greater than Background-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Selenium	16-20334	0816-01-0235	0.41 (J-)	Tuff	0-1
Selenium	16-20121	0816-01-0097	0.44 (J)	Tuff	0-1
Selenium	16-20274	0816-01-0029	0.44 (J)	Tuff	0-1
Selenium	16-20287	0816-01-0028	0.46 (J)	Tuff	0-1
Selenium	16-20376	0816-01-0232	0.47 (J-)	Tuff	0-1
Selenium	16-20598	0816-01-0265	0.48 (J-)	Tuff	0-1
Selenium	16-20528	0816-01-0190	0.50 (J-)	Tuff	0-1
Selenium	16-20457	0816-01-0226	0.53 (J-)	Tuff	0-1
Selenium	16-20305	0816-01-0035	0.54 (J)	Tuff	0-1
Selenium	16-20233	0816-01-0121	0.64 (J)	Tuff	0-1
Selenium	16-20273	0816-01-0032	0.74	Tuff	2-3
Selenium	16-20307	0816-01-0034	0.74	Tuff	0-1
Silver	16-20348	0816-01-0214	1.1 (U)	Soil	0-1
Silver	16-20549	0816-01-0215	1.1 (U)	Soil	0-1
Silver	16-20240	0816-01-0352	1.10	Soil	0-1
Silver	16-20232	RE16-02-45438	1.60	Soil	0-1
Silver	16-20742	RE16-02-45439	7.80	Soil	0-1
Silver	16-20566	0816-01-0213	1.2 (U)	Soil	0-1
Silver	16-20351	0816-01-0050	1.5	Soil	0-1
Silver	16-20387	0816-01-0161	1.5	Soil	0-1
Silver	16-20742	RE16-02-45441	9.7	Soil	2-3
Silver	16-20742	RE16-02-45442	15.8	Soil	2-3
Vanadium	16-20223	0816-01-0083	18.2	Tuff	2-3
Vanadium	16-20223	0816-01-0082	26.4	Tuff	0-0.5

Table 3.2.1-6
Frequency of Detected Inorganic Chemicals Above Background-Exposed Tuff Zone

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	BV (mg/kg)	Frequency of Detects above BV[a]	Frequency of Nondetects above BV
Aluminum	146	146	656 to 28100	7,340	26/146	0/146
Antimony	146	22	[0.02] to 2.70	0.5	3/146	97/146
Arsenic	146	120	[0.11] to 7.20	2.79	16/146	0/146
Barium	146	145	5.20 to 6,980	46	79/146	0/146
Beryllium	146	146	0.25 to 3.30	1.21	26/146	0/146
Cadmium	146	65	[0.015] to 5.70	1.63	2/146	0/146
Chromium	146	145	0.32 to 18.70	7.14	23/146	0/146
Cobalt	146	144	0.35 to 151.00	3.14	53/146	0/146
Copper	146	144	[0.94] to 34.00	4.66	57/146	0/146
Iron	146	146	4,130 to 20,600	14,500	12/146	0/146
Lead	146	146	1.20 to 144.00	11.2	23/146	0/146
Manganese	146	145	103.00 to 842.00	482	11/146	0/146
Mercury	146	30	[0.0028] to 0.22	0.1	1/146	1/146
Nickel	146	132	0.78 to 13.20	6.58	18/146	0/146
Perchlorate	33	7	[0.007] to [0.73]	---	7/33	0/33
Selenium	146	88	0.12 to 1.40	0.3	45/146	1/146
Silver	146	22	[0.04] to 1.80	1	5/146	6/146
Thallium	146	46	[0.012] to 1.40	1.1	3/146	4/146
Vanadium	146	140	[0.38] to 36.70	17	15/146	0/146
Zinc	146	146	23.10 to 118.0	63.5	8/146	0/146

[a]For analytes with no BV, all detects are counted as being above the BV.
--- = No BV available.
[ ] = Non-detect.

Table 3.2.1-7
Wilcoxon Rank Sum Test Distribution Comparison Results of Inorganics with Maximum Values Greater than Background: Confirmation Data Sets vs. Background Data Sets-Exposed Tuff Zone

Analyte	Valid N for Background Data Set	Valid N for MDA P Data Set	Adjusted p-Level[a]	Pass/Fail Test[a]
Aluminum	62	146	0.000	Fail
Antimony	63	146	0.000	Fail
Arsenic	63	146	0.433	Pass
Barium	62	146	0.000	Fail
Beryllium	63	146	0.000	Fail
Cadmium	14	146	0.000	Fail
Chromium	63	147	0.000	Fail
Cobalt	11	146	0.000	Fail
Copper	63	146	0.000	Fail
Iron	63	146	0.000	Fail
Lead	62	146	0.136	Pass
Manganese	63	146	0.000	Fail
Mercury	---	---	---	---
Nickel	62	146	0.000	Fail
Perchlorate	---	---	---	---
Selenium	14	146	0.000	Fail
Silver	63	146	0.000	Fail
Thallium	63	146	0.000	Fail
Vanadium	63	146	0.000	Fail
Zinc	63	146	0.006	Fail

[a]p-Level ∃ 0.05 = Pass, indicating the distributions are not statistically different at the 95% confidence level.
N = Number of samples.
--- = Background data set not available.

Table 3.2.1-8
Quantile Test Results for Exposed Tuff Zone

Analyte	Valid N for Background Data Set	Valid N for MDA P Data Set	Table k[a]	Actual k	Pass/Fail Test[b]
Aluminum	62	146	6	21	Fail
Antimony	77	146	5	106	Fail
Arsenic	63	146	6	4	Pass
Barium	62	146	6	78	Fail
Beryllium	62	146	6	10	Fail
Cadmium	14	146	19	2	Pass
Chromium	63	146	6	3,30	Fail
Cobalt	11	146	19	53	Fail
Copper	63	146	6	33	Fail
Iron	63	146	6	1,12	Fail
Lead	62	146	6	13	Fail
Manganese	63	146	6	1	Pass
Mercury	---	---	---	---	---
Nickel	62	146	6	16	Fail
Perchlorate	---	---	---	---	---
Selenium	14	146	19	113	Fail
Silver	63	146	6	0	Pass
Thallium	63	146	6	0	Pass
Vanadium	63	146	6	6,31	Fail
Zinc	63	146	6	5	Pass

[a]EPA 1994.
[b]Pass = Quantile test determined the background and MDA P data set distribution upper tails are not different.
k = Exceedance of site data.
N = Number of samples.
--- = Background data set not available.

Table 3.2.1-9
Background Test Matrix Table - Exposed Tuff Zone

Analyte	Above/Below BV	Wilcoxon Rank Sum Pass/Fail	Quantile Pass/Fail	COPC?
Aluminum	Above	Fail	Fail	Yes
Antimony	Above	Fail	Fail	Yes
Arsenic	Above	Pass	Pass	No
Barium	Above	Fail	Fail	Yes
Beryllium	Above	Fail	Fail	Yes
Cadmium	Above	Fail	Pass	No[a]
Chromium	Above	Fail	Fail	Yes
Cobalt	Above	Fail	Fail	Yes
Copper	Above	Fail	Fail	Yes
Iron	Above	Fail	Fail	Yes
Lead	Above	Pass	Fail	Yes
Manganese	Above	Fail	Pass	No[b]
Mercury	Above	NA	NA	Yes
Nickel	Above	Fail	Fail	Yes
Perchlorate	NA	NA	NA	Yes
Selenium	Above	Fail	Fail	Yes
Silver	Above	Fail	Pass	No[a]
Thallium	Above	Fail	Pass	No[a]
Vanadium	Above	Fail	Fail	Yes
Zinc	Above	Fail	Pass	Yes[c]

[a]WRS failed due to the fact that the site median was statistically less than the background median.
[b]One hit greater than maximum background.
[c]Zinc was carried forward as a COPC because the WRS failed due to the site median exceeding that for background.
NA = Background data set or BV not available.

Table 3.2.1-10
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Aluminum	16-20490	0816-01-0198	7,560	0-1
Aluminum	16-20667	0816-01-0197	7,610	0-1
Aluminum	16-20695	0816-01-0048	7,870	0-1
Aluminum	16-20513	0816-01-0096	8,350	0-1
Aluminum	16-20628	0816-01-0332	8,370	0-1
Aluminum	16-20698	0816-01-0071	8,450	0-1
Aluminum	16-20702	0816-01-0074	9,020	0-1
Aluminum	16-20658	0816-01-0209	9,190	0-1
Aluminum	16-20441	0816-01-0129	9,740	0-1
Aluminum	16-20702	0816-01-0076	9,780	2-3
Aluminum	16-20660	0816-01-0193	9,910	0-1
Aluminum	16-20622	0816-01-0211	10,400	0-1
Aluminum	16-20474	0816-01-0069	10,400	2-3
Aluminum	16-20404	0816-01-0128	10,400	0-1
Aluminum	16-20454	0816-01-0307	10,600	0-1
Aluminum	16-20375	0816-01-0178	11,000	7-8
Aluminum	16-20337	0816-01-0170	11,800	0-1
Aluminum	16-20474	0816-01-0067	12,100	0-0.5
Aluminum	16-20444	0816-01-0231	12,700	0-1
Aluminum	16-20373	0816-01-0304	13,400	0-1
Aluminum	16-20337	0816-01-0171	13,500	4-5
Aluminum	16-20491	0816-01-0194	13,500	0-1
Aluminum	16-20375	0816-01-0177	15,200	5-6
Aluminum	16-20592	0816-01-0248	16,800	0-1
Aluminum	16-20370	0816-01-0237	17,400	0-1
Aluminum	16-20337	0816-01-0172	28,100	5-6
Antimony	16-20491	0816-01-0194	0.52 (J)	0-1
Antimony	16-20526	0816-01-0324	0.79 (U)	37.3-38.3
Antimony	16-20526	0816-01-0325	0.79 (U)	27.3-28.3
Antimony	16-20526	0816-01-0326	0.79 (U)	53.5-54.5
Antimony	16-20557	0816-01-0327	0.79 (U)	18.7-19.6
Antimony	16-20557	0816-01-0329	0.79 (U)	52.6-53.6
Antimony	16-20557	0816-01-0334	0.79 (U)	11.7-12.6
Antimony	16-20557	0816-01-0333	0.79 (U)	36.7-37.4
Antimony	16-20557	0816-01-0328	0.80 (U)	66-67
Antimony	16-20557	0816-01-0299	0.83 (U)	2-3
Antimony	16-20595	0816-01-0263	0.83 (UJ)	0-1
Antimony	16-20596	0816-01-0259	0.83 (UJ)	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Antimony	16-20373	0816-01-0234	0.83 (U)	0-1
Antimony	16-20374	0816-01-0233	0.83 (U)	0-1
Antimony	16-20513	0816-01-0096	0.83 (UJ)	0-1
Antimony	16-20553	0816-01-0300	0.85 (U)	0-1
Antimony	16-20557	0816-01-0298	0.85 (U)	0-1
Antimony	16-20557	0816-01-0302	0.85 (U)	0-1
Antimony	16-20557	0816-01-0303	0.85 (U)	2-3
Antimony	16-20664	0816-01-0309	0.85 (U)	0-1
Antimony	16-20335	0816-01-0236	0.85 (UJ)	0-1
Antimony	16-20630	0816-01-0330	0.85 (U)	0-1
Antimony	16-20661	0816-01-0251	0.85 (UJ)	2-3
Antimony	16-20665	0816-01-0261	0.85 (U)	0-1
Antimony	16-20562	0816-01-0088	0.86 (UJ)	2-3
Antimony	16-20662	0816-01-0313	0.86 (U)	0-1
Antimony	16-20444	0816-01-0231	0.86 (U)	0-1
Antimony	16-20700	0816-01-0049	0.87 (UJ)	0-1
Antimony	16-20514	0816-01-0103	0.87 (UJ)	0-1
Antimony	16-20561	0816-01-0098	0.87 (UJ)	0-1
Antimony	16-20562	0816-01-0087	0.87 (UJ)	0-1
Antimony	16-20591	0816-01-0318	0.87 (U)	0-1
Antimony	16-20372	0816-01-0230	0.87 (U)	0-1
Antimony	16-20667	0816-01-0197	0.87 (U)	0-1
Antimony	16-20699	0816-01-0057	0.88 (UJ)	0-1
Antimony	16-20558	0816-01-0102	0.88 (UJ)	0-1
Antimony	16-20663	0816-01-0311	0.88 (U)	0-1
Antimony	16-20736	0816-01-0090	0.88 (UJ)	0-1
Antimony	16-20527	0816-01-0191	0.88 (U)	0-1
Antimony	16-20592	0816-01-0248	0.88 (UJ)	0-1
Antimony	16-20632	0816-01-0308	0.88 (U)	0-1
Antimony	16-20702	0816-01-0255	0.88 (UJ)	0-1
Antimony	16-20702	0816-01-0257	0.88 (UJ)	4-5
Antimony	16-20590	0816-01-0316	0.89 (U)	0-1
Antimony	16-20626	0816-01-0312	0.89 (U)	0-1
Antimony	16-20662	0816-01-0314	0.89 (U)	2-3
Antimony	16-20370	0816-01-0237	0.89 (UJ)	0-1
Antimony	16-20696	0816-01-0066	0.90 (U)	0-1
Antimony	16-20551	0816-01-0306	0.90 (U)	0-1
Antimony	16-20590	0816-01-0317	0.90 (U)	2-3

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Antimony	16-20624	0816-01-0322	0.90 (U)	0-1
Antimony	16-20625	0816-01-0321	0.90 (U)	2-3
Antimony	16-20669	0816-01-0315	0.90 (U)	0-1
Antimony	16-20702	0816-01-0076	0.90 (UJ)	2-3
Antimony	16-20442	0816-01-0228	0.90 (U)	0-1
Antimony	16-20477	0816-01-0095	0.90 (UJ)	0-1
Antimony	16-20555	0816-01-0101	0.91 (UJ)	0-1
Antimony	16-20629	0816-01-0319	0.91 (U)	0-1
Antimony	16-20698	0816-01-0071	0.91 (UJ)	0-1
Antimony	16-20702	0816-01-0074	0.91 (UJ)	0-1
Antimony	16-20741	0816-01-0250	0.91 (U)	2-3
Antimony	16-20695	0816-01-0048	0.92 (UJ)	0-1
Antimony	16-20697	0816-01-0051	0.92 (UJ)	0-1
Antimony	16-20515	0816-01-0104	0.92 (UJ)	0-1
Antimony	16-20517	0816-01-0099	0.92 (UJ)	0-1
Antimony	16-20661	0816-01-0252	0.92 (UJ)	6-7
Antimony	16-20474	0816-01-0069	0.93 (U)	2-3
Antimony	16-20516	0816-01-0295	0.93 (U)	0-1
Antimony	16-20516	0816-01-0112	0.93 (UJ)	0-1
Antimony	16-20371	0816-01-0229	0.93 (U)	0-1
Antimony	16-20474	0816-01-0067	0.94 (U)	0-0.5
Antimony	16-20446	0816-01-0203	0.94 (U)	0-1
Antimony	16-20489	0816-01-0200	0.94 (U)	2-3
Antimony	16-20525	0816-01-0189	0.94 (U)	0-1
Antimony	16-20484	0816-01-0201	0.95 (U)	0-1
Antimony	16-20625	0816-01-0320	0.96 (U)	0-1
Antimony	16-20453	0816-01-0223	0.96 (U)	0-1
Antimony	16-20446	0816-01-0204	0.97 (U)	2-3
Antimony	16-20454	0816-01-0307	0.97 (U)	0-1
Antimony	16-20455	0816-01-0207	0.97 (U)	0-1
Antimony	16-20408	0816-01-0238	0.98 (UJ)	0-1
Antimony	16-20449	0816-01-0219	0.98 (U)	0-1
Antimony	16-20485	0816-01-0202	0.98 (U)	0-1
Antimony	16-20489	0816-01-0199	0.98 (U)	0-1
Antimony	16-20490	0816-01-0192	0.98 (U)	0-1
Antimony	16-20490	0816-01-0198	0.98 (U)	0-1
Antimony	16-20414	0816-01-0221	0.99 (U)	0-1
Antimony	16-20447	0816-01-0220	0.99 (U)	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Antimony	16-20479	0816-01-0113	0.99 (UJ)	0-1
Antimony	16-20413	0816-01-0305	1.00 (U)	0-1
Antimony	16-20373	0816-01-0304	1.00 (U)	0-1
Antimony	16-20409	0816-01-0239	1.00 (UJ)	0-1
Antimony	16-20411	0816-01-0241	1.00 (UJ)	0-1
Antimony	16-20451	0816-01-0224	1.00 (U)	0-1
Antimony	16-20452	0816-01-0222	1.00 (U)	0-1
Antimony	16-20586	0816-01-0208	1.10 (U)	0-1
Antimony	16-20658	0816-01-0209	1.20 (U)	0-1
Antimony	16-20413	0816-01-0216	1.30 (U)	0-1
Antimony	16-20628	0816-01-0332	1.4	0-1
Antimony	16-20741	0816-01-0249	2.7 (J-)	5-6
Barium	16-20661	0816-01-0252	47.6	6-7
Barium	16-20478	0816-01-0152	50.3	2-3
Barium	16-20486	0816-01-0212	57.2	0-1
Barium	16-20700	0816-01-0049	59.1	0-1
Barium	16-20527	0816-01-0191	60.5	0-1
Barium	16-20585	0816-01-0132	68.9	0-1
Barium	16-20444	0816-01-0231	71.3	0-1
Barium	16-20595	0816-01-0263	74.7	0-1
Barium	16-20373	0816-01-0304	76.1	0-1
Barium	16-20375	0816-01-0178	94.3	7-8
Barium	16-20562	0816-01-0087	106 (J-)	0-1
Barium	16-20487	0816-01-0154	112	0-1
Barium	16-20699	0816-01-0057	124	0-1
Barium	16-20337	0816-01-0170	131	0-1
Barium	16-20660	0816-01-0193	140	0-1
Barium	16-20474	0816-01-0069	152	2-3
Barium	16-20337	0816-01-0172	155	5-6
Barium	16-20622	0816-01-0211	159	0-1
Barium	16-20515	0816-01-0104	163	0-1
Barium	16-20661	0816-01-0251	171	2-3
Barium	16-20370	0816-01-0237	179 (J)	0-1
Barium	16-20696	0816-01-0066	191	0-1
Barium	16-20695	0816-01-0048	192	0-1
Barium	16-20474	0816-01-0067	200	0-0.5
Barium	16-20702	0816-01-0076	212 (J-)	2-3
Barium	16-20658	0816-01-0209	231	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Barium	16-20702	0816-01-0257	261	4-5
Barium	16-20557	0816-01-0299	277 (J+)	2-3
Barium	16-20375	0816-01-0177	280	5-6
Barium	16-20523	0816-01-0165	285	0-1
Barium	16-20557	0816-01-0303	295	2-3
Barium	16-20404	0816-01-0128	297	0-1
Barium	16-20559	0816-01-0118	315	0-1
Barium	16-20586	0816-01-0208	336	0-1
Barium	16-20667	0816-01-0197	374 (J+)	0-1
Barium	16-20479	0816-01-0113	387	0-1
Barium	16-20557	0816-01-0333	406	36.7-37.4
Barium	16-20629	0816-01-0319	408 (J+)	0-1
Barium	16-20526	0816-01-0326	413	53.5-54.5
Barium	16-20337	0816-01-0171	413	4-5
Barium	16-20441	0816-01-0129	415	0-1
Barium	16-20697	0816-01-0051	441	0-1
Barium	16-20478	0816-01-0151	445	0-1
Barium	16-20698	0816-01-0071	446 (J-)	0-1
Barium	16-20557	0816-01-0298	487 (J+)	0-1
Barium	16-20558	0816-01-0102	489	0-1
Barium	16-20736	0816-01-0090	493	0-1
Barium	16-20488	0816-01-0157	544	0-1
Barium	16-20557	0816-01-0302	552	0-1
Barium	16-20560	0816-01-0141	571	0-1
Barium	16-20741	0816-01-0250	582	2-3
Barium	16-20524	0816-01-0159	587	0-1
Barium	16-20561	0816-01-0098	646	0-1
Barium	16-20702	0816-01-0074	682 (J-)	0-1
Barium	16-20557	0816-01-0327	715	18.7-19.6
Barium	16-20557	0816-01-0334	773	11.7-12.6
Barium	16-20335	0816-01-0236	860 (J)	0-1
Barium	16-20489	0816-01-0199	865	0-1
Barium	16-20489	0816-01-0200	880	2-3
Barium	16-20455	0816-01-0207	1,100	0-1
Barium	16-20741	0816-01-0249	1,110	5-6
Barium	16-20477	0816-01-0095	1,200	0-1
Barium	16-20454	0816-01-0218	1,240	0-1
Barium	16-20453	0816-01-0223	1,240	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Barium	16-20513	0816-01-0096	1,390	0-1
Barium	16-20628	0816-01-0332	1,430 (J+)	0-1
Barium	16-20522	0816-01-0160	1,480	0-1
Barium	16-20702	0816-01-0255	1,590	0-1
Barium	16-20490	0816-01-0192	1,720	0-1
Barium	16-20525	0816-01-0189	1,790	0-1
Barium	16-20526	0816-01-0195	1,800	0-1
Barium	16-20442	0816-01-0228	1,900	0-1
Barium	16-20490	0816-01-0198	1,980	0-1
Barium	16-20371	0816-01-0229	2,060	0-1
Barium	16-20551	0816-01-0306	2,110	0-1
Barium	16-20630	0816-01-0330	2,120 (J+)	0-1
Barium	16-20592	0816-01-0248	2,430	0-1
Barium	16-20491	0816-01-0194	2,980	0-1
Barium	16-20454	0816-01-0307	6,980	0-1
Beryllium	16-20526	0816-01-0325	1.3	27.3-28.3
Beryllium	16-20702	0816-01-0076	1.3	2-3
Beryllium	16-20446	0816-01-0203	1.3	0-1
Beryllium	16-20592	0816-01-0248	1.3	0-1
Beryllium	16-20337	0816-01-0172	1.4	5-6
Beryllium	16-20454	0816-01-0307	1.4	0-1
Beryllium	16-20490	0816-01-0198	1.4	0-1
Beryllium	16-20518	0816-01-0126	1.4	0-1
Beryllium	16-20520	0816-01-0123	1.4	0-1
Beryllium	16-20526	0816-01-0195	1.4	0-1
Beryllium	16-20526	0816-01-0196	1.4	2-3
Beryllium	16-20371	0816-01-0229	1.6	0-1
Beryllium	16-20478	0816-01-0151	1.6	0-1
Beryllium	16-20490	0816-01-0192	1.7	0-1
Beryllium	16-20521	0816-01-0124	1.7	0-1
Beryllium	16-20516	0816-01-0295	1.8	0-1
Beryllium	16-20486	0816-01-0212	1.9	0-1
Beryllium	16-20516	0816-01-0112	1.9	0-1
Beryllium	16-20491	0816-01-0194	2.0	0-1
Beryllium	16-20519	0816-01-0158	2.0	0-1
Beryllium	16-20560	0816-01-0141	2.2	0-1
Beryllium	16-20370	0816-01-0237	2.4	0-1
Beryllium	16-20482	0816-01-0155	2.4	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Beryllium	16-20444	0816-01-0231	3.1	0-1
Beryllium	16-20481	0816-01-0149	3.1	0-1
Beryllium	16-20373	0816-01-0304	3.3	0-1
Chromium	16-20375	0816-01-0178	7.3 (J)	7-8
Chromium	16-20371	0816-01-0229	7.5 (J)	0-1
Chromium	16-20658	0816-01-0209	7.6	0-1
Chromium	16-20441	0816-01-0129	7.9	0-1
Chromium	16-20444	0816-01-0231	8.0 (J)	0-1
Chromium	16-20698	0816-01-0071	8.0	0-1
Chromium	16-20474	0816-01-0069	8.1	2-3
Chromium	16-20628	0816-01-0332	8.1	0-1
Chromium	16-20622	0816-01-0211	8.2	0-1
Chromium	16-20337	0816-01-0170	8.5 (J)	0-1
Chromium	16-20700	0816-01-0049	8.9	0-1
Chromium	16-20491	0816-01-0194	9.1	0-1
Chromium	16-20370	0816-01-0237	9.2	0-1
Chromium	16-20474	0816-01-0067	9.3	0-0.5
Chromium	16-20490	0816-01-0198	9.3	0-1
Chromium	16-20486	0816-01-0212	9.5	0-1
Chromium	16-20375	0816-01-0177	10.1 (J)	5-6
Chromium	16-20337	0816-01-0171	10.4 (J)	4-5
Chromium	16-20592	0816-01-0248	10.8	0-1
Chromium	16-20413	0816-01-0305	11.9	0-1
Chromium	16-20373	0816-01-0304	14.4	0-1
Chromium	16-20736	0816-01-0090	17.4	0-1
Chromium	16-20337	0816-01-0172	18.7 (J)	5-6
Cobalt	16-20478	0816-01-0152	3.2 (J)	2-3
Cobalt	16-20474	0816-01-0069	3.5 (J)	2-3
Cobalt	16-20557	0816-01-0302	3.5 (J)	0-1
Cobalt	16-20453	0816-01-0223	3.5 (J)	0-1
Cobalt	16-20526	0816-01-0195	3.5 (J)	0-1
Cobalt	16-20700	0816-01-0049	3.6 (J)	0-1
Cobalt	16-20525	0816-01-0189	3.6 (J)	0-1
Cobalt	16-20665	0816-01-0261	3.6 (J)	0-1
Cobalt	16-20441	0816-01-0129	3.7 (J)	0-1
Cobalt	16-20697	0816-01-0051	3.7 (J)	0-1
Cobalt	16-20669	0816-01-0315	3.7 (J)	0-1
Cobalt	16-20477	0816-01-0095	3.7 (J)	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Cobalt	16-20699	0816-01-0057	3.8 (J)	0-1
Cobalt	16-20702	0816-01-0257	3.8 (J)	4-5
Cobalt	16-20736	0816-01-0090	3.9 (J)	0-1
Cobalt	16-20413	0816-01-0305	4.0 (J)	0-1
Cobalt	16-20490	0816-01-0192	4.0 (J)	0-1
Cobalt	16-20741	0816-01-0249	4.0 (J)	5-6
Cobalt	16-20658	0816-01-0209	4.1 (J)	0-1
Cobalt	16-20696	0816-01-0066	4.1 (J)	0-1
Cobalt	16-20375	0816-01-0177	4.1 (J)	5-6
Cobalt	16-20695	0816-01-0048	4.2 (J)	0-1
Cobalt	16-20661	0816-01-0252	4.2 (J)	6-7
Cobalt	16-20741	0816-01-0250	4.2 (J)	2-3
Cobalt	16-20486	0816-01-0212	4.5 (J)	0-1
Cobalt	16-20660	0816-01-0193	4.7 (J)	0-1
Cobalt	16-20375	0816-01-0178	4.7 (J)	7-8
Cobalt	16-20698	0816-01-0071	4.8 (J)	0-1
Cobalt	16-20513	0816-01-0096	4.9 (J)	0-1
Cobalt	16-20442	0816-01-0228	5.0 (J)	0-1
Cobalt	16-20661	0816-01-0251	5.1 (J)	2-3
Cobalt	16-20702	0816-01-0074	5.1 (J)	0-1
Cobalt	16-20371	0816-01-0229	5.3 (J)	0-1
Cobalt	16-20491	0816-01-0194	5.3 (J)	0-1
Cobalt	16-20337	0816-01-0172	5.4 (J)	5-6
Cobalt	16-20702	0816-01-0255	5.5 (J)	0-1
Cobalt	16-20474	0816-01-0067	5.8 (J)	0-0.5
Cobalt	16-20551	0816-01-0306	5.8	0-1
Cobalt	16-20337	0816-01-0170	5.9 (J)	0-1
Cobalt	16-20490	0816-01-0198	5.9 (J)	0-1
Cobalt	16-20702	0816-01-0076	6.1	2-3
Cobalt	16-20622	0816-01-0211	6.4	0-1
Cobalt	16-20628	0816-01-0332	6.5	0-1
Cobalt	16-20630	0816-01-0330	6.6	0-1
Cobalt	16-20337	0816-01-0171	7.2 (J)	4-5
Cobalt	16-20373	0816-01-0304	8.1	0-1
Cobalt	16-20592	0816-01-0248	8.2	0-1
Cobalt	16-20664	0816-01-0309	8.5	0-1
Cobalt	16-20629	0816-01-0319	10.5	0-1
Cobalt	16-20404	0816-01-0128	11.0	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Cobalt	16-20625	0816-01-0320	30.2	0-1
Cobalt	16-20662	0816-01-0314	66.8	2-3
Cobalt	16-20454	0816-01-0307	151	0-1
Copper	16-20524	0816-01-0159	4.8	0-1
Copper	16-20696	0816-01-0066	4.9	0-1
Copper	16-20560	0816-01-0141	4.9	0-1
Copper	16-20490	0816-01-0192	4.9	0-1
Copper	16-20441	0816-01-0129	5.0	0-1
Copper	16-20454	0816-01-0307	5.0	0-1
Copper	16-20586	0816-01-0208	5.1	0-1
Copper	16-20516	0816-01-0112	5.2 (J)	0-1
Copper	16-20695	0816-01-0048	5.2	0-1
Copper	16-20702	0816-01-0257	5.2	4-5
Copper	16-20518	0816-01-0126	5.5	0-1
Copper	16-20481	0816-01-0149	5.6	0-1
Copper	16-20667	0816-01-0197	5.6	0-1
Copper	16-20622	0816-01-0211	5.8	0-1
Copper	16-20702	0816-01-0076	5.9	2-3
Copper	16-20404	0816-01-0128	5.9	0-1
Copper	16-20482	0816-01-0155	5.9	0-1
Copper	16-20490	0816-01-0198	5.9	0-1
Copper	16-20486	0816-01-0212	6.0	0-1
Copper	16-20516	0816-01-0295	6.0	0-1
Copper	16-20371	0816-01-0229	6.0	0-1
Copper	16-20658	0816-01-0209	6.1	0-1
Copper	16-20736	0816-01-0090	6.1	0-1
Copper	16-20373	0816-01-0304	6.1	0-1
Copper	16-20474	0816-01-0069	6.4	2-3
Copper	16-20660	0816-01-0193	6.4	0-1
Copper	16-20520	0816-01-0123	6.5	0-1
Copper	16-20702	0816-01-0255	6.5	0-1
Copper	16-20408	0816-01-0238	6.6	0-1
Copper	16-20477	0816-01-0095	6.8	0-1
Copper	16-20372	0816-01-0230	7.0	0-1
Copper	16-20491	0816-01-0194	7.1	0-1
Copper	16-20474	0816-01-0067	7.2	0-0.5
Copper	16-20698	0816-01-0071	7.2	0-1
Copper	16-20702	0816-01-0074	7.2	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Copper	16-20454	0816-01-0218	7.4	0-1
Copper	16-20526	0816-01-0326	7.8	53.5-54.5
Copper	16-20526	0816-01-0324	7.9	37.3-38.3
Copper	16-20375	0816-01-0177	8.0 (J)	5-6
Copper	16-20526	0816-01-0325	8.1	27.3-28.3
Copper	16-20741	0816-01-0249	8.1	5-6
Copper	16-20697	0816-01-0051	8.5	0-1
Copper	16-20513	0816-01-0096	8.6	0-1
Copper	16-20526	0816-01-0195	8.7	0-1
Copper	16-20337	0816-01-0171	9.0 (J)	4-5
Copper	16-20337	0816-01-0172	10.8 (J)	5-6
Copper	16-20551	0816-01-0306	12.0	0-1
Copper	16-20444	0816-01-0231	12.2	0-1
Copper	16-20557	0816-01-0327	13.0	18.7-19.6
Copper	16-20630	0816-01-0330	15.2	0-1
Copper	16-20592	0816-01-0248	17.4	0-1
Copper	16-20374	0816-01-0233	20.5	0-1
Copper	16-20373	0816-01-0234	24.2	0-1
Copper	16-20335	0816-01-0236	24.4	0-1
Copper	16-20370	0816-01-0237	29.5	0-1
Copper	16-20442	0816-01-0228	32.3	0-1
Copper	16-20628	0816-01-0332	34.0	0-1
Iron	16-20486	0816-01-0212	14,600	0-1
Iron	16-20592	0816-01-0248	14,800	0-1
Iron	16-20413	0816-01-0305	14,900	0-1
Iron	16-20375	0816-01-0177	15,300 (J)	5-6
Iron	16-20370	0816-01-0237	15,800	0-1
Iron	16-20337	0816-01-0172	16,100 (J)	5-6
Iron	16-20337	0816-01-0170	16,300 (J)	0-1
Iron	16-20373	0816-01-0304	17,900	0-1
Iron	16-20491	0816-01-0194	17,900	0-1
Iron	16-20490	0816-01-0192	18,100	0-1
Iron	16-20454	0816-01-0307	19,000	0-1
Iron	16-20490	0816-01-0198	20,600	0-1
Lead	16-20702	0816-01-0255	11.6	0-1
Lead	16-20702	0816-01-0076	11.6	2-3
Lead	16-20661	0816-01-0251	12.0	2-3
Lead	16-20488	0816-01-0157	12.4	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Lead	16-20702	0816-01-0074	12.5	0-1
Lead	16-20551	0816-01-0306	12.6	0-1
Lead	16-20697	0816-01-0051	12.8	0-1
Lead	16-20474	0816-01-0067	13.5	0-0.5
Lead	16-20337	0816-01-0172	13.7	5-6
Lead	16-20404	0816-01-0128	13.8	0-1
Lead	16-20337	0816-01-0170	16.9	0-1
Lead	16-20477	0816-01-0095	18.3	0-1
Lead	16-20486	0816-01-0212	19.0	0-1
Lead	16-20662	0816-01-0314	20.4	2-3
Lead	16-20741	0816-01-0249	20.6	5-6
Lead	16-20630	0816-01-0330	21.3	0-1
Lead	16-20662	0816-01-0313	22.4	0-1
Lead	16-20337	0816-01-0171	22.9	4-5
Lead	16-20736	0816-01-0090	25.4	0-1
Lead	16-20592	0816-01-0248	26.5	0-1
Lead	16-20513	0816-01-0096	33.3	0-1
Lead	16-20628	0816-01-0332	38.9	0-1
Lead	16-20474	0816-01-0069	144	2-3
Mercury	16-20665	0816-01-0261	0.18 (U)	0-1
Mercury	16-20628	0816-01-0332	0.22	0-1
Nickel	16-20454	0816-01-0307	6.6	0-1
Nickel	16-20491	0816-01-0194	6.6	0-1
Nickel	16-20404	0816-01-0128	7.2	0-1
Nickel	16-20337	0816-01-0171	7.3	4-5
Nickel	16-20622	0816-01-0211	7.4	0-1
Nickel	16-20698	0816-01-0071	7.5	0-1
Nickel	16-20486	0816-01-0212	8.2	0-1
Nickel	16-20474	0816-01-0069	8.4	2-3
Nickel	16-20474	0816-01-0067	8.5	0-0.5
Nickel	16-20490	0816-01-0198	8.7	0-1
Nickel	16-20375	0816-01-0177	8.8	5-6
Nickel	16-20335	0816-01-0236	8.8	0-1
Nickel	16-20373	0816-01-0304	9.1	0-1
Nickel	16-20592	0816-01-0248	9.3	0-1
Nickel	16-20702	0816-01-0076	10.5	2-3
Nickel	16-20370	0816-01-0237	11.2	0-1
Nickel	16-20628	0816-01-0332	12.5	0-1
Nickel	16-20337	0816-01-0172	13.2	5-6

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Perchlorate	16-20478	0816-01-0151	0.04 (J)	0-1
Perchlorate	16-20557	0816-01-0333	0.06 (J)	36.7-37.4
Perchlorate	16-20557	0816-01-0327	0.06 (J)	18.7-19.6
Perchlorate	16-20526	0816-01-0324	0.06 (J)	37.3-38.3
Perchlorate	16-20557	0816-01-0329	0.08 (J)	52.6-53.6
Perchlorate	16-20373	0816-01-0304	0.23 (J-)	0-1
Perchlorate	16-20413	0816-01-0305	0.24 (J-)	0-1
Selenium	16-20526	0816-01-0324	0.31 (J-)	37.3-38.3
Selenium	16-20562	0816-01-0087	0.31 (J-)	0-1
Selenium	16-20662	0816-01-0314	0.31 (J)	2-3
Selenium	16-20516	0816-01-0335	0.32 (J)	29.2-29.9
Selenium	16-20413	0816-01-0216	0.32 (J)	0-1
Selenium	16-20372	0816-01-0230	0.32 (J-)	0-1
Selenium	16-20491	0816-01-0194	0.33 (J)	0-1
Selenium	16-20441	0816-01-0129	0.34 (J)	0-1
Selenium	16-20526	0816-01-0325	0.34 (J-)	27.3-28.3
Selenium	16-20551	0816-01-0306	0.34 (J-)	0-1
Selenium	16-20554	0816-01-0338	0.35 (J)	76.1-76.8
Selenium	16-20371	0816-01-0229	0.35 (J-)	0-1
Selenium	16-20408	0816-01-0238	0.35 (J-)	0-1
Selenium	16-20695	0816-01-0048	0.36 (J-)	0-1
Selenium	16-20520	0816-01-0123	0.36 (J)	0-1
Selenium	16-20404	0816-01-0128	0.37 (J)	0-1
Selenium	16-20484	0816-01-0201	0.37 (J-)	0-1
Selenium	16-20741	0816-01-0249	0.37 (J-)	5-6
Selenium	16-20554	0816-01-0351	0.38 (J)	19.7-20.3
Selenium	16-20337	0816-01-0170	0.39 (J)	0-1
Selenium	16-20553	0816-01-0300	0.39 (J-)	0-1
Selenium	16-20451	0816-01-0224	0.39 (J-)	0-1
Selenium	16-20452	0816-01-0222	0.39 (J-)	0-1
Selenium	16-20455	0816-01-0207	0.39 (J-)	0-1
Selenium	16-20373	0816-01-0234	0.40 (J-)	0-1
Selenium	16-20561	0816-01-0098	0.41 (J-)	0-1
Selenium	16-20595	0816-01-0263	0.42 (J-)	0-1
Selenium	16-20449	0816-01-0219	0.43 (J-)	0-1
Selenium	16-20337	0816-01-0172	0.44 (J-)	5-6
Selenium	16-20453	0816-01-0223	0.44 (J-)	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Continued)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Selenium	16-20702	0816-01-0257	0.45 (J-)	4-5
Selenium	16-20335	0816-01-0236	0.46 (J-)	0-1
Selenium	16-20413	0816-01-0305	0.47 (J-)	0-1
Selenium	16-20557	0816-01-0303	0.52 (J-)	2-3
Selenium	16-20414	0816-01-0221	0.53 (J-)	0-1
Selenium	16-20558	0816-01-0102	0.54 (J-)	0-1
Selenium	16-20562	0816-01-0088	0.54 (J-)	2-3
Selenium	16-20442	0816-01-0228	0.54 (J-)	0-1
Selenium	16-20454	0816-01-0307	0.54 (J-)	0-1
Selenium	16-20586	0816-01-0208	0.55 (U)	0-1
Selenium	16-20444	0816-01-0231	0.58 (J-)	0-1
Selenium	16-20515	0816-01-0104	0.59	0-1
Selenium	16-20447	0816-01-0220	0.67 (J-)	0-1
Selenium	16-20516	0816-01-0112	0.70	0-1
Selenium	16-20409	0816-01-0239	0.75 (J-)	0-1
Selenium	16-20373	0816-01-0304	1.40 (J-)	0-1
Vanadium	16-20661	0816-01-0251	17.2	2-3
Vanadium	16-20375	0816-01-0178	17.7 (J-)	7-8
Vanadium	16-20491	0816-01-0194	18.0	0-1
Vanadium	16-20702	0816-01-0074	18.1	0-1
Vanadium	16-20474	0816-01-0067	19.4	0-0.5
Vanadium	16-20702	0816-01-0076	20.2	2-3
Vanadium	16-20628	0816-01-0332	20.3	0-1
Vanadium	16-20404	0816-01-0128	20.4	0-1
Vanadium	16-20375	0816-01-0177	20.9 (J-)	5-6
Vanadium	16-20373	0816-01-0304	21.9	0-1
Vanadium	16-20622	0816-01-0211	22.2	0-1
Vanadium	16-20337	0816-01-0171	23.2 (J-)	4-5
Vanadium	16-20337	0816-01-0170	24.7 (J-)	0-1
Vanadium	16-20592	0816-01-0248	24.7	0-1
Vanadium	16-20337	0816-01-0172	36.7	5-6
Zinc	16-20736	0816-01-0090	65.00	0-1
Zinc	16-20519	0816-01-0158	65.10	0-1
Zinc	16-20413	0816-01-0305	65.60	0-1
Zinc	16-20491	0816-01-0194	66.10	0-1

Refer to footnotes at end of table.

Table 3.2.1-10 (Concluded)
Inorganic COPCs: Samples Greater than Background-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Zinc	16-20453	0816-01-0223	70.70	0-1
Zinc	16-20478	0816-01-0152	85.10	2-3
Zinc	16-20490	0816-01-0198	89.00	0-1
Zinc	16-20628	0816-01-0332	118.00	0-1

Table 3.2.2-1
Detected Radiological Analytes: Comparison to Background-Biological Zone

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (pCi/g)	BV (pCi/g)	Frequency of Detects Above BV or Fallout Value
Cesium-137	Soil	3	1	[-0.020] to 0.550	1.65	0/3
Uranium-234	Soil	3	3	0.480 to 0.730	2.59	0/3
Uranium-235	Soil	5	2	[-0.630] to [0.310]	0.20	0/5
Uranium-238	Soil	3	3	0.510 to 0.850	2.29	0/3

[ ] = Non-detect.

Table 3.2.2-2
Detected Radiological Analytes: Comparison to Background-Exposed Tuff Zone

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/g)	Background or Fallout Value (pCi/g)	Frequency of Detects Above BV or Fallout Value
Uranium-234	4	4	0.45 to 0.71	1.98	0/4
Uranium-235	8	2	[-0.27] to 0.068	0.09	0/8
Uranium-238	4	4	0.374 to 0.51	1.93	0/4

[ ] = Non-detect.

Table 3.2.3-1
Frequency of Detected Organics-Biological Zone

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	Frequency of Detection (%)	EQL (mg/kg)
Acetone	5	1	0.014 to [0.026]	20.0	0.03
Amino-2,6-dinitrotoluene[4-]	145	18	0.063 to 0.980	11.8	0.77
Amino-4,6-dinitrotoluene[2-]	145	20	0.044 to 1.10	13.2	0.36
Aroclor-1260	3	1	[0.039] to 0.061	33.3	0.04
Benzoic Acid[a]	139	3	0.1 to [2.3]	2.2	2.30
Bis(2-ethylhexyl)phthalate	139	8	0.110 to [0.470]	5.8	0.47
DDT[4,4'-]	3	1	[0.002] to 0.0079	33.3	0.002
Dichlorobenzene[1,4-][a]	144	1	0.001 to [0.470]	0.7	0.47
Dinitrobenzene[1,3-][a]	145	3	0.046 to [1.40]	2.1	1.40
Dinitrotoluene[2,4-][a]	282	1	[0.08] to [1.40]	0.4	1.40
Dinitrotoluene[2,6-][a]	282	2	[0.08] to [1.40]	0.7	1.40
HMX	145	57	[0.08] to 16.0	38.9	0.36
Methylnaphthalene[2-][a]	139	1	0.040 to [0.470]	0.7	0.47
Nitrotoluene[3-][a]	145	1	[0.080] to [1.40]	0.7	1.40
Nitrotoluene[4-][a]	145	1	[0.080] to [1.40]	0.7	1.40
RDX	145	76	0.069 to 37.00	52.8	0.36
Tetryl[a]	144	1	[0.080] to [1.40]	0.7	1.40
Toluene	5	1	0.001 to [0.007]	20.0	0.01
Trinitrotoluene[2,4,6-]	145	12	0.034 to 1.20	8.3	0.77

[ ] = Non-detect.
[a] Detected in less than 5% of the samples eliminated as a COPC.

Table 3.2.3-2
Organic COPCs: Samples with Detections-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Acetone	16-20004	0816-01-0293	0.014 (J)	Soil	0-0.5
Amino-2,6-dinitrotoluene[4-]	16-20376	0816-01-0164	0.063 (J)	Soil	0-1
Amino-2,6-dinitrotoluene[4-]	16-20300	0816-01-0187	0.069 (J)	Soil	2-3
Amino-2,6-dinitrotoluene[4-]	16-20348	0816-01-0214	0.110 (J)	Soil	0-1
Amino-2,6-dinitrotoluene[4-]	16-20304	0816-01-0036	0.160 (J)	Soil	0-1
Amino-2,6-dinitrotoluene[4-]	16-20694	0816-01-0058	0.230 (J)	Soil	0-1
Amino-2,6-dinitrotoluene[4-]	16-20342	0816-01-0180	0.290	Soil	0-1
Amino-2,6-dinitrotoluene[4-]	16-20387	0816-01-0161	0.420	Soil	0-1
Amino-2,6-dinitrotoluene[4-]	16-20268	RE16-02-45437	0.088 (J)	Soil	0-1
Amino-2,6-dinitrotoluene[4-]	16-20742	RE16-02-45441	0.21	Soil	2-3
Amino-2,6-dinitrotoluene[4-]	16-20742	RE16-02-45442	0.150 (J)	Soil	2-3
Amino-2,6-dinitrotoluene[4-]	16-20148	0816-01-0073	0.150 (J)	Tuff	0-0.5
Amino-2,6-dinitrotoluene[4-]	16-20195	0816-01-0205	0.150 (J)	Tuff	0-1
Amino-2,6-dinitrotoluene[4-]	16-20196	0816-01-0130	0.300	Tuff	0-1
Amino-2,6-dinitrotoluene[4-]	16-20306	0816-01-0033	0.620	Tuff	0-1
Amino-2,6-dinitrotoluene[4-]	16-20232	RE16-02-45438	0.840 (J)	Tuff	0-1
Amino-2,6-dinitrotoluene[4-]	16-20232	RE16-02-45438	0.980	Tuff	0-1
Amino-2,6-dinitrotoluene[4-]	16-20340	0816-01-0176	0.071 (J)	Tuff	2-3
Amino-2,6-dinitrotoluene[4-]	16-20599	RE16-02-45443	0.110 (J)	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20268	RE16-02-45437	0.074 (J)	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20742	RE16-02-45442	0.100 (J)	Soil	2-3
Amino-4,6-dinitrotoluene[2-]	16-20742	RE16-02-45441	0.14	Soil	2-3
Amino-4,6-dinitrotoluene[2-]	16-20301	0816-01-0188	0.044 (J)	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20239	0816-01-0168	0.066 (J)	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20304	0816-01-0036	0.120 (J)	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20348	0816-01-0214	0.130 (J)	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20694	0816-01-0058	0.210 (J)	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20387	0816-01-0161	0.320	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20376	0816-01-0164	0.700	Soil	0-1
Amino-4,6-dinitrotoluene[2-]	16-20599	RE16-02-45443	0.087 (J)	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20148	0816-01-0073	0.110 (J)	Tuff	0-0.5
Amino-4,6-dinitrotoluene[2-]	16-20670	RE16-02-45436	0.190 (J)	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20340	0816-01-0174	0.190 (J)	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20670	RE16-02-45436	0.200 (J)	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20742	RE16-02-45439	0.290	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20196	0816-01-0130	0.300	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20306	0816-01-0033	0.820	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20232	RE16-02-45438	0.920 (J)	Tuff	0-1
Amino-4,6-dinitrotoluene[2-]	16-20232	RE16-02-45438	1.100	Tuff	0-1

Refer to footnotes at end of table.

Table 3.2.3-2 (Continued)
Organic COPCs: Samples with Detections-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Aroclor-1260	16-20316	0816-01-0293	0.061	Soil	0-0.5
Bis(2-ethylhexyl)phthalate	16-20300	0816-01-0187	0.170 (J)	Soil	2-3
Bis(2-ethylhexyl)phthalate	16-20549	0816-01-0215	0.210 (J)	Soil	0-1
Bis(2-ethylhexyl)phthalate	16-20314	0816-01-0354	0.160 (J)	Tuff	0-1
Bis(2-ethylhexyl)phthalate	16-20670	RE16-02-45436	0.110 (J)	Tuff	0-1
Bis(2-ethylhexyl)phthalate	16-20742	RE16-02-45439	0.120 (J)	Tuff	0-1
Bis(2-ethylhexyl)phthalate	16-20196	0816-01-0130	0.160 (J)	Tuff	0-1
Bis(2-ethylhexyl)phthalate	16-20233	0816-01-0121	0.210 (J)	Tuff	0-1
Bis(2-ethylhexyl)phthalate	16-20232	RE16-02-45438	0.280 (J)	Tuff	0-1
DDT[4,4'-]	16-20316	0816-01-0293	0.008	Soil	0-0.5
HMX	16-20742	RE16-02-45442	0.610	Soil	2-3
HMX	16-20268	RE16-02-45437	1.400	Soil	0-1
HMX	16-20153	0816-01-0262	0.118	Soil	0-1
HMX	16-20265	0816-01-0107	0.190 (J)	Soil	0-1
HMX	16-20193	0816-01-0059	0.290 (J)	Soil	0-1
HMX	16-20566	0816-01-0213	0.290 (J)	Soil	0-1
HMX	16-20189	0816-01-0289	0.340	Soil	0-0.5
HMX	16-20342	0816-01-0182	0.420	Soil	2-3
HMX	16-20301	0816-01-0188	0.550	Soil	0-1
HMX	16-20742	RE16-02-45441	0.56	Soil	2-3
HMX	16-20344	0816-01-0184	0.580	Soil	0-1
HMX	16-20344	0816-01-0185	0.620	Soil	3-4
HMX	16-20694	0816-01-0058	0.650	Soil	0-1
HMX	16-20263	0816-01-0106	0.860	Soil	0-1
HMX	16-20262	0816-01-0105	1.000	Soil	0-1
HMX	16-20239	0816-01-0168	1.100	Soil	0-1
HMX	16-20304	0816-01-0036	1.600 (J-)	Soil	0-1
HMX	16-20348	0816-01-0214	1.700	Soil	0-1
HMX	16-20342	0816-01-0180	4.600	Soil	0-1
HMX	16-20004	0816-01-0293	5.700	Soil	0-0.5
HMX	16-20351	0816-01-0050	5.700	Soil	0-1
HMX	16-20124	0816-01-0063	7.700 (J)	Soil	0-1
HMX	16-20387	0816-01-0161	10.000	Soil	0-1
HMX	16-20376	0816-01-0164	2.000	Soil	0-1
HMX	16-20240	0816-01-0352	0.180 (J)	Tuff	0-1
HMX	16-20706	0816-01-0323	0.260	Tuff	0-1
HMX	16-20599	RE16-02-45443	0.310	Tuff	0-1
HMX	16-20598	0816-01-0266	0.390	Tuff	2-3
HMX	16-20598	0816-01-0265	0.448	Tuff	0-1

Refer to footnotes at end of table.

Table 3.2.3-2 (Continued)
Organic COPCs: Samples with Detections-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
HMX	16-20205	RE16-02-44945	0.620	Tuff	0-1
HMX	16-20205	RE16-02-44946	0.660	Tuff	0-1
HMX	16-20692	0816-01-0086	0.710	Tuff	0-1
HMX	16-20314	0816-01-0354	2.400	Tuff	0-1
HMX	16-20694	0816-01-0253	0.120	Tuff	2-3
HMX	16-20476	0816-01-0134	0.150 (J)	Tuff	0-1
HMX	16-20271	0816-01-0140	0.190 (J)	Tuff	0-1
HMX	16-20270	0816-01-0138	0.200 (J)	Tuff	2-3
HMX	16-20334	0816-01-0235	0.200 (J)	Tuff	0-1
HMX	16-20197	0816-01-0120	0.280 (J)	Tuff	0-1
HMX	16-20333	0816-01-0091	0.320 (J)	Tuff	0-1
HMX	16-20305	0816-01-0035	0.350 (J-)	Tuff	0-1
HMX	16-20233	0816-01-0121	0.410	Tuff	0-1
HMX	16-20419	0816-01-0244	0.450	Tuff	0-1
HMX	16-20269	0816-01-0061	0.510	Tuff	0-1
HMX	16-20270	0816-01-0136	0.610	Tuff	0-1
HMX	16-20418	0816-01-0243	0.670	Tuff	2-3
HMX	16-20418	0816-01-0242	0.790	Tuff	0-1
HMX	16-20340	0816-01-0174	0.860	Tuff	0-1
HMX	16-20195	0816-01-0205	1.800	Tuff	0-1
HMX	16-20742	RE16-02-45439	2.200	Tuff	0-1
HMX	16-20148	0816-01-0073	2.500	Tuff	0-0.5
HMX	16-20670	RE16-02-45436	5.000	Tuff	0-1
HMX	16-20670	RE16-02-45436	5.100	Tuff	0-1
HMX	16-20196	0816-01-0130	5.800	Tuff	0-1
HMX	16-20306	0816-01-0033	10.000 (J-)	Tuff	0-1
HMX	16-20232	RE16-02-45438	16.000	Tuff	0-1
HMX	16-20232	RE16-02-45438	16.000	Tuff	0-1
RDX	16-20742	RE16-02-45442	0.110 (J)	Soil	2-3
RDX	16-20268	RE16-02-45437	2.900	Soil	0-1
RDX	16-20549	0816-01-0215	0.069 (J)	Soil	0-1
RDX	16-20566	0816-01-0213	0.100 (J)	Soil	0-1
RDX	16-20191	0816-01-0046	0.120 (J)	Soil	0-1
RDX	16-20300	0816-01-0186	0.180 (J)	Soil	0-1
RDX	16-20006	0816-01-0289	0.280	Soil	0-0.5
RDX	16-20579	0816-01-0065	0.300	Soil	0-1
RDX	16-20694	0816-01-0058	0.490	Soil	0-1

Refer to footnotes at end of table.

Table 3.2.3-2 (Continued)
Organic COPCs: Samples with Detections-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
RDX	16-20342	0816-01-0182	0.530	Soil	2-3
RDX	16-20344	0816-01-0185	0.570	Soil	3-4
RDX	16-20344	0816-01-0184	0.720	Soil	0-1
RDX	16-20004	0816-01-0293	0.740	Soil	0-0.5
RDX	16-20239	0816-01-0168	0.860	Soil	0-1
RDX	16-20193	0816-01-0059	0.970 (J)	Soil	0-1
RDX	16-20263	0816-01-0106	1.300	Soil	0-1
RDX	16-20351	0816-01-0050	1.600	Soil	0-1
RDX	16-20262	0816-01-0105	1.800	Soil	0-1
RDX	16-20304	0816-01-0036	1.900	Soil	0-1
RDX	16-20301	0816-01-0188	2.200	Soil	0-1
RDX	16-20387	0816-01-0161	2.200	Soil	0-1
RDX	16-20348	0816-01-0214	2.600	Soil	0-1
RDX	16-20342	0816-01-0180	5.900	Soil	0-1
RDX	16-20376	0816-01-0164	2.100	Soil	0-1
RDX	16-20340	0816-01-0176	0.094 (J)	Tuff	2-3
RDX	16-20314	0816-01-0361	0.140 (J)	Tuff	0-1
RDX	16-20599	RE16-02-45443	0.210 (J)	Tuff	0-1
RDX	16-20654	0816-01-0085	0.210 (J)	Tuff	2-3
RDX	16-20386	0816-01-0360	0.330	Tuff	0-1
RDX	16-20240	0816-01-0352	0.490	Tuff	0-1
RDX	16-20238	RE16-02-44948	0.560	Tuff	0-1
RDX	16-20706	0816-01-0323	0.768	Tuff	0-1
RDX	16-20278	0816-01-0359	0.950	Tuff	0-1
RDX	16-20598	0816-01-0266	1.250	Tuff	2-3
RDX	16-20598	0816-01-0265	1.800	Tuff	0-1
RDX	16-20241	0816-01-0357	2.300	Tuff	0-1
RDX	16-20205	RE16-02-44945	3.000	Tuff	0-1
RDX	16-20205	RE16-02-44946	3.200	Tuff	0-1
RDX	16-20314	0816-01-0354	3.600	Tuff	0-1
RDX	16-20547	0816-01-0133	0.084 (J)	Tuff	0-1
RDX	16-20274	0816-01-0029	0.100 (J)	Tuff	0-1
RDX	16-20189	0816-01-0247	0.120 (J)	Tuff	2-3
RDX	16-20233	0816-01-0122	0.140 (J)	Tuff	2-3
RDX	16-20476	0816-01-0134	0.140 (J)	Tuff	0-1
RDX	16-20307	0816-01-0034	0.150 (J)	Tuff	0-1
RDX	16-20195	0816-01-0206	0.160 (J)	Tuff	2-3

Refer to footnotes at end of table.

Table 3.2.3-2 (Continued)
Organic COPCs: Samples with Detections-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
RDX	16-20270	0816-01-0138	0.160 (J)	Tuff	2-3
RDX	16-20416	0816-01-0246	0.170 (J)	Tuff	0-1
RDX	16-20694	0816-01-0253	0.205	Tuff	2-3
RDX	16-20389	0816-01-0030	0.310 (J)	Tuff	0-1
RDX	16-20333	0816-01-0091	0.320	Tuff	0-1
RDX	16-20340	0816-01-0174	0.370	Tuff	0-1
RDX	16-20415	0816-01-0245	0.460	Tuff	0-1
RDX	16-20270	0816-01-0136	0.490	Tuff	0-1
RDX	16-20233	0816-01-0121	0.530	Tuff	0-1
RDX	16-20234	0816-01-0115	0.540	Tuff	0-1
RDX	16-20269	0816-01-0062	0.570 (J)	Tuff	2-3
RDX	16-20334	0816-01-0235	0.810	Tuff	0-1
RDX	16-20419	0816-01-0244	1.100	Tuff	0-1
RDX	16-20148	0816-01-0073	1.300	Tuff	0-0.5
RDX	16-20305	0816-01-0035	1.300	Tuff	0-1
RDX	16-20198	0816-01-0114	1.400	Tuff	0-1
RDX	16-20197	0816-01-0120	1.600	Tuff	0-1
RDX	16-20269	0816-01-0061	1.800 (J)	Tuff	0-1
RDX	16-20271	0816-01-0140	1.800	Tuff	0-1
RDX	16-20195	0816-01-0205	2.100	Tuff	0-1
RDX	16-20295	0816-01-0072	2.300	Tuff	0-1
RDX	16-20742	RE16-02-45439	2.700	Tuff	0-1
RDX	16-20418	0816-01-0243	3.900	Tuff	2-3
RDX	16-20418	0816-01-0242	4.600	Tuff	0-1
RDX	16-20196	0816-01-0130	7.400	Tuff	0-1
RDX	16-20670	RE16-02-45436	18.000	Tuff	0-1
RDX	16-20670	RE16-02-45436	19.000	Tuff	0-1
RDX	16-20306	0816-01-0033	22.000	Tuff	0-1
RDX	16-20232	RE16-02-45438	36.000	Tuff	0-1
RDX	16-20232	RE16-02-45438	37.000	Tuff	0-1
Toluene	16-20004	0816-01-0293	0.001 (J)	Soil	0-0.5
Trinitrotoluene[2,4,6-]	16-20348	0816-01-0214	0.034 (J)	Soil	0-1
Trinitrotoluene[2,4,6-]	16-20304	0816-01-0036	0.086 (J)	Soil	0-1
Trinitrotoluene[2,4,6-]	16-20204	0816-01-0168	0.140	Soil	0-1
Trinitrotoluene[2,4,6-]	16-20387	0816-01-0161	0.270	Soil	0-1
Trinitrotoluene[2,4,6-]	16-20004	0816-01-0293	0.300	Soil	0-0.5
Trinitrotoluene[2,4,6-]	16-20198	0816-01-0114	0.067 (J)	Tuff	0-1

Refer to footnotes at end of table.

Table 3.2.3-2 (Concluded)
Organic COPCs: Samples with Detections-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Trinitrotoluene[2,4,6-]	16-20195	0816-01-0205	0.087 (J)	Tuff	0-1
Trinitrotoluene[2,4,6-]	16-20232	RE16-02-45438	0.380 (J)	Tuff	0-1
Trinitrotoluene[2,4,6-]	16-20232	RE16-02-45438	0.450	Tuff	0-1
Trinitrotoluene[2,4,6-]	16-20670	RE16-02-45436	0.550	Tuff	0-1
Trinitrotoluene[2,4,6-]	16-20742	RE16-02-45439	1.200	Tuff	0-1
Trinitrotoluene[2,4,6-]	16-20306	0816-01-0033	1.200	Tuff	0-1

COPC = Chemical of potential concern.
ft = Foot (feet).
ID = Identification.
J = Estimation.
J- = Estimation with a low bias.
mg/kg = Milligram(s) per kilogram.

Table 3.2.3-3
Frequency of Detected Organics-Exposed Tuff Zone

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)	Frequency of Detection (%)	EQL (mg/kg)
Amino-2,6-dinitrotoluene[4-]	143	20	0.049 to 0.550	14.0	0.330
Amino-4,6-dinitrotoluene[2-]	143	23	[2.5E-07] to 0.882	16.1	0.330
Bis(2-ethylhexyl)phthalate	137	7	0.08 to 0.620	5.1	0.430
Carbon Disulfide	5	1	[0.005] to 0.010	20.0	0.006
Di-n-butylphthalate	137	1	0.130 to [0.430]	0.7	0.430
Dinitrobenzene[1,3-]	143	1	0.044 to [0.330]	0.7	0.330
Dinitrotoluene[2,4-]	280	2	0.036 to [0.430]	0.7	0.430
Dinitrotoluene[2,6-]	280	1	[0.080] to [0.430]	0.4	0.430
HMX	143	76	[0.080] to 5.740	53.1	0.330
Methylnaphthalene[2-]	137	1	0.058 to [0.430]	0.7	0.430
Nitrotoluene[4-]	143	1	[0.080] to [0.330]	0.7	0.330
RDX	143	107	0.054 to 10.80	74.8	0.320
Tetryl	143	1	[0.08] to [0.330]	0.7	0.330
Toluene	5	2	0.001 to [0.026]	40.0	0.026
Trinitrobenzene[1,3,5-]	143	8	0.047 to 0.360	5.6	0.330
Trinitrotoluene[2,4,6-]	143	10	0.029 to 0.480	7.0	0.330

[ ] = Non-detect.

Table 3.2.3-4
Organic COPCs: Samples with Detections-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Amino-2,6-dinitrotoluene[4-]	16-20696	0816-01-0066	0.049 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20526	0816-01-0196	0.054 (J)	2-3
Amino-2,6-dinitrotoluene[4-]	16-20337	0816-01-0172	0.055 (J)	5-6
Amino-2,6-dinitrotoluene[4-]	16-20695	0816-01-0048	0.078 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20524	0816-01-0159	0.094 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20586	0816-01-0208	0.096 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20491	0816-01-0194	0.099 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20375	0816-01-0178	0.11 (J)	7-8
Amino-2,6-dinitrotoluene[4-]	16-20490	0816-01-0192	0.14 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20526	0816-01-0195	0.16 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20454	0816-01-0218	0.23 (J)	0-1
Amino-2,6-dinitrotoluene[4-]	16-20661	0816-01-0251	0.09	2-3
Amino-2,6-dinitrotoluene[4-]	16-20628	0816-01-0332	0.09	0-1
Amino-2,6-dinitrotoluene[4-]	16-20741	0816-01-0250	0.11	2-3
Amino-2,6-dinitrotoluene[4-]	16-20551	0816-01-0306	0.12	0-1
Amino-2,6-dinitrotoluene[4-]	16-20630	0816-01-0330	0.16	0-1
Amino-2,6-dinitrotoluene[4-]	16-20741	0816-01-0249	0.20	5-6
Amino-2,6-dinitrotoluene[4-]	16-20702	0816-01-0255	0.31	0-1
Amino-2,6-dinitrotoluene[4-]	16-20592	0816-01-0248	0.44	0-1
Amino-2,6-dinitrotoluene[4-]	16-20454	0816-01-0307	0.55	0-1
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0196	0.042 (J)	2-3
Amino-4,6-dinitrotoluene[2-]	16-20337	0816-01-0171	0.048 (J)	4-5
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0325	0.048 (J)	27.3-28.3
Amino-4,6-dinitrotoluene[2-]	16-20337	0816-01-0172	0.054 (J)	5-6
Amino-4,6-dinitrotoluene[2-]	16-20489	0816-01-0199	0.056 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20695	0816-01-0048	0.057 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0324	0.061 (J)	37.3-38.3
Amino-4,6-dinitrotoluene[2-]	16-20404	0816-01-0128	0.062 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20524	0816-01-0159	0.071 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20586	0816-01-0208	0.080 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20490	0816-01-0192	0.082 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20491	0816-01-0194	0.087 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0195	0.17 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20454	0816-01-0218	0.18 (J)	0-1
Amino-4,6-dinitrotoluene[2-]	16-20628	0816-01-0332	0.08	0-1
Amino-4,6-dinitrotoluene[2-]	16-20551	0816-01-0306	0.09	0-1
Amino-4,6-dinitrotoluene[2-]	16-20741	0816-01-0250	0.11	2-3

Table 3.2.3-4 (Continued)
Organic COPCs: Samples with Detections-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Amino-4,6-dinitrotoluene[2-]	16-20630	0816-01-0330	0.18	0-1
Amino-4,6-dinitrotoluene[2-]	16-20741	0816-01-0249	0.20	5-6
Amino-4,6-dinitrotoluene[2-]	16-20702	0816-01-0255	0.36	0-1
Amino-4,6-dinitrotoluene[2-]	16-20592	0816-01-0248	0.52	0-1
Amino-4,6-dinitrotoluene[2-]	16-20337	0816-01-0170	0.81	0-1
Amino-4,6-dinitrotoluene[2-]	16-20454	0816-01-0307	0.88	0-1
Bis(2-ethylhexyl)phthalate	16-20477	0816-01-0095	0.080 (J)	0-1
Bis(2-ethylhexyl)phthalate	16-20404	0816-01-0128	0.099 (J)	0-1
Bis(2-ethylhexyl)phthalate	16-20630	0816-01-0330	0.100 (J)	0-1
Bis(2-ethylhexyl)phthalate	16-20558	0816-01-0102	0.110 (J)	0-1
Bis(2-ethylhexyl)phthalate	16-20551	0816-01-0306	0.120 (J)	0-1
Bis(2-ethylhexyl)phthalate	16-20702	0816-01-0255	0.53	0-1
Bis(2-ethylhexyl)phthalate	16-20513	0816-01-0096	0.62	0-1
Carbon Disulfide	16-20557	0816-01-0299	0.0098 (J)	2-3
HMX	16-20526	0816-01-0326	0.24 (J-)	53.5-54.5
HMX	16-20526	0816-01-0324	0.5 (J-)	37.3-38.3
HMX	16-20526	0816-01-0325	0.55 (J-)	27.3-28.3
HMX	16-20441	0816-01-0129	0.100 (J)	0-1
HMX	16-20408	0816-01-0238	0.19 (J)	0-1
HMX	16-20557	0816-01-0299	0.20 (J)	2-3
HMX	16-20560	0816-01-0142	0.21 (J)	2-3
HMX	16-20559	0816-01-0119	0.24 (J)	2-3
HMX	16-20486	0816-01-0212	0.24 (J)	0-1
HMX	16-20375	0816-01-0177	0.26 (J)	5-6
HMX	16-20490	0816-01-0192	0.27 (J)	0-1
HMX	16-20663	0816-01-0311	0.09	0-1
HMX	16-20625	0816-01-0320	0.13	0-1
HMX	16-20669	0816-01-0315	0.14	0-1
HMX	16-20662	0816-01-0314	0.22	2-3
HMX	16-20625	0816-01-0321	0.24	2-3
HMX	16-20591	0816-01-0318	0.24	0-1
HMX	16-20665	0816-01-0261	0.25	0-1
HMX	16-20596	0816-01-0259	0.27	0-1
HMX	16-20557	0816-01-0302	0.28	0-1
HMX	16-20374	0816-01-0233	0.28	0-1
HMX	16-20557	0816-01-0298	0.29	0-1
HMX	16-20624	0816-01-0322	0.29	0-1
HMX	16-20517	0816-01-0099	0.30	0-1

Table 3.2.3-4 (Continued)
Organic COPCs: Samples with Detections-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
HMX	16-20557	0816-01-0303	0.30	2-3
HMX	16-20661	0816-01-0251	0.30	2-3
HMX	16-20590	0816-01-0317	0.33	2-3
HMX	16-20478	0816-01-0151	0.33	0-1
HMX	16-20487	0816-01-0154	0.33	0-1
HMX	16-20523	0816-01-0165	0.33	0-1
HMX	16-20558	0816-01-0102	0.33	0-1
HMX	16-20490	0816-01-0198	0.36	0-1
HMX	16-20559	0816-01-0118	0.36	0-1
HMX	16-20702	0816-01-0257	0.36	4-5
HMX	16-20527	0816-01-0191	0.39	0-1
HMX	16-20595	0816-01-0263	0.39	0-1
HMX	16-20560	0816-01-0141	0.40	0-1
HMX	16-20662	0816-01-0313	0.43	0-1
HMX	16-20489	0816-01-0199	0.46	0-1
HMX	16-20586	0816-01-0208	0.46	0-1
HMX	16-20590	0816-01-0316	0.48	0-1
HMX	16-20477	0816-01-0095	0.48	0-1
HMX	16-20524	0816-01-0159	0.49	0-1
HMX	16-20561	0816-01-0098	0.50	0-1
HMX	16-20632	0816-01-0308	0.51	0-1
HMX	16-20452	0816-01-0222	0.54	0-1
HMX	16-20455	0816-01-0207	0.54	0-1
HMX	16-20489	0816-01-0200	0.54	2-3
HMX	16-20526	0816-01-0196	0.54	2-3
HMX	16-20372	0816-01-0230	0.60	0-1
HMX	16-20525	0816-01-0189	0.61	0-1
HMX	16-20453	0816-01-0223	0.65	0-1
HMX	16-20697	0816-01-0051	0.66	0-1
HMX	16-20695	0816-01-0048	0.68	0-1
HMX	16-20626	0816-01-0312	0.69	0-1
HMX	16-20404	0816-01-0128	0.74	0-1
HMX	16-20702	0816-01-0076	0.79	2-3
HMX	16-20736	0816-01-0090	0.79	0-1
HMX	16-20698	0816-01-0071	0.81	0-1
HMX	16-20629	0816-01-0319	0.84	0-1
HMX	16-20337	0816-01-0170	0.92	0-1
HMX	16-20522	0816-01-0160	0.98	0-1

Table 3.2.3-4 (Continued)
Organic COPCs: Samples with Detections-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
HMX	16-20667	0816-01-0197	1.15	0-1
HMX	16-20337	0816-01-0172	1.20	5-6
HMX	16-20454	0816-01-0218	1.20	0-1
HMX	16-20491	0816-01-0194	1.30	0-1
HMX	16-20337	0816-01-0171	1.60	4-5
HMX	16-20630	0816-01-0330	1.63	0-1
HMX	16-20526	0816-01-0195	1.70	0-1
HMX	16-20454	0816-01-0307	2.23	0-1
HMX	16-20592	0816-01-0248	2.30	0-1
HMX	16-20628	0816-01-0332	2.98	0-1
HMX	16-20702	0816-01-0255	3.14	0-1
HMX	16-20741	0816-01-0250	3.28	2-3
HMX	16-20741	0816-01-0249	3.71	5-6
HMX	16-20551	0816-01-0306	5.74	0-1
RDX	16-20519	0816-01-0158	0.054 (J)	0-1
RDX	16-20516	0816-01-0112	0.061 (J)	0-1
RDX	16-20413	0816-01-0216	0.066 (J)	0-1
RDX	16-20698	0816-01-0071	0.075 (J)	0-1
RDX	16-20520	0816-01-0123	0.085 (J)	0-1
RDX	16-20484	0816-01-0201	0.087 (J)	0-1
RDX	16-20518	0816-01-0126	0.091 (J)	0-1
RDX	16-20658	0816-01-0209	0.091 (J)	0-1
RDX	16-20554	0816-01-0145	0.093 (J)	2-3
RDX	16-20441	0816-01-0129	0.099 (J)	0-1
RDX	16-20337	0816-01-0170	0.10 (J)	0-1
RDX	16-20479	0816-01-0113	0.11 (J)	0-1
RDX	16-20586	0816-01-0208	0.11 (J)	0-1
RDX	16-20660	0816-01-0193	0.11 (J)	0-1
RDX	16-20700	0816-01-0049	0.11 (J)	0-1
RDX	16-20444	0816-01-0231	0.12 (J)	0-1
RDX	16-20696	0816-01-0066	0.12 (J)	0-1
RDX	16-20449	0816-01-0219	0.13 (J)	0-1
RDX	16-20451	0816-01-0224	0.13 (J)	0-1
RDX	16-20375	0816-01-0179	0.14 (J)	9-10
RDX	16-20486	0816-01-0212	0.14 (J)	0-1
RDX	16-20554	0816-01-0143	0.24 (J)	0-1
RDX	16-20624	0816-01-0322	0.14	0-1
RDX	16-20665	0816-01-0261	0.14	0-1

Table 3.2.3-4 (Continued)
Organic COPCs: Samples with Detections-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
RDX	16-20669	0816-01-0315	0.16	0-1
RDX	16-20413	0816-01-0305	0.27	0-1
RDX	16-20662	0816-01-0314	0.31	2-3
RDX	16-20662	0816-01-0313	0.36	0-1
RDX	16-20697	0816-01-0051	0.36	0-1
RDX	16-20442	0816-01-0228	0.42	0-1
RDX	16-20375	0816-01-0177	0.43	5-6
RDX	16-20478	0816-01-0151	0.44	0-1
RDX	16-20625	0816-01-0320	0.44	0-1
RDX	16-20513	0816-01-0096	0.46	0-1
RDX	16-20514	0816-01-0103	0.46	0-1
RDX	16-20517	0816-01-0099	0.46	0-1
RDX	16-20474	0816-01-0067	0.50	0-0.5
RDX	16-20626	0816-01-0312	0.57	0-1
RDX	16-20562	0816-01-0087	0.60	0-1
RDX	16-20562	0816-01-0088	0.60	2-3
RDX	16-20524	0816-01-0159	0.61	0-1
RDX	16-20447	0816-01-0220	0.66	0-1
RDX	16-20555	0816-01-0101	0.70	0-1
RDX	16-20404	0816-01-0128	0.75	0-1
RDX	16-20560	0816-01-0142	0.78	2-3
RDX	16-20373	0816-01-0234	0.80	0-1
RDX	16-20477	0816-01-0095	0.83	0-1
RDX	16-20515	0816-01-0104	0.87	0-1
RDX	16-20595	0816-01-0263	0.88	0-1
RDX	16-20490	0816-01-0192	0.92	0-1
RDX	16-20561	0816-01-0098	0.96	0-1
RDX	16-20625	0816-01-0321	1.03	2-3
RDX	16-20702	0816-01-0076	1.10	2-3
RDX	16-20695	0816-01-0048	1.10	0-1
RDX	16-20596	0816-01-0259	1.14	0-1
RDX	16-20741	0816-01-0250	1.15	2-3
RDX	16-20371	0816-01-0229	1.20	0-1
RDX	16-20455	0816-01-0207	1.20	0-1
RDX	16-20527	0816-01-0191	1.20	0-1
RDX	16-20661	0816-01-0251	1.24	2-3
RDX	16-20337	0816-01-0171	1.30	4-5

Table 3.2.3-4 (Continued)
Organic COPCs: Samples with Detections-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
RDX	16-20337	0816-01-0172	1.30	5-6
RDX	16-20372	0816-01-0230	1.40	0-1
RDX	16-20523	0816-01-0165	1.40	0-1
RDX	16-20741	0816-01-0249	1.44	5-6
RDX	16-20629	0816-01-0319	1.56	0-1
RDX	16-20490	0816-01-0198	1.60	0-1
RDX	16-20559	0816-01-0119	1.60	2-3
RDX	16-20667	0816-01-0197	1.62	0-1
RDX	16-20521	0816-01-0124	1.70	0-1
RDX	16-20408	0816-01-0238	1.80	0-1
RDX	16-20487	0816-01-0154	1.80	0-1
RDX	16-20560	0816-01-0141	1.80	0-1
RDX	16-20632	0816-01-0308	1.80	0-1
RDX	16-20525	0816-01-0189	1.90	0-1
RDX	16-20558	0816-01-0102	1.90	0-1
RDX	16-20628	0816-01-0332	1.99	0-1
RDX	16-20557	0816-01-0299	2.00	2-3
RDX	16-20489	0816-01-0199	2.10	0-1
RDX	16-20591	0816-01-0318	2.12	0-1
RDX	16-20590	0816-01-0316	2.13	0-1
RDX	16-20590	0816-01-0317	2.26	2-3
RDX	16-20488	0816-01-0157	2.30	0-1
RDX	16-20702	0816-01-0257	2.47	4-5
RDX	16-20557	0816-01-0334	2.50	11.7-12.6
RDX	16-20452	0816-01-0222	2.60	0-1
RDX	16-20559	0816-01-0118	2.70	0-1
RDX	16-20374	0816-01-0233	2.80	0-1
RDX	16-20526	0816-01-0326	2.80	53.5-54.5
RDX	16-20702	0816-01-0255	2.92	0-1
RDX	16-20491	0816-01-0194	3.00	0-1
RDX	16-20489	0816-01-0200	3.30	2-3
RDX	16-20630	0816-01-0330	3.46	0-1
RDX	16-20557	0816-01-0303	3.51	2-3
RDX	16-20526	0816-01-0196	3.90	2-3
RDX	16-20557	0816-01-0327	3.90	18.7-19.6
RDX	16-20453	0816-01-0223	4.00	0-1
RDX	16-20454	0816-01-0218	4.00	0-1

Table 3.2.3-4 (Concluded)
Organic COPCs: Samples with Detections-Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
RDX	16-20526	0816-01-0325	4.30	27.3-28.3
RDX	16-20557	0816-01-0298	4.50	0-1
RDX	16-20557	0816-01-0302	4.68	0-1
RDX	16-20526	0816-01-0324	4.80	37.3-38.3
RDX	16-20522	0816-01-0160	6.20	0-1
RDX	16-20454	0816-01-0307	7.06	0-1
RDX	16-20551	0816-01-0306	7.37	0-1
RDX	16-20526	0816-01-0195	8.30	0-1
RDX	16-20592	0816-01-0248	10.80	0-1
Toluene	16-20557	0816-01-0299	0.00059 (J)	2-3
Toluene	16-20557	0816-01-0298	0.00072 (J)	0-1
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0328	0.047 (J)	66-67
Trinitrobenzene[1,3,5-]	16-20522	0816-01-0160	0.052 (J)	0-1
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0334	0.088 (J)	11.7-12.6
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0329	0.12 (J)	52.6-53.6
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0327	0.13 (J)	18.7-19.6
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0333	0.14 (J)	36.7-37.4
Trinitrobenzene[1,3,5-]	16-20337	0816-01-0170	0.17 (J)	0-1
Trinitrobenzene[1,3,5-]	16-20526	0816-01-0195	0.36	0-1
Trinitrotoluene[2,4,6-]	16-20526	0816-01-0196	0.029 (J)	2-3
Trinitrotoluene[2,4,6-]	16-20491	0816-01-0194	0.031 (J)	0-1
Trinitrotoluene[2,4,6-]	16-20557	0816-01-0334	0.041 (J)	11.7-12.6
Trinitrotoluene[2,4,6-]	16-20337	0816-01-0172	0.043 (J)	5-6
Trinitrotoluene[2,4,6-]	16-20586	0816-01-0208	0.078 (J)	0-1
Trinitrotoluene[2,4,6-]	16-20454	0816-01-0218	0.079 (J)	0-1
Trinitrotoluene[2,4,6-]	16-20551	0816-01-0306	0.12	0-1
Trinitrotoluene[2,4,6-]	16-20592	0816-01-0248	0.13	0-1
Trinitrotoluene[2,4,6-]	16-20702	0816-01-0255	0.16	0-1
Trinitrotoluene[2,4,6-]	16-20526	0816-01-0195	0.48	0-1

Table 3.2.4-1
Results of Data Review

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Inorganic Chemicals					
Aluminum	---	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Antimony	---	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Arsenic	---	---	---	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background
Barium	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Beryllium	---	---	X	Retained	Retained for exposed tuff zone because detected concentrations exceeded established BVs and failed the statistical tests
Cadmium	---	---	---	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background
Chromium	---	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Cobalt	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests or had samples greater than the maximum BV value by several factors
Copper	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Iron	---	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Lead	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests or had samples greater than the maximum BV value by several factors
Manganese	---	---	---	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background

Refer to footnotes at end of table.

Table 3.2.4-1 (Continued)
Results of Data Review

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Mercury	---	---	X	Retained	Retained for exposed tuff zone because detected concentrations exceeded established BVs and because there is no background data set for comparison
Nickel	---	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Perchlorate	ND	ND	X	Retained	Retained for exposed tuff zone because it was detected in seven samples and does not have an associated BV
Selenium	---	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Silver	X	---	---	Retained	Retained for biological zone because there is no soil background data set for comparison
Thallium	---	---	---	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background
Vanadium	---	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests
Zinc	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed the statistical tests or had samples greater than maximum BV by several factors
Radionuclides					
Cesium-137	---		ND	Eliminated	Eliminated from biological zone because detected concentrations did not exceed established BVs
Uranium-234	---		---	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs
Uranium-235	---		---	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs
Uranium-238	---		---	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs
Organic Chemicals					
Acetone	X		ND	Retained	Retained for biological zone because concentrations were detected in more than 5% of the samples

Refer to footnotes at end of table.

Table 3.2.4-1 (Continued)
Results of Data Review

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Amino-2,6-dinitrotoluene[4-]	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples
Amino-4,6-dinitrotoluene[2-]	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples
Aroclor-1260	X		ND	Retained	Retained for biological zone because concentrations were detected in more than 5% of the samples
Benzoic Acid	---		ND	Eliminated	Eliminated from biological zone because concentrations were detected in less than 5% of the samples
Bis(2-ethylhexyl)phthalate	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples
Carbon Disulfide	ND		X	Retained	Retained for exposed tuff zone because concentrations were detected in more than 5% of the samples
Di-n-butylphthalate	ND		---	Eliminated	Eliminated from exposed tuff zone because concentrations were detected in less than 5% of the samples
DDT[4,4]	X		ND	Retained	Retained for biological zone because concentrations were detected in more than 5% of the samples
Dichlorobenzene[1,4-]	---		ND	Eliminated	Eliminated from biological zone because concentrations were detected in less than 5% of the samples
Dinitrobenzene[1,3-]	---		---	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of the samples
Dinitrotoluene[2,4-]	---		---	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of the samples
Dinitrotoluene[2,6-]	---		---	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of the samples
HMX	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples
Methylnaphthalene[2-]	---		---	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of the samples
Nitrotoluene[3-]	---		ND	Eliminated	Eliminated from biological zone because concentrations were detected in less than 5% of the samples

Refer to footnotes at end of table.

Table 3.2.4-1 (Concluded)
Results of Data Review

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Nitrotoluene[4-]	---		---	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of the samples
RDX	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples
Tetryl	---		---	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of the samples
Toluene	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples
Trinitrobenzene[1,3,5-]	ND		X	Retained	Retained for exposed tuff zone because concentrations were detected in more than 5% of the samples
Trinitrotoluene[2,4,6-]	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples

ND = 100% non-detect within a given zone.
X = Retained as a COPC.
--- = Eliminated as a COPC.

Table 4.2.2-1
Summary Statistics for the MDA P Site COPCs Used for the Human Health Risk Screening Assessment

Analyte	Number of Analyses	Distribution Type	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	95% UCL (mg/kg)
Inorganic Chemicals							
Aluminum	259	Non-Parametric	803	32,700	5,634	4,090	6,049
Antimony	259	Non-Parametric	0.046	2.9	0.390	0.229	0.414
Barium	259	Non-Parametric	3.05	6,980	452	821	535
Beryllium	259	Non-Parametric	0.23	3.3	0.786	0.472	0.834
Chromium	259	Non-Parametric	0.22	39.4	4.90	3.6	5.25
Cobalt	259	Non-Parametric	0.27	151	4.21	10.9	5.34
Copper	259	Non-Parametric	0.47	36.8	6.1	6.39	6.71
Iron	259	Lognormal	4,050	22,500	10,044	2,944	10,335
Lead	259	Non-Parametric	1.2	144	8.52	11.2	9.67
Mercury	259	Non-Parametric	0.001	0.22	0.018	0.018	0.02
Nickel	259	Lognormal	0.65	12.6	4.12	2.41	4.5
Perchlorate	51	Non-Parametric	0.004	0.075	0.025	0.017	0.029
Selenium	259	Non-Parametric	0.05	1.4	0.23	0.16	0.25
Silver	259	Non-Parametric	0.001	15.8	0.42	1.13	0.54
Vanadium	259	Non-Parametric	0.19	29.3	8.90	6.11	9.52
Zinc	259	Non-Parametric	4.7	912	43.3	58.2	49.0
Organic Chemicals							
Acetone	10	Non-Parametric	0.012	0.215	0.06	0.08	0.1
Amino-2,6-dinitrotoluene[4-]	262	Non-Parametric	0.04	0.98	0.15	0.09	0.15
Amino-4,6-dinitrotoluene[2-]	262	Non-Parametric	1.25E-07	1.1	0.15	0.12	0.16
Aroclor-1260	7	Non-Parametric	0.018	0.06	0.025	0.016	0.034
Bis(2-ethylhexyl)phthalate	259	Non-Parametric	0.08	0.62	0.19	0.04	0.2
Carbon Disulfide	5	Non-Parametric	0.003	0.01	0.004	0.003	0.006
DDT[4,4'-]	7	Non-Parametric	0.0009	0.008	0.002	0.003	0.003
HMX	262	Non-Parametric	0.04	16	0.75	1.9	0.95
RDX	262	Non-Parametric	0.04	37	1.47	3.97	1.89
Toluene	10	Lognormal	0.0006	0.013	0.003	0.004	0.008
Trinitrobenzene[1,3,5-]	262	Non-Parametric	0.04	0.7	0.13	0.06	0.14
Trinitrotoluene[2,4,6-]	262	Non-Parametric	0.03	1.2	0.14	0.11	0.16

95% UCL = 95% upper confidence limit of the mean.

Table 4.2.2-2
Summary Statistics for the Biological Zone COPCs Used for the Ecological Risk Screening Assessment

Analyte	Number of Analyses	Distribution Type	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	95% UCL (mg/kg)
Inorganic Chemicals							
Aluminum	137	Lognormal	1,340	32,700	6,321	4,447	7,014
Antimony	137	Non-parametric	0.046	2.90	0.3716	0.28	0.410
Barium	137	Lognormal	9.7	6,630	443	786	656
Chromium	137	Lognormal	0.520	39.4	5.37	3.98	5.95
Cobalt	137	Non-parametric	0.27	44.7	3.42	5.39	4.18
Copper	137	Non-parametric	0.680	36.8	6.64	6.87	7.60
Iron	137	Lognormal	4,050	22,500	9,814	2,999	10,226
Lead	137	Non-parametric	1.5	61.5	9.36	7.5	10.4
Nickel	137	Lognormal	0.650	12.6	4.19	2.47	4.65
Selenium	137	Non-parametric	0.050	0.74	0.22	0.13	0.24
Silver	137	Non-parametric	0.01	15.8	0.49	1.53	0.70
Vanadium	137	Non-parametric	0.19	29.3	9.27	6.39	10.2
Organic Chemicals							
Acetone	5	Normal	0.012	0.014	0.013	0.00096	0.014
Amino-2,6-dinitrotoluene[4-]	139	Non-parametric	0.04	0.98	0.16	0.11	0.18
Amino-4,6-dinitrotoluene[2-]	139	Non-parametric	0.04	1.1	0.16	0.13	0.18
Aroclor-1260	3[a]	NA	0.020	0.061	0.34	NA	0.061
Bis(2-ethylhexyl)phthalate	136	Non-parametric	0.110	0.28	0.19	0.019	0.20
DDT[4,4]	3[a]	NA	0.001	0.008	0.001	NA	0.0079
HMX	139	Non-parametric	0.040	16	0.98	2.48	1.33
RDX	139	Non-parametric	0.040	37	1.65	5.18	2.37
Toluene	5	Non-parametric	0.001	0.003	0.003	0.001	0.0033
Trinitrotoluene[2,4,6-]	139	Non-parametric	0.034	1.2	0.17	0.14	0.18

[a]Too few observations to calculate 95% UCL or standard deviation.
95% UCL = 95% upper confidence limit of the mean.
NA = Not applicable.

Table 4.2.2-3
Comparison of Noncarcinogenic COPCs with SALs (0-5 feet)

Analyte	95% UCL (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Inorganic Chemicals			
Aluminum	6,050	7,400	74,000
Antimony	0.41	3	30
Barium	**534**	520	5,200
Beryllium	0.83	15	150
Cobalt	5.35	450	4,500
Copper	6.71	280	2,800
Iron	**10,335**	2,300	23,000
Lead	9.67	40	400
Mercury	0.02	2.3	23
Nickel	4.50	150	1,500
Perchlorate	0.03	0.78	7.8
Selenium	0.25	38	380
Silver	0.54	38	380
Vanadium	9.52	53	530
Zinc	49.0	2,300	23,000
Organic Chemicals			
Acetone	0.10	160	1,600
Amino-2,6-dinitrotoluene[4-][a]	0.15	6.1	61
Amino-4,6-dinitrotoluene[2-][a]	0.16	6.1	61
Aroclor-1260	0.034[b]	0.11	1.1
Carbon Disulfide	0.01	36	360
HMX	0.95	310	3,100
Toluene	0.005	18	180
Trinitrobenzene[1,3,5-]	0.14	180	1,800

Values in **bold** indicate SAL or 0.1 SAL exceeded by 95% UCL.
[a]2.6-Dinitrotoluene was used as a surrogate SAL (EPA 2001, 71466).
[b]Data set had <10 samples. 95% UCL could not be calculated. Maximum value used.
95% UCL = 95% upper confidence limit of the mean.

Table 4.2.2-4
Comparison of Carcinogenic COPCs with SALs (0-5 feet)

Analyte	95% UCL (mg/kg)	SAL (mg/kg)
Aroclor-1260	0.034[a]	0.22
Bis(2-ethylhexyl)phthalate	0.20	35
Chromium	5.28	210
DDT[4,4'-]	0.0035[a]	1.7
RDX	1.89	4.4
Trinitrotoluene[2,4,6-]	0.14	16

[a]Data set had <10 samples. 95% UCL could not be calculated. Maximum value used.
95% UCL = 95% upper confidence limit of the mean.

Table 4.2.3-1
Summary Statistics for the Biological Zone 5,400 ft² Residential Lot COPCs

Analyte	Number of Analyses	Distribution Type	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	95% UCL (mg/kg)
Inorganic Chemicals							
Aluminum	NA[a]	NA	NA	NA	NA	NA	NA
Antimony	NA[a]	NA	NA	NA	NA	NA	NA
Barium	8	Lognormal	16.9	3,850	897	1,255	1,584
Beryllium	NA[a]	NA	NA	NA	NA	NA	NA
Chromium	NA[a]	NA	NA	NA	NA	NA	NA
Cobalt	NA[a]	NA	NA	NA	NA	NA	NA
Copper	8	Lognormal	0.96	28.9	7.8	9.03	12.7
Iron	NA[a]	NA	NA	NA	NA	NA	NA
Lead	8	Lognormal	2.9	30.3	8.69	9.4	21.8
Mercury	NA[a]	NA	NA	NA	NA	NA	NA
Nickel	NA[a]	NA	NA	NA	NA	NA	NA
Perchlorate	NA[b]	NA	NA	NA	NA	NA	NA
Selenium	8	Non-parametric	0.12	0.64	0.22	0.17	0.31
Silver	8	Non-parametric	0.09	1.6	0.42	0.48	0.69
Vanadium	NA[a]	NA	NA	NA	NA	NA	NA
Zinc	8	Lognormal	17.6	90.5	38.3	22.5	58.6
Organic Chemicals							
Acetone	NA[b]	NA	NA	NA	NA	NA	NA
Amino-2,6-dinitrotoluene[4-]	9	Non-parametric	0.088	0.98	0.33	0.33	0.51
Amino-4,6-dinitrotoluene[2-]	9	Non-parametric	0.074	1.1	0.35	0.38	0.55
Bis(2-ethylhexyl)phthalate	8	Lognormal	0.16	0.28	0.21	0.03	0.23
Carbon Disulfide	NA[b]	NA	NA	NA	NA	NA	NA
DDT[4,4'-]	NA[b]	NA	NA	NA	NA	NA	NA
HMX	9	Lognormal	0.16	16	4.52	6.74	8.03
RDX	9	Lognormal	0.14	37	9.77	15.3	17.7
Toluene	NA[b]	NA	NA	NA	NA	NA	NA
Trinitrobenzene[1,3,5-]	NA[b]	NA	NA	NA	NA	NA	NA
Trinitrotoluene[2,4,6-]	9	Non-parametric	0.145	0.45	0.21	0.12	0.27

[a]Maximum concentration less then the UTL Tuff background concentration.
[b]100% non-detect.
95% UCL = 95% upper confidence limit of the mean.

Table 4.2.3-2
Summary Statistics for the Exposed Tuff Zone 5,400 ft^2 Residential Lot

Analyte	Number of Analyses	Distribution Type	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	Standard Deviation (mg/kg)	95% UCL (mg/kg)
Inorganic Chemicals							
Aluminum	9	Lognormal	2,230	13,500	5,397	4,177	10,415
Antimony	9	Non-parametric	0.34	0.52	0.47	0.05	0.5
Barium	9	Lognormal	865	6,980	2,109	1,944	3,834
Beryllium	9	Lognormal	0.43	2	1.04	0.59	1.75
Chromium	9	Lognormal	2.2	9.3	5.01	2.69	7.75
Cobalt	9	Non-parametric	2.1	151	20	49.1	45.6
Copper	9	Lognormal	1.8	7.4	4.57	1.99	6.85
Iron	9	Non-parametric	9,730	20,600	13,970	4,740	16,404
Lead	NA[a]	NA	NA	11.2	NA	NA	NA
Mercury	NA[a]	NA	NA	0.063	NA	NA	NA
Nickel	9	Lognormal	0.8	8.7	4.39	2.51	5.68
Perchlorate	NA[b]	NA	NA	0.73	NA	NA	NA
Selenium	9	Lognormal	0.125	0.54	0.28	0.15	0.49
Vanadium	9	Lognormal	5.4	18	9.82	4.73	14.4
Zinc	9	Lognormal	18.15	66.1	36.3	15.0	50.7
Organic Chemicals							
Acetone	NA[b]	NA	NA	NA	NA	NA	NA
Amino-2,6-dinitrotoluene[4-]	9	Non-parametric	0.099	0.55	0.2	0.14	0.27
Amino-4,6-dinitrotoluene[2-]	9	Non-parametric	0.056	0.88	0.21	0.26	0.34
Aroclor-1260	NA[b]	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA[b]	NA	NA	NA	NA	NA	NA
Carbon Disulfide	NA[b]	NA	NA	NA	NA	NA	NA
DDT[4,4'-]	NA[b]	NA	NA	NA	NA	NA	NA
HMX	9	Lognormal	0.27	2.23	0.84	0.63	1.59
RDX	9	Lognormal	0.92	7.06	3.02	1.9	5.63
Toluene	NA[b]	NA	NA	NA	NA	NA	NA
Trinitrobenzene[1,3,5-]	NA[b]	NA	NA	NA	NA	NA	NA
Trinitrotoluene[2,4,6-]	9	Non-parametric	0.03	0.16	0.12	0.05	0.15

[a]Maximum concentration less then the UTL Tuff background concentration.
[b]100% non-detect.
95% UCL = 95% upper confidence limit of the mean.
NA = Not applicable.

Table 4.2.3-3
SAL Comparison to 95% UCL Concentrations of Noncarcinogens—
Biological Zone: 5,400 ft² Residential Lot (0-5 feet)

Analyte	95% UCL (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Inorganic Chemicals			
Barium	**1,584**	520	5,200
Copper	12.73	280	2,800
Lead	21.8	40	400
Selenium	0.31	38	380
Silver	0.68	38	380
Zinc	58.6	2,300	23,000
Organic Chemicals			
Amino-2,6-dinitrotoluene[4-][a]	0.51	6.1	61
Amino-4,6-dinitrotoluene[2-][a]	0.55	6.1	61
HMX	8.03	310	3,100

Values in **bold** indicate SAL or 0.1 SAL exceeded by 95% UCL.
[a]2,6-Dinitrotoluene was used as a surrogate SAL (EPA 2001, 71466).
95% UCL = 95% upper confidence limit of the mean.

Table 4.2.3-4
SAL Comparison to 95% UCL Concentrations of Carcinogens—
Biological Zone: 5,400 ft^2 Residential Lot (0-5 feet)

Analyte	95% UCL (mg/kg)	SAL (mg/kg)
Bis(2-ethylhexyl)phthalate	0.26	35
RDX	**17.7**	4.4
Trinitrotoluene[2,4,6-]	0.27	16

Values in bold indicate SAL exceeded by the 95% UCL.
95% UCL = 95% upper confidence limit of the mean.

Table 4.2.3-5
SAL Comparison to 95% UCL Concentrations of Noncarcinogens—
Exposed Tuff Zone: 5,400 ft² Residential Lot (0-5 feet)

Analyte	95% UCL (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Inorganic Chemicals			
Aluminum	**10,415**	7,400	74,000
Antimony	0.50	3	30
Barium	**3,834**	520	5,200
Beryllium	1.75	15	150
Cobalt	45.6	450	4,500
Copper	6.9	280	2,800
Iron	**16,404**	2,300	23,000
Nickel	5.68	150	1,500
Selenium	0.49	38	380
Vanadium	14.4	53	530
Zinc	50.7	2,300	23,000
Organic Chemicals			
Amino-2,6-dinitrotoluene[4-][a]	0.27	6.1	61
Amino-4,6-dinitrotoluene[2-][a]	0.34	6.1	61
HMX	1.6	310	3,100
Trinitrobenzene[1,3,5-]	0.1	180	1,800

Values in **bold** indicate SAL or 0.1 SAL exceeded by 95% UCL.
[a]2,6-Dinitrotoluene was used as a surrogate SAL (EPA 2001, 71466).
95% UCL = 95% upper confidence limit of the mean.

Table 4.2.3-6
SAL Comparison to 95% UCL Concentrations of Carcinogens—Exposed Tuff Zone:
5,400 ft^2 Residential Lot (0-5 feet)

Analyte	95% UCL (mg/kg)	SAL (mg/kg)
Chromium	7.8	210
RDX	**5.63**	4.4
Trinitrotoluene[2,4,6-]	0.15	16

Values in bold indicate SAL exceeded by the 95% UCL.
95% UCL = 95% upper confidence limit of the mean.

Table 4.3.2-1
ESLs for the MDA P Site Receptors for COPCs in the Biological Zone
(mg/kg)

Analyte	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Inorganic Chemicals											
Antimony	0.05	---	---	---	---	---	---	6.2	1	0.57	97
Barium	100	---	230	380	1,000	46,000	1,700	34	4.5	2.4	420
Chromium	2.4	1.4	460	550	680	13,000	5,300	8,000	2,100	700	18,000
Cobalt	0.25	---	0.051	0.093	0.46	6	0.38	5	0.19	0.091	10
Copper	10	13	390	310	260	22,000	3,300	300	170	170	8,900
Iron	---	---	---	---	---	---	---	---	---	---	---
Lead	450	2000	55	72	100	2,700	500	930	220	100	4,600
Nickel	20	100	980	1,200	1,600	38,000	9,700	7,900	2,100	900	31,000
Selenium	0.1	7.7	1.1	2	10	140	8.4	55	1.9	0.91	110
Silver	0.05	---	14	19	30	2,400	100	0.52	0.14	0.091	14
Vanadium	0.025	---	2.8	5.1	28	510	21	790	20	9.6	1,500
Zinc	10	350	97	130	210	4,900	660	1,100	840,000	710,000	1,800,000
Organic Chemicals											
Acetone	---	---	42,000	4,200	2,200	5,600,000	310,000	4.3	3.8	37	---
Amino-2,6-dinitrotoluene[4-]	80	---	---	---	---	---	---	5.8	3.6	5.7	930
Amino-4,6-dinitrotoluene[2-]	80	---	---	---	---	---	---	8.4	5.3	8.3	1,300
Aroclor-1260	---	---	0.44	0.86	15	2.2	1.8	660	10	5	32
Bis(2-ethylhexyl)phthalate	---	---	1	1.9	23	1.7	2.3	3,600	61	30	64
DDT[4,4'-]	3.7	---	0.0026	0.0052	0.12	0.0092	0.0093	200	2.1	1	4.6
HMX	---	500	---	---	---	---	---	51	43	260	37,000
RDX	100	500	---	---	---	---	---	11	9.2	33	4,900
Toluene	200	---	---	---	---	---	---	160	73	70	12,000
Trinitrotoluene[2,4,6-]	0.7	0.7	---	---	---	---	---	77	53	100	16,000

--- = No ESL established.

Table 4.3.2-2
HQ/HI Summary for COPCs in Biological Zone

Analyte	95% UCL, 0-5 ft (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Inorganic Chemicals												
Antimony	4.10E-01	**8.20E+00**	---	---	---	---	---	---	6.61E-02	**4.14E-01**	**7.19E-01**	4.20E-03
Barium	6.56E+02	**6.56E+00**	---	**2.50E+00**	**1.73E+00**	**6.56E-01**	1.43E-02	**3.86E-01**	**1.93E+01**	**1.46E+02**	**2.73E+02**	**1.56E+00**
Chromium	5.95E+00	**2.48E+00**	**4.25E+00**	1.29E-02	1.08E-02	8.80E-03	5.00E-04	1.10E-03	7.00E-04	2.80E-03	8.50E-03	3.00E-04
Cobalt	4.18E+00	**1.67E+01**	---	**8.20E+01**	**4.50E+01**	**9.09E+00**	**6.97E-01**	**1.10E+01**	**8.36E-01**	**2.20E+01**	**4.59E+01**	**4.18E-01**
Copper	7.60E+00	**7.60E-01**	**5.85E-01**	1.96E-02	2.45E-02	2.92E-02	3.00E-04	2.30E-03	2.53E-02	4.47E-02	4.47E-02	9.00E-04
Iron	1.02E+04	---	---	---	---	---	---	---	---	---	---	---
Lead	1.04E+01	2.31E-02	5.20E-03	1.89E-01	1.44E-01	1.04E-01	3.90E-03	2.08E-02	1.12E-02	4.73E-02	1.04E-01	2.30E-03
Nickel	4.65E+00	2.33E-01	4.65E-02	4.70E-03	3.90E-03	2.90E-03	1.00E-04	4.90E-04	5.91E-04	2.20E-03	5.19E-03	2.00E-04
Selenium	2.40E-01	**2.40E+00**	3.12E-02	2.18E-01	1.20E-01	2.40E-02	1.70E-03	2.86E-02	4.40E-03	1.26E-01	2.64E-01	2.20E-03
Silver	7.00E-01	**1.40E+01**	---	5.00E-02	3.68E-02	2.33E-02	2.93E-04	7.03E-03	**1.35E+00**	**5.00E+00**	**7.69E+00**	5.00E-02
Vanadium	1.02E+01	**4.08E+02**	---	**3.64E+00**	**2.00E+00**	**3.64E-01**	2.00E-02	**4.86E-01**	1.29E-02	**5.10E-01**	**1.06E+00**	6.78E-03
Zinc	5.37E+01	**5.37E+00**	1.54E-01	**5.54E-01**	**4.13E-01**	2.56E-01	1.10E-02	8.14E-02	4.89E-02	6.40E-05	7.57E-05	2.99E-05
Organic Chemicals												
Acetone	1.40E-02	---	---	3.33E-07	3.33E-06	6.36E-06	2.50E-09	4.52E-08	3.26E-03	3.68E-03	3.78E-04	---
Amino-2,6-dinitrotoluene[4-]	1.80E-01	2.25E-03	---	---	---	---	---	---	3.10E-02	5.00E-02	3.16E-02	1.94E-04
Amino-4,6-dinitrotoluene[2-]	1.82E-01	2.28E-03	---	---	---	---	---	---	2.17E-02	3.43E-02	2.19E-02	1.40E-04
Aroclor-1260	6.1E-02 [a]	---	---	1.39E-01	7.09E-02	4.07E-03	2.77E-02	3.39E-02	9.24E-05	6.10E-03	1.22E-02	1.91E-03
Bis(2-ethylhexyl) phthalate	2.00E-01	---	---	2.00E-01	1.05E-01	8.70E-03	1.18E-01	8.70E-02	5.56E-05	3.28E-03	6.67E-03	3.13E-03
DDT[4,4'-]	7.9E-03 [a]	2.14E-03	---	**3.04E+00**	**1.52E+00**	6.58E-02	**8.59E-01**	**8.49E-01**	3.95E-05	3.76E-03	7.90E-03	1.72E-03
HMX	1.33E+00	---	2.66E-03	---	---	---	---	---	2.61E-02	3.09E-02	5.12E-03	3.59E-05
RDX	2.37E+00	2.37E-02	4.74E-03	---	---	---	---	---	2.16E-01	2.58E-01	7.18E-02	4.82E-04
Toluene	3.30E-03	1.65E-05	---	---	---	---	---	---	2.06E-05	4.52E-05	4.71E-05	2.75E-07
Trinitro-toluene[2,4,6-]	1.80E-01	2.57E-01	2.57E-01	---	---	---	---	---	2.34E-03	3.40E-03	1.80E-03	1.13E-05
HI		**4.64E+02**	**5.34E+00**	**9.29E+01**	**5.11E+01**	**1.06E+01**	**1.75E+00**	**1.30E+01**	**2.19E+01**	**1.74E+02**	**3.29E+02**	**2.05E+00**

Value in **Bold** indicates HQ > 0.3 or an HI > 1.0.

[a] 95% UCL could not be calculated; maximum detection was used.

--- = ESL not available.

Table 4.3.2-3
HQ/HI Summary of COPCs With Elimination of ESLs Less than Background—Biological Zone

Analyte	95% UCL, 0-5 ft (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Inorganic Chemicals												
Antimony	4.10E-01	NC	---	---	---	---	---	---	6.61E-02	**4.14E-01**	NC	4.27E-03
Barium	6.56E+02	NC	---	NC	**1.72E+00**	**6.56E-01**	1.43E-02	**3.86E-01**	NC	NC	NC	**1.56E+00**
Chromium	5.95E+00	NC	NC	1.29E-02	1.08E-02	8.75E-03	4.58E-04	1.12E-03	7.44E-04	2.83E-03	8.50E-03	3.31E-04
Cobalt	4.18E+00	NC	---	NC	NC	NC	NC	NC	NC	NC	NC	**4.18E-01**
Copper	7.60E+00	NC	NC	1.95E-02	2.45E-02	2.92E-02	3.45E-04	2.30E-03	2.53E-02	4.47E-02	4.47E-02	8.54E-04
Iron	1.02E+04	---	---	---	---	---	---	---	---	---	---	---
Selenium	2.40E-01	NC	3.12E-02	NC	1.20E-01	2.40E-02	1.74E-03	2.86E-02	4.36E-03	1.26E-01	2.64E-01	2.18E-03
Silver	7.00E-01	NC	---	5.00E-02	3.68E-02	2.33E-02	2.92E-04	7.00E-03	NC	NC	NC	5.00E-02
Vanadium	1.02E+01	NC	---	NC	NC	NC	2.00E-02	NC	1.29E-02	NC	NC	6.80E-03
Zinc	5.37E+01	NC	1.54E-01	**5.54E-01**	**4.13E-01**	2.56E-01	1.10E-02	8.14E-02	4.89E-02	6.40E-05	7.57E-05	2.99E-05
Organic Chemicals												
Acetone	1.40E-02	---	---	3.33E-07	3.33E-06	6.36E-06	2.50E-09	4.52E-08	3.26E-03	3.68E-03	3.78E-04	---
Amino-2,6-dinitrotoluene[4-]	1.80E-01	2.25E-03	---	---	---	---	---	---	3.10E-02	5.00E-02	3.16E-02	1.94E-04
Amino-4,6-dinitrotoluene[2-]	1.82E-01	2.28E-03	---	---	---	---	---	---	2.17E-02	3.43E-02	2.19E-02	1.40E-04
Aroclor-1260	6.1E-02 [a]	---	---	1.39E-01	7.09E-02	4.07E-03	2.77E-02	3.39E-02	9.24E-05	6.10E-03	1.22E-02	1.91E-03
Bis(2-ethylhexyl)phthalate	2.00E-01	---	---	2.00E-01	1.05E-01	8.70E-03	1.18E-01	8.70E-02	5.56E-05	3.28E-03	6.67E-03	3.13E-03
DDT[4,4'-]	7.9E-03 [a]	2.14E-03	---	**3.04E+00**	**1.52E+00**	6.58E-02	**8.59E-01**	**8.49E-01**	3.95E-05	3.76E-03	7.90E-03	1.72E-03
HMX	1.33E+00	---	2.66E-03	---	---	---	---	---	2.61E-02	3.09E-02	5.12E-03	3.59E-05
RDX	2.37E+00	2.37E-02	4.74E-03	---	---	---	---	---	2.15E-01	2.38E-01	7.18E-02	4.84E-04
Toluene	3.30E-03	1.65E-05	---	---	---	---	---	---	2.06E-05	4.52E-05	4.71E-05	2.75E-07
Trinitrotoluene[2,4,6-]	1.80E-01	2.57E-01	2.57E-01	---	---	---	---	---	2.34E-03	3.40E-03	1.80E-03	1.13E-05
HI		2.88E-01	4.49E-01	**4.01E+00**	**4.03E+00**	**1.08E+00**	**1.05E+00**	**1.48E+00**	4.58E-01	**9.77E-01**	4.76E-01	**2.05E+00**

Bold indicates HQ > 0.3 or an HI > 1.0.
[a] 95% UCL could not be calculated; maximum detection was used.
NC = HQ not calculated because the ESL is < the BV.
--- = ESL not available.

Table 5.3.2-1
Summary of Step 3: Problem Formulation
COPECs and Receptors, by Media
Unfiltered Water Data Used for Assessment
Guild suffixes: h - herbivore; o - omnivore; i - insectivore; f - flesh

COPEC	Surface Water	Springs	Alluvial Water	Sediment	Soil
Inorganics					
Aluminum	aquatic community	aquatic community	aquatic community, shrew, deer mouse, bat, fox		
Barium	aquatic community[a]	aquatic community	aquatic community	Bkgnd	cottontail, kestrel, plant, fox, kestrel-f
Cadmium	aquatic community	aquatic community	aquatic community		
Cobalt	aquatic community	aquatic community	aquatic community	Bkgnd	
Copper				aquatic community	Bkgnd, plant
Lead				aquatic community	robin-h, robin-o
Manganese	aquatic community	aquatic community	aquatic community		
Silver		aquatic community	aquatic community	aquatic community, swallow	plant, robin-h, robin-o, robin-i
Thallium				bat	
Vanadium				Bkgnd	
Organics					
Di-n-butyl phthalate				swallow	
HMX				bat	deer mouse, cottontail, shrew
RDX				bat	deer mouse

[a]Generic aquatic community, “Final Water Quality Guidance for the Great Lakes System; Final Rule,” or from New Mexico water quality standards.

Table 5.3.2-2
Summaries of Soil Hazard Quotients for COPECs that Exceed One or More Screening Values

	Barium			Copper			Lead		
	Minimum	**Maximum**	**MedUCL**	**Minimum**	**Maximum**	**MedUCL**	**Minimum**	**Maximum**	**MedUCL**
Plant	0.18	**37.**	**7.9**	0.033	**1.4**	0.28	0.38	**3.3**	**2.2**
Invert	NA	NA	NA	0.25	**11.**	**2.2**	0.076	0.66	0.44
Robini	**3.4**	**690.**	**150.**	0.0087	0.37	0.074	0.097	0.84	0.56
Robinip	**2.1**	**420.**	**90.**	0.016	0.66	0.13	0.12	**1.0**	0.66
Robinp	0.80	**160.**	**34.**	0.024	0.99	0.20	0.13	**1.2**	0.77
Kestrel	0.46	**93.**	**20.**	0.001	0.043	0.0088	0.0078	0.068	0.045
Kestrelf	0.018	**3.7**	0.79	0.00021	0.0087	0.0018	0.0040	0.035	0.023
Cottontail	0.59	**120.**	**26.**	0.022	0.93	0.19	0.010	0.088	0.058
Mouse	**4.4**	**890.**	**190.**	0.033	**1.4**	0.28	0.016	0.14	0.093
Shrew	**8.0**	**1600.**	**340.**	0.021	0.87	0.18	0.027	0.24	0.16
Fox	0.050	**10.**	**2.1**	0.00049	0.02	0.0042	0.0013	0.011	0.0074

	Silver			HMX			RDX		
	Minimum	**Maximum**	**MedUCL**	**Minimum**	**Maximum**	**MedUCL**	**Minimum**	**Maximum**	**MedUCL**
Plant	**3.2**	**74.**	**36.**	NA	NA	NA	0.0016	0.055	0.0072
Invert	NA	NA	NA	NA	NA	NA	NA	NA	NA
Robini	0.22	**5.3**	**2.6**	NA	NA	NA	NA	NA	NA
Robinip	0.48	**11.**	**5.6**	NA	NA	NA	NA	NA	NA
Robinp	0.71	**17.**	**8.2**	NA	NA	NA	NA	NA	NA
Kestrel	0.027	0.65	0.32	NA	NA	NA	NA	NA	NA
Kestrelf	0.0048	0.11	0.056	NA	NA	NA	NA	NA	NA
Cottontail	0.0035	0.083	0.041	0.17	**260.**	**11.**	0.026	0.90	0.12
Mouse	0.0048	0.11	0.056	0.19	**290.**	**12.**	0.031	**1.1**	0.14
Shrew	0.0025	0.060	0.029	0.019	**29.**	1.2	0.007	0.24	0.031
Fox	0.000057	0.0014	0.00074	0.000086	0.13	0.0055	0.000031	0.0011	0.00014

Bolded values exceed criteria.
NA = Criteria not available.
Diet suffixes on receptor names: i – invertebrate; p – plant; f - flesh.

Table 5.3.2-3
Summaries of Drinking Water Pathway Hazard Quotients for COPEC Detected Values that Exceed One or More Screening Values

	Aluminum			Barium			Cadmium		
	Minimum	**Maximum**	**MedianUCL**	**Minimum**	**Maximum**	**MedianUCL**	**Minimum**	**Maximum**	**MedianUCL**
Aqcomm[a]	0.14	**1000.**	**15.**	**26.**	**4600.**	**820.**	**1.50**	**35.**	**8.0**
Bat	0.0010	**7.6**	0.11	0.030	**5.3**	0.94	0.000035	0.00084	0.00019
Cottontail	0.00064	**4.8**	0.070	0.018	**3.2**	0.56	0.000022	0.00052	0.00012
Mouse	0.0012	**9.1**	0.13	0.035	**6.2**	**1.1**	0.000042	0.00100	0.00023
Fox	0.00055	**4.1**	0.06	0.016	**2.8**	0.50	0.000020	0.00047	0.00011
Shrew	0.0014	**11.**	0.15	0.041	**7.2**	**1.3**	0.000050	0.00120	0.00027
Kestrel	0.000013	0.10	0.0015	0.00013	0.023	0.0041	0.000018	0.00043	0.00010
Robin	0.000016	0.12	0.0017	0.00015	0.027	0.0048	0.000022	0.00052	0.00012
Swallow	0.000027	0.20	0.0030	0.00026	0.046	0.0082	0.000037	0.00088	0.00020

	Cobalt			Manganese			Silver		
	Minimum	**Maximum**	**MedianUCL**	**Minimum**	**Maximum**	**MedianUCL**	**Minimum**	**Maximum**	**MedianUCL**
Aqcomm[a]	0.18	**5.9**	**2.2**	0.021	**54.**	**1.3**	**2.5**	**20.**	**8.1**
Bat	0.0045	0.15	0.054	6.3E-06	0.016	0.00039	0.0074	0.060	0.024
Cottontail	0.0027	0.088	0.032	3.8E-06	0.0096	0.00023	0.0044	0.036	0.014
Mouse	0.0054	0.18	0.065	7.4E-06	0.019	0.00045	0.0089	0.072	0.029
Fox	0.0023	0.077	0.028	3.3E-06	0.0085	0.00020	0.0039	0.031	0.013
Shrew	0.0061	0.20	0.073	8.9E-06	0.023	0.00055	0.010	0.081	0.033
Kestrel	0.0034	0.11	0.041	3.6E-07	0.00092	0.000022	0.000020	0.000016	0.000064
Robin	0.0039	0.13	0.046	4.1E-07	0.0011	0.000025	0.000023	0.00019	0.000076
Swallow	0.0066	0.22	0.079	7.4E-07	0.0019	0.000045	0.000040	0.00033	0.00013

Bolded values exceed criteria.
[a]Generic Aquatic Community.

Table 5.3.2-4
Summaries of Sediment Hazard Quotients for COPEC Detected Values that Exceed One or More Screening Values

	Barium			Cobalt			Copper			Lead		
	Minimum	**Maximum**	**Median UCL**	**Minimum**	**Maximum**	**Median UCL**	**Minimum**	**Maximum**	**Median UCL**	**Minimum**	**Maximum**	**Median UCL**
Bat[a]	**1.9**	**4800**	**770**	**9.2**	**200**	**52**	0.0070	0.33	0.053	0.019	0.64	0.12
Swallow[b]	0.019	**47**	**7.5**	**15**	**320**	**85**	0.0029	0.14	0.022	0.035	**1.2**	0.21
AqComm[c]	0.13	**330**	**53**	NA[d]	NA	NA	0.075	**3.6**	0.57	0.11	**3.8**	0.68

	Silver			Thallium			Vanadium			Di-n-butylphthalate		
	Minimum	**Maximum**	**Median UCL**	**Minimum**	**Maximum**	**Median UCL**	**Minimum**	**Maximum**	**Median UCL**	**Minimum**	**Maximum**	**Median UCL**
Bat[a]	**2.3**	**130**	**30**	0.68	**16**	**5.9**	0.041	**4.2**	**1.3**	0.000076	0.0059	0.0015
Swallow[b]	0.014	0.76	0.18	NA	NA	NA	0.13	**13**	**4.0**	0.54	**42**	**10**
AqComm[c]	0.28	**15**	**3.6**	NA	NA	NA	NA	NA	NA	0.012	0.91	0.23

	HMX			RDX		
	Minimum	**Maximum**	**Median UCL**	**Minimum**	**Maximum**	**Median UCL**
Bat[a]	0.0027	0.49	0.055	0.0046	0.95	0.051
Swallow[b]	NA	NA	NA	NA	NA	NA
AqComm[c]	NA	NA	NA	NA	NA	NA

Bolded values exceed criteria.
[a]Emergent insect ingestion pathway.
[b]Emergent insect ingestion pathway.
[c]Generic sediment insect community.
[d]Screening ESL not available.
NA = Criteria not available.

Table 5.5.1-1
Cañon de Valle Small Mammal Trapping Results for Spring and Fall 2001
Number of Individuals by Species and Reproductive Status

	Juvenile Female	Juvenile Male	Pregnant Female	Lactating Female	Non-Reproductive Female	Non-Scrotal Male	Scrotal Male	Totals
Spring 2001								
Cañon de Valle								
Deer Mouse[a]	2		1	2	3	5	8	**21**
Montane Vole[b]				1		3		**4**
Totals	**2**		**1**	**3**	**3**	**8**	**8**	**25**
Pajarito Canyon								
Deer Mouse					2	2	4	**8**
Montane Vole							1	**1**
Totals					**2**	**2**	**5**	**9**
Fall 2001								
Cañon de Valle								
Deer Mouse	6	3		3	6	5	2	**25**
Brush Mouse[c]			1	1	7	8		**17**
Pinion Mouse[d]					1			**1**
Western Harvest Mouse[e]	2	2	2	1	2	3		**12**
Wood Rat[f]						4		**4**
Totals	**8**	**5**	**3**	**5**	**16**	**20**	**2**	**59**
Pajarito Canyon								
Deer Mouse		2	2	1	5	6	1	**17**
Brush Mouse			1	1	3	2	1	**8**
Wood Rat				1		1	1	**3**
Totals		**2**	**3**	**3**	**8**	**9**	**3**	**28**

[a] *Peromyscus maniculatus.*
[b] *Microtus montanus.*
[c] *Peromyscus boylii.*
[d] *Peromyscus truei.*
[e] *Reithrodontomys megalotis.*

[f] *Neotoma mexicana.*

Table 5.5.1-2
Deer Mouse Population Density Estimates by Trapping Grid and Season

Location	Spring 2001 individuals/ha (±95% CI)	Fall 2001 individuals/ha (±95% CI)
Cañon de Valle, Upper Grid	10.5 (4)	NA[a]
Cañon de Valle, Lower Grid	24 (9)	144 (66)
Pajarito Canyon, Upper Grid	7.1 (3.8)	11.3 (7.5)
Pajarito Canyon, Lower Grid	9.1 (4.1)	18.7 (8)

[a]Population density not calculated because new capture data are non-linear (5,4,8,6). See text for explanation.
CI = Confidence level.
ha = Hectare.
NA = Not applicable.

Table 5.5.1-3a
Small Mammal Weights, Spring and Fall 2001
Data Summaries and Statistical Testing for Differences Between
Canyons and Sexes within a Species

Group (n)	Min.	1st Qtr.	Median	Mean	3rd Qtr.	Max.
Spring 2001 Deer Mouse Data Summary						
CdV Males (13)	13.5	15.00	16.00	17.77	20.00	25
CdV Females (6)	15.0	17.25	18.25	18.58	19.62	23
Pajarito Males (6)	16.0	18.25	19.50	20.17	20.00	28
Pajarito Females (2)	17.0	17.75	18.50	18.50	19.25	20
Fall 2001 Deer Mouse Data Summary						
CdV Males (7)	15.0	15.50	16.5	16.93	17.5	21
CdV Females (9)	13.0	19.00	21.0	19.50	22.0	22
Pajarito Males (7)	14.5	15.55	19.0	17.66	19.5	20
Pajarito Females (8)	14.5	16.50	18.0	18.06	19.5	22
Fall 2001 Brush Mouse Data Summary						
CdV Males (8)	14	15.0	17.25	17.75	18.62	25.0
CdV Females (9)	12	14.5	14.80	16.64	18.00	24.0
Pajarito Males (3)	18	18.5	19.00	18.83	19.25	19.5
Pajarito Females (5)	19	19.0	20.00	20.10	20.50	22.0
Fall 2001 Wood Rat Data Summary						
CdV Males (4)	130	130	138	139	147	150
Pajarito Males (2)	92	111	130	130	149	168
Pajarito Females (1)	130	130	130	130	130	130

Max. = Maximum.
Min. = Minimum.
Qtr. = Quarter.

Table 5.5.1-3b
Small Mammal Weights, Spring and Fall 2001
Statistical Testing for Differences Between
Canyons and Sexes within a Species

	Kruskal-Wallis Rank Sum Test P-Value		**ANOVA P-Value**	
	Four groups	**Two groups**	**Four groups**	**Two groups**
Spring 2001 Deer Mouse	0.60	0.24	0.60	0.24
Fall 2001 Deer Mouse	0.23	0.55	0.29	0.62
Fall 2001 Brush Mouse	0.11	**0.024**	0.27	0.074
Fall 2001 Wood Rat	---	0.71	---	0.66

ANOVA = Analysis of variance.
--- = Test could not be run due to lack of CdV females.

Table 5.5.1-4
TRVs for Top Carnivore Receptors and ESLs for Whole Small Mammals Associated with Cañon de Valle COPECs

COPEC	TRV, mg/kg-d	Lab Study Organism	Risk Screening Receptor	Mexican Spotted Owl ESL, mg/kg
Barium	12.6	Chicken	Kestrel	63
Lead	5.1	Kestrel	Kestrel	25
Silver	5.4	Turkey	Kestrel	27
Copper	47	Chicken	Kestrel	235
HMX	75	Mouse	Fox	375
RDX	10	Rat	Fox	50

The NOAEL calculation is as follows:

$$\text{Dose, mg for NOAEL}_{owl} = \text{TRV} \times 0.6 \text{ kg Owl Body Weight}$$

$$\text{NOAEL mg/kg}_{owl} = (\text{Dose} / 120 \text{ g/d Owl Intake Rate}) \times 1000 \text{ g/kg}$$

$$\text{ESL} = \text{NOAEL}$$

NOAEL = No-observed-adverse-effect level.
TRV = Toxicity Reference Value.

Table 5.5.2-1
Sensitive Species Metrics for Cañon de Valle Relative to Three Reference Sites

	Cañon de Valle (2.6)[a]	**Los Alamos Canyon (13.0)**	**Pajarito Canyon (9.0)**	**Guaje Canyon (10.0)**
EPT	6	18	10	16
EPT/EPT + Chironomids	0.66	0.25	0.84	0.90
CDTq	91.0	71.4	80.0	62.0

[a]Numbers in parentheses indicate miles upstream from the mouth of the canyon.
CDTq = Community tolerance dominance quotient.
EPT = Ephemeroptera, plecoptera, and trichoptera.

Table 5.5.2-2a
Data Summaries of Sediment and
Water Toxicity Testing with *Chironomus tentans*

Group	Min.	1st Qtr.	Median	Mean	3rd Qtr.	Max.
Percent Survival Data Summaries Starting number is 10 individuals per replicate, with 8 replicates per site						
Starmer's Gulch	60	77.5	90	82.5	90	90
Above MDA P	30	60.0	75	68.75	80	90
Below MDA P	70	80.0	90	86.25	90	100
Growth Data Summaries Ash-free dry weight, mg/individual, based upon surviving individuals						
Starmer's Gulch	0.34	0.43	0.44	0.4356	0.46	0.52
Above MDA P	0.34	0.35	0.37	0.3756	0.38	0.44
Below MDA P	0.35	0.37	0.39	0.3956	0.40	0.50

Table 5.5.2-2b
Statistical Evaluations of Sediment and
Water Toxicity Testing with *Chironomus tentans*
Pairwise Comparisons Using Wilcoxon Rank Sum Test and Student's t Test

		Survival	
	Starmar's Gulch	Above MDA P	Below MDA P
Starmer's Gulch	---	Wilcoxon, p=0.08 Student's t, p=0.10	Wilcoxon, p=0.64 Student's t, p=0.49
Above MDA P	Wilcoxon, **p=0.03** Student's t, **p=0.01**	---	Wilcoxon, **p=0.03** Student's t, **p=0.03**
Below MDA P	Wilcoxon, p=0.10 Student's t, p=0.10	Wilcoxon, p=0.27 Student's t, p=0.28	---
	Growth		

Table 5.7-1
Data Summaries of Detected Values for MDA P Site Soils and Cañon de Valle Overbank Soils

	Min.	1st Qtr.	Median	Mean	3rd Qtr.	Max.	Detects
MDA P Site Soils							
Barium	18.7	120	200.5	538.7	503	6630	70
RDX	0.069	0.2625	0.73	3.176	2.125	37	36
Aluminum	2630	5542	7305	7926	9750	19900	70
Cadmium	0.04	0.0665	0.087	0.1545	0.12	1.4	23
Cobalt	0.69	2.125	3.35	3.954	4.075	44.7	70
Copper	0.68	3.9	5.1	7.373	8.275	36.8	70
HMX	0.118	0.5725	1.05	2.828	2.425	16	32
Lead	3.8	8.325	10.45	12.18	13.87	61.5	70
Manganese	30.9	179	225	257.6	298.8	1290	70
Silver	0.099	0.165	0.73	2.146	1.5	15.8	15
Vanadium	2.9	8.3	12.2	12.89	15.3	29.3	69
Cañon de Valle Overbank Soils							
Barium	184	4430	5620	9264	9575	37300	30
RDX	0.16	0.32	0.49	0.8833	0.72	5.5	21
Aluminum	3030	4312	5370	5316	6332	8880	30
Cadmium	0.06	0.085	0.22	0.309	0.4075	1.1	10
Cobalt	1.50	4.175	5.30	6.703	7.3	17.5	30
Copper	3.30	14.3	24.55	26.53	29.4	139	30
HMX	0.19	0.8	1.60	16.47	12	290	27
Lead	7.60	28.18	36.30	35.59	44.50	65.9	30
Manganese	75.2	278.8	341	341	378.50	980	30
Silver	0.63	2.675	3.60	5.478	8.050	14.9	28
Vanadium	8.90	11.98	14.3	14.35	15.7	21.2	30

Table 5.7-2
Statistical Comparisons of Cañon de Valle COPECs to MDA P Site Soils

COPEC	Gehan Test p-value	Quantile Test p-value
Aluminum	0.000049	0.0021
Barium	1.0	1.0
Cadmium	*	0.033
Cobalt	1.0	1.0
Copper	1.0	1.0
HMX	*	1.0
Lead	1.0	1.0
Manganese	1.0	1.0
RDX	*	1.0
Silver	*	1.0
Vanadium	1.0	0.99

*Insufficient number of detects for the statistical test.

Figures

LIST OF FIGURES & PHOTOS

Photograph 2.7-1. Post-excavation condition of MDA P Site, before stabilization and reseeding, 2001

Photograph 2.7-2. Condition of the MDA P Site, October 2002

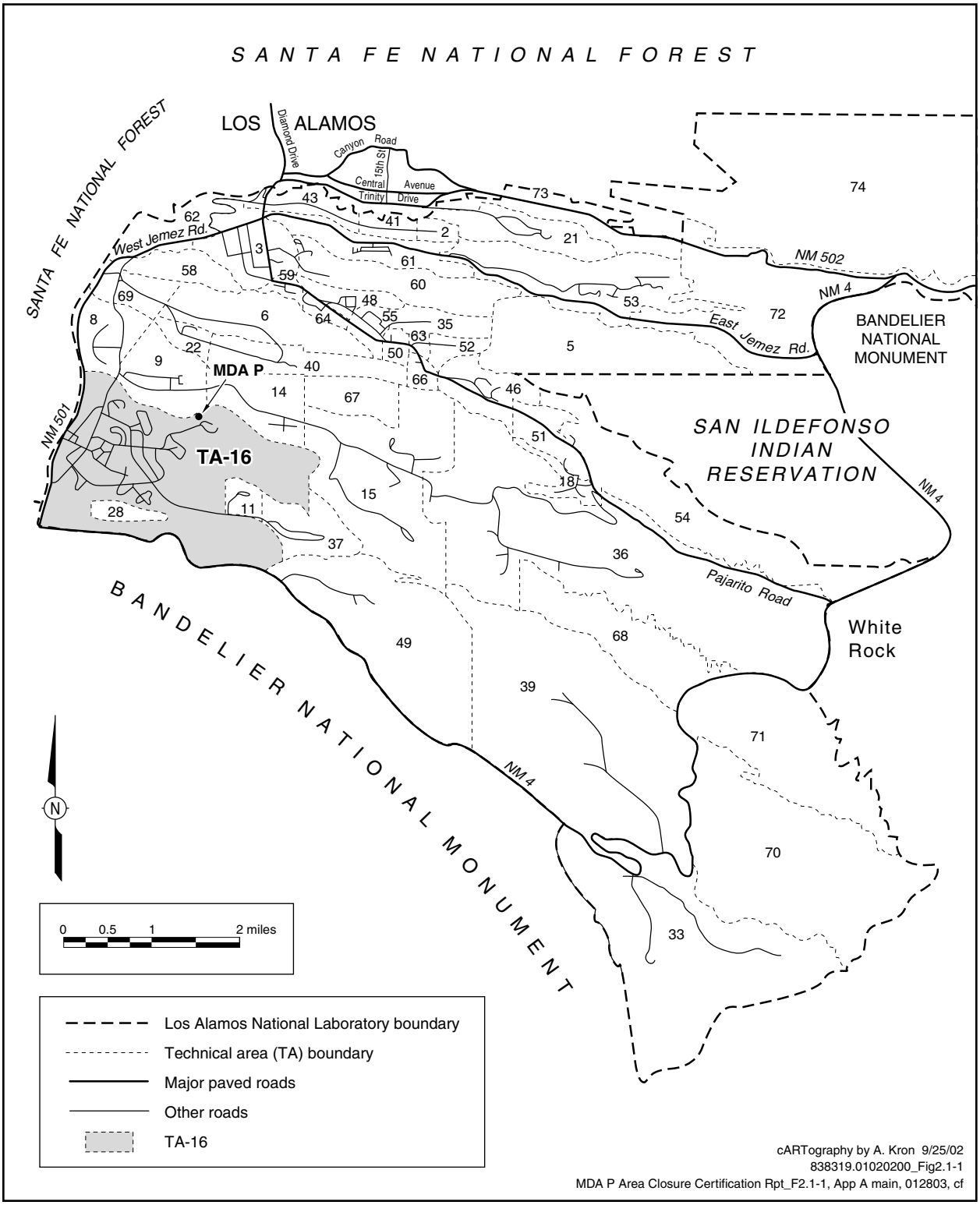


Figure 2.1-1 General Location of TA-16 and the MDA P Site

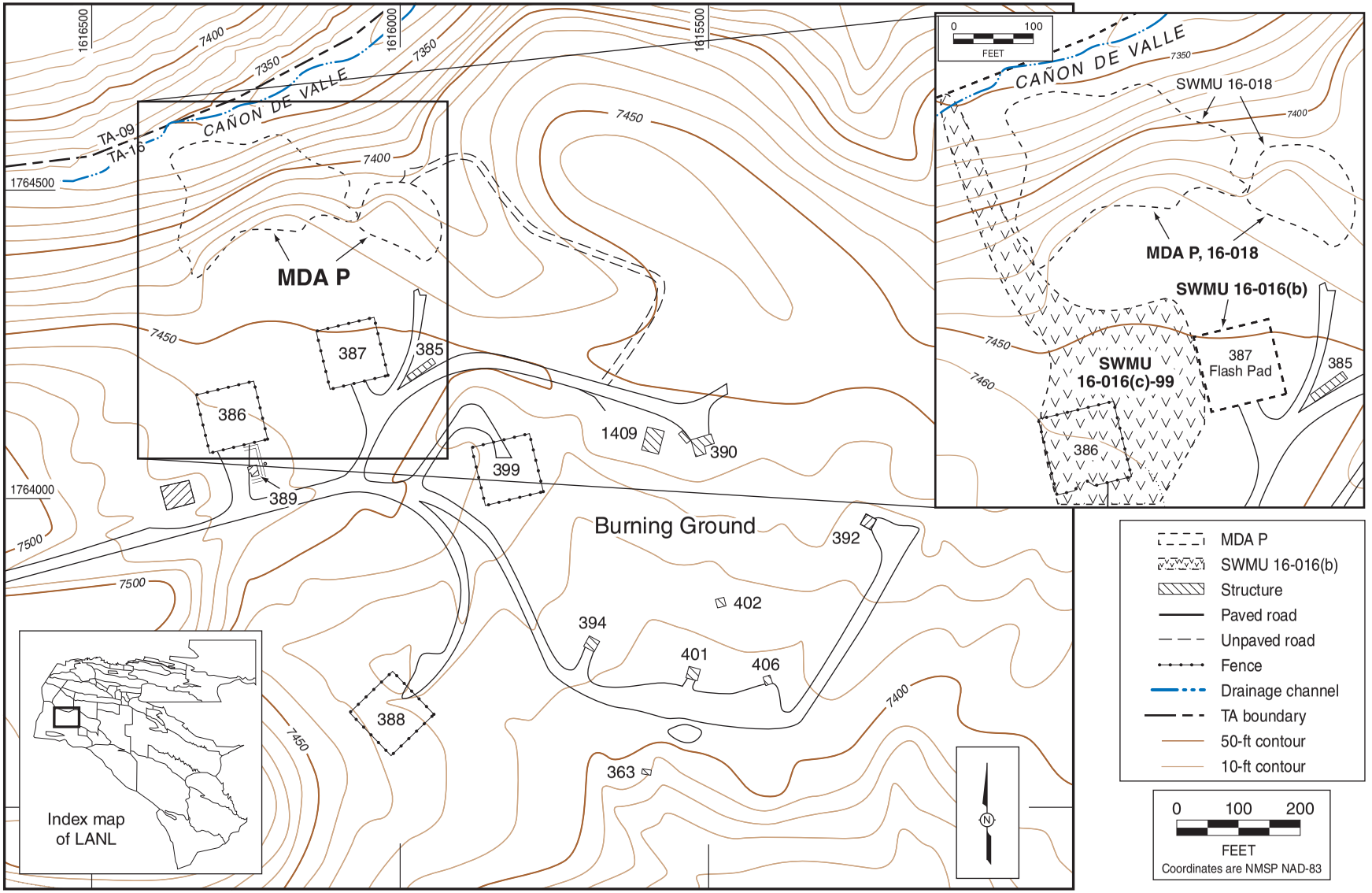


Figure 2.1-2. Individual SWMUs at the MDA P Site proir to excavation

Figure 5.2.1-1. Down-canyon Profile of
Barium Concentrations for the Overbank Soils

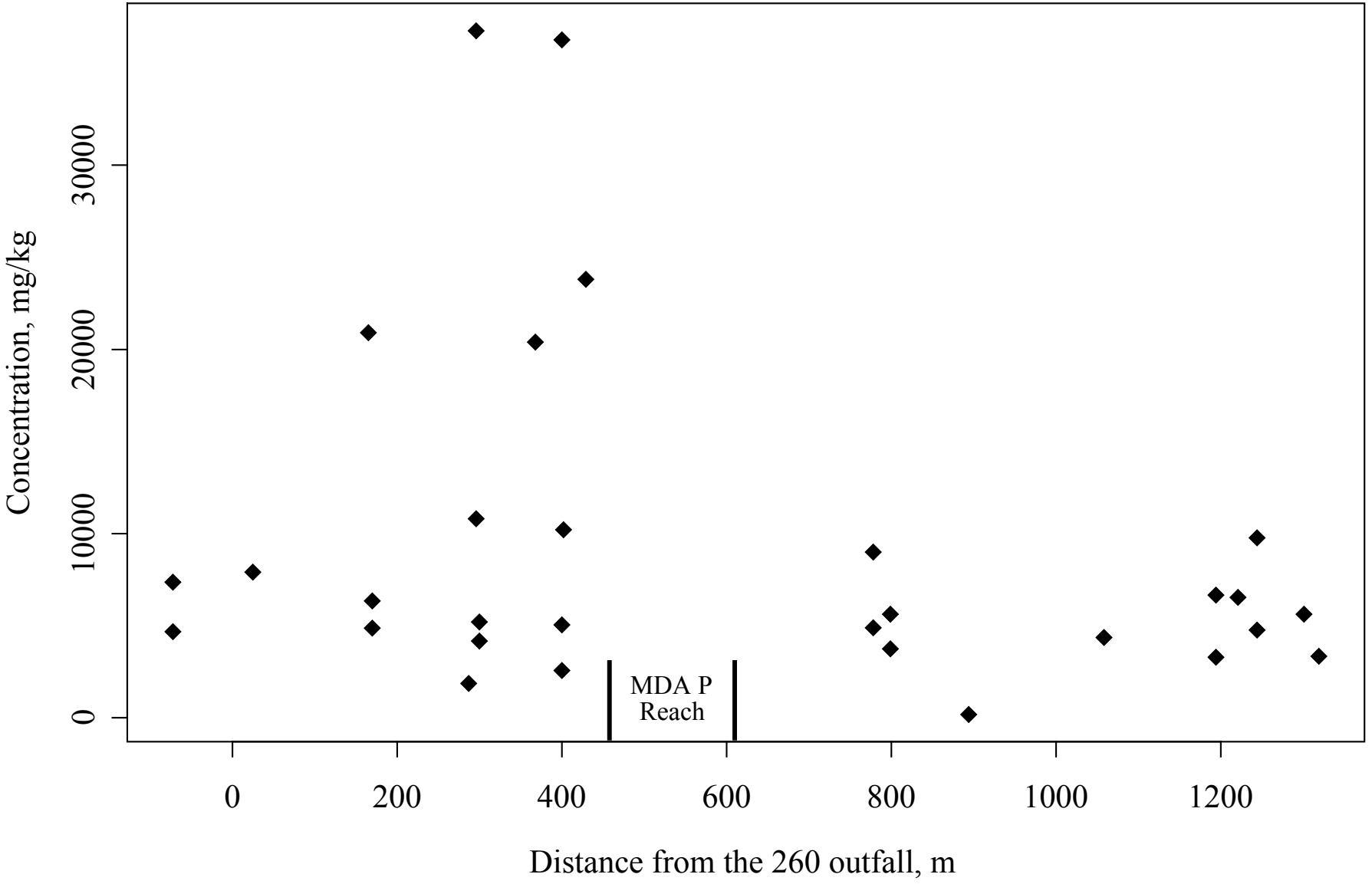


Figure 5.2.1-2. Down-canyon Profile of
Barium Concentrations for the Active Channel Sediments

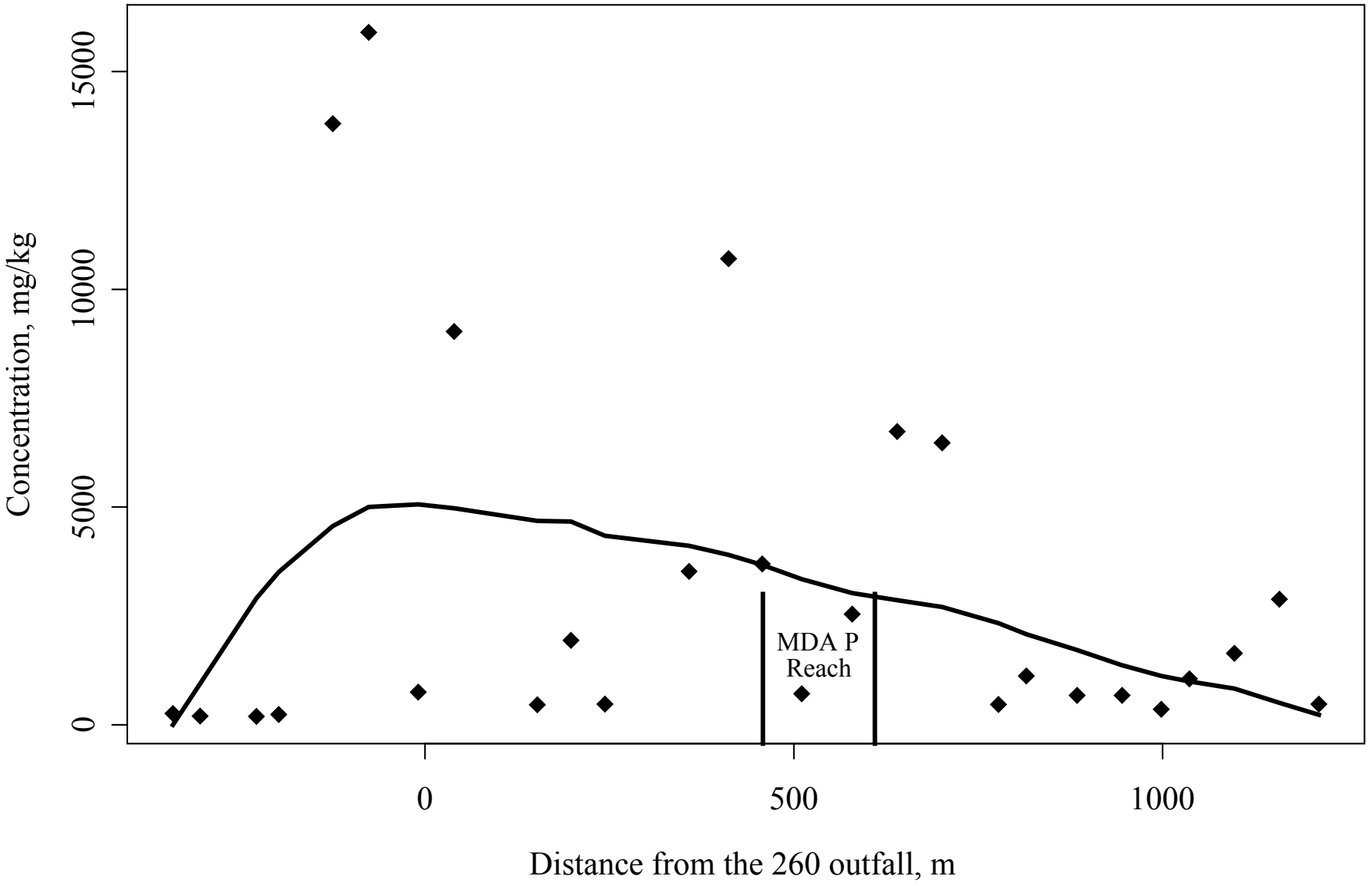


Figure 5.2.2-1

COPEC Concentrations by Geomorphic Feature

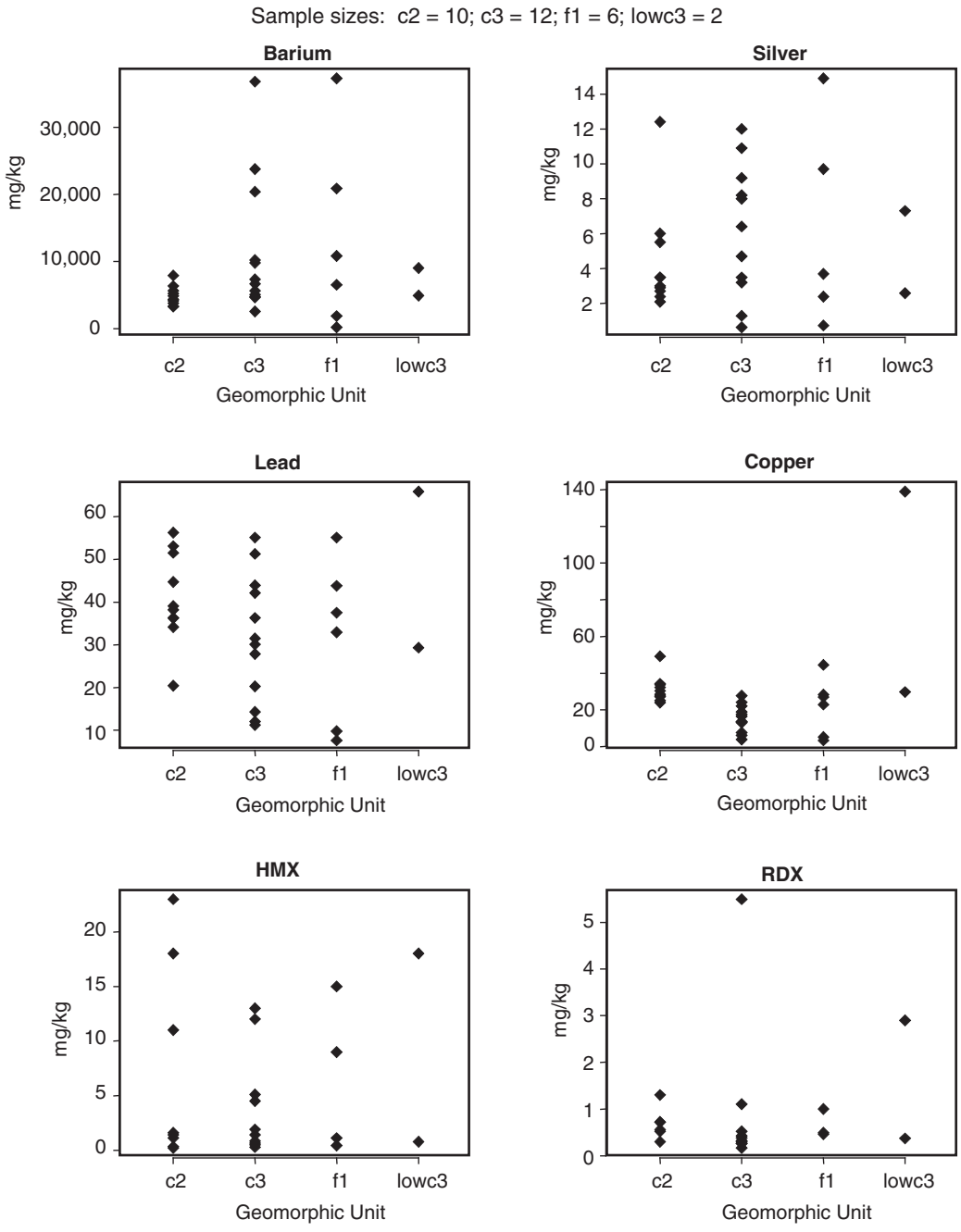


Figure 5.5.1-1

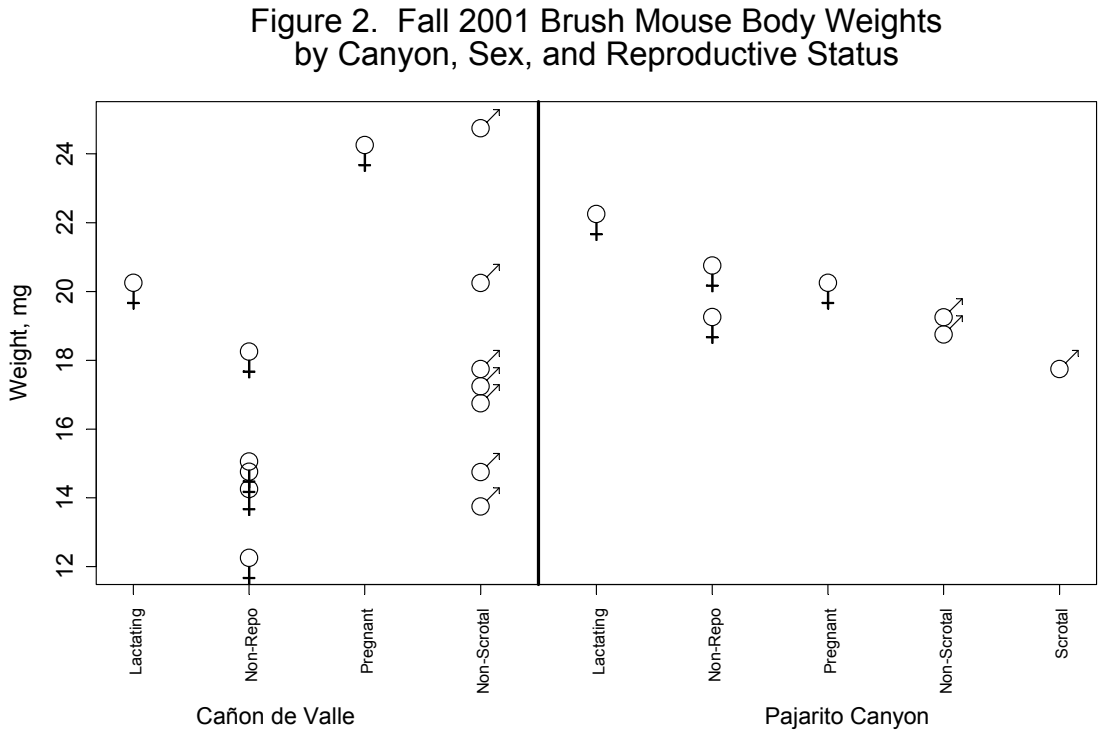


Figure 2. Fall 2001 Brush Mouse Body Weights
by Canyon, Sex, and Reproductive Status
Weight, mg
12
14
16
18
20
22
24
Lactating
Non-Repo
Pregnant
Non-Scrotal
Lactating
Non-Repo
Pregnant
Non-Scrotal
Scrotal
Cañon de Valle
Pajarito Canyon

Figure 5.5.1-2

Figure 3. Deer Mouse Contaminant Body Burdens
Numbers above data groups are detects (solid symbol)
and nondetects (open symbol)

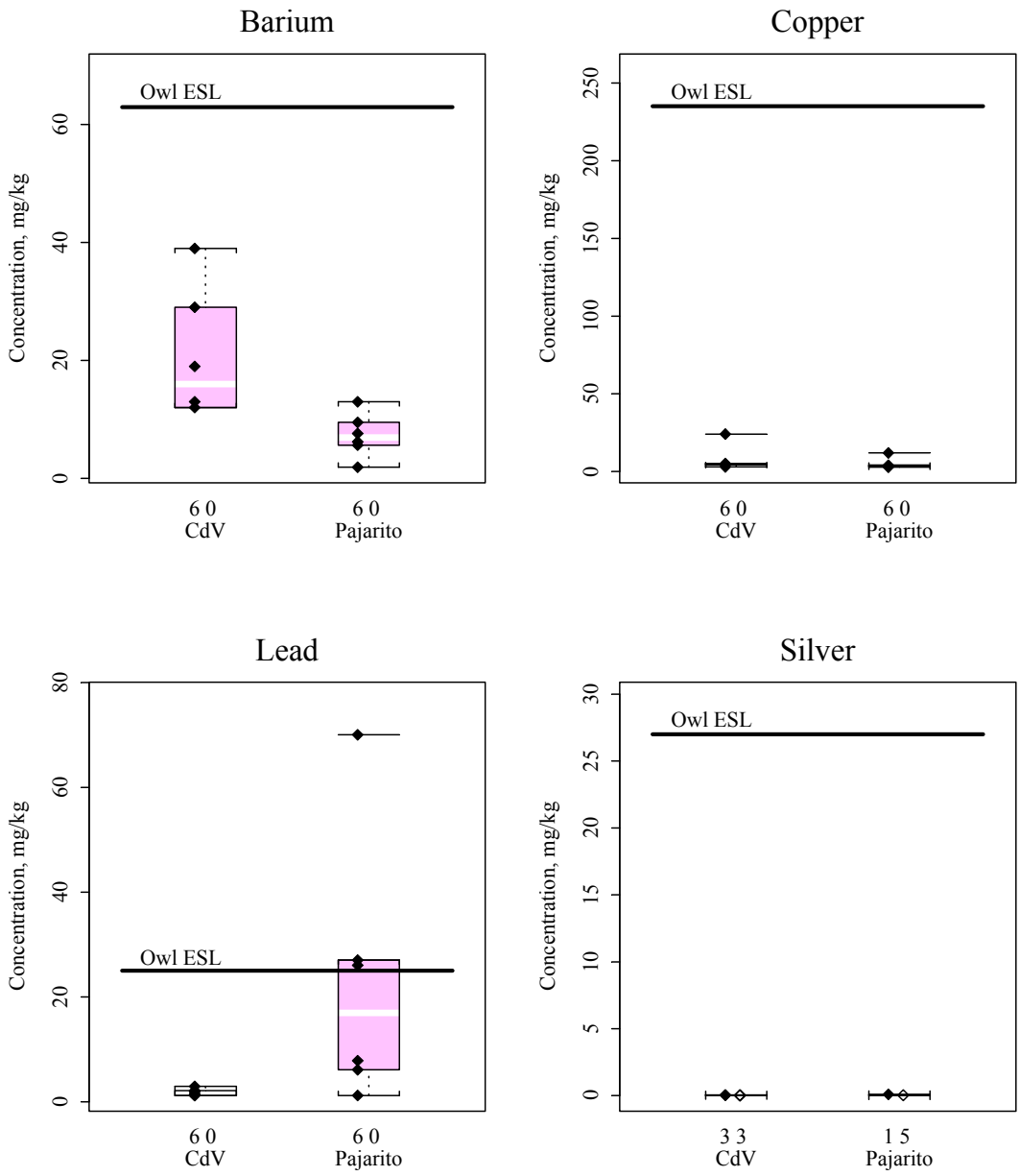
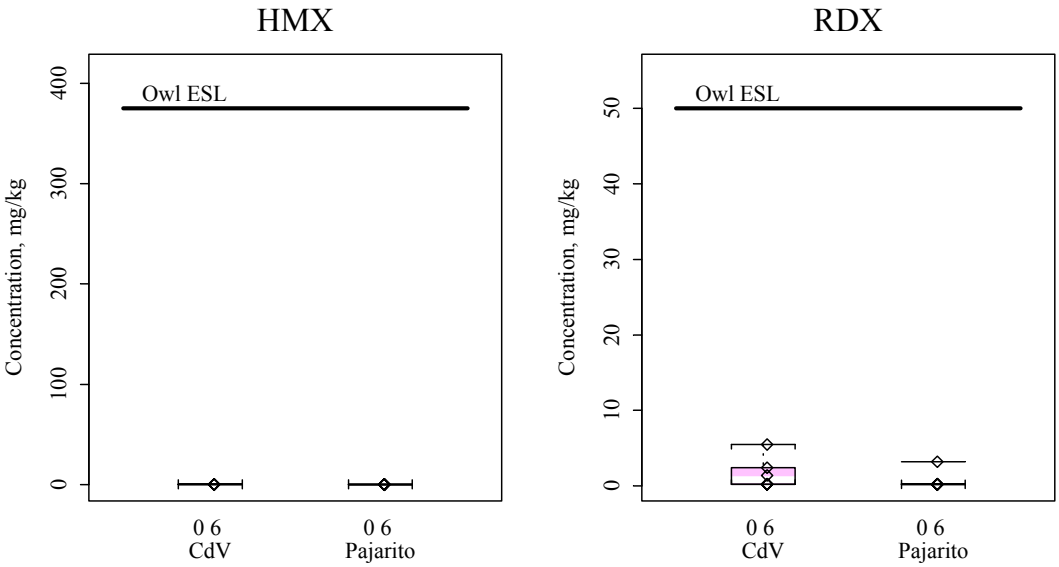


Figure 5.5.1-2 (continued)

Figure 3. Deer Mouse Contaminant Body Burdens
Numbers above data groups are detects (solid symbol)
and nondetects (open symbol)



Appendix B

Confirmation Sample Database

B-1.0 SUMMARY OF PHASE II CONFIRMATION SAMPLING

This appendix summarizes the analytical results obtained from the Phase II confirmation sampling at the MDA P Site. This summary includes a description of the analytical methods used to assess potential residual contamination at the MDA P Site, including the number of samples collected for chemical analysis, the data validation procedures used during the data quality assessment, and the associated qualifiers assigned to the analytical results. Because of the large number of MDA P Site Phase II confirmation samples, validation results and qualifiers are not provided for individual samples.

Table B-1.0-1 presents the analytical suites and total number of samples taken during this investigation, as committed to in the closure plan modification in May 2002 (LANL 2002, 73159). Table B-1.0-2 presents the confirmation samples, by analytical suites, collected for the boreholes. There are differences between the sampling indicated in Table 4-2 of the May 2002 modification and the final sampling as of January 2003. These differences represent slight discrepancies in Table 4-2 (less than 6% of the total samples collected for any given analyte group due to counting inaccuracies) and changes in sampling due to the additional excavation performed in September 2001 which were not captured in Table 4-2 of the May 2002 modification. Twelve samples were removed from the Phase II sample database because the locations from which these samples were collected were later excavated.

Table B-1.0-1

MDA P Site Phase II Confirmation Sample Summary: Analytical Suites and Total Number of Samples in Soil and Tuff

Analyte Type	Total Samples Reported in May 2002 Closure Plan Modification[a]	Actual Total Samples[a] (as of May 2002)	Final Total Soil and Tuff Samples[a] (as of January 2003)	Total Duplicates Reported in May 2002 Closure Plan Modification	Actual Total Duplicates (as of May 2002)	Final Total Duplicates (as of January 2003)
TAL metals	311	309	290	34	32	29
Hexavalent chromium	311	309	290	34	32	29
Mercury	311	309	290	34	32	29
Perchlorate	60	60	61	10	10	9
Reactive cyanide	5	7	3	0	0	0
Reactive sulfide	5	7	7	0	0	0
Total cyanide	5	7	3	0	0	0
Dioxins/furans	5	7	7	0	0	0
Herbicides (chlorinated)	5	7	10	0	0	0
HE	313	317	291	34	32	29
PCBs	5	7	7	0	0	0
Pesticides (organochlorine)	5	7	7	0	0	0
SVOCs	313	295	276	34	32	29
VOCs	23[b]	13	12[c]	1	0	1
Gamma spectroscopy	5	7	7	0	0	0
Gross alpha/ gross beta	5	0	0	0	0	0

Table B-1.0-1 (continued)

MDA P Site Phase II Confirmation Sample Summary: Analytical Suites and Total Number of Samples in Soil and Tuff

Analyte Type	Total Samples Reported in May 2002 Closure Plan Modification[a]	Actual Total Samples[a] (as of May 2002)	Final Total Soil and Tuff Samples[a] (as of January 2003)	Total Duplicates Reported in May 2002 Closure Plan Modification	Actual Total Duplicates (as of May 2002)	Final Total Duplicates (as of January 2003)
Isotopic uranium	7	7	7	0	0	0
Asbestos	5	7	7	0	0	0
pH	5	7	7	0	0	0

[a] Total of confirmation samples used in risk analysis: soil and tuff samples, borehole core samples, and baseline samples.

[b] Includes 10 borehole VOC vapor samples.

[c] Includes 7 borehole VOC vapor samples.

Table B-1.0-2

MDA P Site Phase II Borehole Sample Summary: Analytical Suites and Total Number of Samples

Analyte Type	Total Borehole Samples Reported in May 2002 Closure Plan Modification	Final Total Borehole Samples (as of January 2003)
TAL metals	12	38
Hexavalent chromium	12	38
Mercury	12	38
Perchlorate	8	16
HE	12	39
SVOCs	8	24
VOCs	10[a]	12[b]

[a] VOCs referred to in May 2002 closure plan modification were for VOCs as vapors only and included two QA/QC samples.

[b] Includes samples for VOCs collected from borehole cores (5) and VOCs as vapors (7).

B-2.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance (QA)/quality control (QC) and data validation procedures were implemented in accordance with the requirements of the QA project plan (LANL 1996, 54609), and the analytical services statement of work (SOW) for contract laboratories (LANL 2000, 71233). The results of the QA/QC activities were used to estimate the accuracy, bias, and precision of the analytical measurements. QC samples, including field duplicates, method blanks, blank spikes, matrix spikes, and laboratory control samples (LCSs), were used to assess accuracy and bias. Internal standards, external standards, surrogates, and tracers were used to assess accuracy. The type and frequency of QC analyses are described in the analytical services SOW (LANL 2000, 71233). Other QC factors such as sample preservation and holding times were also assessed. Requirements for sample preservation and holding times are given in the ER Project standard operating procedure (SOP) LANL-ER-SOP-1.02, Rev. 0, “Sample Containers and Preservation.” Evaluating these QC indicators allows estimates of the accuracy, bias, and precision of the analytical suites. Data entry into the final confirmation sample database that was used for the assessment of risk and for the closure certification of the MDA P Site followed the procedures outlined in the ER Project desk

instruction (DI) LANL-ER-DI-4.28, Rev. 0, Quality Assurance Checklist for Preparation of Data Sets from the ER Project Technical Database.

LCSs, method blanks, matrix spike samples, field duplicate samples, interference check samples, and serial dilution samples were used to assess the accuracy and precision of inorganic and organic chemical analyses. Each of these QA/QC sample types is defined in the ER Project analytical services SOW (LANL 2000, 71233) and described briefly below.

LCSs are used to monitor the overall performance of each step during the analysis, including sample digestion. Analytical results for the samples were qualified if individual LCS recoveries were outside the 75–125% range specified in the national functional guidelines (NFGs) (EPA 1994, 48639). According to NFGs, results less than five times the method blank result are qualified as not detected (U).

The accuracy of chemical analyses is also assessed with matrix spike samples. A matrix spike sample is designed to provide information about the effect of each sample matrix on the sample preparation procedures and analytical technique. The spike sample recoveries should be within the acceptance criteria range of 75–125%, according to LANL-ER-SOP-15.05, Routine Validation of Inorganic Data.

Analyzing field duplicate samples assesses the precision of inorganic chemical analyses. All relative percent differences (RPDs) between the sample and the field duplicate should be ±35%, according to LANL-ER-SOP-15.05, and in accordance with the MDA P SAP (LANL 1999, 63546).

The data review determined that the data are of good quality and are sufficient for validating the demonstration of clean closure.

B-3.0 INORGANIC CHEMICAL ANALYSES

A total of 319 samples were collected and analyzed for TAL metals during the MDA P Site Phase II confirmation sampling. The inorganic analysis methods for this data set are provided with the data in the database that can be found on the CD at the front of this report. The qualifiers that were assigned to inorganic analytes based on data validation are defined in Table B-7.0-1.

B-4.0 ORGANIC CHEMICAL ANALYSES

A total of 320 samples were collected for organic chemical analyses during the MDA P Site Phase II confirmation sampling. These samples were analyzed for HE (320 samples), SVOCs (305 samples), VOCs (12 samples), dioxins/furans (7 samples), herbicides (7 samples), PCBs (7 samples), and pesticides (7 samples) (Table B-1.0-1). Data validation was performed to ensure that all QC procedures were followed, as required by the ER Project analytical services SOW (LANL 1995, 49738). The qualifiers that were assigned to organic analytes based on the data validation are defined in Table B-7.0-1. One trip blank sample was submitted for VOC analysis with each sample shipment.

B-5.0 RADIOCHEMICAL ANALYSES

A total of seven samples were analyzed for radionuclides using the methods provided with the data in the database that can be found on the CD at the front of this report.

Radionuclides with reported values lower than the minimum detectable activity were qualified as nondetected (U). In addition, each radionuclide result was compared with the corresponding 1-sigma total propagated uncertainty (TPU). If the result was not greater than three times TPU, it was qualified as nondetected (U).

The precision and bias of the radiochemical analyses performed at off-site fixed laboratories were assessed using matrix spike samples, LCSs, method blanks, duplicates, and tracers. The ER Project analytical services SOW specifies that spike sample recoveries should be within ±25% of the certified value (LANL 2000, 71233). LCSs were analyzed to assess the accuracy of radionuclide analyses. The LCSs were used to monitor the overall performance of each step during the analysis, including the radiochemical separation preparation. The ER Project analytical services SOW specifies that LCS recoveries should be within ±25% of the certified value. Method blanks were also used to assess bias. The ER Project analytical services SOW specifies that the method blank concentration should not exceed the required EQL.

Data validation was performed to ensure that all QC procedures were followed as required by the ER Project analytical services SOW. The qualifiers that were assigned to radiochemical analytes based on data validation are defined in Table B-7.0-1.

B-6.0 BOREHOLE SAMPLING

Five boreholes were sampled for TAL metals, hexavalent chromium, mercury, perchlorate, HE, SVOCs, and VOCs (Table B-1.0-2). Borehole 273 was drilled primarily for geologic logging; however, analytical data derived from the sampling of Borehole 273 (0 to 5 ft) were included in the risk analysis. A VOC vapor analysis was also conducted in the boreholes. The borehole sampling was conducted to assess the potential vertical migration of chemicals at the MDA P Site. The details of the borehole sampling are provided in section 2.3.5.2 of the closure certification report.

B-7.0 DATA VALIDATION QUALIFIERS

The data qualifiers that were applied during data validation are defined in Table B-7.0-1.

Table B-7.0-1
Data Qualifiers Used in the Data Validation Procedure

Qualifier	Explanation
U	The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.
J	The reported value should be regarded as estimated.
J+	The reported value should be regarded as estimated and biased high.
J-	The reported value should be regarded as estimated and biased low.
UJ	The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit.
R	The sample results were rejected because of serious deficiencies in the ability to analyze the sample and meet quality control criteria; presence or absence cannot be verified.

B-8.0 CONFIRMATION SAMPLE DATABASE

Complete analytical results from the Phase II confirmation sampling of the MDA P Site are provided in this subsection and in Microsoft Access format on the CD attached to the front of this report. Some copies of this report contain a hard copy and a CD version of the analytical results; others contain only the CD version. (Because of its length, the hard copy has been inserted into a separate binder—see Volume 2 of 2). The Access database can be queried on any field. Descriptions of each field in the database, including abbreviations, are provided in Table B-8.0-1.

Within the hard copy are three tables: Table B-8.0-2, which contains the results of all soil and tuff sampled as part of confirmation; Table B-8.0-3, which contains the results of tuff samples collected from the five boreholes (273, 516, 526, 554, and 557); and Table B-8.0-4, which contains the results of VOC vapor sam-

pling in Boreholes 526, 554, and 557. On the CD are two Microsoft Excel files. The file titled ER2003_0643_App_B_SOLID.xls contains the information found in both Table B-8.0-2 and Table B-8.0-3, whose contents are described above. The file titled ER2003_0643_App_B_GAS.xls corresponds to Table B-8.0-4, whose contents are described above.

Samples are identified by a unique location identification (ID) number and a unique sample ID number. The nomenclature for the location ID is as follows, using 16-20624 as an example: *16* refers to TA-16, and *20624* functions as a unique identifier given to a sample at the time of sample collection. The nomenclature for the sample ID is as follows, using 0816-01-0322 as an example: *0816* refers to TA-16, *01* indicates the year in which the sample was collected (in this case, 2001), and *0322* indicates that the sample was collected in Grid Number 0322. Samples collected in 2002 after the discovery and removal of additional debris have sample IDs as follows, using RE16-02-45436 as an example: *RE16* refers to TA-16, *02* indicates the year in which the sample was collected (in this case, 2002), and the final three digits of *45436* indicate that the sample was collected in Grid Number 436.

Table B-8.0-1
Description of Phase II Confirmation Sample Database Fields

Field Name	Description
ANALYSIS_DATE	The date (and time, if available) of analysis of this aliquot of the sample, as reported by the analytical laboratory.
ANALYTE_CODE	The code for the analyte, assigned by the Laboratory. In the case of organic compounds, it is the CAS number. In the case of radionuclides, elements, or inorganic compounds, it is the chemical symbol. In the case of non-chemical analytes, it is an abbreviation of the analyte name.
ANALYTE_NAME	The name of the analyte that corresponds to the CAS number, chemical symbol, or property measured. (This field maps to ANALYTE_CODE_DESC in FIMAD.EDD_ANALYTE_CODE_LIST.)
ANALYTICAL_SUITE	The analytical method, as reported by the analytical laboratory, that was used to analyze the sample. This field may include the method source (e.g., SW-846) and method number (e.g., 6010B), or it may include the analytical laboratory's internal standard operating procedure.
ANYL_METH_CODE	The technique used to analyze the sample, as reported by the analytical laboratory.
BEGIN_DEPTH	The top of the depth interval sampled. (This field maps to TOP_DEPTH in DATADM.SAMPLE_DETAIL.)
COLLECTION_DATE	The date and time during which this sample was obtained. (This field maps to START_DATE_TIME in DATADM.SAMPLE_DETAIL.)
COMPOS_TYPE_CODE	A code associated with a valid composite type for a sample. See LUT_COMPOS_TYPE for a list of allowed values.
DEPTH_UNITS	The unit of measure in which the depth is presented. (This field maps to DEPTH_UOM in DATADM.SAMPLE_DETAIL.)
DEPTH	The depth interval in which the sample was taken.
DILUTION_FACTOR	The overall dilution of this sample aliquot, as reported by the analytical laboratory. A value of 1 should correspond to nominal conditions for the method. Values greater than 1 indicate that the sample aliquot was diluted for analysis. Values less than 1 indicate that the sample aliquot was concentrated for analysis.
DLC	Decision level concentration
END_DEPTH	The bottom of the depth interval sampled. (This field maps to BOTTOM_DEPTH in DATADM.SAMPLE_DETAIL.)

Table B-8.0-1
Description of Phase II Confirmation Sample Database Fields

Field Name	Description
EXCAV_FLAG	A flag that indicates whether the environmental medium from which the sample was collected has since been excavated. The possible values are Yes, No, and Null.
FIELD_PREP	The sample preparation that is done in the field prior to sending the sample to an analytical laboratory. See LUT_FLD_PREP for a list of possible values. (This field maps to FLD_PREP_CODE in DATADM.SAMPLE_HDR.)
FIELD_QC_TYPE_CODE	A code associated with a QC sample type submitted by the sampling organization. See LUT_FLD_QC_TYPE for a list of possible values. A NULL value represents a non-QC sample.
FLD_MATRIX_CODE	A code associated with the sample matrix, as perceived by the field person. See LUT_FLD_MATRIX for a list of possible values.
FU4_QUAL	This field indicates the qualifier that was assigned by the analytical laboratory.
IDL	The instrument detection limit.
LAB_CODE	An identifier for the specific analytical laboratory that performed the analysis.
LAB_NAME	The name of the analytical laboratory that performed the sample analysis and provided the analytical data.
LAB_REPORT_NUM	An identifier that is used to link request numbers that are submitted together for analysis.
LAB_QUALIFIER	A string of single-letter result qualifiers assigned by the analytical laboratory, based on defined rules and values.
LANL_QUALIFIER_1	A string of single-letter result qualifiers assigned by the Laboratory, based on defined rules and values. Multiple Laboratory qualifiers may be assigned to one result. See LUT_LANL_QUALIFIER for a list of possible values.
LANL_QUALIFIER_2	A string of single-letter result qualifiers assigned by the Laboratory, based on defined rules and values. Multiple Laboratory qualifiers may be assigned to one result.
LANL_QUALIFIER_3	A string of single-letter result qualifiers assigned by the Laboratory, based on defined rules and values. Multiple Laboratory qualifiers may be assigned to one result.
LANL_QUALIFIER_4	A string of single-letter result qualifiers assigned by the Laboratory, based on defined rules and values. Multiple Laboratory qualifiers may be assigned to one result.
LANL_QUALIFIER_REASON_1	A code that represents the reason for the corresponding Laboratory qualifier, based on defined rules and values. If multiple Laboratory qualifiers are assigned to one result, there will be a corresponding reason code for each qualifier. See LUT_LANL_QUALIFIER_REASON for the descriptions of reason codes.
LANL_QUALIFIER_REASON_2	A code that represents the reason for the corresponding Laboratory qualifier, based on defined rules and values. If multiple Laboratory qualifiers are assigned to one result, there will be a corresponding reason code for each qualifier. See LUT_LANL_QUALIFIER_REASON for the descriptions of reason codes.
LANL_QUALIFIER_REASON_3	A code that represents the reason for the corresponding Laboratory qualifier, based on defined rules and values. If multiple Laboratory qualifiers are assigned to one result, there will be a corresponding reason code for each qualifier. See LUT_LANL_QUALIFIER_REASON for the descriptions of reason codes.
LANL_QUALIFIER_REASON_4	A code that represents the reason for the corresponding Laboratory qualifier, based on defined rules and values. If multiple Laboratory qualifiers are assigned to one result, there will be a corresponding reason code for each qualifier. See LUT_LANL_QUALIFIER_REASON for the descriptions of reason codes.

Table B-8.0-1
Description of Phase II Confirmation Sample Database Fields

Field Name	Description
LANL_SET_TYPE_CODE_1	Validation set type code, indicating the process that was used in the validation.
LANL_SET_TYPE_CODE_2	Validation set type code, indicating the process that was used in the validation.
LANL_SET_TYPE_CODE_3	Validation set type code, indicating the process that was used in the validation.
LANL_SET_TYPE_CODE_4	Validation set type code, indicating the process that was used in the validation.
LOCATION_ID	A unique identification number assigned to a specific location which may have corresponding *x* and *y* coordinates. The format is represented by TA-*NNNNN*. (This field maps to LOCATION_NAME in DATADM.LOCATION_HDR.)
MATRIX	A description of the sample matrix, as reported by the analytical laboratory.
MDA	The method detection activity.
MDL	The method detection limit.
MEDIA_CODE	An alias for EVAL_CLASS_CODE, indicating the environmental media that will be compared to background.
PERCENT_MOISTURE	The percentage of a sample that is composed of water, as reported by the analytical laboratory. The percentage of moisture may be listed in this field or it may be listed as an individual analyte with the result listed in the SAMPLE_VALUE field.
RFI_REASON_CODE	A code that identifies the reason a qualifier was assigned to an analytical result.
SAMPLE_ID	A unique sample identifier assigned by Laboratory specification. The SAMPLE_ID format varies, depending upon the Laboratory sampling organization that was responsible for collecting the sample.
SAMPLE_TECH_CODE	A code associated with the sample analytical method, as reported by the analytical laboratory.
SAMPLE_TYPE_CODE	A code associated with the type of sample for which analytical results are being provided, as reported by the analytical laboratory.
SAMPLE_USG_CODE	A code that indicates the purpose for which a sample was obtained and analyzed. See LUT_SAMPLE_USG for a list of codes.
SAMPLE_VALUE	The reportable result for the analyte, as received from the analytical laboratory. (This field maps to RESULT in FIMAD.ANYL.)
SEQ_NUM	A unique sequence number that provides a primary key to the FIMAD.ANYL database table.
SHIPPING_DATE	The date the sample was shipped to the analytical laboratory.
STD_REPORTING_UNITS	The standard unit of measure assigned by the Laboratory, calculated from an algorithm chosen by the apparent appropriateness of the unit for the matrix and analyte for the record.
PRS	The acronym for potential release site; a spatial and/or regulatory definition for a potentially contaminated area.
PRS_ORDER	Sorting field for PRS.
QUANT_LMT	The quantitation limit.
REQUEST_NUM	An identifier, assigned by the Laboratory, used to designate a group of samples that were submitted to the analytical laboratory for analysis at the same time.
RFI_CLASS	An identifier, assigned by the Laboratory, used for gross grouping of analytical data by RAD, ORGANIC, and INORGANIC.
STD_SAMPLE_VALUE	A value that is obtained by the Laboratory performing calculations on the result reported by the analytical laboratory to convert the value from the reporting units to standardized units, to allow comparison between analytical records using a standard unit of measure. (This field maps to STD_RESULT in FIMAD.ANYL.)

Table B-8.0-1

Description of Phase II Confirmation Sample Database Fields

Field Name	Description
STD_UNCERTAINTY	A value that is obtained by the Laboratory performing calculations on the uncertainty reported by the analytical laboratory to convert the value from the reporting units to standardized units, to allow comparison between analytical records using a standard unit of measure.
TEXT_RESULT	Free text comments about an analytical result, provided by the analytical laboratory.
UNCERTAINTY	The uncertainty associated with a sample value, as reported by the analytical laboratory. For radionuclide results received since April 1995, the uncertainty value is the 1-sigma TPU associated with the measurement.
URI	A sequence number which provides a primary key for the table.

Appendix C

Site Photographs

The following pages contain thumbnails of site-related photographs. The same images can be viewed, with captions, on the CD included at the front of this report. Using a web browser, choose Open from the File menu and select the file named `Photos.htm` from the `ER2003_0643_App_C` folder on tthe CD.

MDAP 1965-12-31

MDAP 1966-12-31

MDAP 1966-12-31a

MDAP 1987-12-31

MDAP 1996-01-31

MDAP 1996-01-31a

MDAP 1996-01-31b

MDAP 1996-03-01

MDAP 1996-08-09

MDAP 1996-08-16

MDAP 1996-08-16a

MDAP 1996-08-27

MDAP 1996-08-30

MDAP 1996-08-30a

MDAP 1996-09-16

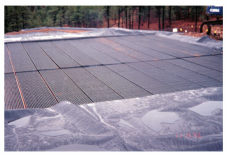
MDAP 1996-09-16a

MDAP 1996-09-23

MDAP 1996-10-16

MDAP 1996-10-30

MDAP 1996-10-30a



MDAP 1996-11-15

MDAP 1997-09-16

MDAP 1997-09-16a

MDAP 1997-09-28

MDAP 1997-11

MDAP 1997-11-19

MDAP 1997-11-21

MDAP 1997-11a

MDAP 1998-08-18

MDAP 1998-08-18a

MDAP 1998-10-01

MDAP 1998-11-13

MDAP 1998-11-13a

MDAP 1998-11-13b

MDAP 1998-11-13c

MDAP 1998-11-13d

MDAP 1998-11-13e

MDAP 1998-11-13f

MDAP 1998-11-13g

MDAP 1998-12

MDAP 1998-12-03

MDAP 1998-12-03a

MDAP 1998-12-17

MDAP 1998-12-17a

MDAP 1999-03-17

MDAP 1999-03-17a

MDAP 1999-03-24

MDAP 1999-03-30

MDAP 1999-03-31

MDAP 1999-03-31a

MDAP 1999-04

MDAP 1999-04-29

MDAP 1999-04-30

MDAP 1999-04-30a

MDAP 1999-04-30b

MDAP 1999-04-30c

MDAP 1999-04-30d

MDAP 1999-04-30e

MDAP 1999-04-30f

MDAP 1999-04-30g

MDAP 1999-04-30h

MDAP 1999-04-30i

MDAP 1999-04-30j

MDAP 1999-04a

MDAP 1999-06-01

MDAP 1999-06-01a

MDAP 1999-06-03

MDAP 1999-06-14

MDAP 1999-06-14a

MDAP 1999-06-14b

MDAP 1999-06-14c

MDAP 1999-06-14d

MDAP 1999-08-12

MDAP 1999-08-12a

MDAP 1999-08-13

MDAP 1999-08-13a

MDAP 1999-08-13b

MDAP 1999-08-13c

MDAP 1999-08-16

MDAP 1999-09-01

MDAP 1999-09-01a

MDAP 1999-09-12

MDAP 1999-09-14

MDAP 1999-09-21

MDAP 1999-09-21a

MDAP 1999-10-12

MDAP 1999-11-01

MDAP 1999-11-05

MDAP 1999-11-05a

MDAP 1999-11-22

MDAP 1999-11-28

MDAP 1999-11-29

MDAP 2000-02-02

MDAP 2000-02-13

MDAP 2000-03-31

MDAP 2000-03-31a

MDAP 2000-04-05

MDAP 2000-04-05a

MDAP 2000-04-05b

MDAP 2000-04-05c

MDAP 2000-04-05d

MDAP 2000-04-05e

MDAP 2000-04-05f

MDAP 2000-04-05g

MDAP 2000-05-30

MDAP 2000-05-30a

MDAP 2000-05-30b

MDAP 2000-05-30c

MDAP 2000-05-30d

MDAP 2000-07-10

MDAP 2000-07-10a

MDAP 2000-08-14

MDAP 2000-08-14b

MDAP 2001-04-10

MDAP 2001-04-10a

MDAP 2001-04-10b

MDAP 2001-04-10c

MDAP 2001-05-07

MDAP 2001-05-07a

MDAP 2001-05-07b

MDAP 2001-06-05

MDAP 2001-06-19

MDAP 2001-06-25

MDAP 2001-07-10

MDAP 2001-07-10a

MDAP 2001-07-20

MDAP 2001-07-27

MDAP 2001-07-27a

MDAP 2001-07-27b

MDAP 2001-07-28

MDAP 2001-08-09

MDAP 2001-08-09a

MDAP 2001-08-27

MDAP 2001-08-29

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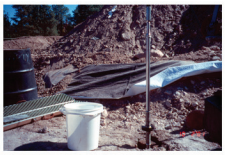
MDAP 2001-08-30

MDAP 2001-09-13

MDAP 2001-09-13a

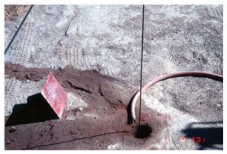
MDAP 2001-09-13b

MDAP 2001-09-28



MDAP 2001-10-02

MDAP 2001-10-03



MDAP 2001-10-03a

The following table pairs the file name of each photograph with its caption.

Photograph File Name	Caption
MDAP 1965-12-31.JPG	Southern view of MDA P, demolition derbies exposed
MDAP 1966-12-31.JPG	Demolition of TA-16 building, resulting debris deposited in MDA P
MDAP 1966-12-31a.JPG	Dump trucks moving debris from TA-16 demolition sites to MDA P
MDAP 1987-12-31.JPG	Aerial view of MDA P, looking south
MDAP 1996-01-31.JPG	Visible debris on north face of MDA P, looking toward west lobe of landfill
MDAP 1996-01-31a.JPG	Visible debris on north face of MDA P
MDAP 1996-01-31b.JPG	Visible debris at bottom of west lobe of MDA P, initial point of removal activities
MDAP 1996-03-01.JPG	Visible debris on north face of MDA P
MDAP 1996-08-09.JPG	Drainage and base of storage pad on east side of MDA P
MDAP 1996-08-16.JPG	MDA P from across Cañon de Valle
MDAP 1996-08-16a.JPG	Temporary storage of MDA P debris; material has been washed, characterized, and moved to 90s Line storage site
MDAP 1996-08-27.JPG	Southern view of MDA P debris from across Cañon de Valle
MDAP 1996-08-30.JPG	MDA P from across Cañon de Valle
MDAP 1996-08-30a.JPG	North face of MDA P; boundary of east and west lobes visible
MDAP 1996-09-16.JPG	MDA P from across Cañon de Valle; beginning of site preparation; storage connex visible in background
MDAP 1996-09-16a.JPG	MDA P from across Cañon de Valle; beginning of site preparation; storage connex visible in background
MDAP 1996-09-23.JPG	MDA P from across Cañon de Valle; beginning of site preparation; storage connex visible in background
MDAP 1996-10-16.JPG	MDA P from across Cañon de Valle, looking southeast
MDAP 1996-10-30.JPG	MDA P from across Cañon de Valle, looking southeast, winter
MDAP 1996-10-30a.JPG	MDA P from across Cañon de Valle, looking southeast, winter
MDAP 1996-11-15.JPG	Construction of MDA P decontamination pad; 2 x 8 redwood boards support grates
MDAP 1997-09-16.JPG	Construction of runoff catch trench at base of east lobe, MDA P
MDAP 1997-09-16a.JPG	Construction of runoff catch trench at base of east lobe, MDA P
MDAP 1997-09-28.JPG	Construction of runoff catch trench at base of east lobe, MDA P
MDAP 1997-11.JPG	Excavation of initial characterization trenches at west lobe, MDA P
MDAP 1997-11-19.JPG	Using field instrumentation to characterize test trenches at west lobe, MDA P
MDAP 1997-11-21.JPG	Excavator used for initial test trenches located at west lobe, MDA P
MDAP 1997-11a.JPG	Demolition debris at base of MDA P
MDAP 1998-08-18.JPG	Remote excavation system and lead robotics engineer
MDAP 1998-08-18a.JPG	Remote excavation system
MDAP 1998-10-01.JPG	Assembly of material sorting system
MDAP 1998-11-13.JPG	Identification of materials removed from MDA P

Photograph File Name	Caption
MDAP 1998-11-13a.JPG	Initial location of robot excavator control trailer for remote excavation of lower portion of west lobe, MDA P
MDAP 1998-11-13b.JPG	Robot excavator control console
MDAP 1998-11-13c.JPG	Material decontamination operations at MDA P decontamination pad
MDAP 1998-11-13d.JPG	Placement of blast protection barriers
MDAP 1998-11-13e.JPG	Removal of cleaned excavation debris from decontamination pad
MDAP 1998-11-13f.JPG	Personnel blast protection shield
MDAP 1998-11-13g.JPG	Laboratory Hazardous Material Emergency Response Team
MDAP 1998-12.JPG	Excavation of initial characterization trenches at west lobe, MDA P
MDAP 1998-12-03.JPG	Excavation of clean soil at southern boundary of MDA P
MDAP 1998-12-03a.JPG	Excavation debris on decontamination pad
MDAP 1998-12-17.JPG	Material separation equipment in clean soil borrow pit at southern boundary of MDA P
MDAP 1998-12-17a.JPG	Temporary storage of cleaned excavation debris at 90s Line
MDAP 1999-03-17.JPG	Pipe decontamination activities at MDA P
MDAP 1999-03-17a.JPG	Removal of top layer of west lobe, MDA P
MDAP 1999-03-24.JPG	Soil sorting and removal
MDAP 1999-03-30.JPG	Concrete size-reduction activities at 90s Line
MDAP 1999-03-31.JPG	Application of soil cement to temporary stockpile
MDAP 1999-03-31a.JPG	Loading scrap steel for disposal off-site
MDAP 1999-04.JPG	Landfill debris staged at 90s Line temporary storage site
MDAP 1999-04-29.JPG	Landfill debris staged at 90s Line temporary storage site
MDAP 1999-04-30.JPG	Remote excavator staged at east-west lobe boundary
MDAP 1999-04-30a.JPG	Excavation debris being staged on MDA P decontamination pad
MDAP 1999-04-30b.JPG	Transport truck weighing in before trip to Waste Control Specialists disposal site
MDAP 1999-04-30c.JPG	Removal of decontamination pad grates for soil removal
MDAP 1999-04-30d.JPG	Loading soil at west end of MDA P for transport to temporary storage
MDAP 1999-04-30e.JPG	Level C characterization activities
MDAP 1999-04-30f.JPG	MDA P debris decontamination activities
MDAP 1999-04-30g.JPG	Loading cleaned debris for transport to temporary storage
MDAP 1999-04-30h.JPG	Debris cleaning, prior to removal
MDAP 1999-04-30i.JPG	HE soil sorting on the MDA P soil lay-down area
MDAP 1999-04-30j.JPG	HE soil sorting on the MDA P soil lay-down area
MDAP 1999-04a.JPG	Soil staging at 90s Line
MDAP 1999-06-01.JPG	Soil sorting and removal equipment used at MDA P
MDAP 1999-06-01a.JPG	North face of west lobe, MDA P, looking south
MDAP 1999-06-03.JPG	Manual soil staging activities at MDA P
MDAP 1999-06-14.JPG	Barium nitrate chunks found at MDA P
MDAP 1999-06-14a.JPG	West lobe. MDA P, after significant removal activities
MDAP 1999-06-14b.JPG	Example of positive HE test for TNT
MDAP 1999-06-14c.JPG	Soil removal activities at MDA P, looking south
MDAP 1999-06-14d.JPG	North face of MDA P from bottom of Cañon de Valle
MDAP 1999-08-12.JPG	Multiple excavators used to move “safe” material up from and out of MDA P landfill
MDAP 1999-08-12a.JPG	Multiple excavators used to move “safe” material up from and out of MDA P landfill
MDAP 1999-08-13.JPG	Remote excavation system in operation at west lobe of MDA P, looking east
MDAP 1999-08-13a.JPG	Remote excavation system in operation at west lobe of MDA P, looking east
MDAP 1999-08-13b.JPG	Remote excavation system in operation at west lobe of MDA P, looking east

Photograph File Name	Caption
MDAP 1999-08-13c.JPG	Remote excavation system in operation at west lobe of MDA P, looking up from bottom of Cañon de Valle, east
MDAP 1999-08-16.JPG	Remains of multiple trucks found at MDA P
MDAP 1999-09-01.JPG	MDA P site, 50% of west lobe removed
MDAP 1999-09-01a.JPG	North face of MDA P during soil removal activities
MDAP 1999-09-12.JPG	Remains of one of twelve trucks removed from MDA P
MDAP 1999-09-14.JPG	Soil removal activities at west lobe, MDA P
MDAP 1999-09-21.JPG	Large elk herds were abundant around the MDA P site
MDAP 1999-09-21a.JPG	MDA P landfill, much of west lobe removed; material lay-down area and remote excavation systems are visible
MDAP 1999-10-12.JPG	Remote excavator in operation at west lobe, MDA P, looking west
MDAP 1999-11-01.JPG	Concrete pad for material sorting operations, southwest of MDA P
MDAP 1999-11-05.JPG	Remote excavator in operation on the North Face of MDA P
MDAP 1999-11-05a.JPG	Robot excavator control trailer set up for excavation of lower north face, MDA P
MDAP 1999-11-22.JPG	MDA P excavation debris
MDAP 1999-11-28.JPG	MDA P soils staging area
MDAP 1999-11-29.JPG	MDA P decontamination pad
MDAP 2000-02-02.JPG	MDA P, facing west, most of west lobe completed
MDAP 2000-02-13.JPG	Staging trucks to receive soil for transport to Waste Control Specialists
MDAP 2000-03-31.JPG	Placing liners in soil transport trucks at 90s Line
MDAP 2000-03-31a.JPG	Staging trucks to receive soil for transport to Waste Control Specialists
MDAP 2000-04-05.JPG	North face of MDA P, after removal of contaminated material
MDAP 2000-04-05a.JPG	North face of MDA P, after removal of contaminated material
MDAP 2000-04-05b.JPG	North face of MDA P, after removal of contaminated material
MDAP 2000-04-05c.JPG	Soil removal activities at east lobe, MDA P
MDAP 2000-04-05d.JPG	North face of MDA P, after removal of contaminated material
MDAP 2000-04-05e.JPG	North face of MDA P, after removal of contaminated material
MDAP 2000-04-05f.JPG	Excavation of east lobe, MDA P, looking west from robot control room site
MDAP 2000-04-05g.JPG	Overview of MDA P site; excavation of east lobe in progress
MDAP 2000-05-30.JPG	Burn damage from Cerro Grande Fire, east of MDA P
MDAP 2000-05-30a.JPG	Burn damage from Cerro Grande Fire, southwest of MDA P
MDAP 2000-05-30b.JPG	Burn damage from Cerro Grande Fire, along access road to MDA P
MDAP 2000-05-30c.JPG	Burn damage from Cerro Grande Fire, TA-2
MDAP 2000-05-30d.JPG	Temporary soil stockpile at 90s Line
MDAP 2000-07-10.JPG	MDA P after remediation, looking west
MDAP 2000-07-10a.JPG	MDA P after remediation, looking southwest
MDAP 2000-08-14.JPG	Northern view of MDA P across old burn pad, after soil removal
MDAP 2000-08-14b.JPG	Top view of MDA P after remediation, looking north
MDAP 2001-04-10.JPG	West view of lower half of MDA P after remediation
MDAP 2001-04-10a.JPG	East view MDA P after remediation
MDAP 2001-04-10b.JPG	MDA P after remediation
MDAP 2001-04-10c.JPG	MDA P after remediation
MDAP 2001-05-07.JPG	Cerro Grande Fire damage near MDA P
MDAP 2001-05-07a.JPG	Cerro Grande Fire damage near MDA P
MDAP 2001-05-07b.JPG	Cerro Grande Fire damage near MDA P
MDAP 2001-06-05.JPG	Geophysical drill rig in operation at west lobe, MDA P

Photograph File Name	Caption
MDAP 2001-06-19.JPG	Geophysical drill rig in operation at west lobe, MDA P
MDAP 2001-06-25.JPG	Geophysical drill rig in operation at west lobe, MDA P
MDAP 2001-07-10.JPG	Placement of BMPs along north face of MDA P
MDAP 2001-07-10a.JPG	Soil sampling activities along bottom of Cañon de Valle
MDAP 2001-07-20.JPG	Soil sampling activities along bottom of Cañon de Valle
MDAP 2001-07-27.JPG	Core samples in bedrock at MDA P
MDAP 2001-07-27a.JPG	Core sampling crew on west lobe, MDA P
MDAP 2001-07-27b.JPG	Core sampling crew on west lobe, MDA P
MDAP 2001-07-28.JPG	Core sampling crew on west lobe, MDA P
MDAP 2001-08-09.JPG	MDA P hydrologic characterization
MDAP 2001-08-09a.JPG	MDA P hydrologic characterization
MDAP 2001-08-27.JPG	Site reconstruction
MDAP 2001-08-29.JPG	MDA P core samples
MDAP 2001-08-29a.JPG	Retrieval of MDA P core samples
MDAP 2001-08-30.JPG	MDA P geophysical drilling activities
MDAP 2001-09-13.JPG	MDA P hydrologic characterization
MDAP 2001-09-13a.JPG	MDA P hydrologic characterization
MDAP 2001-09-13b.JPG	MDA P soil characterization with an XRF detector
MDAP 2001-09-28.JPG	Temporary soil storage
MDAP 2001-10-02.JPG	Soil sampling activities at MDA P
MDAP 2001-10-03.JPG	Well logging at MDA P
MDAP 2001-10-03a.JPG	MDA P sample hole

Appendix D

Supporting Documentation/Correspondence

This appendix contains copies of correspondence (and related documents) sent between the Laboratory and the New Mexico Environment Department (NMED) related to the closure activities at MDA P and Flash Pad 387 and the cleanup of SWMU 16-016(c)-99. Collectively, these sites are referred to as the "MDA P Site." Each document includes information relevant to one or more decisions that have been made regarding the closure and cleanup activities at the MDA P Site.

All correspondence is included in its entirety, with the exception of the August 10, 2000, letter from the Laboratory to the NMED, which is missing Table 2 and Figure 2.1. The color rows in Table 2 and the large format of Figure 2.1 rendered these portions of the letter unreproducible; however, complete versions of all the documents in this appendix are retained at the Risk Reduction and Environmental Stewardship – Remediation Services Records Processing Facility. The documents are part of the permanent record regarding the MDA P Site closure and cleanup activities.

One of the primary purposes for including this set of supporting documentation and correspondence is to provide a record of closure performance changes and their approvals. Variances to the NMED-approved closures plans for the MDA P Site and Flash Pad 387 have been identified and are summarized in Table D-1. Changes to the Phase I closure implementation activities are summarized in Table D-1, all of which were previously identified in a number of letters and/or Class I Closure Modification requests. All of the Phase I changes to the approved closure plan for MDA P were incorporated into the NMED-approved May 2002 request for closure plan modification (LANL 2002, 73159). Thus, all changes to the Phase I activities are no longer represented as deviations or variances, according to the definition of such changes in the MDA P closure plan (LANL 1995, 58713). Approved changes are divided into the following four categories in the table: changes to the schedule; changes to the estimates of waste types and/or volumes; changes to the sampling plan; and changes to waste management practices, including decontamination, staging, and/or disposal.

- *Closure Plan Schedule.* The schedule for closure implementation was extended to include additional time required for remote handling of the detonable explosives debris at MDA P; delays in excavation due to the Cerro Grande fire; and additional excavation required in the eastern portion of the site, which was discovered during the initial Phase II confirmation sampling.

- *Waste Estimates.* The estimates of waste from the debris excavation and removal activities were revised a number of times, as the Phase I activities progressed.

- *Phase I Sampling.* The procedures for the sampling, as delineated in the SAP (LANL 1999, 63546) were revised as the closure implementation progressed, including the numbers of samples collected for waste characterization and disposition.

- *Waste Management Procedures.* Changes in various waste management procedures included changes promulgated in regulations and/or standards or the interpretation of such regulations and/or standards (e.g., the land treatment disposal standard for barium); sampling of decontamination rinsate water; and other treatment-related issues.

The remainder of this appendix is attached electronically to all copies of the closure certification report (see CD included at the front of this report).

Table D-1
Approved Closure Plan Changes to MDA P Site Closure Activities

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
Changes to the Closure Plan Schedule				
6.1.1.4/6-7	"An amendment to the Closure Plan will be submitted to the NMED whenever a change occurs in the expected year of closure "	"Unanticipated delays have been incurred due to the presence of detonable pieces of HE. It has been determined that closure will exceed the proposed 26 months to complete Phase I and Phase II. Phase I includes removing waste from the waste pile and was estimated to be 17 months from the time the Closure Plan was submitted. This time frame has already passed; therefore a new closure plan schedule has been prepared and submitted to HRMB as a Class I Closure Plan Modification. Per their request, the new closure plan schedule completion date has been extended until September 2001."	Class I closure plan modification to schedule	July 22, 1998, letter[a] March 10, 1999, letter[b] May 7, 1999, letter[c]
6.1.2.1/6-9	"For this project, an extension of the 90-day and 180-day closure time frames will be necessary. Removal of wastes and completion of closure activities will require at least 20 months if a risk assessment is not conducted."			
6.1.2.2/6-9	"If completion of final closure will take longer than 26 months from the time the closure plan is approved, the Laboratory will submit a closure plan amendment "			
6.2.7/ 6-26	"If a risk assessment is necessary but additional waste removal is not required, the total time to complete closure is estimated to be 26 months. This schedule assumes no unanticipated delays."			

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Corres-pondence
Figure 6-2	Estimated Project Schedule with no Risk Assessment.			
6.1.2.1/6-9 & 6-10	Figure 6-2, Estimated Project Schedule (Revision 1.0, May 1999) Start / Finish Begin operations 5/13/96 5/13/96 Preliminary construction 5/13/96 11/27/98 Excavate, decontaminate & sample 11/5/97 4/28/00 Waste treatment (as needed) 7/1/99 4/28/00 Phase II sampling 2/28/00 6/23/00 Final closure report 4/3/00 11/30/00 Reseed/replant vegetation 5/22/00 9/7/01 "For this project, an extension of the 90-day and 180-day closure time frames will be necessary. Removal of wastes and completion of closure activities as described in Sections 6.3.4, 6.2.5, and 6.2.6 will extend until September 2001. This extended time frame is necessary because the Laboratory was unable to meet the original project schedule for waste removal due to safe operating process at the site having to be re-evaluated when detonable pieces of HE were observed during excavation. The extended time frame is also necessary because of the following factors: • the logistics of removing relatively large amounts of waste from a steep incline; • decontaminating waste in an area that is limited in size; and • weather conditions that cannot be predicted with any high degree of accuracy. For these reasons, the Laboratory requests that NMED approve the extended project schedule until September 2001 for final closure. The anticipated closure schedule is presented in Section 6.2.7."	Figure 6-2. Estimated Project Schedule (Revision 2.0, May 2002) Start / Finish Field work 11/5/97 10/31/02 16-006(e) septic tank removal 4/4/02 5/9/02 Eco risk assessment 6/4/02 10/31/02 Final closure report 3/4/02 1/31/03 Site restoration 5/26/04 11/3/04 "For this project, an extension of the 90-day and 180-day closure time frames will be necessary. Removal of wastes and completion of closure activities as described in Sections 6.3.4, 6.2.5, and 6.2.6 will extend until the end of January 2003. This extended time frame is necessary because the Laboratory was unable to meet the original project schedule for waste removal due to safe operating process at the site having to be re-evaluated when detonable pieces of HE were observed during excavation. The extended time frame is also necessary because of the following factors: • The Cerro Grande fire delayed completion of excavation; • The Phase II Sampling and Analysis Plan was submitted in August 1999, supplemental information was submitted on August 10, 2000, and on April 26, 2001, verbal approval was given on May 30, 2001, written approval was given on June 7, 2001, and deviational changes to Phase II sampling and analysis plan were submitted on August 2, 2001; • During Phase II sampling, additional contamination was found and excavated from a small drainage on the eastern edge of the site. For these reasons, the Laboratory requests that NMED approve the extended project schedule until January 2003 for final closure. The anticipated closure schedule is presented in Section 6.2.7."	Class I closure plan modification to schedule	May 13, 2002, letter[d] May 30, 2002, letter[e]

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
6.1.2.2/ 6-9	"As indicated in Figure 6-2, removal of wastes and completion of closure activities will need to be extended until September 2001. If completion of final closure activities will take longer than September 2001, the Laboratory will submit a closure plan amendment in accordance with 265.112(c)."	"As indicated in Figure 6-2, removal of wastes and completion of closure activities will need to be extended until January 2003. If completion of final closure activities will take longer than January 2003, the Laboratory will submit a closure plan amendment in accordance with 265.112(c)."	Class I closure plan modification to schedule	May 13, 2002, letter[d] May 30, 2002, letter[e]
Changes to the Closure Plan Waste Estimates				
1.1.3/ 1-8	"Approximately 30,000 cubic yards (yd^3) of debris will be excavated."	"After the submittal and approval of the original Closure Plan, it was discovered that the southern part of the morphologic feature of MDA P is composed of uncontaminated soils placed during the original construction of the burning grounds. Therefore, a large volume of clean fill that composes the morphologic feature of MDA P will not be removed, but will be sampled during the Phase II verification activities. The new estimated volume is 16,500 cubic yards. This new volume has been reflected as a Class I Closure Plan Modification (May 7, 1999 letter[c])."	Class I closure plan modification of waste estimates	July 22, 1998, letter[a] May 7, 1999, letter[c]
4.1.3.1/ 4-3	"Based on the estimated waste pile volume (30,000 yd^3) ."			
6.2.3/ 6-19	"The MDA P waste pile contains an estimated 30,000 yd^3 of waste and debris."			

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
1.1.3/ 1-8	"To achieve closure, the entire waste pile, including hazardous and non-hazardous waste and soil, will be removed. Approximately 16,500 cubic yards (yd^3) of debris and contaminated media will be excavated."	"To achieve closure, the entire waste pile, including hazardous and non-hazardous waste and soil, will be removed. Approximately 60,000* cubic yards (yd^3) of debris and contaminated media will be excavated. *52,187 cubic yards of media have been excavated and 55,093 cubic yards of waste were submitted for off-site disposal; 21,500 cubic yards of waste were hazardous."	Class I closure plan modification of waste estimates	May 13, 2002, letter[d] May 30, 2002, letter[e]
4.1.3.1/ 4.3	"Based on the estimated volume of the waste-pile volume (16,500 yd^3), a total of approximately 165 composite samples will be collected."	"Based on the estimated volume of the waste-pile and contaminated media 60,000* cubic yards (yd^3), a total of approximately 500 composite samples will be collected. *52,187 cubic yards of media have been excavated and 55,093 cubic yards of waste were submitted for off-site disposal; 21,500 cubic yards of waste were hazardous."		
Table 4-2/ 4-17	Table 4-2, Summary of Samples and Analysis, provides the number of samples based on 16,500 yd^3 of waste.	"Table 4-2, Summary of Samples and Analysis, was revised to provide the number of samples based on 60,000 yd^3 of waste."		
6.2.3/ 6-19	"The MDA P waste pile contains an estimated 16,500 yd^3 of waste and debris. It is anticipated that 500 yd^3 of excavated soil will require treatment. This estimate is based on professional judgment and visual inspection of the waste pile."	"The MDA-P waste pile contains an estimated maximum volume of 60,000 yd^3 of waste, debris, and contaminated media. It is estimated that 21,000 yd^3 of excavated soil will require treatment and disposal as hazardous waste at a permitted, off-site facility."		
Changes to the Closure Plan Sampling				
4.1.3.1/ 4-3	"Based on the estimated waste pile volume (30,000 yd^3), a total of approximately 300 composite samples will be collected."	"The estimated number of soil samples to be collected during Phase I will be proportional to the reduced estimated volume of waste of 16,500 cubic yards (165 composite samples). The new estimated number of soil samples has been reflected as a Class I Closure Plan Modification, submitted with the May 7, 1999, letter[c]. Duplicate, rinsate blank, and matrix spike samples were also adjusted to reflect the new estimate. (See new Table 4-2 replacement page in the May 7, 1999, letter[c])."	Class I closure plan modification to Phase I sampling	July 22, 1998, letter[a] May 7, 1999, letter[c]
Table 4-2	Summary of Samples and Analyses.			

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
6.1.2.2/ 6-9	Not applicable.	"The Phase II Sampling and Analysis Plan was submitted in August 1999, supplemental information was submitted on August 10, 2000, and on April 26, 2001, verbal approval was given on May 30, 2001, written approval was given on June 7, 2001, and deviational changes to Phase II sampling and analysis plan were submitted on August 2, 2001."	Class I Closure plan modification to Include SAP and changes to SAP	May 13, 2002, letter[d] May 30, 2002, letter[e]
SAP - 3.2/30	"Two field split duplicates samples will be collected from the Closure Unit scale. One field split duplicate will be collected from the PRS Cluster scale. One field split duplicate sample will be collected from both the east and west Investigation Areas."	"The quality control samples will be collected at a ratio of 1 to 10 field samples. The locations of the QC samples have been pre-selected to attempt to obtain positive results. The locations are chosen on the basis of existing field screening results obtained after completion of excavation."	Deviational change to SAP	August 1999 SAP[f] August 2, 2001, letter[g]
SAP - 2.2.3.2/22 April 2001 letter – pg. 2	"The Closure Unit strata will be sampled on a 10 x 10 m grid by a discrete grab (soil) or auger (tuff) sample taken from the center of grid cells ." (August 1999 SAP[f])	"The locations of field samples were locally adjusted from grid centers to coincide with drainages and low spots that may have concentrated contaminants."	Deviational change to SAP	August 1999 SAP[f]
	" grid cells identified for "center of the cell" sampling " (April 26, 2001, letter[h])			April 26, 2001, letter[h]
	"If the grid center identified for sampling " (April 26, 2001 letter[h])			August 2, 2001, letter[g]

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Corres-pondence
SAP – 2.2.3.2/25 April 2001 letter – pg. 3	" four boreholes will be drilled in Cañon de Valle between MDA P and the watercourse " (August 1999 SAP[f]) "The fourth borehole in this group will be located at the toe of the former landfill " (April 26, 2001 letter[h])	"The core hole planned for bedrock at the toe of the landfill was not drilled. After excavation, it was apparent that the exposed toe of the landfill consisted of terrace associated with the Cañon de Valle stream bed. This terrace contained cobble and talus rock debris in a sand matrix. The exposed bedrock topography on the lower slopes did not allow the placement of a drill rig."	Deviational change to SAP	August 1999 SAP[f] April 26, 2001, letter[h] August 2, 2001, letter[g]
SAP – 2.2.3.2/25 April 2001 letter – pg. 3	" four boreholes will be drilled in Cañon de Valle between MDA P and the watercourse " (August 1999 SAP[f]) "The fourth borehole in this group will be located at the toe of the former landfill. This boring will be sampled for continuous core to approximately 25 ft depth (elevation approx. 7335 ft msl). The target depth represents the elevation of the stream in Cañon de Valle." (April 26, 2001 letter[h])	"Sampling along the exposed toe of the landfill consisted of four exploratory pits in the terrace materials. Two samples were collected in each pit, one from the near surfaces and one from above the water table. The sampling parameters were consistent with the approved SAP. These samples were collected with the objective to demonstrate that no contaminants migrated from the landfill."	Deviational change to SAP	August 1999 SAP[f] April 26, 2001, letter[h] August 2, 2001, letter[g]
SAP – 2.2.3.2/25 April 2001 letter – pg. 3	" four boreholes will be drilled in Cañon de Valle between MDA P and the watercourse " (August 1999 SAP[f]) "Three boreholes will be located beneath the upper footprint of the landfill area " The three grids with the greatest potential for these conditions are 374, 486, and 489 beneath the western, middle, and eastern parts of the landfill, respectively." (April 26, 2001 letter[h])	"The core hole panned for the former west lobe of the landfill was not drilled. After completion of excavation, it was apparent that there were no hazardous wastes associated with this area of the landfill and little potential for residual contaminants."	Deviational change to SAP	August 1999 SAP[f] April 26, 2001, letter[h] August 2, 2001, letter[g]

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
SAP – 2.2.3.2/25 April 2001 letter – pg. 3	" four boreholes will be drilled in Cañon de Valle between MDA P and the watercourse " (August 1999 SAP[f]) "Three boreholes will be located beneath the upper footprint of the landfill area " The three grids with the greatest potential for these conditions are 374, 486, and 489 beneath the western, middle, and eastern parts of the landfill, respectively." (April 26, 2001 letter[h])	"The two remaining planned core holes were drilled at grids 526 and 557. These are grids that existing field screening data indicated having the highest residual contaminant concentrations for the landfill. There was topographic indication that these cells were in locations where pre-landfill stream channels may have concentrated contaminants."	Deviational change to SAP	August 1999 SAP[f] April 26, 2001, letter[h] August 2, 2001, letter[g]
SAP – 2.2.3.2/25 April 2001 letter – pg. 4	" four boreholes will be drilled in Cañon de Valle between MDA P and the watercourse to a depth of 20 ft " (August 1999 SAP[f]) "These boreholes will be sampled for continuous core to approximately 33 ft depth (elevation approx. 7416 ft msl). The target depth represents the top of the densely welded zone of the Bandelier Tuff beneath the landfill." (April 26, 2001 letter[h])	"To compensate for the 2 core holes eliminated, the 2 core holes at grids 526 and 557 were drilled to depths approximately 10-ft below the elevation of the Cañon del Valle stream channel (~60 ft each)."	Deviational change to SAP	August 1999 SAP[f] April 26, 2001, letter[h] August 2, 2001, letter[g]
April 2001 letter – pg. 3	"After sufficient time for any vapors resulting from drilling have dissipated, a gas sample will be collected in each bore hole and analyzed for volatiles." (April 26, 2001 letter[h])	"Additional VOC samples were collected in the 2 core holes at grids 526 and 557 in lieu of the samples planned for the 2 core holes eliminated. Two samples from 2 depths were collected from each. An atmospheric blank was also collected at each location."	Deviational change to SAP	April 26, 2001, letter[h] August 2, 2001 letter[g]

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Corres-pondence
Changes to the Closure Plan Waste Management Procedures				
1.1.3/1-8	"The final rinsate from the debris will be sampled to demonstrate that any debris waste characteristics have been removed."	"The original Closure Plan had conflicting language (Section 1.1.3, Page 1-8, 3rd paragraph) with respect to treatment or verification standard for hazardous debris currently contained in the approved Closure Plan per 20 NMAC 4.1, Subpart IX, 268.45(a)(1). The HRMB required the Laboratory to submit a Class I Closure Plan Modification under 20 NMAC 4.1, Subpart V, 270.42, Appendix I (a)(2): correction of typographical errors (March 10, 1999 letter[b]). The Laboratory submitted a Class I Closure Plan Modification for the typographical error, in which the sampling of decon water language was removed and replaced with visual inspection language consistent with Chapter 4 of the Approved Closure Plan (May 7, 1999 letter[c])."	Class I Closure Plan modification to decontamin-ation procedure	March 10, 1999, letter[b] May 7, 1999, letter[c]
Table 4-2	Summary of Samples and Analyses			
6.3.2/6-28	"If Appendix VIII constituents are not detected in the final rinsate samples "			
Not applicable	Not applicable.	"The land disposal treatment standard for barium (7.6 mg/L) has changed as of May 26, 1998 (63 FR 28555). The HRMB has given the Laboratory permission to use the EPA's newly promulgated Phase IV LDR treatment standard of 21 mg/L in addition to identifying underlying hazardous constituents (UHCs) expected to be present in metal-bearing waste (D005-barium at 100 mg/L) (March 10, 1999 letter[b])."	Regulatory change	July 22, 1998, letter[a] September 18, 1998, letter[i] November 9, 1998, letter[i] March 10, 1999, letter[b]

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
Table 3-4/ 3-13	"Note (b) Because the HE was burned before disposal, D003 and K044 waste is not expected to be present. If the waste exhibits the characteristic of reactivity due to explosivity, it will be classified as D003 and K044 waste."	"HE is currently managed as any reactive characteristic hazardous waste (D003) and treated by Laboratory personnel at the 387 Burn Pad. To the best of the Laboratory's knowledge, all wastewater treatment sludge from the manufacturing and processing of explosives was burned to remove the characteristic (reactivity) for which it was listed (K044), thereby rendering it no longer listed per the mixture rule. Since detonable pieces of HE will be segregated from soil, the soil is not expected to be considered a reactive characteristic hazardous waste."	Regulatory interpretation	July 22, 1998, letter[a]
6.2.6/ 6-25	"This segregation area will be used for temporary storage of soils/debris in rolloff boxes or other containers and temporary storage of liquids in drums."	"Decontamination liquid is currently stored in several 20,000-gallon single walled steel tanks designed to fractionate solids from liquids. Stormwater is stored in three 10,000-gallon single walled steel tanks (each devoted to a separate runoff trench). Unknown liquids are either containerized or are already in containers. These are stored on spill pallets within the area of contamination until they can be characterized. Soils (both non-hazardous and hazardous) are stored separately within the area of contamination in 100 yd^3 lots. Small debris are staged in wire cage pallets to minimize handling. All liquids, soil, and debris removed from MDA P are stored in separate lined bermed pads."	Regulatory interpretation	July 22, 1998, letter[a] May 7, 1999, letter[c]
6.2.6/ 6-24	"On-site treatment of contaminated soils or liquids will be conducte. The treatment will occur in less than 90 days and is exempted from permit requirements as described in 20 NMAC 4.1, Subpart V, Section 262.34. On-site treatment is expected to consist of stabilization of barium contaminated soils."	"During an April 8, 1999 meeting with HRMB, ER Project personnel discussed the possibility of finding F-listed constituents in soil or on debris removed from MDA P once excavation activities entered into the east lobe. Historically gasoline, kerosene, and solvents were used in an ignition train to start the burn process at the 387 Burn Pad and to keep the burn hot. In most cases, it is not possible for the Laboratory to determine whether the presence of a hazardous constituent was a product of incomplete combustion or the result of disposal of residues from an F-listed solvent. HRMB has approved an approach whereby the Laboratory will manage waste materials removed from MDA P as F-listed wastes only when there is directly observable evidence that the waste at issue, i.e., soils or debris, were in contact with an F-listed source. All other soil and debris waste will undergo waste characterization to determine whether the waste is a characteristic hazardous waste."	Regulatory interpretation	May 20, 1999, letter[k]

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
Not applicable	Not applicable.	"In a September 18, 1998 letter[i], HRMB stated that the sorting pad and filtration system for on-site treatment of barium-contaminated soils shall meet the requirement for a temporary unit as defined in 20 NMAC 4.1, Subpart V, Section 264.533. Currently, there are no intentions to treat barium-contaminated soils; therefore the use of a filtration system will not be implemented. The Laboratory believes that segregating pieces of HE from soil at MDA P does not constitute treatment because it does not alter the chemical or physical characteristics of the waste streams generated (November 9, 1999 letter[c]). The Laboratory is currently following EPA guidance for management of remediation waste in a document entitled "Management of Remediation Waste Under RCRA" (EPA 530-F98-026 dated October 1998) that allows consolidation of hazardous waste within an area of contamination without creating a new point of hazardous waste generation or triggering land disposal restrictions or minimum technology requirements."	Regulatory interpretation	September 18, 1998, letter[i] November 9, 1998' letter[j] March 10, 1999, letter[b] May 7, 1999, letter[c]
6.2.6/ 6-25	"The treatment tank used for soil stabilization will be within this segregation area and bermed separately."	"Currently, there are no intentions to treat barium-contaminated soils; therefore there are no treatment tanks associated with soil stabilization for treatment of barium-contaminated soils within the segregation area."	Variance to Phase I waste treatment procedures	July 22, 1998, letter[a] November 9, 1998, letter[xxx]
2.1.1.3/2-4	"A surface runon trench was installed in 1994 as a mechanism for erosion control that redirects rainwater and snowmelt around the waste pile and serves to limit infiltration of water into the waste pile."	"In March 1999, the Storm Water Pollution Prevention Plan for MDA P was updated to account for waste handling and management systems required at MDA P. As part of the new waste handling and management systems required for HE segregation, the west end of the trench has been filled with gravel to create a French drain. Stormwater will be redirected around the new hand-sorting pad into the French drain. The sorting pad contains its own water containment and collection system."	Variance to Phase I waste handling procedures	July 22, 1998, letter[a]

Closure Plan Section/Page	Closure Plan Information, As Submitted	Closure Plan Information, As Revised	Type of Change	Related Correspondence
6.2.4/ 6-19	"Nearby, two 40- x 40-ft evaporation ponds will be constructed for the drying of treated soils."	"Since there will be no treatment of barium contaminated soils, the evaporation ponds have not been constructed. A HE hand-sorting pad of similar dimensions has been utilized in the same location as the evaporation ponds."	Variance to Phase I waste treatment procedures	July 22, 1998, letter[a]

[a] July 22, 1998, letter from Julie Canepa and Theodore J. Taylor to Benito Garcia (LANL 1998, 59714) regarding potential operational deviations from the MDA P closure plan.

[b] March 10, 1999, letter from Benito Garcia to Theodore Taylor and Dr. John C. Brown (NMED 1999, 63074), replying to the November 9, 1998, letter (LANL 1998, 62240) regarding the MDA P Closure Plan and correspondence related to operational deviations.

[c] May 7, 1999, letter from Julie Canepa and Theodore J. Taylor to Benito Garcia (LANL 1994, 63409) regarding submittal of class 1 closure plan modification for MDA P and response to comments contained in the March 10, 1999 letter from HRMB (NMED 1999, 63074).

[d] May 13, 2002, letter from Julie Canepa and Everett Trollinger to John Young (LANL 2002, 73159) regarding submittal of Revised Request for Class 1 Closure Plan Modification for Material Disposal Area (MDA) P.

[e] May 30, 2002, letter from James Bearzi to John Brown and Everett Trollinger (NMED 2002, 73198), regarding Notice of Administrative Completeness and Approval of Revised Request for Class 1 Closure Plan Modification for Material Disposal Area (MDA) P.

[f] August 1999, sampling and analysis plan for MDA P (LANL 1999, 63546).

[g] August 2, 2001, letter from Kenneth V. Bostick to John Young (LANL 2001, 70252) regarding deviations from the MDA P sampling and analysis plan.

[h] April 26, 2001, letter from Julie A. Canepa and Theodore J. Taylor to John Young (LANL 2001, 70272) regarding additional information for MDA P Phase II confirmation sampling.

[i] September 18, 1998, letter from Benito Garcia to Theodore J. Taylor and John C. Brown (NMED 1998, 62559) regarding the requirement of a Class 2 modification for the potential operational deviations from the MDA P Closure Plan.

[j] November 9, 1998, letter from Julie Canepa and Theodore J. Taylor to Benito Garcia (LANL 1998, 62240), responding to the September 18, 1998, letter.

[k] May 20, 1999, letter from Julia Canepa and Theodore J. Taylor to James Bearzi (LANL 1999, 63343) regarding MDA P waste determination strategy.

Appendix E

MDA P Site,
Phase II Confirmation Sampling,
Chain-of-Custody Forms

E-1.0 OVERVIEW

Chain-of-custody (COC) forms were used during the collection of Phase II confirmation samples to document sample collection information (e.g., date, time, and sample medium); track the transfer of samples between personnel; and track shipment to, and receipt of, samples by the respective analytical laboratories.

All copies of a COC form must accompany the sample(s) to the Laboratory's Sample Management Office (SMO). The Field Team Leader (FTL), or FTL designee, is responsible for ensuring (1) delivery of the samples to the SMO, and (2) the completeness and accuracy of the form. Upon delivery to the SMO, the FTL or FTL designee signs the *relinquished by* block and an SMO representative signs the *received by* block, along with the date and time. All copies of a given COC form require signatures, unless carbon paper or "no carbon required" paper was used. After the acknowledgement and receipt of samples by SMO, the FTL or FTL designee retains the third (pink) copy for the sampling team's records. The original (top or white) copy is kept with the samples, and the second (yellow) copy is forwarded to the RRES-RS RPF by the SMO. Any individual accepting custody of a sample or set of samples is required to verify that all containers identified on the COC form are contained in the package(s) being accepted, as acknowledged by a signature on the COC form. COC forms are retained at the RPF as part of the permanent record of field sampling activities.

E-2.0 NOTATIONS

Prior to the SMO 1.2.3 release (deployed October 1, 2002), an application defect existed during the generation and printing of the COC records. Under certain conditions, extra pages were printed so that the total number of pages reported at the top of the form might inaccurately represent the actual number of pages.

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The COC forms make up the remainder of this appendix. Some copies of this report have been distributed with photocopies of the forms as well as an electronic version on CD; other copies of the report include only the electronic version on CD (see CD included at the front of this report).

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Appendix F

Regulatory References for
Clean Closure Demonstration

This appendix contains the regulatory references that are used to support the Laboratory's approach to demonstrating clean closure for MDA P and that clarify EPA's intent concerning the applicability of closure equivalency demonstrations:

- 52 FR 8704, which finalized conforming changes between 40 CFR 265 and 264 closure requirements to ensure that future interim status closures would be equally protective and stringent as closures for permitted units;
- 52 FR 45788, which provides the option of clean-closure equivalency demonstrations for units that had closed prior to 1987 conforming changes;
- 53 FR 9944, which clarifies the term "waste residues," and
- OSWER Policy Directive 9476.00-18, which provides guidance on demonstrating equivalence of Part 265 clean closures with Part 264 requirements.

The Laboratory's position, based on these sources, is that a clean closure demonstration is required for MDA P, not a closure equivalency demonstration. Regulations in 40 CFR 270.1(c) do not explicitly state the applicability of the closure equivalency demonstration requirement for pre-1987 closures; however, the intent in the preamble language is clear.