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DEPARTMENT OF ENERGY
Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

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NMED Hazardous
Waste Bureau

EMLA-2022-BF095-02-001

May 24, 2022

Mr. Rick Shean
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of the Supplemental Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1

Dear Mr. Shean:

Enclosed please find two hard copies with electronic files of the "Supplemental Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1." Enclosure 1 includes an electronic copy of a redline strikeout version of the report that incorporates all changes made in response to the New Mexico Environment Department's (NMED's) comments dated December 13, 2021; April 7, 2022; and May 10, 2022. Responses to NMED's December 13 comments were submitted on March 15, 2022, and a revised version in response to NMED's April 7 comments was submitted on April 21, 2022. Responses to NMED's May 10 comments are provided in Enclosure 2. Submittal of this report fulfills fiscal year 2022 Milestone #13 in Appendix B of the 2016 Compliance Order on Consent.

If you have any questions, please contact Emily Day at (505) 695-4243 (emily.day@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

ARTURO
DURAN

Digitally signed by ARTURO DURAN
Date: 2022.05.24 12:15:40 -06'00'

Arturo Q. Duran
Compliance and Permitting Manager
U.S. Department of Energy
Environmental Management
Los Alamos Field Office

Enclosures:

1. Two hard copies with electronic files (including a redline strikeout version) – Supplemental Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1 (EM2022-0109)
2. Response to the New Mexico Environment Department Draft Comments on U.S. Department of Energy Draft Responses for the Revised Supplemental Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Dated May 10, 2022 (EM2022-0347)

cc (letter with hard-copy enclosure[s]):
Cheryl Rodriguez, EM-LA

cc (letter with CD/DVD enclosure[s]):
Laurie King, EPA Region 6, Dallas, TX
Steve Yanicak, NMED-DOE-OB
Chris Catechis, NMED-RPD
emla.docs@em.doe.gov
n3brecords@em-la.doe.gov
Public Reading Room (EPRR)
PRS website

cc (letter emailed):
Jennifer Payne, LANL
Stephen Hoffman, EM-LA
William Alexander, N3B
Brenda Bowlby, N3B
Emily Day, N3B
Michael Erickson, N3B
Kim Lebak, N3B
Joseph Legare, N3B
Dana Lindsay, N3B
Pamela Maestas, N3B
Joseph Murdock, N3B
M. Lee Bishop, EM-LA
John Evans, EM-LA
Michael Mikolanis, EM-LA
David Nickless, EM-LA

May 2022
EM2022-0109

Supplemental Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1

N3B Los Alamos

EM2022-0109

Supplemental Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1

May 2022

Responsible program director:

Michael O. Erickson		Program Director	RCRA Remediation Program	5/13/22
Printed Name	Signature	Title	Organization	Date

Responsible N3B representative:

Troy Thomson	Troy Thomson	Program Manager	N3B Environmental Remediation Program	5/16/22
Printed Name	Signature	Title	Organization	Date

Responsible DOE EM-LA representative:

Arturo Q. Duran	ARTURO DURAN Digitally signed by ARTURO DURAN Date: 2022.05.24 12:16:18 -06'00'	Compliance and Permitting Manager	Office of Quality and Regulatory Compliance	
Printed Name	Signature	Title	Organization	Date

EXECUTIVE SUMMARY

This supplemental investigation report evaluates the nature and extent of contamination and potential human health and ecological risks for two solid waste management units (SWMUs) and one area of concern (AOC) at Los Alamos National Laboratory (LANL or the Laboratory) in Technical Area 49 (TA-49) outside the nuclear environmental site (NES) boundary. These three sites were investigated in 2009–2010, and the investigation results were documented in the investigation report for sites at TA-49 outside the NES, submitted by the U.S. Department of Energy (DOE) and Los Alamos National Security, LLC, to the New Mexico Environment Department (NMED) in September 2010. The approved investigation report concluded that additional sampling to define the extent of contamination was needed for these SWMUs and AOC. Additional sampling requirements for these sites were documented in the approved Phase II investigation work plan for sites at TA-49 outside the NES, submitted to NMED in February 2011. This revised supplemental investigation report, prepared by Newport News Nuclear BWXT-Los Alamos, LLC (N3B), addresses NMED's comments concerning the original submission of the supplemental investigation report.

After the investigation report and Phase II investigation work plan had been approved, NMED and the U.S. Department of Energy (DOE) entered into a framework agreement for the realignment of environmental priorities at the Laboratory. Under the framework agreement, NMED and DOE agreed to review characterization efforts undertaken to date pursuant to the Compliance Order on Consent to identify those sites where the nature and extent of contamination have been adequately characterized. Pursuant to the framework agreement, the Laboratory reviewed its data evaluation process with respect to U.S. Environmental Protection Agency (EPA) guidance and the framework agreement principles and concluded that this process could be revised to more efficiently complete site characterization, while providing full protection of human health and the environment. Specifically, the process for evaluating data to define extent of contamination was revised to provide a greater emphasis on risk reduction, consistent with EPA guidance.

The revised process was used to evaluate the 2009–2010 data and previous decision-level investigation data for the three sites identified in the Phase II investigation work plan as requiring additional sampling to define extent. Based on the evaluation of investigation results using the revised process, the extent of contamination has been defined (or a determination has been made that no further sampling for extent is warranted) at the three sites. However, NMED has directed the Laboratory to perform additional sampling and analyses for two of the sites. Human health and ecological risk assessments were performed for all three sites.

The following recommendations are based on the results of data evaluations presented in this supplemental investigation report.

- The DOE Environmental Management Los Alamos Field Office (EM-LA) and N3B recommend corrective action complete without controls for one site for which extent is defined and which poses no potential unacceptable human health risks or doses under any scenario and no unacceptable ecological risk.
- EM-LA and N3B recommend additional sampling and analyses at two sites as directed by NMED in its notice of disapproval of the original investigation report of TA-49 sites outside the NES boundary.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by Triad National Security, LLC. The Laboratory is located in north-central New Mexico, approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site covers approximately 36 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons that contain perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 to 7800 ft above mean sea level (amsl).

The Laboratory has been a participant in a national effort by DOE to clean up sites and facilities formerly involved in weapons research and development. The goal of this effort is to ensure past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, the Laboratory has investigated sites potentially contaminated by past Laboratory operations.

This supplemental investigation report addresses two solid waste management units (SWMUs) and one area of concern (AOC) outside the nuclear environmental site (NES) at Technical Area 49 (TA-49). The NES boundary used in this report is the boundary that existed at the time the investigation work plan was prepared in 2008. The boundary has subsequently been revised, and some sites previously inside the NES boundary are now outside the current NES boundary. These sites are potentially contaminated with hazardous chemicals and radionuclides. The New Mexico Environment Department (NMED), pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 458.1, Change 4, Radiation Protection of the Public and the Environment, and DOE Order 435.1, Radioactive Waste Management. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

Corrective actions at the Laboratory are subject to a Compliance Order on Consent (the Consent Order). This supplemental investigation report describes work activities that were completed in accordance with the Consent Order.

1.1 General Site Information

The TA-49 sites outside the NES boundary consist of nine SWMUs and AOCs (Table 1.1-1). Two AOCs were investigated and/or remediated before the Consent Order went into effect and have been approved for no further action. Historical details of previous investigations and data for all nine sites are provided in the historical investigation report (HIR) for the TA-49 sites outside the NES boundary (LANL 2007, 098523). The investigations of AOC 49-008(a) and SWMU 49-008(b) are deferred per Table IV-2 of the Consent Order. The remaining five SWMUs and AOCs were evaluated in the approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465). Although investigation of AOC 49-008(a) is deferred under the Consent Order, it was also included in the approved investigation work plan for the purpose of collecting samples around former transformer pads. The approved investigation report presented the investigation status and results from sampling activities conducted in 2009–2010 for the six sites investigated (LANL 2010, 110654.16; NMED 2010, 110859). The investigation report concluded that nature and extent were not defined for three sites. The report concluded that nature and extent were defined and no unacceptable human health or environmental risk existed for two sites. These two sites were recommended for corrective action complete without controls. Only limited sampling was performed at AOC 49-008(a) because the investigation is deferred under the Consent Order and further sampling was recommended for this site when investigation is no longer deferred.

Table 1.1-1 lists the nine TA-49 sites located outside the NES boundary with a brief description, summary of previous investigations, and investigation activities conducted in 2009–2010 for each site. Figure 1.1-1 shows the location of TA-49 with respect to the Laboratory, and Figure 1.1-2 shows the locations of the SWMUs and AOCs within TA-49 and identifies those located outside the NES boundary.

1.2 Purpose of Investigation

Six SWMUs and AOCs outside the NES at TA-49 were addressed by the 2009–2010 investigation because these sites are potentially contaminated with hazardous chemicals and radionuclides, and final assessments of site contamination, associated risks, and recommendations for additional corrective actions remain incomplete. For each site, the objectives of the 2009–2010 investigation were to (1) establish the nature and extent of contamination; (2) determine whether current site conditions pose a potential unacceptable risk/dose to human health or the environment; and (3) assess whether any additional sampling and/or corrective actions are required.

Based on the data evaluation guidelines the Laboratory used at the time the investigation report was prepared, the Laboratory concluded that the extent of contamination was not defined for four SWMUs and AOCs; two sites were recommended for corrective action complete without controls. Further investigation of one of these sites is deferred under the Consent Order; recommendations for additional sampling at the other three sites to define extent were incorporated into the approved Phase II investigation work plan (LANL 2011, 111691; NMED 2011, 203824). In January 2012, after the investigation report and Phase II investigation work plan had been approved, NMED and DOE entered into a framework agreement for realignment of environmental priorities at the Laboratory. Under the framework agreement, NMED and DOE agreed to review characterization efforts undertaken to date pursuant to the Consent Order to identify those sites where the nature and extent of contamination have been adequately characterized. The framework agreement also stipulated the use of U.S. Environmental Protection Agency (EPA) guidance in this process, except in cases where EPA guidance was not supported by sound science. Pursuant to the framework agreement, the Laboratory reviewed its data evaluation process with respect to EPA guidance and the framework agreement principles and concluded that this process could be revised to complete site characterization more efficiently, while providing full protection of human health and the environment. Specifically, the process for evaluating data to define extent of contamination was revised to provide a greater emphasis on risk/dose reduction, consistent with EPA guidance. Key changes to the data evaluation process are as follows:

- Initially identify chemicals of potential concern (COPCs) to focus efforts on the constituents of most concern.
- Screen COPCs against soil screening levels (SSLs) and screening action levels (SALs) during determination of extent to focus efforts on characterizing contamination potentially posing risk/dose and requiring corrective action.
- Perform screening-level risk/dose evaluations on all sites, even if extent is not defined, to incorporate risk/dose reduction into recommendations for further actions.

The 2009–2010 investigation data for the three sites proposed for Phase II investigation for which nature and extent were not defined were reevaluated using this revised process, and the results are presented in this supplemental investigation report.

All analytical data collected from the 2009–2010 investigation activities are presented and evaluated in this report, along with decision-level data from previous investigations.

1.3 Document Organization

This report is organized in 9 sections, including this introduction, with multiple supporting appendixes. Section 2 provides details on site conditions (surface and subsurface). Section 3 provides an overview of the scope of the activities performed during implementation of the work plan. Section 4 describes the regulatory criteria used to evaluate potential risk/dose to ecological and human health receptors. Section 5 describes the data review methods. Section 6 presents an overview of the operational history of each site, historical releases, summaries of previous investigations, results of the field activities performed during the 2009–2010 investigation, site contamination, evaluation of the nature and extent of contamination, and summaries of the results of the human health and ecological risk-screening assessments. Section 7 presents the conclusions of the nature and extent of contamination investigation and risk-screening assessments. Section 8 discusses recommendations based on applicable data and the risk-screening assessments. Section 9 includes a list of references cited and the map data sources used in all the figures and plates.

The appendixes include acronyms, a metric conversion table, and definitions of data qualifiers used in this report (Appendix A); field methods (Appendix B); geodetic survey coordinates of sample locations (Appendix C); field screening results and borehole logs (Appendix D); investigation-derived waste (IDW) management (Appendix E); analytical program descriptions and summaries of data quality (Appendix F); analytical suites and results and analytical reports (Appendix G); box plots and statistical results (Appendix H); risk-screening assessments (Appendix I); and an assessment of trenches located in Area 6 West (SWMU 49-004) completed by the Laboratory’s Cultural Resource Team (Appendix J).

2.0 SITE CONDITIONS

2.1 Surface Conditions

2.1.1 Soil

Soil within TA-49 outside the NES has been disturbed. The soil was originally composed of Hackroy Series and Typic Eutroboralf soil. The soil is intermixed with patches of bedrock, which occurs predominantly near the edges of the mesa, east of developed areas of TA-49.

Hackroy soil is classified as Alfisols and is described in the “Soil Survey of Los Alamos County, New Mexico” (Nyhan et al. 1978, 005702) as follows: “The surface layer of the Hackroy soil is a brown sandy loam, about 10 cm thick. The subsoil is reddish brown clay, gravelly clay, or clayey loam about 20 cm thick. The depth to tuff bedrock and effective rooting depth is 20 to 50 cm.”

The fine-loamy Typic Eutroboralf soil consists of deep, well-drained soil formed in material weathered from tuff on nearly level to gently sloping mesa tops. The surface layer is a very dark grayish-brown loam, sandy loam, or very fine sandy loam, about 5 cm thick. The subsoil is a brown loam over a clay loam about 55 cm thick. The substratum is a brown gravelly clay loam over reddish clay that may or may not contain pumice. Permeability is considered moderately slow (Nyhan et al. 1978, 005702, p. 32).

2.1.2 Surface Water

Most Los Alamos surface water occurs as ephemeral (flowing in response to precipitation), intermittent (flowing in response to availability of snowmelt or groundwater discharge), or interrupted (alternation of perennial, ephemeral, and intermittent stretches) streams in canyons cut into the Pajarito Plateau (Nylander et al. 2003, 076059.49, p. 4-1).

Runoff and infiltration are the critical components that influence the surface hydrology at TA-49. These mechanisms are the predominant pathways by which contaminants could be mobilized and transported from the site.

There is no current evidence of a hydraulic connection between the surface water and groundwater at TA-49. No perennial sources of surface water occur at TA-49 and no current evidence exists of a hydraulic connection between surface water and groundwater (Weir and Purtymun 1962, 011890; Purtymun and Ahlquist 1986, 014722).

2.1.2.1 Surface-Water Runoff

Surface-water runoff control is provided by drainage ditches along the roads within TA-49. In addition, one site [SWMU 49-005(a)] is regulated under the Laboratory's National Pollutant Discharge Elimination System Individual Permit (IP), and site-specific storm water controls have been installed at this site per the IP. Surface-water runoff potentially carries contaminants and drains off-site. The direction of surface-water runoff from Frijoles Mesa flows northward into Water Canyon, eastward into a tributary canyon to Ancho Canyon, or southward into Ancho Canyon (LANL 2007, 098523).

Runoff from summer storms on the Pajarito Plateau typically reaches a maximum discharge in less than 2 h and has duration of less than 24 h (Purtymun et al. 1980, 006048). When the discharge rate is high, runoff can carry large amounts of suspended and bed-load sediment as far as the Rio Grande. Spring snowmelt occurs at a much less intense rate (e.g., over a period of several weeks to months). This lower flow rate also results in the movement of sediment, but with less surface erosion than during the summer storms. The Ancho and Water Canyons reaches downgradient of TA-49 experience ephemeral flow caused by runoff during the intense summer storms and snowmelt events.

2.1.2.2 Surface-Water Quality

Surface-water quality data have been collected for approximately 30 yr at the Beta borehole surface water station in Water Canyon (about 2000 ft north of Material Disposal Area [MDA] AB), in Water and Ancho Canyons at NM 4 and sporadically in drainages leading from MDA AB following intense rainfall events. No contamination of surface water at these locations has been identified in the 30 yr of monitoring (LANL 1992, 007670, p. 4-45; LANL 2006, 093925). Monitoring of storm water under the IP has shown detections of gross-alpha radioactivity above the target action level in the IP but below the upper tolerance limit for runoff from undeveloped landscape (LANL 2016, 601395).

2.1.2.3 Surface-Water Infiltration

Surface-water infiltration provides a potential mechanism for contaminants to move into the subsurface (LANL 1992, 007670, p. 4-13). Surface-water infiltration studies conducted at Pajarito Canyon have indicated that infiltration through mesa-top soil into the tuff is not significant (LANL 2007, 098523). Surface-water infiltration pathways at TA-49 include native or disturbed soil, intact tuff, backfilled shafts, fracture systems, and boreholes.

Evapotranspiration (ET) processes limit the transfer of water to the Bandelier Tuff. The characteristics of the tuff (naturally low-moisture content and high porosity) provide a large storage capacity for infiltrating fluid and likely inhibit infiltrating liquid from penetrating the thick unsaturated zone at TA-49 (LANL 1992, 007670, p. 4-14).

2.2 Subsurface Conditions

2.2.1 Stratigraphic Units

TA-49 lies on the east side of the Jemez Mountain's volcanic field and on the western perimeter of the Española Basin of the Rio Grande rift. The bedrock at or near the surface of the mesa top is composed entirely of the Bandelier Tuff (LANL 1992, 007670, p. 4-33).

The stratigraphy of TA-49 was originally mapped in 1959 using three deep-test wells (DT-5A, DT-9, and DT-10) and four coreholes (CH-1, CH-2, CH-3, and CH-4). The Tshirege Member of the Bandelier Tuff is approximately 595 to 670 ft thick beneath TA-49. Underlying the Tshirege Member is approximately 200 ft of the Otowi Member of the Bandelier Tuff.

In 1994, a 700-ft-deep borehole (location 49-02901) was drilled southeast of Area 2 to provide supplemental information to the geologic map of TA-49 (Stimac et al. 2002, 073391, p. 1). Geologic field observations confirm the exposed bedrock at TA-49 is restricted to units of the Tshirege Member of the Bandelier Tuff. Below the Tshirege Member, in descending order, are the Tsankawi Pumice Bed, tephras and volcaniclastic sediment of the Cerro Toledo interval, and the Otowi Member of the Bandelier Tuff.

The Bandelier Tuff consists of the Otowi and Tshirege Members, which are stratigraphically separated in many places by the tephras and volcaniclastic sediment of the Cerro Toledo interval. The Bandelier Tuff was emplaced during cataclysmic eruptions of the Valles Caldera between 1.61 and 1.22 million yr ago. The tuff is composed of pumice, minor rock fragments, and crystals supported in an ashy matrix. It is a prominent cliff-forming unit because of its generally strong consolidation (Broxton and Reneau 1995, 049726).

The Tshirege Member is the upper member of the Bandelier Tuff and is the most widely exposed bedrock unit of the Pajarito Plateau (Griggs and Hem 1964, 092516; Smith and Bailey 1966, 021584; Bailey et al. 1969, 021498; Smith et al. 1970, 009752). Emplacement of this unit occurred during eruptions of the Valles Caldera approximately 1.2 million yr ago (Izett and Obradovich 1994, 048817; Spell et al. 1996, 055542). The Tshirege Member is a multiple-flow, ash-and-pumice sheet that forms the prominent cliffs in most of the canyons on the Pajarito Plateau. Time breaks between the successive emplacements of flow units caused the tuff to cool as several distinct cooling units. For this reason, the Tshirege Member consists of at least four cooling subunits that display variable physical properties vertically and horizontally (Smith and Bailey 1966, 021584; Crowe et al. 1978, 005720; Broxton et al. 1995, 050121). From youngest to oldest the subunits are Qbt 4, Qbt 3, Qbt 2, Qbt 1v, and Qbt 1g. Qbt 4 is exposed on the surface or near surface at TA-49. The consolidation in this member is largely from compaction and welding at high temperatures after the tuff was emplaced. Its light brown, orange-brown, purplish, and white cliffs have numerous, mostly vertical fractures that may extend from several feet up to several tens of feet.

The Tshirege Member includes thin but distinctive layers of bedded, sand-sized particles called surge deposits that demark separate flow units within the tuff. Surge beds within the Bandelier Tuff are of particular interest with respect to the TA-49 subsurface hydrological conceptual model. A pyroclastic surge bed is found at a depth of about 60 ft below ground surface (bgs) in corehole CH-2. Surge beds tend to have a higher permeability than the surrounding tuff and may act as a capillary barrier, inhibiting downward transport of contaminants and promoting lateral flow and potentially acting as a perching layer. For that reason, boreholes drilled through this surge bed are particularly important when searching for perched water.

At least 21 boreholes and 30 test shafts penetrate the surge bed layer located at approximately 60 ft bgs between Qbt 4 and Qbt 3. No perched water was encountered at the surge bed layer within these boreholes and test shafts.

The Tshirege Member is underlain by the Otowi Member. It consists of moderately consolidated (indurated), porous, and nonwelded vitric tuff (ignimbrite) that forms gentle colluvium-covered slopes along the base of canyon walls. The Otowi ignimbrites contain light gray to orange pumice that is supported in a white to tan ash matrix (Broxton et al. 1995, 050121; Broxton et al. 1995, 050119; Goff 1995, 049682). The ash matrix consists of glass shards, broken pumice, and crystal fragments, and fragments of perlite.

Below the Otowi Member are interbedded Puye Formation conglomerates and basalts that sit atop the undivided siltstones and sandstones of the Santa Fe Group.

2.2.2 Hydrogeology

The subsurface hydrology at TA-49 is dominated by unsaturated conditions. The top of the regional saturated zone occurs approximately 1170 ft bgs near the center of MDA AB at deep test well DT-5A. The upper 800 ft of the unsaturated zone is within the Bandelier Tuff (LANL 1992, 007670, p. 4-18).

Relatively small volumes of water move beneath the mesa tops of the Pajarito Plateau under natural conditions because of low rainfall, high evaporation, and efficient water use by vegetation. During wetter years, vegetal growth is enhanced and is capable of removing larger volumes of available moisture. Atmospheric evaporation may extend within the mesas, further inhibiting downward flow (Rogers and Gallaher 1995, 097569, p. 27). Water content in the unsaturated zone within the tuff has been measured monthly or bimonthly in the unsaturated zone since 2000. It tends to range between 5% and 10% by volume under natural conditions (LANL 2005, 092389, pp. A-1-A-6).

Water content measured at locations within the boundary of the ET cover and the former asphalt pad at MDA AB is slightly higher, ranging from 5% to 20% by volume (LANL 2005, 092389, pp. A-3–A-6). Continuous moisture monitoring of the near-surface cover material at Area 2 shows that seasonal impulses of water are readily removed in the spring and summer when ET is maximized (LANL 2007, 098492).

2.2.2.1 Groundwater

In the Los Alamos area, groundwater occurs as (1) water in shallow alluvium in some of the larger canyons, (2) intermediate-perched groundwater (a perched groundwater body lies above a less permeable layer and is separated from the underlying aquifer by an unsaturated zone), and (3) the regional aquifer (Collins et al. 2005, 092028). Numerous wells have been installed at the Laboratory and in the surrounding area to investigate the presence of groundwater in these zones and to monitor groundwater quality.

The Laboratory formulated a comprehensive groundwater protection plan for an enhanced set of characterization and monitoring activities. The annual Interim Facility-Wide Groundwater Monitoring Plan (e.g., LANL 2015, 600467) details the implementation of extensive groundwater characterization across the Pajarito Plateau within an area potentially affected by past and present Laboratory operations. The investigation of the Water Canyon/Cañon de Valle watershed was completed in 2011 (LANL 2011, 207069), although additional groundwater investigations are being conducted to support the future corrective measures evaluation for Consolidated Unit 16-021(c)-99.

Alluvial Groundwater

Surface-water infiltration creates small, localized saturated zones in the alluvial fill of the canyon bottoms of Pajarito Plateau (LANL 1992, 007670, p. 4-21). Water infiltrates the alluvium until it reaches less-permeable layers that slow or impede flow. The size of the perched water zones are affected by the rate of ET and the movement of water into underlying rock.

In 1990, three shallow monitoring wells were installed in Water Canyon downgradient of TA-49. No perched water zones were encountered during drilling activities. Springs and seeps are known to occur in the lower reaches of Water and Ancho Canyons, far downgradient of TA-49 (near the Rio Grande), but none have been identified within the boundaries of TA-49 (LANL 2007, 098523).

Lateral groundwater flow occurs between stratigraphic permeability barriers within the Bandelier Tuff. Lateral discharges from canyon walls or canyon bottoms could provide a potential for contaminant transport. However, this is not plausible, given the current average annual rainfall and infiltration quantities seen at TA-49 (LANL 1992, 007670, p. 4-21).

Intermediate-Perched Groundwater

The three test wells (DT-5A, DT-9, and DT-10) and other boreholes drilled within TA-49 have not indicated the presence of perched water in tuff or volcanics above the regional aquifer despite the presence of potential perching beds (Purtymun and Stoker 1987, 006688, p. 8). The absence of perched water indicates that no recharge to the regional aquifer occurs through the Pajarito Plateau in the vicinity of TA-49 (Purtymun and Stoker 1987, 006688, p. 8). Subsurface moisture monitoring conducted from 2000 to 2005 did not indicate the presence of perched groundwater beneath TA-49.

Regional Groundwater

Deep groundwater beneath TA-49 is part of the regional aquifer that serves all of the municipal and industrial water use in Los Alamos County (Purtymun 1984, 006513). Little to no recharge occurs through the mesa tops of the Pajarito Plateau to the regional aquifer (LANL 2007, 098523).

The potentiometric surface of the regional aquifer beneath TA-49 lies completely within the Puye Formation and the Cerros del Rio basalt. Groundwater moves eastward and discharges into the Rio Grande through seeps and springs (Purtymun et al. 1980, 006048). Aquifer tests performed in the three deep test wells at TA-49 found the average groundwater velocity to be 345 ft/yr in the upper 490 ft of the aquifer. The gradient on the upper surface of the aquifer is about 40 to 60 ft/mi beneath the western and central portion of the plateau within the volcanic sediment portion. It steepens to 80 to 120 ft/mi as the aquifer moves into the less permeable sediment of the Tesuque Formation (Purtymun and Ahlquist 1986, 014722).

Well DT-5A showed an approximate 4-ft water-level decline from 1960 to 1964. This decline was attributed to pumping of supply wells located to the north. Well DT-9 recorded a 3-ft water-level decline over a 21-yr period from 1960 to 1982. At well DT-10, water levels declined 0.5 ft/yr from 1960 to 1967. These declines in water levels reflect the normal, deep, groundwater-level trend for the region (Purtymun and Ahlquist 1986, 014722).

2.2.2.2 Vadose Zone

The unsaturated zone from the mesa surface to the top of the regional aquifer is referred to as the vadose zone. The source of moisture for the vadose zone is precipitation, but much of it runs off, evaporates, or is absorbed by plants. The subsurface vertical movement of water is influenced by properties and conditions of the materials that make up the vadose zone.

Although water moves slowly through the unsaturated tuff matrix, it can move rapidly through fractures if saturated conditions exist (Hollis et al. 1997, 063131). Fractures may provide conduits for fluid flow but probably only in discrete, disconnected intervals of the subsurface. Because they are open to the passage of both air and water, fractures can have both wetting and drying effects, depending on the relative abundance of water in the fractures and the tuff matrix.

The Bandelier Tuff is very dry and does not readily transmit moisture. Most of the pore spaces in the tuff are of capillary size and have a strong tendency to hold water against gravity by surface-tension forces. Vegetation is very effective at removing moisture near the surface. During the summer rainy season, when rainfall is highest, near-surface moisture content is variable because of higher rates of evaporation and of transpiration by vegetation, which flourishes during this time.

The various units of the Bandelier Tuff tend to have relatively high porosities. Porosity ranges between 30% and 60% by volume, generally decreasing for more highly welded tuff. Permeability varies for each cooling unit of the Bandelier Tuff. The moisture content of native tuff is low, generally less than 5% by volume throughout the profile (Kearl et al. 1986, 015368; Purtymun and Stoker 1990, 007508).

3.0 SCOPE OF ACTIVITIES

This section presents an overview of the field activities performed during the implementation of the TA-49 sites outside the NES boundary approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465). The field investigation results and observations obtained from this investigation are presented in detail in section 6 and in the supporting appendixes.

3.1 Field Activities

The following subsections describe the scope of field activities for the 2009–2010 TA-49 investigation of sites outside the NES boundary, including geodetic surveys; field screening; surface and shallow subsurface soil investigations; borehole drilling, sampling and pore-gas sampling; health and safety monitoring; and waste management activities. Details regarding the field methods and procedures used to perform these field activities are presented in Appendix B.

3.1.1 Geodetic Survey

Geodetic surveys were conducted to identify historical, surface and shallow subsurface, and borehole sampling locations. These surveys were conducted before and upon completion of the drilling and surface sampling campaigns to establish the spatial coordinates for all sampling locations and boreholes. A Trimble 5700 differential global positioning system was used and survey data were collected by qualified personnel and conformed to Laboratory Information Architecture project standards IA-CB02, “GIS Horizontal Spatial Reference System,” and IA-D802, “Geospatial Positioning Accuracy Standard for A/E/C and Facility Management.” All coordinates are expressed as State Plane Coordinate System 83, New Mexico Central, U.S. ft coordinates and are presented in Appendix C.

3.1.2 Field Screening

Core samples, drill cuttings, surface, and shallow subsurface material were screened for gross-alpha and -beta radiation. Screening was performed using an Eberline E600 with either a 380AB or SHP360 probe (or equivalent) in accordance with the Laboratory's Standard Operating Procedure (SOP) 10.07, Field Monitoring for Surface and Volume Radioactivity Levels. The probe was held less than 1 in. away from the medium. Measurements were made by conducting a quick scan to find the location with the highest initial reading and then collecting a 1-min reading at that location to determine gross-alpha and -beta radiation levels. Soil and core material was sampled and logged only after radiological field-screening measurements were established so appropriate precautions could be taken, if necessary, before the sample was collected. Field personnel collected and recorded daily background measurements for gross-alpha and gross-beta radiation on boring logs, sample collections logs, and in log books. Borehole logs are included in Appendix D, and sample collection logs are included in Appendix G (on DVD).

All samples were also submitted to the American Radiation Services, Inc., laboratory in White Rock, New Mexico for gross-alpha, -beta, and -gamma analysis before by the Laboratory's Sample Management Office (SMO) to ensure compliance with U.S. Department of Transportation (DOT) requirements.

Surface samples from Area 6 West and Area 10 were selected for laboratory analyses based on the results of the gross-alpha and -beta results. Gross-alpha and -beta screening thresholds were established in the approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465). If surface sample results exceeded the screening thresholds for gross alpha and/or beta, they were submitted for laboratory analyses. Details regarding the surface sampling and field-screening process are presented in section 3.1.3 and in the approved work plan (LANL 2008, 102215; NMED 2008, 100465).

Immediately after sample retrieval, organic vapor monitoring of subsurface samples was performed using a MiniRae 2000, Model PGM-7600 photoionization detector (PID) with an 11.7-electronvolt bulb. In addition, headspace vapor screening for organic vapors was performed on recovered subsurface media in accordance with SOP-06.33, Headspace Vapor Screening with a Photoionization Detector. Samples were placed in a glass container and covered with aluminum foil. The container was sealed, shaken gently, and allowed to equilibrate for 5 min. The sample was screened by inserting the PID probe into the container and measuring and recording any detected vapors. The workers' breathing zone was also monitored using the MiniRae 2000.

Field-screening results were recorded on the borehole logs and/or corresponding sample collection logs, in the site safety officer field notebook, and in the radiation control technician's (RCT's) field notes. Field-screening results for organic vapors and alpha- and beta-radioactivity are presented in Table 3.1-1 for AOC 49-002 and SWMU 49-005(a) and Table 3.1-2 for SWMU 49-004. Field-screening results, along with the physical characteristics of the core (e.g., contacts, elevated moisture, or staining), were considered when sampling intervals were selected and are shown in the borehole logs included in Appendix D and in sample collection logs included in Appendix G (on DVD).

3.1.3 Surface and Shallow Subsurface Soil Investigation

A total of 660 surface and shallow subsurface soil samples from 330 locations were collected for gross-alpha and -beta radiological screening in October and November 2009 from Area 6 West and Area 10. Of these screening samples, 206 samples from 103 locations were submitted for laboratory analyses. Surface and shallow subsurface samples were collected in accordance with the approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465). Locations of surface screening samples at Area 6 West (SWMU 49-004) and Area 10 [AOC 49-002 and SWMU 49-005(a)] are shown in Figures 3.1 1 and 3.1-2, respectively.

Extensive surface sampling was conducted at Area 10 [AOC 49-002 and SWMU 49-005(a)]. The strategy for characterizing the nature and extent of surface contamination at Area 10 consisted of an iterative sampling approach that combined screening-level sampling with systematic, criteria-based biased laboratory analytical sampling. Surface samples were collected across a grid that extended a minimum of 100 ft from historical samples with detections of contaminants exceeding background values (BVs) or fallout values (FVs). Based on proximity to previously elevated concentrations, three categories of samples (Category I, II, and III) were established in each area. Category I samples are near historical locations, Category II samples are within 50 ft of the Category I samples, and Category III samples are within 100 ft of the Category I samples. The locations of screening-level surface samples collected from Area 10 [AOC 49-002 and SWMU 49-005(a)] are presented in Figure 3.1-2.

All surface and shallow subsurface samples were screened for gross-alpha and -beta radiation by American Radiation Services, Inc., and submitted for laboratory analyses based on the screening results as specified in the guidelines established in the approved work plan (LANL 2008, 102215; NMED 2008, 100465). Samples for laboratory analyses were collected from predetermined biased locations and at screening-level locations where either gross alpha and/or beta exceeded the established screening thresholds of 25 pCi/g or 50 pCi/g, respectively. If a Category III screening-level sample exceeded either screening threshold, additional step-out surface samples were collected until the field-screening results were below the predefined thresholds.

Screening-level surface samples were placed in 1-gal. plastic bags and stored in a locked sample container pending analysis of field-screening results. All biased samples were immediately placed in appropriate sample containers and submitted for laboratory analysis of the following analytical suites: americium-241, isotopic plutonium, isotopic uranium, and target analyte list (TAL) metals and by gamma spectroscopy. For biased samples, if gross-beta exceeded 50 pCi/g, samples were also submitted for laboratory analysis of iodine-129, strontium-90, and technetium-99. For screening samples, if gross alpha exceeded 25 pCi/g, samples were bottled and submitted for laboratory analysis of the following analytical suites: americium-241, isotopic plutonium, isotopic uranium, and TAL metals and by gamma spectroscopy; if gross beta exceeded 50 pCi/g, samples were also submitted for laboratory analysis of iodine-129, strontium-90, and technetium-99. The radiological screening results that guided selection of samples for laboratory analyses are presented in Tables D-1 through D-10 in Appendix D. It should be noted that total uranium was a common analyte for many of the site characterization samples collected from SWMUs and AOCs throughout the Laboratory during the 1990s. Because of the presence of naturally occurring uranium in geologic formations throughout northern New Mexico and the Laboratory, isotopic uranium replaced total uranium in the analytical suites for site characterization samples collected at many SWMUs and AOCs at the Laboratory. Analysis of site characterization samples for isotopic uranium is more accurate than analysis for total uranium, and isotopic uranium results more clearly indicate whether the uranium detected is natural or from historical Laboratory operations at the site.

Based on the gross-alpha and -beta radiation-screening results, a total of 64 samples from 32 locations from Area 10 were submitted for laboratory analyses. Surface and shallow subsurface samples were collected from 0.0 to 0.5 ft and 0.5 to 1.5 ft at each location using the hand-auger method in accordance with SOP-06.10, Hand Auger and Thin-Wall Tube Sampler.

Standard quality assurance/quality control (QA/QC) samples (field duplicates and rinsate samples) were collected in accordance with SOP-01.05, Field Quality Control Samples. All sample collection activities were coordinated with the SMO. Upon collection, samples remained in the controlled custody of the field team until delivered to the SMO. Sample custody was then relinquished to the SMO for delivery to a preapproved off-site analytical laboratory.

Specific details regarding the results of the field screening and subsequent sampling and laboratory analyses conducted at AOC 49-002 and SWMUs 49-004 and 49-005(a) are presented in section 6.

3.1.4 Subsurface Investigation

The 2009–2010 subsurface investigation at TA-49 sites outside the NES boundary included the drilling and sampling of eight boreholes. Following drilling, pore-gas samples were collected from several boreholes for analysis of volatile organic compounds (VOCs) and tritium. The details of these subsurface investigations are discussed below.

3.1.4.1 Borehole Drilling and Subsurface Sampling

A total of 26 samples were collected from eight boreholes drilled to depths ranging from 10 to 65 ft bgs. Subsurface soil, fill and rock samples were collected and analyzed to further characterize the TA-49 sites outside the NES boundary. All boreholes were drilled using a CME-85 hollow-stem auger drill rig equipped with a split core barrel continuous core sampling system. Four boreholes were drilled in both Area 6 West and Area 10. The locations of the boreholes drilled in Area 6 West and Area 10 are presented in Figures 3.1-1 and 3.1-2, respectively. The borehole logs are presented in Appendix D.

Samples were collected at target depth intervals based on criteria established in the approved work plan (LANL 2008, 102215; NMED 2008, 100465). All sampled core material was placed in the appropriate sampling containers, labeled, documented, and preserved (as appropriate) for transport to the SMO. Samples were submitted for laboratory analysis of the following analytical suites: explosive compounds, perchlorate, TAL metals, cyanide, americium-241, isotopic plutonium, isotopic uranium, VOCs, and semivolatile organic compounds (SVOCs). Area 10 subsurface samples were also submitted for laboratory analysis of nitrate. It should be noted that total uranium was a common analyte for many of the site characterization samples collected from SWMUs and AOCs throughout the Laboratory during the 1990s. Because of the presence of naturally occurring uranium in geologic formations throughout northern New Mexico and the Laboratory, isotopic uranium replaced total uranium in the analytical suites for site characterization samples collected at many SWMUs and AOCs at the Laboratory. Analysis of site characterization samples for isotopic uranium is more accurate than the analysis for total uranium, and isotopic uranium results more clearly indicate if detected uranium is natural or from historical Laboratory operations at the site.

Standard QA/QC samples (field duplicates and rinsate samples) were collected in accordance with SOP-01.05, Field Quality Control Samples. All sample collection activities were coordinated with the SMO. Upon collection, samples remained in the controlled custody of the field team until delivered to the SMO. Sample custody was then relinquished to the SMO for delivery to a preapproved off-site analytical laboratory.

3.1.4.2 Pore-Gas Sampling

After completion of drilling, subsurface pore-gas samples were collected in accordance with SOP-5074, Sampling for Sub-atmospheric Air, and submitted for laboratory analysis of VOCs and tritium. Three pore-gas samples were collected from discrete subsurface depth intervals using a single and/or double-packer assembly.

The total depth (TD) pore-gas sample from each borehole was collected using a single inflatable packer. All subsequent pore-gas samples were collected using a straddle packer system that isolated a discrete 2-ft interval within the borehole. Before sampling, each interval was purged until measurements of carbon dioxide and oxygen were stable and representative of subsurface conditions. Subsurface pore-gas samples were collected in SUMMA canisters for VOC analysis and in silica gel samples for tritium analysis.

3.1.5 Borehole Abandonment

Boreholes were abandoned in accordance with SOP-05.03, Monitoring Well and Borehole Abandonment. All boreholes were abandoned with bentonite grout by filling upward from the bottom via tremie pipe to within 2 ft of the surface. After 24 to 48 h, the backfilled level was checked for settling, and additional grout was added as necessary. The remainder of each boring was capped with Portland type I/II cement to surface grade.

3.1.6 Equipment Decontamination

Drilling and sampling equipment was decontaminated to minimize the potential for cross-contamination between sampling locations. Dry decontamination methods were used whenever possible and included using Fantastik cleaner, paper towels, and brushes. Decontamination procedures followed SOP-1.08, Field Decontamination of Drilling and Sampling Equipment. All equipment including survey equipment and heavy equipment, such as forklifts, drill rigs, etc., were screened by an RCT and released following DOT regulations before entering and exiting the site.

3.1.7 Health and Safety Measures

All 2009–2010 investigation activities were conducted in accordance with a site-specific health and safety plan, an integrated work document, and a radiological work permit that detailed work steps, potential hazards, hazard controls, and required training to conduct work. These health and safety measures included the use of level-D personal protective equipment (PPE) and field monitoring for VOCs and gross-alpha and -beta radiation.

A site-specific security plan was required by facility operations to work in TA-49. All field team members were trained to and adhered to the security requirements.

3.1.8 Waste Management

All IDW generated during the TA-49 investigation was managed in accordance with the IDW management plan in the approved work plan (LANL 2008, 102215; NMED 2008, 100465) as well as applicable regulations and Laboratory SOPs. These SOPs incorporate the requirements of all applicable U.S. Environmental Protection Agency (EPA) and NMED regulations. The SOP applicable to the characterization and management of IDW is SOP-5238, Characterization and Management of Environmental Project Waste.

The waste streams associated with the investigation included drill cuttings and core materials and contact IDW. Drill cuttings generated during drilling and sampling activities were placed in 1-yd^3 Wrangler bags or 55-gal. drums and staged in an appropriate area for less-than-90-day waste storage. This waste stream was characterized in accordance with the approved waste characterization strategy form (WCSF). The drill cutting and discarded core waste stream are classified as non-hazardous. PPE and other contact waste were stored in a single 55- or 30-gal. drum. Pending characterization, all drums were placed on pallets in appropriate less-than-90-day waste storage areas or satellite accumulation areas. As described in the WCSF, the contact IDW was characterized using knowledge of the waste-generating process and the levels of radioactive contamination encountered. Details regarding waste generated during the 2009–2010 investigation, including the WCSF and waste management and disposition, are presented in Appendix E.

3.2 Deviations

Deviations from the approved work plan occurred during the implementation of the TA-49 investigation are summarized below (LANL 2008, 102215; NMED 2008, 100465).

The approved work plan prescribed the drilling of 1 angled boring beneath Area 10 at SWMU 49-005(a) (LANL 2008, 102215; NMED 2008, 100465). Because the landfill boundaries were not identified, an angled borehole was not drilled under the center of the landfill. Four vertical boreholes were drilled in the area associated with SWMU 49-005(a) and all approved samples were collected.

4.0 REGULATORY CRITERIA

This section describes the criteria used for evaluating potential risk to ecological and human receptors. Regulatory criteria identified by medium in the Consent Order include cleanup standards, risk-based screening levels, and risk-based cleanup goals.

Human health risk-screening evaluations were conducted for the sites outside the NES at TA-49 using NMED guidance (NMED 2015, 600915). Ecological risk-screening assessments were performed using Laboratory guidance (LANL 2015, 600921).

4.1 Current and Future Land Use

The specific screening levels used in the risk evaluation and corrective-action decision process at a site depend on the current and reasonably foreseeable future land use(s). The current and reasonably foreseeable future land use(s) for a site determines the receptors and exposure scenarios used to select screening and cleanup levels. The land use within TA-49 is currently industrial and is expected to remain industrial for the reasonably foreseeable future. A construction worker scenario is evaluated because maintenance or repair of underground utilities is a reasonable possibility in the foreseeable future. The residential scenario is evaluated for comparison purposes per the Consent Order and is the decision scenario for sites that do not require future controls.

4.2 Screening Levels

Human health and ecological risk-screening evaluations were conducted for the COPCs detected in solid media at sites outside the NES at TA-49. The human health risk-screening assessments (Appendix I) were performed on inorganic and organic COPCs using NMED SSLs for the industrial, construction worker, and residential scenarios (NMED 2015, 600915). When an NMED SSL was not available for a COPC, SSLs were obtained from the May 2016 EPA regional tables (adjusted to a risk level of 1×10^{-5} for carcinogens). EPA regional screening levels are not available for construction workers; therefore, when regional screening levels were used for a COPC, the construction worker SSLs were calculated using toxicity values from the May 2016 EPA regional screening tables and exposure parameters from NMED guidance (NMED 2015, 600915). Radionuclides were assessed using the Laboratory SALs for the same scenarios (LANL 2015, 600929). Surrogate SSLs were used for some COPCs for which no SSLs were available based on structural similarity or breakdown products.

NMED guidance includes total chromium SSLs (NMED 2015, 600915). Because the toxicity of chromium strongly depends on its oxidation state, NMED and EPA have SSLs for trivalent chromium and hexavalent chromium. For screening purposes, the NMED SSLs for total chromium are typically used for comparison with total chromium results unless there is a known or suspected source of hexavalent chromium at the SWMU or AOC or site conditions could alter the speciation of chromium in the environment. Total chromium screening levels are appropriate for low-level releases to soil from sources not associated with hexavalent chromium. However, NMED and EPA recommend collecting valence-specific data for chromium when chromium is likely to be an important contaminant at a site and when hexavalent chromium may exist (NMED 2015, 600915; http://www2.epa.gov/risk/regional-screening-table-users-guide-june-2015).

There are no known sources of hexavalent chromium use (e.g., cooling towers, electroplating) at the SWMUs and AOC outside the NES at TA-49. Total chromium results for all sites are screened using the NMED SSLs for total chromium.

4.3 Ecological Screening Levels

The ecological risk-screening assessments (Appendix I) were conducted using ecological screening levels (ESLs) obtained from the ECORISK Database, Version 3.3 (LANL 2015, 600921). The ESLs are based on similar species and are derived from experimentally determined no observed adverse effect levels (NOAELs), lowest observed adverse effect levels (LOAELs), or doses determined lethal to 50% of the test population. Information relevant to the calculation of ESLs, including concentration equations, dose equations, bioconcentration factors, transfer factors, and toxicity reference values are presented in the ECORISK Database, Version 3.3 (LANL 2015, 600921).

4.4 Cleanup Standards

As specified in the Consent Order, SSLs for inorganic and organic chemicals (NMED 2015, 600915) are used as soil cleanup levels unless they are determined to be impracticable or values do not exist for the current and reasonably foreseeable future land uses. SALs are used as soil cleanup levels for radionuclides (LANL 2015, 600929). Screening assessments compare COPC concentrations for each site with SSLs and SALs.

The cleanup goals specified in Section VIII of the Consent Order are a target risk of 1×10^{-5} for carcinogens or a hazard index (HI) of 1 for noncarcinogens. For radionuclides, the target dose is 25 mrem/yr as authorized by DOE Order 458.1. The SSLs/SALs used for the risk-screening assessments in Appendix I are based on these cleanup goals.

4.5 Pore-Gas Screening Levels

The Consent Order does not identify any cleanup standards, risk-based screening levels (SLs), risk-based cleanup goals, or other regulatory criteria for pore gas. For TA-49 pore-gas samples, screening was performed for human health risk based on vapor intrusion into buildings and for potential contamination of groundwater. Vapor intrusion screening was performed using NMED's vapor intrusion screening levels (NMED 2015, 600915).

A screening evaluation for potential contamination of groundwater by pore gas is provided comparing maximum concentrations of VOCs in pore gas with SLs based on equilibrium partitioning using the appropriate Henry's law constant with groundwater standards or SLs. This screening process evaluates the potential for the VOC concentrations to result in contamination of groundwater in excess of standards or SLs. No applicable standards or SLs are available for tritium in pore vapor; however, the approved work plan (LANL 2008, 102691; NMED 2008, 100464) prescribed comparison of tritium pore-gas data with the EPA groundwater maximum contaminant level (MCL) for tritium.

The analysis evaluated the groundwater concentration that would be in equilibrium with the maximum concentrations of VOCs detected at TA-49. The equilibrium relationship between air and water concentrations is described by the following equation.

$$C_{water} = C_{air} / H' \qquad \textbf{Equation 4.5-1}$$

Where C_{water} = the volumetric concentration of contaminant in water,

C_{air} = the volumetric concentration of contaminant in air, and

H' = dimensionless form of Henry's law constant.

If the predicted concentration of a particular VOC in groundwater is less than the SL, then no potential exists for an exceedance of the groundwater standards or SLs at the contaminant/groundwater interface.

The screening evaluation is based on groundwater standards or tap water SLs and Henry's law constants that describe the equilibrium relationship between vapor and water concentrations. The source of the Henry's law constants is the NMED risk-assessment guidance document (NMED 2015, 600915) or the May 2016 EPA regional screening tables. The following dimensionless form of Henry's law constant was used:

$$H' = \frac{C_{air}}{C_{water}} \qquad \textbf{Equation 4.5-2}$$

Equation 4.5-2 can be used to calculate the screening value (SV):

$$SV = \frac{C_{air}}{1000 \times H' \times SL} \qquad \textbf{Equation 4.5-3}$$

Where C_{air} = the concentration of a particular VOC in the pore-gas sample (µg/m^3),

H' = the dimensionless Henry's law constant,

SL = the screening level (µg/L), and

1000 is a conversion factor from L to m^3.

The SLs are the groundwater standards or tap water SLs. The groundwater standards are the EPA MCL or New Mexico Water Quality Control Commission (NMWQCC) groundwater standard, whichever is lower. If no MCL or NMWQCC standard is available, the NMED tap water SLs (NMED 2015, 600915) or the EPA regional tap water SLs, adjusted to 10^{-5} risk for carcinogens, are used (http://www.epa.gov/risk/risk-based-screening-table-generic-tables). The numerator in Equation 4.5-3 is the concentration of the VOC in pore gas, and the denominator represents the pore-gas concentration needed to exceed the SL. Therefore, if the SV is less than 1, the concentration of the VOC in pore gas does not exceed the SL, even if the VOC plume were to come in contact with groundwater. Table 4.5-1 presents the calculated concentrations of contaminants in pore gas corresponding to groundwater standards and tap water SLs.

Equation 4.5-3 was used to screen the maximum concentrations of VOCs detected in pore-gas samples from the investigation. Screening was performed for each of the VOCs detected in pore gas using the maximum detected concentrations (Table 4.5-2).

5.0 DATA REVIEW METHODOLOGY

The purpose of the data review is to define the nature and extent of contaminant releases for each SWMU or AOC outside the NES at TA-49. The nature of a contaminant release refers to the specific contaminants present, the affected media, and associated concentrations. The nature of contamination is defined through identification of COPCs, which is discussed in section 5.1. The identification of a chemical or radionuclide as a COPC does not mean the constituent(s) is related to the site and a result of site operations. A COPC is identified because it is present at a site based on the criteria discussed below, but it might be present because of adjacent and/or upgradient operations and/or infrastructure typical of industrial and urban development. If such origins are evident, the constituents might be excluded from the data analyses and risk assessments. The extent of contamination refers to the spatial distribution of COPCs, with an emphasis on the distribution of COPCs potentially posing a risk or requiring corrective action. The process for determining the extent of contamination and for concluding no further sampling for extent is warranted is discussed in section 5.2.

5.1 Identification of COPCs

COPCs are chemicals and radionuclides that may be present as a result of releases from SWMUs or AOCs. Inorganic chemicals and some radionuclides occur naturally, and inorganic chemicals and radionuclides detected because of natural background are not considered COPCs. Similarly, some radionuclides may be present as a result of fallout from historical nuclear weapons testing, and these radionuclides are also not considered COPCs. The Laboratory collected data on background concentrations of many inorganic chemicals, naturally occurring radionuclides, and fallout radionuclides. These data have been used to develop media-specific BVs and FVs (LANL 1998, 059730). For inorganic chemicals and radionuclides for which BVs or FVs exist, identification of COPCs involves background comparisons, which are described in sections 5.1.1 and 5.1.2. If no BVs or FVs are available or if samples are collected where FVs are not appropriate (i.e., greater than 1.0-ft depth or in rock), COPCs are identified based on detection status (i.e., if the inorganic chemical or radionuclide is detected, it is identified as a COPC unless there is information indicating it is not present as a result of a release from the SWMU or AOC).

Organic chemicals may also be present as a result of anthropogenic activities unrelated to the SWMU or AOC or, to a lesser extent, from natural sources. Because no background data are available for organic chemicals, background comparisons cannot be performed in the same manner as for inorganic chemicals or radionuclides. Therefore, organic COPCs are identified on the basis of detection status (i.e., the organic chemical is detected). When the nature of contamination is assessed, the history of site operations may be evaluated to determine whether an organic COPC is present because of a release from a SWMU or AOC or is present from a non-site-related source. Organic chemicals that are clearly present from sources other than releases from a SWMU or AOC may be eliminated as COPCs and not evaluated further.

5.1.1 Inorganic Chemical and Radionuclide Background Comparisons

The COPCs are identified for inorganic chemicals and radionuclides according to Laboratory procedures EP-SOP-10071, Background Comparisons for Inorganic Chemicals, and EP-SOP-10073, Background Comparisons for Radionuclides. Inorganic COPCs are identified by comparing site data with BVs, by statistical comparisons, and with other lines of evidence, as applicable (LANL 1998, 059730). The upper end of the background data set may be used for comparison if one or more of the following conditions exist:

- Statistically determined BV is significantly greater than the maximum background concentration.

- Statistical tests cannot be performed because of insufficient data (fewer than eight samples and/or five detections per medium) or a high percentage of nondetections.
- Sufficient numbers of samples have been collected to determine nature and extent, but results are predominately nondetections.
- Site history does not indicate the constituent is directly related to site activities or to a dominant waste stream.
- Spatial analyses do not show a pattern or trend indicating contamination.
- The maximum detected concentration is statistically determined to be an outlier. (Note: A sufficient number of samples must be collected to show a point is an outlier and is not indicative of a hot spot.)

Radionuclides are identified as COPCs based on background comparisons and statistical methods if BVs or FVs are available, based on detection status if BVs or FVs have not been established, or based on other lines of evidence, as applicable.

Background data are generally available for inorganic chemicals in soil, sediment, and tuff (LANL 1998, 059730). However, some analytes (e.g., nitrate, perchlorate, and hexavalent chromium) have no BVs. A BV may be either a calculated value from the background data set (upper tolerance limit [UTL] or the 95% upper confidence bound on the 95th quantile) or a detection limit (DL). When a BV is based on a DL, there is no corresponding background data set for that analyte/media combination.

For inorganic chemicals, data are evaluated by sample media to facilitate the comparison with media-specific background data. To identify inorganic COPCs, the first step is to compare the sampling result with BVs. If sampling results are above the BV and sufficient data are available (eight or more sampling results and five or more detections), statistical tests are used to compare the site sample data with the background data set for the appropriate media. If statistical tests cannot be performed because of insufficient data or a high percentage of nondetections, the sampling results are compared with the BV and the upper end of the background concentrations for the appropriate media. If concentrations are above the BV but no results are greater than the upper end of the background data set, lines of evidence are presented to determine whether the inorganic chemical is or is not a COPC. If at least one sampling result is above the BV and the upper end of the background data set, the inorganic chemical is identified as a COPC. The same evaluation is performed using DLs when an inorganic chemical is not detected but has a DL above the BV. If no BV is available, detected inorganic chemicals are identified as COPCs.

Radionuclides are identified as COPCs based on comparisons with BVs for naturally occurring radionuclides or with FVs for fallout radionuclides. Thorium-228, thorium-230, thorium-232, uranium-234, uranium-235/236, and uranium-238 are naturally occurring radionuclides. Americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, and tritium are fallout radionuclides.

Naturally occurring radionuclides detected at activities above their respective BVs are identified as COPCs unless lines of evidence can be presented to establish that particular radionuclides are not COPCs. If there is no associated BV or FV and the radionuclide is detected, it is retained as a COPC.

The FVs for the fallout radionuclides apply to the top 0.0 to 1.0 ft of soil and fill and to sediment regardless of depth. If a fallout radionuclide is detected in soil or fill samples collected below 1.0 ft or in tuff samples, the radionuclide is identified as a COPC. For soil and fill samples from 1.0 ft bgs or less, if the activity of a fallout radionuclide is greater than the FV, comparisons of the top 0.0 to 1.0-ft sampling data are made with the fallout data set. The radionuclide is eliminated as a COPC if activities are similar to fallout activities or lines of evidence can be presented to establish the radionuclide is not a COPC.

Sediment results are evaluated in the same manner, although all data are included, not just the data from 0.0 to 1.0 ft bgs.

The FV for tritium in surface soil (LANL 1998, 059730) is in units of pCi/mL. This FV requires using sample percent moisture to convert sample tritium data from pCi/g (as provided by analytical laboratories) to the corresponding values in units of pCi/mL. Because sample percent moisture historically has been determined using a variety of methods, often undocumented, the Laboratory adopted the conservative approach of identifying tritium in soil as a COPC based on detection status.

Sample media encountered during investigations at sites in the TA-49 NES include soil (all soil horizons, designated by the media code ALLH or SOIL), fill material (media code FILL), alluvial sediment (media code SED), and Bandelier Tuff (media codes Qbt 1v, Qbt 1g, Qbt 2, Qbt 3, and Qbt 4). Because no separate BVs are available for fill material, fill samples are evaluated by comparison with soil BVs (LANL 1998, 059730). In this report, the discussions of site contamination in soil include fill samples along with soil samples in sample counts and comparisons with background. Fill samples are not discussed separately from soil. The units of the upper Bandelier Tuff (Qbt 2, Qbt 3, and Qbt 4) are likewise evaluated together with respect to background, as are the units of the lower Bandelier Tuff (Qbo, Qct, and Qbt 1g) (LANL 1998, 059730).

5.1.2 Statistical Methods Overview

A variety of statistical methods may be applied to each of the data sets. The use of any of these methods depends on how appropriate the method is for the available data. The results of the statistical tests are presented in Appendix H tables.

5.1.2.1 Distributional Comparisons

Comparisons between site-specific data and Laboratory background data are performed using a variety of statistical methods. These methods begin with a simple comparison of site data with a UTL estimated from the background data (UTL or the 95% upper confidence bound on the 95th quantile). The UTLs are used to represent the upper end of the concentration distribution and are referred to as BVs. The UTL comparisons are then followed, when appropriate, by statistical tests that evaluate potential differences between the distributions. These tests are used for testing hypotheses about data from two potentially different distributions (e.g., a test of the hypothesis that site concentrations are elevated above background levels). Nonparametric tests most commonly performed include the Gehan test (modification of the Wilcoxon Rank Sum test) and the quantile test (Gehan 1965, 055611; Gilbert and Simpson 1990, 055612).

The Gehan test is recommended when between 10% and 50% of the data sets are nondetections. It handles data sets with nondetections reported at multiple DLs in a statistically robust manner (Gehan 1965, 055611; Millard and Deverel 1988, 054953). The Gehan test is not recommended if either of the two data sets has more than 50% nondetections. If there are no nondetected concentrations in the data, the Gehan test is equivalent to the Wilcoxon Rank Sum test. The Gehan test is the preferred test because of its applicability to a majority of environmental data sets and its recognition and recommendation in EPA-sponsored workshops and publications.

The quantile test is better suited to assessing shifts in a subset of the data. The quantile test determines whether more of the observations in the top chosen quantile of the combined data set come from the site data set than would be expected by chance, given the relative sizes of the site and background data sets. If the relative proportion of the two populations being tested is different in the top chosen quantile of the data from that of the remainder of the data, the distributions may be partially shifted because of a subset of site data. This test is capable of detecting a statistical difference when only a small number of concentrations are elevated (Gilbert and Simpson 1992, 054952). The quantile test is the most useful distribution shift test where samples from a release represent a small fraction of the overall data collected. The quantile test is applied at a prespecified quantile or threshold, usually the 80th percentile. The test cannot be performed if more than 80% (or, in general, more than the chosen percentile) of the combined data are nondetected values. It can be used when the frequency of nondetections is approximately the same as the quantile being tested. For example, in a case with 75% nondetections in the combined background and site data set, application of a quantile test comparing 80th percentiles is appropriate. However, the test cannot be performed if nondetections occur in the top chosen quantile. The threshold percentage can be adjusted to accommodate the detection rate of an analyte or to look for differences further into the distribution tails. The quantile test is more powerful than the Gehan test for detecting differences when only a small percentage of the site concentrations are elevated.

If the differences between two distributions appear to occur far into the tails, the slippage test might be performed. This test evaluates the potential for some of the site data to be greater than the maximum concentration in the background data set if, in fact, the site data and background data came from the same distribution. This test is based on the maximum concentration in the background data set and the number (“n”) of site concentrations that exceed the maximum concentration in the background set (Gilbert and Simpson 1990, 055612, pp. 5–8). The result (p-value) of the slippage test is the probability that “n” site samples (or more) exceed the maximum background concentration by chance alone. The test accounts for the number of samples in each data set (number of samples from the site and number of samples from background) and determines the probability of “n” (or more) exceedances if the two data sets came from identical distributions. This test is similar to the BV comparison in that it evaluates the largest site measurements but is more useful than the BV comparison because it is based on a statistical hypothesis test, not simply on a statistic calculated from the background distribution.

Statistical tests for radionuclides are performed only in limited cases. There are no background data sets for naturally occurring radionuclides in soil or tuff, so statistical tests were not performed if there were any detections of uranium isotopes above BV in soil or tuff. Although there are background data sets for fallout radionuclides in soil, the background data are limited to the depth range of 0.0 to 1.0 ft bgs for evaluation of fallout radionuclides. Therefore, statistical tests were not performed for fallout radionuclides in soil. Fallout values are not applicable for tuff, so statistical tests cannot be performed. Background data sets are available for naturally occurring and fallout radionuclides in sediment, and background evaluations for sediment are not limited to the depth range of 0.0 to 1.0 ft bgs. Therefore, statistical tests can be performed for radionuclides in sediment. However, statistical tests for radionuclides in sediment were not performed for a site if there were also detections of naturally occurring radionuclides above BV in soil, detections of fallout radionuclides above FV in soil in the 0.0 to 1.0 ft bgs depth range, detections of fallout radionuclides in soil below 1.0 ft bgs, and/or detections of fallout radionuclides in tuff.

For all statistical tests, a p-value less than 0.05 was the criterion for accepting the null hypothesis that site sampling results are different from background. If results from two of the three statistical tests described above (Gehan, quantile, and slippage) indicate site concentrations of a constituent are not statistically different from background, that constituent may be eliminated as a COPC.

5.1.2.2 Graphical Presentation

Box plots are provided in Appendix H for a visual representation of the data and to help illustrate the presence of outliers or other anomalous data that might affect statistical results and interpretations. The plots allow a visual comparison among data distributions. The differences of interest may include an overall shift in concentration (shift of central location) or, when the centers are nearly equal, a difference between the upper tails of the two distributions (elevated concentrations in a small fraction of one distribution). The plots may be used in conjunction with the statistical tests (distributional comparisons) described above. Unless otherwise noted, the nondetected concentrations are included in the plots at their reported DL.

The box plots produced in Appendix H of this report consist of a box, a line across the box, whiskers (lines extended beyond the box and terminated with a short perpendicular line), and points outside the whiskers. The box area of the plot is the region between the 25th percentile and the 75th percentile of the data, the interquartile range or middle half of the data. The horizontal line within the box represents the median (50th percentile) of the data. The whiskers extend to the most extreme point that is not considered an outlier, with a maximum whisker length of 1.5 times the interquartile range, outside of which data may be evaluated for their potential to be outliers. The concentrations are plotted as points overlying the box plot. When a data set contains both detected concentrations and nondetected concentrations reported as DLs, the detected concentrations are plotted as Xs and the nondetected concentrations are plotted as Os.

5.2 Extent of Contamination

Spatial concentration trends are initially used to determine whether the extent of contamination is defined. Evaluation of spatial concentration data considers the conceptual site model of the release and subsequent migration. Specifically, the conceptual site model should define where the highest concentrations would be expected if a release had occurred and how these concentrations should vary with distance and depth. If the results are different from the conceptual site model, it could indicate that no release has occurred or there are other sources of contamination.

In general, both laterally and vertically decreasing concentrations are used to define extent. If concentrations are increasing or not changing, other factors are considered to determine whether extent is defined or if additional extent sampling is warranted. These factors include

- the magnitude of concentrations and rate of increase compared with SSLs/SALs,
- the magnitude of concentrations of inorganic chemicals or radionuclides compared with the maximum background concentrations for the medium,
- concentrations of organic chemicals compared with estimated quantitation limits (EQLs), and
- results from nearby sampling locations.

The primary focus for defining the extent of contamination is characterizing contamination that poses a potential unacceptable risk and may require additional corrective actions. As such, comparison with SSLs/SALs is used as an additional step following a determination of whether extent is defined by decreasing concentrations with depth and distance and whether concentrations are below EQLs or DLs. The initial SSL/SAL comparison uses the residential SSL/SAL (regardless of whether the current and reasonably foreseeable future land use is residential) because this value is typically the most protective. If the current and reasonably foreseeable future land use is not residential and if the residential SSL/SAL is exceeded or otherwise similar to COPC concentrations, comparison with the relevant SSL/SAL may also be conducted. For all SWMUs and AOCs at TA-49, the current and reasonably foreseeable future land use is industrial (section 4.1).

The SSL/SAL comparison is not necessary if all COPC concentrations are decreasing with depth and distance. If, however, concentrations increase with depth and distance or do not display any obvious trends, the SSLs/SALs are used to determine whether additional sampling for extent is warranted. If the COPC concentrations are sufficiently below the SSL/SAL (e.g., the residential and/or industrial SSL/SAL is 10 times [an order of magnitude]) or more than all concentrations), the COPC does not pose a potential unacceptable risk and no further sampling for extent is warranted. The validity of the assumption that the

COPC does not pose a risk is confirmed with the results of the risk-screening assessment. The calculation of risk also assists in determining whether additional sampling is warranted to define the extent of contamination needing additional corrective actions.

Calcium, magnesium, potassium, and sodium may be COPCs for some sites. These constituents are essential nutrients, and their maximum concentrations are compared with NMED's essential nutrient screening levels (NMED 2015, 600915). If the maximum concentration is less than the screening level(s), no additional sampling for extent is warranted and the inorganic chemical is eliminated from further evaluation in the risk assessment.

6.0 TA-49 SITES OUTSIDE NES BACKGROUND AND FIELD INVESTIGATION RESULTS

6.1 Background of TA-49

6.1.1 Site Description

TA-49, also known as the Frijoles Mesa Site, occupies approximately 1280 acres along the south-central boundary of the Laboratory (Figure 1.1-1). The mesa is centrally located on the Pajarito Plateau at an average elevation of approximately 7140 ft amsl. The plateau is roughly midway between the Jemez Mountains to the west and the White Rock Canyon of the Rio Grande to the east. TA-49 is located within the Ancho, North Ancho, and Water Canyon watersheds. The northern boundary of TA-49 is defined by the edge of the Frijoles Mesa, which overlooks Water Canyon, and forms the southern boundaries of TA-15 and TA-37. State highway NM 4 forms the southwest boundary of TA-49 as well as the Laboratory's boundary. The southeast boundary of TA-49 is formed by TA-39.

A period of experimental activity at TA-49 took place from late 1959 to mid-1961, during which hydronuclear and related experiments deposited plutonium, uranium, lead, and beryllium in underground shafts. These experiments were conducted in subsurface shafts located at MDA AB (Areas 2, 2A, and 2B) and Areas 1, 3, and 4. Thirty-five hydronuclear experiments and nine related calibration, equation-of-state, and criticality experiments, all involving some fissile material, were conducted in 3- or 6-ft-diameter shafts at depths ranging from 31 to 108 ft bgs (Purtymun and Stoker 1987, 006688, p. 2). These sites are all located within the NES.

Between 1959 and 1961, auxiliary areas were operated to support the experiments conducted at TA-49. These auxiliary areas are located outside the current NES. Area 5 served as the central control area for the hydronuclear experiments. A network of buried cables radiating out from Area 5 allowed for remote electronic measurements of the hydronuclear experiments. Most of these cables were later removed and disposed of in landfills at TA-49 (LANL 1997, 056594, pp. 3-4).

Area 6 West contains an inactive landfill and open burning area used for the disposal of solid material generated from activities conducted elsewhere at TA-49. Nonradioactive materials were burned or buried at SWMU 49-004 in Area 6 West between 1959 and 1961. This open burning/landfill area was also used for the burial of uncontaminated materials generated during general site cleanups in 1971 and 1984 (LANL 1992, 007670, p. 6.4-9).

Area 10 contained a calibration chamber used to perform tests related to the hydronuclear experiments performed elsewhere at TA-49.

Lead shielding was used in Areas 5 and 10 and may be present in surface soil. Based on the detailed historical information available, it is evident that other chemicals were used in very limited quantities at TA-49 (LANL 1992, 007670, pp. 3-8).

The location of TA-49 is shown in Figure 1.1-1, and the location of each TA-49 SWMU and AOC, including those outside the NES boundary, is presented in Figure 1.1-2.

6.1.2 Operational History

Before 1959, the Laboratory recognized there were potential safety problems with nuclear weapons in the nation’s stockpile. These problems were related to the possibility of a significant nuclear yield because of accidental detonation of the device’s high explosive (HE) component. The possibility of detonation during the assembly stage or while the device was stored in the arsenal necessitated the design and implementation of underground experiments to assess this potential problem. Historical aspects of the decision to conduct the experiments are described in a Laboratory report (Thorn and Westervelt 1987, 006672, p. 1-3).

The hydronuclear experiments ceased in the summer of 1961 (DOE 1987, 008663). In 1965, a Laboratory group studying atmospheric phenomena conducted lightning observation experiments using the photographic tower in Area 5. More recently, the portion of TA-49 near the NES has been used for emergency response operations and training. TA-49 also serves as a buffer zone for activities at adjacent firing sites (TA-15 and TA-39).

In 1977, the La Mesa fire burned much of TA-49, destroying essentially all remaining combustible structures at the site (LANL 1992, 007670, pp. 3-10). As part of the 1984 cleanup, two small landfills [AOC 49-005(b) at Area 5 and SWMU 49-005(a) at Area 10] were created to bury uncontaminated construction debris (LANL 1992, 007670, pp. 3-11).

6.1.3 Summary of Releases

No documented historical releases are associated with activities conducted at SWMUs 49-004 and 49-005(a) and AOC 49-002.

6.1.4 Current Site Use and Status

The Laboratory’s High-Power Microwave Group occasionally uses the day room in building 49-115 and its immediate vicinity for equipment development and the roadway between Areas 10 and 12 as a microwave test range. The Laboratory’s Hazardous Devices Team (HDT) uses the HDT training facility, building 49-113 and the associated HE magazine building 49-114 for small-scale explosives training exercises. Additional training facilities have been constructed recently to include structures and equipment for simulated transportation and other emergencies. Additional expansion of these facilities is expected.

Building 49-113 also houses the Laboratory’s Alternate Emergency Operations Center. This facility is equipped with extensive communications systems and computers. The Laboratory conducts electrical grounding measurements in a small area immediately west of the HDT’s training facility.

The Laboratory also maintains the Bandelier Meteorological Station in the southeast portion of TA-49 as part of its network of meteorological stations (LANL 1992, 007670, p. 3-12).

6.2 AOC 49-002, Calibration Chamber Facility

6.2.1 Site Description and Operational History

AOC 49-002 is an underground experimental calibration chamber and two associated shafts located in Area 10 (Figure 6.2-1). This site was used for calibration tests associated with hydronuclear experiments performed elsewhere at TA-49 in 1960 and 1961. Each shaft is approximately 6 ft to 7 ft × 64 ft. One is an elevator shaft used to transport personnel and equipment; an elevator building previously located over the elevator shaft has been removed. The other shaft is the calibration shaft. The shafts are connected at the bottom by a tunnel or gallery that is 4 ft × 7 ft × 12 ft. The calibration room, which is 14 ft × 10 ft, was lined with 8 in. of reinforced concrete faced with a 1-in. steel plate. The calibration shaft was used to place a portable pulse neutron source over calibration samples placed in the calibration room. A hydraulic lift platform at the bottom of the calibration room was connected to a hydraulic oil reservoir at the surface. Concrete radiation shields at the top of the calibration shaft are still in place. A concrete pad around the top of both shafts served as a foundation for the elevator building and shielding wall and is still in place.

The entrances to both shafts have been covered with concrete blocks. The elevator shaft is believed to still be open, while the calibration shaft was reportedly backfilled with soil and crushed tuff. Other surface features, including the hydraulic oil reservoir, have been removed. Small amounts (e.g., milligram quantities) of enriched uranium were occasionally released through spallation from critical assemblies during tests, although this material generally was cleaned up. Operation of the pulse neutron source may have activated surrounding soil and structures, but by now activation products have decayed to undetectable levels. The total volume of hydraulic oil in the lift system was estimated to be less than 100 gal. and is not believed to contain polychlorinated biphenyls (PCBs). Use of the site after 1961 did not involve hazardous materials other than small radioactive sources used for radiochemical counting (LANL 1992, 007670, pp. 6.5-1-6.5-6).

6.2.2 Relationship to Other SWMUs and AOCs

AOC 49-002 is located within Area 10, which also includes SWMU 49-005(a). SWMU 49-005(a) is located approximately 65 ft east of AOC 49-002 and is within the area sampled to characterize potential releases from AOC 49-002.

6.2.3 Summary of Previous Investigations

During the 1995 Resource Conservation and Recovery Act (RCRA) facility investigation (RFI), a gamma survey was conducted at 18 locations on a 25- × 25-ft grid established over the area above the shafts, around the concrete pads covering the shafts, and around structure locations at AOC 49-002. No radiologically contaminated areas were identified (LANL 1997, 056594, p. 53). Twelve surface soil samples (0.0 to 0.5 ft bgs) were collected from 12 grid locations around the concrete pads covering the shafts. All 12 samples were field screened for beta/gamma radiation and submitted for analysis by gamma spectroscopy; a subset of 6 samples was also submitted for analysis of TAL metals. One additional sample was collected from the former location of the hydraulic oil reservoir for the former elevator. This sample was field-screened for beta/gamma radiation and submitted for analysis of TAL metals, SVOCs, isotopic plutonium, and pesticides/PCBs and by gamma spectroscopy. Inorganic chemicals detected above BVs included antimony, copper, lead, mercury, uranium, and zinc. No organic chemicals were detected. No radionuclides were detected or detected above BVs/FVs (LANL 1997, 056594, pp. 23-35).

6.2.4 Site Contamination

6.2.4.1 Soil, Rock, and Sediment Sampling

Based on previous investigation results, further characterization was required to assess potential contamination at AOC 49-002. As a result, the following activities were completed as part of the 2009−2010 investigation.

- A total of 64 samples were collected from 33 locations within and surrounding AOC 49-002. At all but 2 locations, samples were collected at the surface (0.0 to 0.5 ft bgs) and from the subsurface (0.5 to 1.5 ft bgs). At 2 locations, only a subsurface (0.5 to 1.5 ft bgs) sample was collected. All samples were analyzed at off-site fixed laboratories for TAL metals, americium-241, isotopic plutonium, isotopic uranium, and gamma-emitting radionuclides.

The 2009–2010 sampling locations at AOC 49-002 are presented on Plate 1. Table 6.2-1 presents the samples collected and analyses requested for AOC 49-002 and the associated overland corridor. The geodetic coordinates of sampling locations are presented in Table 3.1-1.

6.2.4.2 Soil, Rock, and Sediment Field-Screening Results

Organic vapors were not detected above 0.7 ppm during headspace (PID) field screening of samples at AOC 49-002. No radiological screening results exceeded twice the daily site background levels. Field-screening results are presented in Table 3.1-1. There were no changes to sampling or other activities as a result of health- and safety-based field-screening results.

Two surface samples from AOC 49-002 exceeded either the gross-alpha and/or -beta screening thresholds and additional samples were collected and submitted for appropriate laboratory analyses. The gross-alpha and -beta screening results that guided additional sampling are presented in Tables D-6 through D-10 in Appendix D.

6.2.4.3 Soil, Rock, and Sediment Sampling Analytical Results

Decision-level data at AOC 49-002 consist of results from 77 samples (76 soil and 1 tuff) collected from 33 locations.

Inorganic Chemicals

A total of 71 samples (70 soil and 1 tuff) were collected at AOC 49-002 and analyzed for TAL metals. Seven samples were collected and analyzed for total uranium. Table 6.2-2 presents the inorganic chemicals above BVs and detected inorganic chemicals with no BVs. Plate 2 shows the spatial distribution of inorganic chemicals detected or detected above BVs at AOC 49-002. Because fewer than 8 tuff samples were collected, statistical tests could not be performed for tuff.

Aluminum was detected above the Qbt 2,3,4 BV (7340 mg/kg) in one sample at a concentration of 10,100 mg/kg. Aluminum is retained as a COPC.

Antimony was detected above the soil BV (0.83 mg/kg) in 1 sample at a concentration of 13.9 mg/kg and had DLs (0.934 mg/kg to 5.7 mg/kg) above the soil and Qbt 2,3,4 BVs (0.5 mg/kg) in 69 samples. Antimony is retained as a COPC.

Barium was detected above the Qbt 2,3,4 BV (46 mg/kg) in one sample at a concentration of 121 mg/kg. Barium is retained as a COPC.

Cadmium was detected above the soil BV (0.4 mg/kg) in 4 samples with a maximum concentration of 1.49 mg/kg and had DLs (0.491 mg/kg to 0.653 mg/kg) above the BV in 30 samples. Statistical tests were not performed because the background data set for soil contains too few detections. The concentrations were only 0.046 mg/kg, 0.176 mg/kg, 0.33 mg/kg, and 1.09 mg/kg above the BV and below or similar to the 2 or 3 highest soil background concentrations (0.6 mg/kg, 1.4 mg/kg, and 2.6 mg/kg). The DLs were 0.091 mg/kg to 0.253 mg/kg above the BV, below the 3 highest background DLs (2 mg/kg, 2 mg/kg, and 2 mg/kg), and below or similar to the 3 highest soil background concentrations (0.6 mg/kg, 1.4 mg/kg, and 2.6 mg/kg). Cadmium was not detected or not detected above BV in the other 37 samples (detected below BV in 36 samples). Cadmium is not a COPC.

Calcium was detected above the soil BV (2200 mg/kg) in 2 samples with a maximum concentration of 6730 mg/kg. The quantile and slippage tests indicated site concentrations of calcium in soil are not statistically different from background (Figure H-1 and Table H-1). Calcium is not a COPC.

Chromium was detected above the Qbt 2,3,4 BV (7.14 mg/kg) in 1 sample at a concentration of 8.35 mg/kg. The concentration was only 1.21 mg/kg above BV and below or similar to the 2 highest Qbt 2,3,4 background concentrations (6.2 mg/kg and 13 mg/kg). Chromium was detected below the soil BV in the other 70 samples. Chromium is not a COPC.

Cobalt was detected above the soil and Qbt 2,3,4 BVs (8.64 mg/kg and 3.14 mg/kg) in 1 soil sample and 1 tuff sample with a maximum concentration of 10.3 mg/kg. The Gehan and quantile tests indicated site concentrations of cobalt in soil are not statistically different from background (Figure H-2 and Table H-1). The concentration above the Qbt 2,3,4 BV (3.99 mg/kg) was only 0.85 mg/kg above the BV and was below the soil BV. Cobalt was detected below the soil BV in the other 69 samples. Cobalt is not a COPC.

Copper was detected above the soil and Qbt 2,3,4 BVs (14.7 mg/kg and 4.66 mg/kg) in three soil samples and one tuff sample with a maximum concentration of 98.9 mg/kg. The Gehan and slippage tests indicated site concentrations of copper in soil are statistically different from background (Figure H-3 and Table H-1). Copper is retained as a COPC.

Lead was detected above the soil BV (22.3 mg/kg) in five samples with a maximum concentration of 48 mg/kg. The Gehan and quantile tests indicated site concentrations of lead in soil are not statistically different from background (Figure H-4 and Table H-1). Lead is not a COPC.

Manganese was detected above the soil BV (671 mg/kg) in one sample at a concentration of 899 mg/kg. The Gehan and quantile tests indicated site concentrations of manganese in soil are not statistically different from background (Figure H-5 and Table H-1). Manganese is not a COPC.

Mercury was detected above the soil BV (0.1 mg/kg) in three samples with a maximum concentration of 0.72 mg/kg. Mercury is retained as a COPC.

Nickel was detected above the Qbt 2,3,4 BV (6.58 mg/kg) in 1 sample at a concentration of 7.39 mg/kg. The concentration was only 0.81 mg/kg above BV, similar to the maximum Qbt 2,3,4 background concentration (7 mg/kg), and below the soil BV (15.4 mg/kg). Nickel was detected below the soil BV in the other 70 samples. Nickel is not a COPC.

Selenium was not detected above the Qbt 2,3,4 BV (0.3 mg/kg) but had a DL (1.01 mg/kg) above the BV in 1 sample. The DL is 0.51 mg/kg below the soil BV and selenium was not detected with DLs below BV in the other 70 samples. Selenium is not a COPC.

Vanadium was detected above the Qbt 2,3,4 BV (17 mg/kg) in 1 sample at a concentration of 18 mg/kg. The concentration was only 1 mg/kg above the BV, 3 mg/kg below the maximum Qbt 2,3,4 background concentration (21 mg/kg), and below the soil BV (39.6 mg/kg). Vanadium was detected below the soil BV in the other 70 samples. Vanadium is not a COPC.

Zinc was detected above the soil BV (48.8 mg/kg) in 10 samples with a maximum concentration of 446 mg/kg. The Gehan and quantile tests indicated site concentrations of zinc in soil are not statistically different from background (Figure H-6 and Table H-1). However, the maximum concentration is substantially above BV. Zinc is retained as a COPC.

Organic Chemicals

One sample was collected at AOC 49-002 and analyzed for SVOCs and pesticides/PCBs at AOC 49-002. No SVOCs and pesticides/PCBs were detected at AOC 49-002 (Plate 3).

Radionuclides

A total of 77 samples (76 soil and 1 tuff) were collected at AOC 49-002 and analyzed for gamma-emitting radionuclides. Seventy-one samples (70 soil and 1 tuff) were collected and analyzed for isotopic plutonium and 64 samples (63 soil and 1 tuff) for americium-241and isotopic uranium. Table 6.2-3 presents the radionuclides detected or detected above BVs/FVs. Plate 4 shows the spatial distribution of detected radionuclides at AOC 49-002.

Americium-241 was detected above the soil FV (0.013 pCi/g) in one sample at an activity of 0.184 pCi/g. Americium-241 is retained as a COPC.

Plutonium-239/240 was detected above the soil FV (0.054 pCi/g) in one sample at an activity of 0.116 pCi/g. The quantile and slippage tests indicated site activities of plutonium-239/240 in soil are not statistically different from background (Figure H-7 and Table H-1). Plutonium-239/240 is not a COPC.

6.2.4.4 Nature and Extent of Contamination

The nature and extent of inorganic and radionuclide COPCs at AOC 49-002 were evaluated using the process described in section 5.2 and are discussed below.

Inorganic Chemicals

Inorganic COPCs at AOC 49-002 include aluminum, antimony, barium, copper, mercury, and zinc.

Aluminum was detected above the Qbt 2,3,4 BV in one sample at a concentration of 10,100 mg/kg. Concentrations increased with depth at location 49-609560 and decreased laterally. The residential and industrial SSLs were approximately 7.7 times (67,900 mg/kg below the residential SSL) and 128 times the maximum concentration, respectively. Aluminum was detected below BV in 70 other samples and the concentration of aluminum in the soil sample immediately overlying the tuff sample at location 49-609560 was below the soil BV. The spatial distribution of aluminum concentrations is not indicative of contamination from a release. The lateral extent of aluminum is defined, and further sampling for vertical extent is not warranted.

Antimony was detected above the soil BV in 1 sample at a concentration of 13.9 mg/kg and had DLs (0.934 mg/kg to 5.7 mg/kg) above the soil and Qbt 2,3,4 BVs in 69 samples. The residential and industrial SSLs were approximately 2.3 times and 37 times the maximum concentration and industrial SSLs were approximately 5.5 times and 91 times the maximum DL, respectively. The one detection above BV and the highest DLs (5.5 mg/kg to 5.7 mg/kg) were associated with RFI samples collected in 1995. For the

64 samples collected in 2009, antimony was detected below BV at 0.573 mg/kg in 1 sample and not detected, with DLs from 0.413 mg/kg to 2.02 mg/kg. The residential SSL was approximately 55 times the maximum detected concentration from 2009 and approximately 16 times the maximum DL from 2009. During the 2009 investigation, samples were collected adjacent to the 1995 sampling locations and antimony was not detected. Further sampling for extent of antimony is not warranted.

Barium was detected above the Qbt 2,3,4 BV in one sample at a concentration of 121 mg/kg. Concentrations increased with depth and decreased laterally. The residential SSL was approximately 129 times the maximum concentration. The lateral extent of barium is defined, and further sampling for vertical extent is not warranted

Copper was detected above the soil and Qbt 2,3,4 BVs in 3 soil samples and 1 tuff sample with a maximum concentration of 98.9 mg/kg. Only 1 depth was sampled at locations 49-07539 and 49-07548. Copper was either not detected above BV in the deeper sample or was not detected above BV at nearby locations 49-609544 and 49-609542, respectively. Concentrations did not change substantially with depth (0.29 mg/kg) at location 49-609560, decreased with depth at location 49-609544, and decreased laterally (the concentration in the surface sample at location 49-609560 was 5.47 mg/kg and below the soil BV [Appendix G, Pivot Tables]). The residential SSL was approximately 32 times the maximum concentration. The lateral extent of copper is defined, and further sampling for vertical extent is not warranted.

Mercury was detected above the soil BV in three samples with a maximum concentration of 0.72 mg/kg. Only one depth was sampled at locations 49-07536 and 49-07539. Mercury was either not detected above BV in the deeper sample or was not detected above BV at nearby locations 49-609545 and 49-609544, respectively. Concentrations decreased with depth at location 49-609545 and decreased laterally. The lateral and vertical extent of mercury are defined.

Zinc was detected above the soil BV in 10 samples with a maximum concentration of 446 mg/kg. Only 1 depth was sampled at locations 49-07536, 49-07539, and 49-07539. Zinc was not detected above BV in the deeper sample at nearby locations 49-609545 and 49-609542 but increased with depth at nearby location 49-609544. Concentrations increased with depth at locations 49-609543, decreased with depth at locations 49-609542, 49-609545, 49-609547, and 49-609558, and decreased laterally. The residential SSL was approximately 872 times the maximum concentration. The lateral extent of zinc is defined, and further sampling for vertical extent is not warranted.

Organic Chemicals

No organic chemicals were detected at AOC 49-002.

Radionuclides

Radionuclide COPCs at AOC 49-002 include americium-241.

Americium-241 was detected above the soil FV in one sample at an activity of 0.184 pCi/g. Activities increased with depth and decreased laterally. The residential SAL was approximately 451 times the maximum activity. The lateral extent of americium-241 is defined, and further sampling for vertical extent is not warranted.

6.2.5 Summary of Human Health Risk Screening

Industrial Scenario

No carcinogenic COPCs were identified in the 0.0 to 1.0–ft depth interval. The industrial HI is 0.04, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.005 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Construction Worker Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The construction worker HI is 0.4, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.02 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Residential Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The residential HI is approximately 0.6, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.06 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial, construction worker, and residential scenarios at AOC 49-002.

6.2.6 Summary of Ecological Risk Screening

Based on the evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for threatened and endangered [T&E] species), and LOAEL analyses, no potential unacceptable ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, red fox, and Mexican spotted owl exist at AOC 49-002.

6.3 SWMU 49-004, Landfill

6.3.1 Site Description and Operational History

SWMU 49-004 is a landfill in Area 6 West used from 1959 to 1961 for open-pit burning of combustible construction materials and for the burial of uncontaminated residues generated from other areas at TA-49 (Purtymun and Stoker 1987, 006688) (Figure 6.3-1). Wastes disposed of at this site were reportedly screened for radioactivity before burial (LANL 1992, 007670, p. 6.3-6). No documentation exists concerning disposal of hazardous chemicals, but disposal of such chemicals is unlikely based on the nature of activities conducted at TA-49. During the 1971 cleanup of TA-49, the landfill was reopened for disposal of uncontaminated materials, principally from Area 11. Similarly, the site was reopened during the 1984 general cleanup of TA-49 when a trench measuring 30 ft × 100 ft × 15 ft was excavated at the site for the disposal of uncontaminated solid materials (LANL 1992, 007670, p. 6.3-7).

The RFI work plan (LANL 1992, 007670) describes four open trenches located west of SWMU 49-004, although they are not part of SWMU 49-004 (Figure 6.3-1). The work plan also indicates these previously undocumented trenches were identified from a review of historical aerial photographs. The trenches were not present in photographs taken in 1935 but were present in photographs taken in 1954, 1965, and 1977. Construction of these trenches, therefore, appears to predate activities at TA-49. The trenches were examined during a 1991 field inspection and noted to be approximately 10 ft × 6 ft × 100 ft. One trench appeared to have been backfilled, and one passed through a prehistoric ruin. No evidence of debris was present in or around the trenches. The work plan also noted that interviews and archival searches did not identify additional information concerning these trenches (LANL 1992, 007670, pp. 6.3-11-6.3-12). The possibility that the trenches were utilized by the Laboratory for material disposal or other purposes cannot be categorically excluded (LANL 1997, 056594, p. 52).

In 2009, the Laboratory Cultural Resources Team evaluated the possible origin and nature of the four open trenches located west of SWMU 49-004. The documented results of the archeological assessment are presented in Appendix J of this supplemental investigation report.

The Laboratory Cultural Resource Team concluded that two of the trenches (Trenches B and C) are directly associated with visible ancestral pueblo masonry room blocks sites (LA 15861 and LA 15866A, respectively) and were purposely placed to gain information and/or artifacts from the trench excavations. The Laboratory Cultural Resources Team memorandum states that Trenches A and D could have also been used to explore ancestral field house structures; however, this does not preclude the possibility that one of these two trenches (Trench D) was later used for disposal of debris from TA-49.

6.3.2 Relationship to Other SWMUs and AOCs

SWMU 49-004 is the only site located within Area 6 West. The nearest SWMU or AOC is AOC 49-008(b), located approximately 700 ft southeast of SWMU 49-004.

6.3.3 Summary of Previous Investigations

During a 1987 environmental survey, surface soil samples (0.0 to 0.5 ft bgs) and vegetation samples were collected at the open-burning/landfill area and analyzed for TAL metals and radionuclides. Results showed elevated levels of radionuclides, lead, and beryllium (LANL 1992, 007670, p. 6.3-7).

During the June 1991 geophysical survey conducted at the open burning/landfill area, magnetic and electromagnetic anomalies observed were likely from cable and other metallic debris reportedly buried in the landfill. Survey results indicated that the trench extends northeast about 130 ft beyond the staked area to the edge of Water Canyon increasing total landfill lateral dimensions to approximately 35 ft × 330 ft (LANL 1992, 007670, pp. 6.3-7-6.3-10).

Evaluation of the 1991 geophysical survey results revealed that the 1987 survey sampling locations were not over the main body of the landfill (LANL 1992, 007670, p. 6.3-11).

During the 1995 RFI, a radiological survey was conducted on a 25- × 25-ft grid at SWMU 49-004. Based on survey results, an additional 18 survey points were added at the northwest corner of the grid. No radiologically contaminated areas were identified; however, field-screening results were above background levels at several locations (Blair 1996, 055332). Thirty-four surface (0.0 to 0.5 ft bgs) samples were collected from 34 locations on the sampling grid established over SWMU 49-004 and from the grid points added at the northwest corner of SWMU 49-004 based on the 1991 geophysical survey. The samples were field-screened for beta/gamma radiation and organic vapors and submitted for analysis by gamma spectroscopy. A subset of 18 of the samples were also submitted for analysis of isotopic plutonium and TAL metals (LANL 1997, 056594, pp. 53-67).

During the 1995 RFI, boreholes were drilled at 7 locations approximately 50 ft apart along the longitudinal axis of the SWMU 49-004 disposal area. The boreholes were advanced to a depth of 15 ft bgs or until undisturbed tuff was encountered, whichever occurred first. Cores were collected for each 5-ft interval; a total of 18 samples were collected from the 7 boreholes. All samples were field-screened for beta/gamma radiation and organic vapors and submitted for analysis by gamma spectroscopy. A subset of 9 samples (at least 1 from each borehole) was submitted for analysis of isotopic plutonium, TAL metals, and SVOCs.

Inorganic chemicals detected above background included aluminum, barium, calcium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, nickel, potassium, silver, uranium, vanadium, and zinc (LANL 2007, 098523). One organic chemical, 2-chloronaphthalene, was detected in one subsurface fill sample at SWMU 49-004. Radionuclides detected, or detected above BVs/FVs, included americium-241, cesium-137, plutonium-238, and plutonium-239/240. Historical sampling locations and detected concentrations are provided in plates, maps, and tables included in this report.

During the 1995 RFI, a gamma survey was conducted on a 10- × 10-ft grid over the four open trenches located west of SWMU 49-004. No radiologically contaminated areas were identified (LANL 1997, 056594, p. 53). Single auger holes were drilled at three of the four open trenches and the soil was examined. Each site had 1.5 to 3.0 ft of clay soil underlain by pumice. This same pumice material was on the piles of excavated soil at the ends of the trenches. No foreign debris was observed in the augered cuttings. Beta/gamma field screening of the cuttings indicated measurements below background. Based on field observations, it appeared that no material was buried in the trenches (LANL 1997, 056594, p. 53). No samples were collected from the four open trenches during the 1995 RFI.

6.3.4 Site Contamination

6.3.4.1 Soil, Rock, and Sediment Sampling

Based on previous investigation results, further characterization was required to assess potential contamination at SWMU 49-004. As a result, the following activities were completed as part of the 2009−2010 investigation.

- A total of 126 samples were collected from 64 locations at SWMU 49-004. At all but 2 locations, samples were collected at the surface (0.0 to 0.5 ft bgs) and from the subsurface (0.5 to 1.5 ft bgs). At 2 locations, a sample was collected only from the subsurface (0.5 to 1.5 ft bgs). All samples were analyzed at off-site fixed laboratories for TAL metals, gamma-emitting radionuclides, americium-241, isotopic plutonium, and isotopic uranium. Five samples were also submitted for analysis of strontium-90 and technetium-99.
- A total of 12 samples were collected from 4 boreholes within the footprint of the SWMU 49-004 landfill. Samples were collected from 3 depth intervals at each borehole over the range of 0.0 to 65.0 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, cyanide, perchlorate, explosive compounds, SVOCs, VOCs, americium-241, isotopic plutonium, isotopic uranium, and tritium.

The 2009–2010 sampling locations at SWMU 49-004 are presented on Plate 5. Table 6.3-1 presents the samples collected and analyses requested for SWMU 49-004. The geodetic coordinates of sampling locations are presented in Appendix C.

6.3.4.2 Soil, Rock, and Sediment Field-Screening Results

Organic vapors were not detected above 1.4 ppm during headspace (PID) screening of samples at SWMU 49-004. No radiological field-screening results exceeded twice the daily site background levels. Field-screening results are presented in Table 3.1-1. There were no changes to sampling or other activities as a result of health and safety-based field-screening results.

Seven shallow or shallow subsurface samples from SMWU 49-004 exceeded either the gross-alpha and/or -beta screening thresholds and additional samples were collected and submitted for appropriate laboratory analyses. The gross-alpha and/or -beta screening results that guided additional sampling are presented in Tables D-1 through D-5 in Appendix D.

6.3.4.3 Soil, Rock, and Sediment Sampling Analytical Results

Decision-level data at SWMU 49-004 consist of results from 190 samples (177 soil and 13 tuff) collected from 109 locations.

Inorganic Chemicals

A total of 164 samples (152 soil and 12 tuff) were collected at SWMU 49-004 and analyzed for TAL metals and 12 samples (3 soil and 9 tuff) for cyanide and perchlorate. Table 6.3-2 presents the inorganic chemicals above BVs and detected inorganic chemicals with no BVs. Plate 6 shows the spatial distribution of inorganic chemicals detected or detected above BVs at SWMU 49-004.

Aluminum was detected above the soil and Qbt 2,3,4 BVs (29,200 mg/kg and 7340 mg/kg) in one soil sample and five tuff samples with a maximum concentration of 35,100 mg/kg. The quantile and slippage tests indicated site concentrations of aluminum in soil are not statistically different from background (Figure H-8 and Table H-2). The Gehan and quantile tests indicated site concentrations of aluminum in tuff are statistically different from background (Figure H-9 and Table H-3). Aluminum is retained as a COPC.

Antimony was not detected above the soil and Qbt 2,3,4 BVs (0.83 mg/kg and 0.5 mg/kg) but had DLs (0.992 mg/kg to 6.5 mg/kg) above the BVs in 8 soil samples and 12 tuff samples. The quantile test indicated site concentrations of antimony in soil are statistically different from background (Figure H-10 and Table H-2). Antimony is retained as a COPC.

Barium was detected above the soil and Qbt 2,3,4 BVs (295 mg/kg and 46 mg/kg) in three soil samples and six tuff samples with a maximum concentration of 403 mg/kg. The Gehan and quantile tests indicated site concentrations of barium in soil are statistically different from background (Figure H-11 and Table H-2). The Gehan and quantile tests indicated site concentrations of barium in tuff are statistically different from background (Figure H-12 and Table H-3). Barium is retained as a COPC.

Beryllium was detected above the soil BV (1.83 mg/kg) in two samples at a concentration of 2 mg/kg. The quantile and slippage tests indicated site concentrations of beryllium in soil are not statistically different from background (Figure H-13 and Table H-2). Beryllium is not a COPC.

Cadmium was not detected above the soil BV (0.4 mg/kg) but had DLs (0.527 mg/kg to 0.69 mg/kg) above the BV in eight samples. The quantile and slippage tests indicated site concentrations of cadmium in soil are not statistically different from background (Figure H-14 and Table H-2). Cadmium is not a COPC.

Calcium was detected above the soil and Qbt 2,3,4 BVs (6120 mg/kg and 2200 mg/kg) in one soil sample and five tuff samples with a maximum concentration of 10800 mg/kg. The Gehan and quantile tests indicated site concentrations of calcium in soil are not statistically different from background (Figure H-15 and Table H-2). The Gehan and quantile tests indicated site concentrations of calcium in tuff are statistically different from background (Figure H-16 and Table H-3). Calcium is retained as a COPC.

Chromium was detected above the Qbt 2,3,4 BV (7.14 mg/kg) in five samples with a maximum concentration of 10.4 mg/kg. The Gehan and quantile tests indicated site concentrations of chromium in tuff are statistically different from background (Figure H-17 and Table H-3). Chromium is retained as a COPC.

Cobalt was detected above the soil and Qbt 2,3,4 BVs (8.64 mg/kg and 3.14 mg/kg) in nine soil samples and four tuff samples with a maximum concentration of 13.4 mg/kg. The Gehan and quantile tests indicated site concentrations of cobalt in soil are statistically different from background (Figure H-18 and Table H-2). The Gehan and quantile tests indicated site concentrations of cobalt in tuff are not statistically different from background (Figure H-19 and Table H-3). Cobalt is retained as a COPC.

Copper was detected above the soil and Qbt 2,3,4 BVs (14.7 mg/kg and 4.66 mg/kg) in 13 soil samples and 5 tuff samples with a maximum concentration of 339 mg/kg. The Gehan and quantile tests indicated site concentrations of copper in soil are statistically different from background (Figure H-20 and Table H-2). The Gehan and quantile tests indicated site concentrations of copper in soil are statistically different from background (Figure H-21 and Table H-3). Copper is retained as a COPC.

Iron was detected above the Qbt 2,3,4 BV (14,500 mg/kg) in one sample at a concentration of 16,400 mg/kg. The Gehan and quantile tests indicated site concentrations of iron in tuff are statistically different from background (Figure H-22 and Table H-3). Iron is retained as a COPC.

Lead was detected above the soil and Qbt 2,3,4 BVs (22.3 mg/kg and 11.2 mg/kg) in six soil samples and six tuff samples with a maximum concentration of 64.5 mg/kg. The quantile and slippage tests indicated site concentrations of lead in soil are not statistically different from background (Figure H-23 and Table H-2). The Gehan and quantile tests indicated site concentrations of lead in tuff are statistically different from background (Figure H-24 and Table H-3). Lead is retained as a COPC.

Magnesium was detected above the Qbt 2,3,4 BV (1690 mg/kg) in five samples with a maximum concentration of 2760 mg/kg. The Gehan and quantile tests indicated site concentrations of magnesium in tuff are statistically different from background (Figure H-25 and Table H-3). Magnesium is retained as a COPC.

Manganese was detected above the soil BV (671 mg/kg) in six samples with a maximum concentration of 1030 mg/kg. The quantile and slippage tests indicated site concentrations of manganese in soil are not statistically different from background (Figure H-26 and Table H-2). Manganese is not a COPC.

Mercury was detected above the soil BV (0.1 mg/kg) in one sample at a concentration of 0.11 mg/kg and had DLs (0.11 mg/kg to 0.12 mg/kg) above the BV in 4 samples. The detected concentration was only 0.01 mg/kg above the BV and the DLs were only 0.01 mg/kg to 0.12 mg/kg above the BV. Mercury was not detected or not detected above BVs in the other 155 samples (detected below BVs in 70 samples). Mercury is not a COPC.

Nickel was detected above the soil and Qbt 2,3,4 BVs (15.4 mg/kg and 6.58 mg/kg) in one soil sample and six tuff samples with a maximum concentration of 19.6 mg/kg. The Gehan and quantile tests indicated site concentrations of nickel in soil are statistically different from background (Figure H-27 and Table H-2). The quantile and slippage tests indicated site concentrations of nickel in tuff are statistically different from background (Figure H-28 and Table H-3). Nickel is retained as a COPC.

Perchlorate was detected in six samples with a maximum concentration of 0.00802 mg/kg. Perchlorate is retained as a COPC.

Potassium was detected above the soil BV (3460 mg/kg) in six samples with a maximum concentration of 4310 mg/kg. The Gehan and quantile tests indicated site concentrations of potassium in soil are not statistically different from background (Figure H-29 and Table H-2). Potassium is not a COPC.

Selenium was detected above the soil BV (1.52 mg/kg) in two samples with a maximum concentration of 1.9 mg/kg but had DLs (0.998 mg/kg to 1.14 mg/kg) above the Qbt 2,3,4 BV (0.3 mg/kg) in nine samples.

The Gehan and quantile tests indicated site concentrations of selenium in soil are statistically different from background (Figure H-30 and Table H-2). Selenium is retained as a COPC.

Silver was detected above the soil BV (1 mg/kg) in three samples with a maximum concentration of 11.6 mg/kg and had DLs (1.4 mg/kg to 1.6 mg/kg) above the BV in nine samples. Silver is retained as a COPC.

Sodium was detected above the soil BV (915 mg/kg) in three samples with a maximum concentration of 1840 mg/kg. The Gehan and quantile tests indicated site concentrations of sodium in soil are not statistically different from background (Figure H-31 and Table H-2). Sodium is not a COPC.

Thallium was detected above the soil BV (0.73 mg/kg) in 2 samples with a maximum concentration of 0.77 mg/kg and had DLs (0.97 mg/kg to 1.4 mg/kg) above the BV in 20 samples. The quantile and slippage tests indicated site concentrations of thallium in soil are not statistically different from background (Figure H-32 and Table H-2). Thallium is not a COPC.

Uranium was detected above the soil and Qbt 2,3,4 BVs (1.82 mg/kg and 2.4 mg/kg) in 19 soil samples and 3 tuff samples with a maximum concentration of 10.7 mg/kg. The Gehan and slippage tests indicated site concentrations of uranium in soil are statistically different from background (Figure H-33 and Table H-2). Uranium is retained as a COPC.

Vanadium was detected above the Qbt 2,3,4 BV (17 mg/kg) in four samples with a maximum concentration of 22.1 mg/kg. The quantile and slippage tests indicated site concentrations of vanadium in tuff are not statistically different from background (Figure H-34 and Table H-3). Vanadium is not a COPC.

Zinc was detected above the soil and Qbt 2,3,4 BVs (48.8 mg/kg and 63.5 mg/kg) in 25 soil samples and 2 tuff samples with a maximum concentration of 812 mg/kg. The Gehan and quantile tests indicated site concentrations of zinc in soil are statistically different from background (Figure H-35 and Table H-2). Zinc is retained as a COPC.

Organic Chemicals

A total of 12 samples (3 soil and 9 tuff) were collected at SWMU 49-004 and analyzed for explosive compounds, SVOCs, and VOCs. Table 6.3-3 summarizes the analytical results for detected organic chemicals. Plate 7 shows the spatial distribution of detected organic chemicals.

Organic chemicals detected at SWMU 49-004 include bis(2-ethylhexyl)phthalate, 2-chloronaphthalene, methylene chloride, 2-methylnaphthalene, naphthalene, and pyrene. The detected organic chemicals are retained as COPCs.

Radionuclides

A total of 178 samples (274 soil and 4 tuff) were collected at SWMU 49-004 and analyzed for gamma-emitting radionuclides, 164 samples (152 soil and 12 tuff) for isotopic plutonium, 138 samples (129 soil and 9 tuff) for americium-241 and isotopic uranium, 12 samples (3 soil and 9 tuff) for tritium, and 5 soil samples for strontium-90 and technetium-99. Table 6.3-4 presents the radionuclides detected or detected above BVs/FVs. Plate 8 shows the spatial distribution of detected radionuclides at SWMU 49-004.

Americium-241 was detected above the soil FV (0.013 pCi/g) in five samples, detected in one soil sample from below 1.0 ft bgs, and detected in one tuff sample with a maximum activity of 0.43 pCi/g. Americium-241 is retained as a COPC.

Cesium-134 was detected in one sample at an activity of 0.073 pCi/g. Cesium-134 is retained as a COPC.

Cesium-137 was detected above the soil FV (1.65 pCi/g) in 4 samples with a maximum activity of 3.28 pCi/g. Cesium-137 is retained as a COPC.

Plutonium-238 was detected above the soil FV (0.023 pCi/g) in two samples and detected in one soil sample below 1.0 ft bgs with a maximum activity of 0.025 pCi/g. Plutonium-238 is retained as a COPC.

Plutonium-239/240 was detected above the soil FV (0.054 pCi/g) in 16 samples, detected in 5 soil samples from below 1.0 ft bgs, and detected in 3 tuff samples with a maximum activity of 0.435 pCi/g. Plutonium-239/240 is retained as a COPC.

Tritium was detected in two samples with a maximum activity of 0.0314 pCi/g. Tritium is retained as a COPC.

6.3.4.4 Nature and Extent of Contamination

The nature and extent of inorganic and radionuclide COPCs at SWMU 49-004 were evaluated using the process described in section 5.2 and are discussed below.

Inorganic Chemicals

Inorganic COPCs at SWMU 49-004 include aluminum, antimony, barium, calcium, chromium, cobalt, copper, iron, lead, magnesium, nickel, perchlorate, selenium, silver, uranium, and zinc.

Aluminum was detected above the soil and Qbt 2,3,4 BVs in 1 soil sample and 5 tuff samples with a maximum concentration of 35,100 mg/kg. Concentrations decreased with depth at locations 49-609883, 49-609884, and 49-609885. Only one sample was analyzed for metals at location 49-06219, but concentrations decreased with depth in deeper samples at location 49-609885, which is adjacent to location 49-06219 (Plate 6). Concentrations increased with depth at location 49-608967. The residential and industrial SSLs were approximately 2.2 times (42,900 mg/kg below the SSL) and 37 times the maximum concentration at location 49-608967. The concentration of aluminum in the soil sample immediately overlying the tuff sample at location 49-608967 was below the soil BV, and aluminum was not detected above BV in deeper samples from adjacent RFI sample location 49-06217. Concentrations decreased laterally. The lateral extent of aluminum is defined, and further sampling for vertical extent is not warranted.

Antimony was not detected above the soil and Qbt 2,3,4 BVs but had DLs (0.992 mg/kg to 6.5 mg/kg) above the BVs in 8 soil samples and 12 tuff samples. The residential and industrial SSLs were approximately 4.8 times and 80 times the maximum DL. The highest DLs (5.7 mg/kg to 6.5 mg/kg) were associated with RFI samples collected in 1995. For the 138 samples collected in 2009, antimony was detected below BV in 96 samples with concentrations ranging from 0.074 mg/kg to 0.45 mg/kg and not detected in 42 samples, with DLs from 0.17 mg/kg to 1.15 mg/kg. The residential SSL was approximately 70 times the maximum detected concentration from 2009 and approximately 27 times the maximum DL from 2009. During the 2009 investigation, samples were collected adjacent to the 1995 sampling locations and antimony was not detected. Further sampling for extent of antimony is not warranted.

Barium was detected above the soil and Qbt 2,3,4 BVs in three soil samples and six tuff samples with a maximum concentration of 403 mg/kg. Concentrations increased with depth at locations 49-608961, 49-608964, and 49-608467; decreased with depth at locations 49-609882, 49-609883, 49-609884, and 49-609885; and decreased laterally. The residential SSL was approximately 38 times the maximum concentration. The lateral extent of barium is defined, and further sampling for vertical extent is not warranted.

Calcium was detected above the soil and Qbt 2,3,4 BVs in one soil sample and five tuff samples with a maximum concentration of 10,800 mg/kg. Concentrations increased with depth at location 49-608998 and decreased with depth at locations 49-609882, 49-609883, and 49-609884. Only one sample at location 49-06219 was analyzed for metals, but concentrations decreased with depth in deeper samples at location 49-609885, which is next to location 49-06219 (Plate 6). Concentrations decreased laterally. The NMED residential essential nutrient SSL was approximately 1200 times the maximum concentration. The lateral extent of calcium is defined, and further sampling for vertical extent is not warranted.

Chromium was detected above the Qbt 2,3,4 BV in five samples with a maximum concentration of 10.4 mg/kg. Concentrations decreased with depth at locations 49-609883, 49-609884, and 49-609885. Only one sample at location 49-06219 was analyzed for metals, but concentrations decreased with depth in deeper samples at location 49-609885, which is next to location 49-06219 (Plate 6). Concentrations decreased laterally. As discussed in section 4.2, because there was no known use of hexavalent chromium at this site, the results were compared with the residential SSL for trivalent chromium (117,000 mg/kg). The residential trivalent chromium SSL was approximately 11,200 times the maximum concentration. The lateral extent of chromium is defined, and further sampling for vertical extent is not warranted.

Cobalt was detected above the soil and Qbt 2,3,4 BVs in nine soil samples and four tuff samples with a maximum concentration of 13.4 mg/kg. Concentrations increased with depth at locations 49-06214, 49-608961, 49-608989, 49-609013, and 49-609017 and decreased with depth at locations 49-06213, 49-608971, 49-609008, 49-609016, 49-609883, 49-609884, and 49-609885. Only one sample at location 49-06219 was analyzed for metals, but concentrations decreased with depth in deeper samples at location 49-609885, which is next to location 49-06219 (Plate 6). Vertical extent at location 49-06214 is defined by deeper samples below BV at location 49-609882, which is next to location 49-06214 (Plate 6). Concentrations increased laterally at locations 49-609013, 49-609016, and 49-609017. The residential and industrial SSLs were approximately 1.7 times and 26 times the maximum concentration. All locations where extent of cobalt is not defined are outside the footprint of the landfill, and the spatial distribution of detections above BV does not show a pattern or trend indicating contamination. Further sampling for extent of cobalt is not warranted.

Copper was detected above the soil and Qbt 2,3,4 BVs in 13 soil samples and 5 tuff samples with a maximum concentration of 339 mg/kg. Concentrations increased with depth at locations 49-06216, 49-608979, and 49-608998 and did not change substantially with depth (0.6 mg/kg) at location 49-608981. Only one sample was analyzed for metals at location 49-06219, but concentrations decreased with depth in a deeper sample at location 49-609885, which is next to location 49-06219 (Plate 6). Only one depth was sampled at location 49-06222, but copper was not detected above BV in a deeper sample at location 49-608972, which is next to location 49-06222 (Plate 6). Concentrations decreased with depth at all other locations and decreased laterally. The residential and industrial SSLs were approximately 26 times and 432 times the maximum concentration where vertical extent is not defined (120 mg/kg at location 49-608998), respectively. The lateral extent of copper is defined, and further sampling for vertical extent is not warranted.

Iron was detected above the Qbt 2,3,4 BV in one sample at a concentration of 16,400 mg/kg. Concentrations decreased with depth and decreased laterally. The lateral and vertical extent of iron are defined.

Lead was detected above the soil and Qbt 2,3,4 BVs in six soil samples and six tuff samples with a maximum concentration of 64.5 mg/kg. Concentrations increased with depth at locations 49-608978, 49-608998, and 49-609882 but were below the maximum soil and Qbt 2,3,4 background concentrations (28 mg/kg and 15.5 mg/kg, respectively) at locations 49-608978 and 49-609882. Only one sample at location 49-06219 was analyzed for metals, but concentrations decreased with depth in deeper samples at location 49-609885, which is next to location 49-06219 (Plate 6). Only one depth was sampled at location 49-06222, but lead was not detected above BV in a deeper sample at location 49-608972, which is next to location 49-06222 (Plate 6). Concentrations decreased with depth at all other locations and decreased laterally. The residential and industrial SSLs were approximately 6.2 times and 12 times the maximum concentration (335 mg/kg and 735 mg/kg below the respective SSLs), respectively. The residential and industrial SSLs were approximately 8.8 times and 18 times the maximum concentration where vertical extent is not defined (45.5 mg/kg at location 49-608998), respectively. Lead was detected above BV at 11 of 90 sample locations, and the spatial distribution of detections above BV does not show a pattern or trend indicating contamination. The lateral extent of lead is defined, and further sampling for vertical extent is not warranted.

Magnesium was detected above the Qbt 2,3,4 BV in five samples with a maximum concentration of 2760 mg/kg. Only one sample was analyzed for metals at location 49-06219, but concentrations decreased with depth in deeper samples at location 49-609885, which is next to location 49-06219 (Plate 6). Concentrations decreased with depth at all other locations and decreased laterally. The NMED residential essential nutrient SSL was 123 times the maximum concentration. The lateral extent of magnesium is defined, and further sampling for vertical extent is not warranted.

Nickel was detected above the soil and Qbt 2,3,4 BVs in one soil sample and six tuff samples with a maximum concentration of 19.6 mg/kg. Concentrations increased with depth at location 49-608979 and decreased with depth at locations 49-609882, 49-609883, 49-609884, and 49-609885. Only one sample at location 49-06219 was analyzed for metals, but concentrations decreased with depth in deeper samples at location 49-609885, which is next to location 49-06219 (Plate 6). Concentrations decreased laterally. The residential SSL was approximately 80 times the maximum concentration. The lateral extent of nickel is defined, and further sampling for vertical extent is not warranted.

Perchlorate was detected in six samples with a maximum concentration of 0.00802 mg/kg. Concentrations decreased with depth at all locations and decreased laterally. The lateral and vertical extent of perchlorate are defined.

Selenium was detected above the soil BV in two samples with a maximum concentration of 1.9 mg/kg and had DLs (0.998 mg/kg to 1.14 mg/kg) above the Qbt 2,3,4 BV in nine samples. Concentrations increased with depth at locations 49-608998 and 49-609021 and increased laterally at location 49-609021. The residential SSL was approximately 920 times the maximum concentration and 1540 times the maximum DL. Further sampling for extent of selenium is not warranted.

Silver was detected above the soil BV in three samples with a maximum concentration of 11.6 mg/kg and had DLs (1.4 mg/kg to 1.6 mg/kg) above the BV in nine samples. Concentrations increased with depth at location 49-608998, decreased with depth at locations 49-06215 and 49-608978, and decreased laterally. The residential SSL was approximately 34 times the maximum concentration and 244 times the maximum DL. The lateral extent of silver is defined, and further sampling for vertical extent is not warranted.

Uranium was detected above the soil and Qbt 2,3,4 BVs in 19 soil samples and 3 tuff samples with a maximum concentration of 10.7 mg/kg. Concentrations did not change substantially with depth (0.1 mg/kg and 0.2 mg/kg, respectively) at locations 49-06213 and 49-06214. Only one depth was sampled or only one sample was analyzed for uranium at 18 other locations, and no samples collected at nearby sampling locations with deeper samples were analyzed for uranium (Plate 6). Concentrations increased laterally at location 49-06227 by 2 mg/kg. All 2010 samples were analyzed for isotopic uranium and the uranium isotopes were not detected above BVs. The residential SSL was approximately 22 times the maximum concentration. Further sampling for extent of uranium is not warranted.

Zinc was detected above the soil and Qbt 2,3,4 BVs in 25 soil samples and 2 tuff samples with a maximum concentration of 812 mg/kg. Concentrations increased with depth at locations 49-608968, 49-608984, and 49-608998 and did not change substantially with depth (0.6 mg/kg) at location 49-608981. Only one depth was sampled at locations 49-06116, 49-06117, 49-06118, 49-06137, 49-06138, 49-06141, 49-06142, 49-06144, and 49-06145. Concentrations decreased with depth or were below BVs in deeper samples collected near all these locations (location 49-06218 near 49-06116; location 49-608969 near 49-06117; location 49-608970 near 49-06118; location 49-608977 near 49-06137; location 49-608978 near 49-06138; location 49-608980 near 49-06141; and location 49-608982 near 49-06144), except locations 49-06142 and 49-06145 (Plate 6). Only one sample was analyzed for zinc at location 49-06217, but concentrations did not change substantially with depth (2.4 mg/kg) compared with the surface sample collected at nearby location 49-608981 (Plate 6). Concentrations decreased with depth at all other locations and decreased laterally. The residential SSL was approximately 29 times the maximum concentration. The lateral extent of zinc is defined, and further sampling for vertical extent is not warranted.

Organic Chemicals

Organic COPCs at SWMU 49-004 include bis(2-ethylhexyl)phthalate, 2-chloronaphthalene, methylene chloride, 2-methylnaphthalene, naphthalene, and pyrene.

Bis(2-ethylhexyl)phthalate was detected in one sample at a concentration of 10.1 mg/kg. Concentrations decreased with depth and decreased laterally. The lateral and vertical extent of bis(2-ethylhexyl)phthalate are defined.

Chloronaphthalene[2-] was detected in one sample at a concentration of 0.36 mg/kg. Concentrations decreased with depth and decreased laterally. The lateral and vertical extent of 2-chloronaphthalene are defined.

Methylene chloride was detected in one sample at a concentration of 0.00274 mg/kg. Concentrations decreased with depth and decreased laterally. The lateral and vertical extent of methylene chloride are defined.

Methylnaphthalene[2-] was detected in one sample at a concentration of 0.0138 mg/kg. Concentrations decreased with depth and decreased laterally. The lateral and vertical extent of 2-methylnaphthalene are defined.

Naphthalene was detected in one sample at a concentration of 0.0207 mg/kg. Concentrations decreased with depth and decreased laterally. The lateral and vertical extent of naphthalene are defined.

Pyrene was detected in one sample at a concentration of 0.0172 mg/kg. Concentrations decreased with depth and decreased laterally. The lateral and vertical extent of pyrene are defined.

Radionuclides

Radionuclide COPCs at SWMU 49-004 include americium-241, cesium-134, cesium-137, plutonium-238, plutonium-239/240, and tritium.

Americium-241 was detected above the soil FV in five samples, detected in one soil sample below 1.0 ft bgs, and detected in one tuff sample with a maximum activity of 0.43 pCi/g. Activities did not change substantially with depth (0.091 pCi/g) at location 49-608985 and decreased with depth at locations 49-06214 and 49-609883. Only one depth was sampled at locations 49-06106, 49-06108, and 49-06233, but americium-241 was not detected in deeper samples collected near these locations (location 49-608962 near 49-06106; location 49-608964 near 49-06108; and location 49-608972 near location 49-06223) (Plate 8). Activities decreased laterally. The residential SAL was approximately 193 times the maximum activity. The lateral extent of americium-241 is defined, and further sampling for vertical extent is not warranted.

Cesium-134 was detected in one sample at an activity of 0.073 pCi/g. Activities decreased with depth and decreased laterally. The lateral and vertical extent of cesium-134 are defined.

Cesium-137 was detected above the soil FV in four samples with a maximum activity of 3.28 pCi/g. Only one depth was sampled at locations 49-06221, 49-06222, 49-06225, and 49-06227. Cesium-137 was not detected in deeper samples collected near these locations (location 49-608973 near 49-06221; location 49-608972 near 49-06222; location 49-608974 near 49-06225; and location 49-608976 near 49-06227) (Plate 8). Activities decreased laterally. The lateral and vertical extent of cesium-137 are defined.

Plutonium-238 was detected above the soil FV in one sample and detected in one soil sample below 1.0 ft bgs with a maximum activity of 0.025 pCi/g. Only one depth was sampled at location 49-06137, and only one sample was analyzed for isotopic plutonium at location 49-06216. Plutonium-238 was not detected in deeper samples collected near these locations (location 49-608977 near 49-06137 and location 49-609884 near 49-06216) (Plate 8). Activities decreased laterally. The lateral and vertical extent of plutonium-238 are defined.

Plutonium-239/240 was detected above the soil FV in 16 samples, detected in 5 soil samples below 1.0 ft bgs, and detected in 3 tuff samples with a maximum activity of 0.435 pCi/g. Activities increased with depth at location 49-608985, did not change substantially with depth (0.023 pCi/g and 0.047 pCi/g, respectively) at locations 49-06213 and 49-609014, and decreased with depth at locations 49-06214, 49-609008, 49-609013, 49-609882, and 49-609883. Only 1 depth was sampled at locations 49-06106, 49-06107, 49-06118, 49-06221, 49-06222, 49-06226, and 49-06227, and only 1 sample was analyzed for isotopic plutonium at locations 49-06215, 49-06216, 49-06217, and 49-06218. Plutonium-239/240 was not detected in deeper samples collected near these locations (location 49-608962 near 49-06106; location 49-608963 near 49-06107; location 49-608970 near 49-06118; location 49-608965 near 49-06215; location 49-609884 near 49-06216; location 49-609883 near 49-06217; location 49-609883 near 49-06218; location 49-608973 near 49-06221; location 49-608972 near 49-06222; location 49-608975 near 49-06226; and location 49-608976 near 49-06227) (Plate 8). Activities did not change substantially laterally (0.022 pCi/g and 0.057 pCi/g, respectively) at locations 49-609013 and 49-609014. The residential SAL was approximately 182 times the maximum activity. Further sampling for extent of plutonium-239/240 is not warranted.

Tritium was detected in two samples with a maximum activity of 0.0314 pCi/g. Activities decreased with depth at each location and decreased laterally. The lateral and vertical extent of tritium are defined.

6.3.4.5 Subsurface Vapor Sampling and Results

Two pore-gas samples were collected from one borehole (location 49-609882) and analyzed for VOCs and tritium. Table 6.3-5 presents the samples collected and analyses requested for SWMU 49-004.

Table 6.3-6 summarizes the analytical results for detected VOCs in pore gas. Plate 7 shows the spatial distribution of detected VOCs. Table 6.3-7 presents the tritium detected in pore gas. Plate 8 shows the spatial distribution of detected tritium.

VOCs detected in pore gas at SWMU 49-004 include acetone; benzene; 2-butanone; chloromethane; dichlorodifluoromethane; ethylbenzene; 4-ethyltoluene; styrene; toluene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; total xylenes; 1,2-xylene; and 1,3-xylene+1,4-xylene. The detected VOCs are retained as COPCs.

Tritium was detected in one sample with a maximum activity of 674 pCi/L. Tritium is retained as a COPC.

Nature and Extent of Contamination in Subsurface Pore Gas

The approved work plan (LANL 2008, 102215; NMED 2008, 100465) prescribed the collection of two pore-gas samples from the bottom of the landfill and TD at one of the boreholes drilled at SWMU 49-004 to determine whether the boring should be completed as a vapor-monitoring well. If VOCs were detected in the vapor-phase sample at concentrations greater than 10% of the pore-gas screening levels presented in section 4.5 or if tritium was detected in the vapor-phase sample at a concentration greater than the groundwater MCL (20,000 pCi/L), the borehole would be completed as a vapor-monitoring well.

Screening was performed for each of the VOCs detected in pore-gas samples collected from SWMU 49-004 using the maximum detected concentration. These results show that the SVs are below 0.1 in all cases, indicating that VOCs in subsurface pore gas are not a potential source of groundwater contamination (Table 4.5-2).

The maximum detected tritium activity at SWMU 49-004 (674 pCi/L) is less than the groundwater MCL (20,000 pCi/L). Therefore, tritium is not a potential source of groundwater contamination.

The concentrations of all VOCs were less the 10% of the pore-gas screening levels for groundwater protection and the maximum tritium activity was less than the MCL. Therefore, the borehole at SWMU 49-004 was not completed as a vapor-monitoring well.

6.3.5 Summary of Human Health Risk Screening

Industrial Scenario

The total excess cancer risk for the industrial scenario is 2×10^{-7}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2015, 600915). The industrial HI is 0.05, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.3 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Construction Worker Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0-ft depth interval. The construction worker HI is 0.7, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.5 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Residential Scenario

The total excess cancer risk for the residential scenario is 8×10^{-6}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2015, 600915). The residential HI is approximately 1, which is equivalent to the NMED target HI of 1 (NMED 2015, 600915). The total dose is 1 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial, construction worker, and residential scenarios at SWMU 49-004.

6.3.6 Summary of Ecological Risk Screening

Based on the evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of exposure point concentrations and screening levels to background concentrations, no potential unacceptable ecological risks to the earthworm, plant, American robin, American kestrel, pocket gopher, deer mouse, montane shrew, desert cottontail, red fox, and Mexican spotted owl exist at SWMU 49-004.

6.4 SWMU 49-005(a), Landfill

6.4.1 Site Description and Operational History

SWMU 49-005(a) is an inactive landfill located within Area 10 (Figure 6.2-1). The landfill, described as a small pit, was constructed north of the road that runs east from Area 10. SWMU 49-005(a) was constructed in 1984 as a disposal area for nonradiologically contaminated debris generated during the 1984 general surface cleanup of TA-49 (LANL 1997, 056594, p. 25).

6.4.2 Relationship to Other SWMUs and AOCs

SWMU 49-005(a) is located within Area 10, which also includes AOC 49-002. SWMU 49-005(a) is located approximately 65 ft east of AOC 49-002 and is within the area sampled to characterize potential releases from AOC 49-002.

6.4.3 Summary of Previous Investigations

During the 1995 RFI, a radiological survey was conducted over the landfill area; no measurements above background were detected. Two surface samples (0.0 to 0.5 ft bgs) and two subsurface samples (4.0 to 9.0 ft and 7.3 to 10.0 ft bgs) were collected from two borehole locations within the suspected landfill. The samples were field-screened for beta/gamma radiation and submitted for analyses of isotopic plutonium, TAL metals, and SVOCs and by gamma spectroscopy. Inorganic chemicals detected above BVs included arsenic, barium, beryllium, calcium, chromium, copper, magnesium, nickel, potassium, and uranium. Two organic chemicals [bis(2-ethylhexyl)phthalate and 2-butanone] were detected. Radionuclides detected or detected above BVs/FVs included plutonium-238 and plutonium-239/240 (LANL 1997, 056594, pp. 25–35). Sampling locations and detected concentrations are provided in plates, maps, and tables included in this report.

6.4.4 Site Contamination

6.4.4.1 Soil, Rock, and Sediment Sampling

Based on previous investigation results, further characterization was required to assess potential contamination at SWMU 49-005(a). As a result, the following activities were completed as part of the 2009−2010 investigation.

- A total of 14 samples were collected from 4 locations around the perimeter of SWMU 49-005(a). At 3 locations, samples were collected from 3 depth intervals within the range of 0.0 to 10.0 ft bgs. A 1 location, samples were collected from 5 depth intervals within the range of 0.0 to 10.0 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, cyanide, nitrate, perchlorate, explosive compounds, SVOCs, VOCs, americium-241, isotopic plutonium, isotopic uranium, and tritium.

The 2009–2010 sampling locations at SWMU 49-005(a) are shown on Plate 1. Table 6.4-1 presents the samples collected and analyses requested for SWMU 49-005(a). The geodetic coordinates of sampling locations are presented in Table 3.1-1.

6.4.4.2 Soil, Rock, and Sediment Field-Screening Results

Organic vapors were not detected above 0.7 ppm during headspace (PID) screening of samples at SWMU 49-005(a). No radiological screening results exceeded twice the daily site background levels. The field-screening results are presented in Table 3.1-3. There were no changes to sampling or other activities as a result of field-screening results.

6.4.4.3 Soil, Rock, and Sediment Sampling Analytical Results

Decision-level data at SWMU 49-005(a) consist of results from 18 samples (7 soil and 11 tuff) collected from 6 locations.

Inorganic Chemicals

A total of 18 samples (7 soil and 11 tuff) were collected at SWMU 49-005(a) and analyzed for TAL metals and 14 samples (5 soil and 9 tuff) for cyanide, nitrate, and perchlorate. Two soil samples were also analyzed for total uranium. Table 6.4-2 presents the inorganic chemicals above BVs and detected inorganic chemicals with no BVs. Plate 2 shows the spatial distribution of inorganic chemicals detected or detected above BVs at SWMU 49-005(a). Because fewer than 8 soil samples were collected, statistical tests could not be performed for soil.

Aluminum was detected above the Qbt 2,3,4 BV (7340 mg/kg) in six samples with a maximum concentration of 21,900 mg/kg. The Gehan and quantile tests indicated site concentrations of aluminum in tuff are statistically different from background (Figure H-36 and Table H-4). Aluminum is retained as a COPC.

Antimony was not detected above the Qbt 2,3,4 BV (0.5 mg/kg) but had DLs (0.75 mg/kg to 0.81 mg/kg) above BV in two samples. Antimony is retained as a COPC.

Arsenic was detected above the Qbt 2,3,4 BV (2.79 mg/kg) in four samples with a maximum concentration of 3.4 mg/kg. The Gehan and quantile tests indicated site concentrations of arsenic in tuff are statistically different from background (Figure H-37 and Table H-4). Arsenic is retained as a COPC.

Barium was detected above the Qbt 2,3,4 BV (46 mg/kg) in eight samples with a maximum concentration of 165 mg/kg. The Gehan and quantile tests indicated site concentrations of barium in tuff are statistically different from background (Figure H-38 and Table H-4). Barium is retained as a COPC.

Beryllium was detected above the Qbt 2,3,4 BV (1.21 mg/kg) in one sample at a concentration of 1.9 mg/kg. The Gehan and quantile tests indicated site concentrations of beryllium in tuff are statistically different from background (Figure H-39 and Table H-4). Beryllium is retained as a COPC.

Calcium was detected above the Qbt 2,3,4 BV (2200 mg/kg) in four samples with a maximum concentration of 3320 mg/kg. The Gehan and quantile tests indicated site concentrations of calcium in tuff are statistically different from background (Figure H-40 and Table H-4). Calcium is retained as a COPC.

Chromium was detected above the Qbt 2,3,4 BV (7.14 mg/kg) in six samples with a maximum concentration of 18.4 mg/kg. The Gehan and quantile tests indicated site concentrations of chromium in tuff are statistically different from background (Figure H-41 and Table H-4). Chromium is retained as a COPC.

Cobalt was detected above the Qbt 2,3,4 BV (3.14 mg/kg) in four samples with a maximum concentration of 6.4 mg/kg. The Gehan and quantile tests indicated site concentrations of cobalt in tuff are statistically different from background (Figure H-42 and Table H-4). Cobalt is retained as a COPC.

Copper was detected above the Qbt 2,3,4 BV (4.66 mg/kg) in seven samples with a maximum concentration of 8.5 mg/kg. The Gehan and quantile tests indicated site concentrations of copper in tuff are statistically different from background (Figure H-43 and Table H-4). Copper is retained as a COPC.

Cyanide was not detected above the soil and Qbt 2,3,4 BVs (0.5 mg/kg) but had DLs (0.51 mg/kg to 0.59 mg/kg) above the BVs in five soil samples and nine tuff samples. The DLs were only 0.01 mg/kg to 0.09 mg/kg above the BV and were 10.6 mg/kg to 10.7 mg/kg below the residential SSL. Cyanide was not detected with DLs below BVs in the other four samples. Laboratory background soil samples were not analyzed for cyanide and the BV is based on DLs (LANL 1998, 059730). DLs slightly greater than BV, therefore, are not necessarily indicative of potential cyanide contamination. SWMU 49-005(a) was a landfill used to dispose of debris from surface cleanup activities and there is no history of cyanide use at the site. Cyanide is not a COPC.

Lead was detected above the Qbt 2,3,4 BV (11.2 mg/kg) in two samples with a maximum concentration of 12.3 mg/kg. The quantile and slippage tests indicated site concentrations of lead in tuff are not statistically different from background (Figure H-44 and Table H-4). Lead is not a COPC.

Magnesium was detected above the Qbt 2,3,4 BV (1690 mg/kg) in seven samples with a maximum concentration of 3720 mg/kg. The Gehan and quantile tests indicated site concentrations of magnesium in tuff are statistically different from background (Figure H-45 and Table H-4). Magnesium is retained as a COPC.

Mercury was not detected above the soil and Qbt 2,3,4 BVs (0.1 mg/kg for both) but had DLs (0.11 mg/kg to 0.12 mg/kg) above the BV in 1 soil sample and 2 tuff samples. The DLs were only 0.01 mg/kg to 0.02 mg/kg above the BV. Mercury was not detected or not detected above BV in the other 15 samples (detected below BV in 12 samples). Mercury is not a COPC.

Nickel was detected above the Qbt 2,3,4 BV (6.58 mg/kg) in seven samples with a maximum concentration of 12.1 mg/kg. The quantile and slippage tests indicated site concentrations of nickel in tuff are statistically different from background (Figure H-46 and Table H-4). Nickel is retained as a COPC.

Nitrate was detected in 14 samples with a maximum concentration of 1.8 mg/kg. Nitrate is naturally occurring and the concentrations reflect naturally occurring levels of nitrate. Nitrate is not a COPC.

Perchlorate was detected in one sample at a concentration of 0.0037 mg/kg. Perchlorate is retained as a COPC.

Potassium was detected above the Qbt 2,3,4 BV (3500 mg/kg) in one sample at a concentration of 4090 mg/kg. The Gehan and quantile tests indicated site concentrations of potassium in tuff are not statistically different from background (Figure H-47 and Table H-4). Potassium is not a COPC.

Selenium was detected above the Qbt 2,3,4 BV (0.3 mg/kg) in nine samples with a maximum concentration of 1.3 mg/kg and had DLs (0.81 mg/kg and 0.88 mg/kg) above the BV in two samples. Selenium is retained as a COPC.

Thallium was not detected above the soil and Qbt 2,3,4 BVs (0.73 mg/kg and 1.1 mg/kg) but had DLs (1.4 mg/kg to 1.5 mg/kg) above the BVs in 4 samples. Because there were no detections of thallium, statistical tests could not be performed. The DLs were similar to the maximum soil background concentration (1 mg/kg) and below or similar to the two highest Qbt 2,3,4 background concentrations (1.3 mg/kg and 1.7 mg/kg). Thallium was not detected or not detected above BVs in the other 14 samples (detected below BVs in 9 samples). Thallium is not a COPC.

Uranium was detected above the soil and Qbt 2,3,4 BVs (1.82 mg/kg and 2.4 mg/kg) in two soil samples and one tuff sample with a maximum concentration of 4.09 mg/kg. Uranium is retained as a COPC.

Vanadium was detected above the Qbt 2,3,4 BV (17 mg/kg) in three samples with a maximum concentration of 22.6 mg/kg. The Gehan and quantile tests indicated site concentrations of vanadium in tuff are statistically different from background (Figure H-48 and Table H-4). Vanadium is retained as a COPC.

Organic Chemicals

A total of 14 samples (5 soil and 9 tuff) were collected at SWMU 49-005(a) and analyzed for explosive compounds, SVOCs, and VOCs. Table 6.4-3 summarizes the analytical results for detected organic chemicals. Plate 3 shows the spatial distribution of detected organic chemicals.

Organic chemicals detected at SWMU 49-005(a) include bis(2-ethylhexyl)phthalate and 2-butanone. The detected organic chemicals are retained as COPCs.

Radionuclides

A total of 14 samples (5 soil and 9 tuff) were collected at SWMU 49-005(a) and analyzed for americium-241, isotopic plutonium, isotopic uranium and tritium and 4 samples (2 soil and 2 tuff) for gamma-emitting radionuclides. Table 6.4-4 presents the radionuclides detected or detected above BVs/FVs. Plate 4 shows the spatial distribution of detected radionuclides at SWMU 49-005(a).

Plutonium-238 was detected above the soil FV (0.023 pCi/g) in one sample and detected in one tuff sample with a maximum activity of 0.032 pCi/g. Plutonium-238 is retained as a COPC.

Plutonium-239/240 was detected above the soil FV (0.054 pCi/g) in one sample at an activity of 0.083 pCi/g. Plutonium-239/240 is retained as a COPC.

6.4.4.4 Nature and Extent of Soil and Rock Contamination

The nature and extent of inorganic, organic, and radionuclide COPCs at SWMU 49-005(a) were evaluated using the process described in section 5.2 and are discussed below.

Inorganic Chemicals

Inorganic COPCs at SWMU 49-005(a) include aluminum, antimony, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, magnesium, nickel, perchlorate, selenium, uranium, and vanadium.

Aluminum was detected above the Qbt 2,3,4 BV in six samples with a maximum concentration of 21,900 mg/kg. Concentrations increased with depth at locations 49-07512 and 49-07527 and decreased with depth at locations 49-609986, 49-609987, and 49-609988. Concentrations decreased laterally. The residential and industrial SSLs were approximately 3.6 times (56,100 mg/kg below the residential SSL) and 59 times the maximum concentration. All detections of aluminum above BV were in tuff samples and aluminum was detected below BV in overlying soil samples at all locations. The vertical distribution of aluminum is not indicative of contamination. The lateral extent of aluminum is defined, and further sampling for vertical extent is not warranted.

Antimony was not detected above the Qbt 2,3,4 BV but had DLs (0.75 mg/kg to 0.81 mg/kg) above the BV in two samples. The residential SSL was approximately 38 times the maximum DL. Further sampling for extent of antimony is not warranted.

Arsenic was detected above the Qbt 2,3,4 BV in four samples with a maximum concentration of 3.4 mg/kg. Concentrations increased with depth at location 49-07527 and decreased with depth at locations 49-609986, 49-609987, and 49-609988. Concentrations did not change substantially laterally (0.5 mg/kg). All detections of arsenic above BV were in tuff samples and arsenic was detected below BV in overlying soil samples at all locations. All concentrations were below the maximum Qbt 2,3,4 background concentration (5 mg/kg). The vertical distribution of arsenic is not indicative of contamination. Further sampling for extent of arsenic is not warranted.

Barium was detected above the Qbt 2,3,4 BV in eight samples with a maximum concentration of 165 mg/kg. Concentrations increased with depth at locations 49-07512 and 49-07527 and decreased with depth at locations 49-609986, 49-609987, and 49-609988. Concentrations increased laterally. The residential SSL was approximately 165 times the maximum concentration. Further sampling for extent of barium is not warranted.

Beryllium was detected above the Qbt 2,3,4 BV in one sample at a concentration of 1.9 mg/kg. Concentrations increased with depth at location 49-07527 and decreased laterally. The residential SSL was approximately 82 times the maximum concentration. The lateral extent of beryllium is defined, and further sampling for vertical extent is not warranted.

Calcium was detected above the Qbt 2,3,4 BV in four samples with a maximum concentration of 3320 mg/kg. Concentrations increased with depth at locations 49-07512 and 49-07527 and decreased with depth at locations 49-609986 and 49-609987. Concentrations decreased laterally. The NMED residential essential nutrient SSL was approximately 3900 times the maximum concentration. The lateral extent of calcium is defined, and further sampling for vertical extent is not warranted.

Chromium was detected above the Qbt 2,3,4 BV in six samples with a maximum concentration of 18.4 mg/kg. Concentrations increased with depth at locations 49-07512 and 49-07527 and decreased with depth at locations 49-609986, 49-609987, and 49-609988. Concentrations increased laterally at location 49-609986. All concentrations except the maximum concentration were below the maximum Qbt 2,3,4 background concentration (13 mg/kg). As discussed in section 4.2, because there was no known use of hexavalent chromium at this site, the results were compared with the residential SSL for trivalent chromium (117,000 mg/kg). The residential trivalent chromium SSL was approximately 6360 times the maximum concentration. Further sampling for extent of chromium is not warranted.

Cobalt was detected above the Qbt 2,3,4 BV in 4 samples with a maximum concentration of 6.4 mg/kg. Concentrations decreased with depth at locations 49-609986, 49-609987, and 49-609988 and increased laterally at locations 49-609986 and 49-609987. The residential and industrial SSLs were approximately 3.6 times and 55 times the maximum concentration. The tuff BV is based on analysis of background samples using neutron activation (LANL 1998, 059730), which is different from the method used to analyze investigation samples. All detections of cobalt in tuff at SWMU 49-005(a) were less than the soil BV and the results are not indicative of contamination. The vertical extent of cobalt is defined, and further sampling for lateral extent is not warranted.

Copper was detected above the Qbt 2,3,4 BV in seven samples with a maximum concentration of 8.5 mg/kg. Concentrations increased with depth at locations 49-07512 and 49-07527 and decreased with depth at locations 49-609986, 49-609987, and 49-609988. Concentrations did not change substantially laterally (0.3 mg/kg). The residential SSL was approximately 368 times the maximum concentration. Further sampling for extent of copper is not warranted.

Magnesium was detected above the Qbt 2,3,4 BV in seven samples with a maximum concentration of 3720 mg/kg. Concentrations increased with depth at locations 49-07512 and 49-07527 and decreased with depth at locations 49-609986, 49-609987, and 49-609988. Concentrations decreased laterally. The NMED residential essential nutrient SSL was approximately 91 times the maximum concentration. The lateral extent of magnesium is defined and further sampling for vertical extent is not warranted.

Nickel was detected above the Qbt 2,3,4 BV in seven samples with a maximum concentration of 12.1 mg/kg. Concentrations increased with depth at locations 49-07512 and 49-07527 and decreased with depth at locations 49-609986, 49-609987, and 49-609988. Concentrations decreased laterally. The residential SSL was approximately 129 times the maximum concentration. The lateral extent of nickel is defined, and further sampling for vertical extent is not warranted.

Perchlorate was detected in one sample at a concentration of 0.0037 mg/kg. Concentrations increased with depth and laterally, and were below the estimated DL. The residential SSL was approximately 14,800 times the maximum concentration. Further sampling for extent of perchlorate is not warranted.

Selenium was detected above the Qbt 2,3,4 BV in nine samples with a maximum concentration of 1.3 mg/kg and had DLs (0.81 mg/kg and 0.88 mg/kg) above the BV in two samples. Concentrations did not change substantially with depth (0.31 mg/kg to 0.48 mg/kg) at locations 49-609986, 49-609987, 49-609988, and 49-609989 and did not change substantially laterally (0.25 mg/kg to 0.44 mg/kg) outward from locations 49-07512 and 49-07527 (the concentrations in the surface samples at locations 49-07512, 49-07527, 49-609986, 49-609987, 49-609988, and 49-609989 were 0.86 mg/kg, 0.85 mg/kg, 0.31 mg/kg, 0.48 mg/kg, 0.32 mg/kg, and 0.33 mg/kg, respectively, and below the soil BV [Appendix G, Pivot Tables]). The residential SSL was approximately 300 times the maximum concentration and 445 times the maximum DL. Further sampling for extent of selenium is not warranted.

Uranium was detected above the soil and Qbt 2,3,4 BVs in two soil samples and one tuff sample with a maximum concentration of 4.09 mg/kg. Concentrations increased with depth at location 49-07527 and decreased with depth at location 49-07512. Samples from boreholes at step-out locations around the landfill were not analyzed for uranium. These samples were analyzed for isotopic uranium and no uranium isotopes were detected above BVs. The residential SSL was approximately 57 times the maximum concentration. Further sampling for extent of uranium is not warranted.

Vanadium was detected above the Qbt 2,3,4 BV in three samples with a maximum concentration of 22.6 mg/kg. Concentrations decreased with depth at locations 49-609986, 49-609987, and 49-609988 and decreased laterally. The residential and industrial SSLs were approximately 17 times and 289 times the maximum concentration. The vertical extent of vanadium is defined, and further sampling for lateral extent is not warranted.

Organic Chemicals

Organic COPCs at SWMU 49-005(a) include bis(2-ethylhexyl)phthalate and 2-butanone.

Bis(2-ethylhexyl)phthalate was detected in two samples with a maximum concentration of 0.16 mg/kg. Concentrations increased with depth at location 49-609989, decreased with depth at location 49-609988, and did not change substantially laterally (0.114 mg/kg) at location 49-609989. All concentrations were below EQLs. The residential SSL was approximately 2380 times the maximum concentration. Further sampling for extent of bis(2-ethylhexyl)phthalate is not warranted.

Butanone[2-] was detected in one sample at a concentration of 0.0018 mg/kg. Concentrations decreased with depth and increased laterally. Concentration was below the EQL. The residential SSL was approximately 20,800,000 times the maximum concentration. The vertical extent of 2-butanone is defined, and further sampling for lateral extent is not warranted.

Radionuclides

Radionuclide COPCs at SWMU 49-005(a) include plutonium-238 and plutonium-239/240.

Plutonium-238 was detected above the soil FV in one sample and detected in one tuff sample with a maximum activity of 0.032 pCi/g. Activities increased with depth at location 49-07527, decreased with depth at location 49-07512, and decreased laterally. The residential SAL was approximately 2620 times the maximum activity. The lateral extent of plutonium-238 is defined and further sampling for vertical extent is not warranted.

Plutonium-239/240 was detected above the soil FV in one sample at an activity of 0.083 pCi/g. Activities decreased with depth at location 49-07512 and decreased laterally. The lateral and vertical extent of plutonium-239/240 are defined.

6.4.4.5 Subsurface Vapor Sampling and Results

One pore-gas sample was were collected from one borehole (location 49-609987) and analyzed for VOCs and tritium. Table 6.4-5 presents the sample collected and analyses requested for SWMU 49-005(a).

Table 6.4-6 summarizes the analytical results for detected VOCs in pore gas. Plate 3 shows the spatial distribution of detected VOCs. Table 6.3-7 presents the tritium detected in pore gas. Plate 4 shows the spatial distribution of detected tritium.

VOCs detected in pore gas at SWMU 49-005(a) include acetone; benzene; 2-butanone; chloromethane; dichlorodifluoromethane, ethyl benzene, 4-ethyltoluene, styrene, toluene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene; total xylenes; 1,2-xylene; and 1,3-xylene+1,4-xylene. The detected VOCs are retained as COPCs.

Tritium was detected in one sample with a maximum activity of 509 pCi/L. Tritium is retained as a COPC.

Nature and Extent of Contamination in Subsurface Pore Gas

The approved work plan (LANL 2008, 102215; NMED 2008, 100465) prescribed the collection of one pore-gas sample from the TD of the borehole drilled at SWMU 49-005(a) to determine whether the boring should be completed as a vapor-monitoring well. If VOCs were detected in the vapor-phase sample at concentrations greater than 10% of the pore-gas screening levels presented in section 4.5, or if tritium was detected in the vapor-phase sample at a concentration greater than the groundwater MCL (20,000 pCi/L), the borehole would be completed as a vapor-monitoring well.

Screening was performed for each of the VOCs detected in pore-gas samples collected from SWMU 49-005(a) using the maximum detected concentrations. These results show that the SVs are below 0.1 in all cases, indicating that VOCs in subsurface pore gas are not a potential source of groundwater contamination (Table 4.5-2).

The maximum detected tritium activity at SWMU 49-005(a) (509 pCi/L) is less than the groundwater MCL (20,000 pCi/L). Therefore, tritium is not a potential source of groundwater contamination.

The concentrations of all VOCs were less the 10% of the pore-gas screening level for groundwater protection and the maximum tritium activity was less than the MCL. Therefore, the borehole at SWMU 49-005(a) was not completed as a vapor-monitoring well.

6.4.5 Summary of Human Health Risk Screening

Industrial Scenario

The total excess cancer risk for the industrial scenario is 9×10^{-10}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2015, 600915). The industrial HI is 0.0006, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.002 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Construction Worker Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The construction worker HI is 0.6, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.01 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Residential Scenario

The total excess cancer risk for the residential scenario is 9×10^{-6}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2015, 600915). The residential HI is 0.7, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.04 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial, construction worker, and residential scenarios at SWMU 49-005(a).

6.4.6 Summary of Ecological Risk Screening

Based on the evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of exposure point concentrations and screening levels to background, the potential for unacceptable ecological risks to the earthworm, plant, American robin, American kestrel, pocket gopher, deer mouse, montane shrew, desert cottontail, red fox, and Mexican spotted owl at SWMU 49-005(a) is minimal.

7.0 CONCLUSIONS

7.1 Nature and Extent of Contamination

Based on the revised evaluation of the available data, the nature and extent of contamination have been defined and/or no further sampling for extent is warranted for the three sites investigated previously or during the 2009–2010 investigation of TA-49 sites outside the NES.

The nature and extent of contamination have been defined and/or no further sampling for extent is warranted for the following TA-49 sites outside the NES:

- AOC 49-002, Underground Calibration Chamber and Elevator Shaft
- SWMU 49-004, Inactive Open Burning Area and Landfill

- SWMU 49-005(a), Inactive Small Debris Landfill

7.2 Summary of Risk-Screening Assessments

Three sites were evaluated for potential human health and ecological risks.

7.2.1 Human Health Risk-Screening Assessment

For the industrial, construction worker, and residential scenarios, the total excess cancer risks were less than the 1×10^{-5} target risk level and the HIs were less than or equivalent to the target HI of 1 at all sites.

The total doses were below the target dose limit of 25 mrem/yr as authorized by DOE Order 458.1 for the industrial, construction worker, and residential scenarios at all sites.

Sites at TA-49 are not accessible by the public and are not planned for release by DOE in the foreseeable future. Therefore, an as low as reasonably achievable (ALARA) evaluation for radiological exposure to the public is not currently required. Should DOE’s plans for releasing these areas change, an ALARA evaluation will be conducted at that time.

7.2.2 Ecological Risk-Screening Assessment

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, the relationship of exposure point concentrations and screening levels to background, the potential for unacceptable ecological risks to the earthworm, plant, American robin, American kestrel, pocket gopher, deer mouse, montane shrew, desert cottontail, red fox, and Mexican spotted owl at any of the TA-49 sites outside the NES is minimal.

8.0 RECOMMENDATIONS

The determination of site status is based on the results of the risk-screening assessments and the nature and extent evaluation. Depending upon the decision scenario used, the sites are recommended as corrective actions complete either with or without controls or for additional action. The residential scenario is the only scenario under which corrective action complete without controls is applicable; that is, no additional corrective actions or conditions are necessary. The other decision scenarios (industrial and construction worker) result in corrective action complete with controls; that is, some type of institutional controls must be in place to ensure land use remains consistent with site cleanup levels. The current and reasonably foreseeable future land use at TA-49 outside the NES is industrial.

8.1 Additional Field Characterization and Remediation Activities

Although the results of the nature and extent evaluations and human health and ecological risk screening assessments, indicate no additional site characterization or remediation activities are warranted, NMED ‘s notice of disapproval (NOD) for the investigation report of TA-49 sites outside of the NES boundary directed that the Laboratory conduct additional sampling and analyses at two sites (NMED 2010, 110470).

NMED’s NOD directed the Laboratory to drill at least two boreholes next to the calibration and elevator shafts at AOC 49-002 to investigate the extent of contamination at the bottom of the shafts (NMED 2010, 110470). Although the approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465) did not include the collection of deep samples adjacent to the shafts, additional sampling and analyses in boreholes drilled adjacent to the calibration and elevator shafts will be conducted as part of the Phase II investigation. The boreholes should extend beneath the bottom of the 64-ft-deep shafts.

NMED's NOD also directed the Laboratory to perform additional sampling and analysis at SWMU 49-004 for dioxins and furans based on the past history of open burning at this site (NMED 2010, 110470). Although the analysis of dioxins and furans was not originally required in the approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465), additional sampling and analysis for dioxins and furans at SMWU 49-004 will be conducted as part of the Phase II investigation.

8.2 Recommendations for Corrective Actions Complete

The three sites evaluated in this supplemental investigation report do not pose potential unacceptable risks or doses under the industrial, construction worker, and residential scenarios and have no potential ecological risks to any receptor. However, for two of these sites, additional sampling and analyses will be conducted as part of the Phase II investigation per NMED's direction (NMED 2010, 110470).

For one site, the nature and extent of contamination are defined and/or no further sampling for extent is warranted and no potential unacceptable risks or doses to human health under the industrial, construction worker, and residential scenarios and to ecological receptors exist. Therefore, the DOE Environmental Management Los Alamos Field Office and N3B recommend no further investigation or remediation activities are warranted at this site, and the site is appropriate for corrective actions complete without controls (Table 8.2-1):

- SWMU 49-005(a), Inactive Small Debris Landfill

8.3 Schedule for Recommended Activities

A revised Phase II investigation work plan will be prepared and submitted to NMED after this supplemental investigation report is approved. The revised work plan will provide details and a schedule for implementing sampling activities and submitting the Phase II investigation report.

9.0 REFERENCES AND MAP DATA SOURCES

9.1 References

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

Bailey, R.A., R.L. Smith, and C.S. Ross, 1969. "Stratigraphic Nomenclature of Volcanic Rocks in the Jemez Mountains, New Mexico," in *Contributions to Stratigraphy*, U.S. Geological Survey Bulletin 1274-P, Washington, D.C. (Bailey at el. 1969, 021498)

Blair, A., December 19, 1996. "TA-49 FIDLER Survey," Los Alamos National Laboratory memorandum (ESH-19:96-0456) to A. Dye (ESH-19) from B. Art (ESH-19), Los Alamos, New Mexico. (Art 1996, 055332)

Broxton, D.E., G.H. Heiken, S.J. Chipera, and F.M. Byers, Jr., June 1995. “Stratigraphy, Petrography, and Mineralogy of Bandelier Tuff and Cerro Toledo Deposits,” in *Earth Science Investigation for Environmental Restoration—Los Alamos National Laboratory, Technical Area 21*, Los Alamos National Laboratory report LA-12934-MS, Los Alamos, New Mexico, pp. 33-63. (Broxton et al. 1995, 050121)

Broxton, D.E., P.A. Longmire, P.G. Eller, and D. Flores, June 1995. “Preliminary Drilling Results for Boreholes LADP-3 and LADP-4,” in *Earth Science Investigation for Environmental Restoration—Los Alamos National Laboratory, Technical Area 21*, Los Alamos National Laboratory report LA-12934-MS, Los Alamos, New Mexico, pp. 93-109. (Broxton et al. 1995, 050119)

Broxton, D.E., and S.L. Reneau, August 1995. “Stratigraphic Nomenclature of the Bandelier Tuff for the Environmental Restoration Project at Los Alamos National Laboratory,” Los Alamos National Laboratory report LA-13010-MS, Los Alamos, New Mexico. (Broxton and Reneau 1995, 049726)

Collins, K.A., A.M. Simmons, B.A. Robinson, and C.I. Nylander (Eds.), December 2005. “Los Alamos National Laboratory's Hydrogeologic Studies of the Pajarito Plateau: A Synthesis of Hydrogeologic Workplan Activities (1998–2004),” Los Alamos National Laboratory report LA-14263-MS, Los Alamos, New Mexico. (Collins et al. 2005, 092028)

Crowe, B.M., G.W. Linn, G. Heiken, and M.L. Bevier, April 1978. “Stratigraphy of the Bandelier Tuff in the Pajarito Plateau, Applications to Waste Management,” Los Alamos Scientific Laboratory report LA-7225-MS, Los Alamos, New Mexico. (Crowe et al. 1978, 005720)

DOE (U.S. Department of Energy), October 1987. “Phase I: Installation Assessment, Los Alamos National Laboratory,” draft, Volume 1 of 2, Comprehensive Environmental Assessment and Response Program, Environment and Health Division, Environmental Programs Branch, Albuquerque Operations Office, Albuquerque, New Mexico. (DOE 1987, 008663)

EPA (U.S. Environmental Protection Agency), January 21, 2005. “EPA's Prior Decisions on SWMU/AOC Sites at Los Alamos National Laboratory (LANL),” U.S. Environmental Protection Agency letter to J. Bearzi (NMED-HRMB) from L.F. King (EPA Federal Facilities Section Chief), Dallas, Texas. (EPA 2005, 088464)

Gehan, E.A., June 1965. “A Generalized Wilcoxon Test for Comparing Arbitrarily Singly-Censored Samples,” *Biometrika,* Vol. 52, No. 1 and 2, pp. 203–223. (Gehan 1965, 055611)

Gilbert, R.O., and J.C. Simpson, November 1990. “Statistical Sampling and Analysis Issues and Needs for Testing Attainment of Background-Based Cleanup Standards at Superfund Sites,” Proceedings of The Workshop on Superfund Hazardous Waste: Statistical Issues in Characterizing a Site: Protocols, Tools, and Research Needs, U.S. Environmental Protection Agency, Arlington, Virginia. (Gilbert and Simpson 1990, 055612)

Gilbert, R.O., and J.C. Simpson, December 1992. “Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3: Reference-Based Standards for Soils and Solid Media,” document prepared for the U.S. Environmental Protection Agency, Pacific Northwest Laboratory, Richland, Washington. (Gilbert and Simpson 1992, 054952)

Goff, F., June 1995. “Geologic Map of Technical Area 21,” in *Earth Science Investigations for Environmental Restoration—Los Alamos National Laboratory, Technical Area 21*, Los Alamos National Laboratory report LA-12934-MS, Los Alamos, New Mexico, pp. 7–18. (Goff 1995, 049682)

Griggs, R.L., and J.D. Hem, 1964. “Geology and Ground-Water Resources of the Los Alamos Area, New Mexico,” U.S. Geological Survey Water Supply Paper 1753, Washington, D.C. (Griggs and Hem 1964, 092516)

Hollis, D., E. Vold, R. Shuman, K.H. Birdsell, K. Bower, W.R. Hansen, D. Krier, P.A. Longmire, B. Newman, D.B. Rogers, and E.P. Springer, March 27, 1997. “Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G,” Rev. 2.1, Los Alamos National Laboratory document LA-UR-97-85, Los Alamos, New Mexico. (Hollis et al. 1997, 063131)

Izett, G.A., and J.D. Obradovich, February 10, 1994. “^{40}Ar/^{39}Ar Age Constraints for the Jaramillo Normal Subchron and the Matuyama-Brunhes Geomagnetic Boundary,” *Journal of Geophysical Research,* Vol. 99, No. B2, pp. 2925–2934. (Izett and Obradovich 1994, 048817)

Kearl, P.M., J.J. Dexter, and M. Kautsky, December 1986. “Vadose Zone Characterization of Technical Area 54, Waste Disposal Areas G and L, Los Alamos National Laboratory, New Mexico, Report 4: Preliminary Assessment of the Hydrologic System through Fiscal Year 1986,” UNC Technical Services report GJ-54, Grand Junction, Colorado. (Kearl et al. 1986, 015368)

LANL (Los Alamos National Laboratory), May 1992. “RFI Work Plan for Operable Unit 1144,” Los Alamos National Laboratory document LA-UR-92-900, Los Alamos, New Mexico. (LANL 1992, 007670)

LANL (Los Alamos National Laboratory), August 1997. “RFI Report for Technical Area 49 Potential Release Sites (Areas 5, 6, 10, and 11),” Los Alamos National Laboratory document LA-UR-97-2786, Los Alamos, New Mexico. (LANL 1997, 056594)

LANL (Los Alamos National Laboratory), September 22, 1998. “Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory,” Los Alamos National Laboratory document LA-UR-98-4847, Los Alamos, New Mexico. (LANL 1998, 059730)

LANL (Los Alamos National Laboratory), December 2005. “2005 Annual Moisture Monitoring Report for Material Disposal Area AB at Technical Area 49,” Los Alamos National Laboratory document LA-UR-05-8256, Los Alamos, New Mexico. (LANL 2005, 092389)

LANL (Los Alamos National Laboratory), September 2006. “Environmental Surveillance at Los Alamos During 2005,” Los Alamos National Laboratory report LA-14304-ENV, Los Alamos, New Mexico. (LANL 2006, 093925)

LANL (Los Alamos National Laboratory), October 2007. “Historical Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary,” Los Alamos National Laboratory document LA-UR-07-6078, Los Alamos, New Mexico. (LANL 2007, 098492)

LANL (Los Alamos National Laboratory), October 2007. “Historical Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary,” Los Alamos National Laboratory document LA-UR-07-6428, Los Alamos, New Mexico. (LANL 2007, 098523)

LANL (Los Alamos National Laboratory), January 2008. “Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1,” Los Alamos National Laboratory document LA-UR-08-0449, Los Alamos, New Mexico. (LANL 2008, 102215)

LANL (Los Alamos National Laboratory), December 2009. “Radionuclide Screening Action Levels (SALs) from RESRAD, Version 6.5,” Los Alamos National Laboratory document LA-UR-09-8111, Los Alamos, New Mexico. (LANL 2009, 107655)

LANL (Los Alamos National Laboratory), September 2010. “Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1,” Los Alamos National Laboratory document LA-UR-10-6033, Los Alamos, New Mexico. (LANL 2010, 110654.16)

LANL (Los Alamos National Laboratory), February 2011. “Phase II Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary,” Los Alamos National Laboratory document LA-UR-11-0553, Los Alamos, New Mexico. (LANL 2011, 111691)

LANL (Los Alamos National Laboratory), September 2011. “Investigation Report for Water Canyon/ Cañon de Valle,” Los Alamos National Laboratory document LA-UR-11-5478, Los Alamos, New Mexico. (LANL 2011, 207069)

LANL (Los Alamos National Laboratory), May 2015. “Interim Facility-Wide Groundwater Monitoring Plan for the 2016 Monitoring Year, October 2015–September 2016,” Los Alamos National Laboratory document LA-UR-15-23276, Los Alamos, New Mexico. (LANL 2015, 600467)

LANL (Los Alamos National Laboratory), September 2015. “Derivation and Use of Radionuclide Screening Action Levels, Revision 4,” Los Alamos National Laboratory document LA-UR-15-24859, Los Alamos, New Mexico. (LANL 2015, 600929)

LANL (Los Alamos National Laboratory), October 2015. “ECORISK Database (Release 3.3),” on CD, LA-UR-15-27397, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2015, 600921)

LANL (Los Alamos National Laboratory), October 2015. “Screening-Level Ecological Risk Assessment Methods, Revision 4,” Los Alamos National Laboratory document LA-UR-15-27577, Los Alamos, New Mexico. (LANL 2015, 600982)

LANL (Los Alamos National Laboratory), May 1, 2016. “2015 Update to the Site Discharge Pollution Prevention Plan, Revision 1, NPDES Permit No. NM0030759, Water/Cañon de Valle Watershed, Receiving Waters: Cañon de Valle, Potrillo Canyon, Water Canyon, and Fence Canyon, Volume 4,” Los Alamos National Laboratory document LA-UR-16-22378, Los Alamos, New Mexico. (LANL 2016, 601395)

Millard, W.P., and S.J. Deverel, December 1988. “Nonparametric Statistical Methods for Comparing Two Sites Based on Data with Multiple Nondetect Limits,” *Water Resources Research,* Vol. 24, No. 12, pp. 2087–2098. (Millard and Deverel 1988, 054953)

NMED (New Mexico Environment Department), February 14, 2008. "Approval with Modifications, Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2008, 100465)

NMED (New Mexico Environment Department), August 12, 2010. "Notice of Disapproval, Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 110470)

NMED (New Mexico Environment Department), September 22, 2010. "Approval with Modifications, Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 110859)

NMED (New Mexico Environment Department), February 21, 2011. "Certificates of Completion, Areas of Concern Outside the Nuclear Environmental Site Boundary, Technical Area 49," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 111822)

NMED (New Mexico Environment Department), June 10, 2011. "Approval, Phase II Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 203824)

NMED (New Mexico Environment Department), July 2015. "Risk Assessment Guidance for Site Investigations and Remediation," Hazardous Waste Bureau and Ground Water Quality Bureau, Santa Fe, New Mexico. (NMED 2015, 600915)

Nyhan, J.W., L.W. Hacker, T.E. Calhoun, and D.L. Young, June 1978. "Soil Survey of Los Alamos County, New Mexico," Los Alamos Scientific Laboratory report LA-6779-MS, Los Alamos, New Mexico. (Nyhan et al. 1978, 005702)

Nylander, C.L., K.A. Bitner, G. Cole, E.H. Keating, S. Kinkead, P. Longmire, B. Robinson, D.B. Rogers, and D. Vaniman, March 2003. "Groundwater Annual Status Report for Fiscal Year 2002," Los Alamos National Laboratory document LA-UR-03-0244, Los Alamos, New Mexico. (Nylander et al. 2003, 076059.49)

Purtymun, W.D., January 1984. "Hydrologic Characteristics of the Main Aquifer in the Los Alamos Area: Development of Ground Water Supplies," Los Alamos National Laboratory report LA-9957-MS, Los Alamos, New Mexico. (Purtymun 1984, 006513)

Purtymun, W.D., and A.J. Ahlquist, 1986. "Geologic and Hydrologic Evaluation of Technical Area 49," Los Alamos National Laboratory document HSE-8-86-1183, Los Alamos, New Mexico. (Purtymun and Ahlquist 1986, 014722)

Purtymun, W.D., R.J. Peters, and J.W. Owens, December 1980. "Geohydrology of White Rock Canyon of the Rio Grande from Otowi to Frijoles Canyon," Los Alamos Scientific Laboratory report LA-8635-MS, Los Alamos, New Mexico. (Purtymun et al. 1980, 006048)

Purtymun, W.D., and A.K. Stoker, November 1987. "Environmental Status of Technical Area 49, Los Alamos, New Mexico," Los Alamos National Laboratory report LA-11135-MS, Los Alamos, New Mexico. (Purtymun and Stoker 1987, 006688)

Purtymun, W.D., and A.K. Stoker, September 1990. "Perched Zone Monitoring Well Installation," Los Alamos National Laboratory document LA-UR-90-3230, Los Alamos, New Mexico. (Purtymun and Stoker 1990, 007508)

Rogers, D.B., and B.M. Gallaher, September 1995. "The Unsaturated Hydraulic Characteristics of the Bandelier Tuff," Los Alamos National Laboratory report LA-12968-MS, Los Alamos, New Mexico. (Rogers and Gallaher 1995, 097569)

Smith, R.L., and R.A. Bailey, 1966. "The Bandelier Tuff: A Study of Ash-Flow Eruption Cycles from Zoned Magma Chambers," *Bulletin Volcanologique,* Vol. 29, pp. 83-103. (Smith and Bailey 1966, 021584)

Smith, R.L., R.A. Bailey, and C.S. Ross, 1970. "Geologic Map of the Jemez Mountains, New Mexico," U.S. Geological Survey Miscellaneous Investigations Series, Map I-571, Washington, D.C. (Smith et al. 1970, 009752)

Spell, T.L., I. McDougall, and A.P. Doulgeris, December 1996. "Cerro Toledo Rhyolite, Jemez Volcanic Field, New Mexico: ^{40}Ar/^{39}Ar Geochronology of Eruptions between Two Caldera-Forming Events," *Geological Society of America Bulletin,* Vol. 108, No. 12, pp. 1549-1566. (Spell et al. 1996, 055542)

Stimac, J.A., D.E. Broxton, E.C. Kluk, S.J. Chipera, and J.R. Budahn, July 2002. "Stratigraphy of the Tuffs from Borehole 49-2-700-1 at Technical Area 49, Los Alamos National Laboratory, New Mexico," Los Alamos National Laboratory report LA-13969, Los Alamos, New Mexico. (Stimac et al. 2002, 073391)

Thorn, R.N., and D.R. Westervelt, February 1987. "Hydronuclear Experiments," Los Alamos National Laboratory report LA-10902-MS, Los Alamos, New Mexico. (Thorn and Westervelt 1987, 006672)

Weir, J.E., Jr., and W.D. Purtymun, 1962. "Geology and Hydrology of Technical Area 49, Frijoles Mesa, Los Alamos County, New Mexico," U.S. Geological Survey Administrative Release, Albuquerque, New Mexico. (Weir and Purtymun 1962, 011890)

9.2 Map Data Sources

Data sources used in original figures and/or plates created for this report are described below and identified by legend title.

LANL Technical Areas - Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 04 December 2008.

Paved roads - Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Dirt roads - Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Drainages - WQH Drainage_arc; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; 1:24,000 Scale Data; 03 June 2003.

LANL structures - Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

LANL fence lines - Security and Industrial Fences and Gates; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Former/other existing TA-49 structures - Description of: Geospatial Data Created for Maps Appearing in TA-49 HIRS and IWPS, K. Crowell, ERID-098702, October 2007

LANL PRS boundaries - Potential Release Sites; Los Alamos National Laboratory, Waste and Environmental Services Division, Environmental Data and Analysis Group, EP2009-0137; 1:2,500 Scale Data; 13 March 2009.

TA-49 2009/10 sample locations - TPMC field survey data, now found in: Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, 12 April 2010.

LANL historical sample locations - Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, 21 January 2010.

Contours - Hypsography, 10, 20, and 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

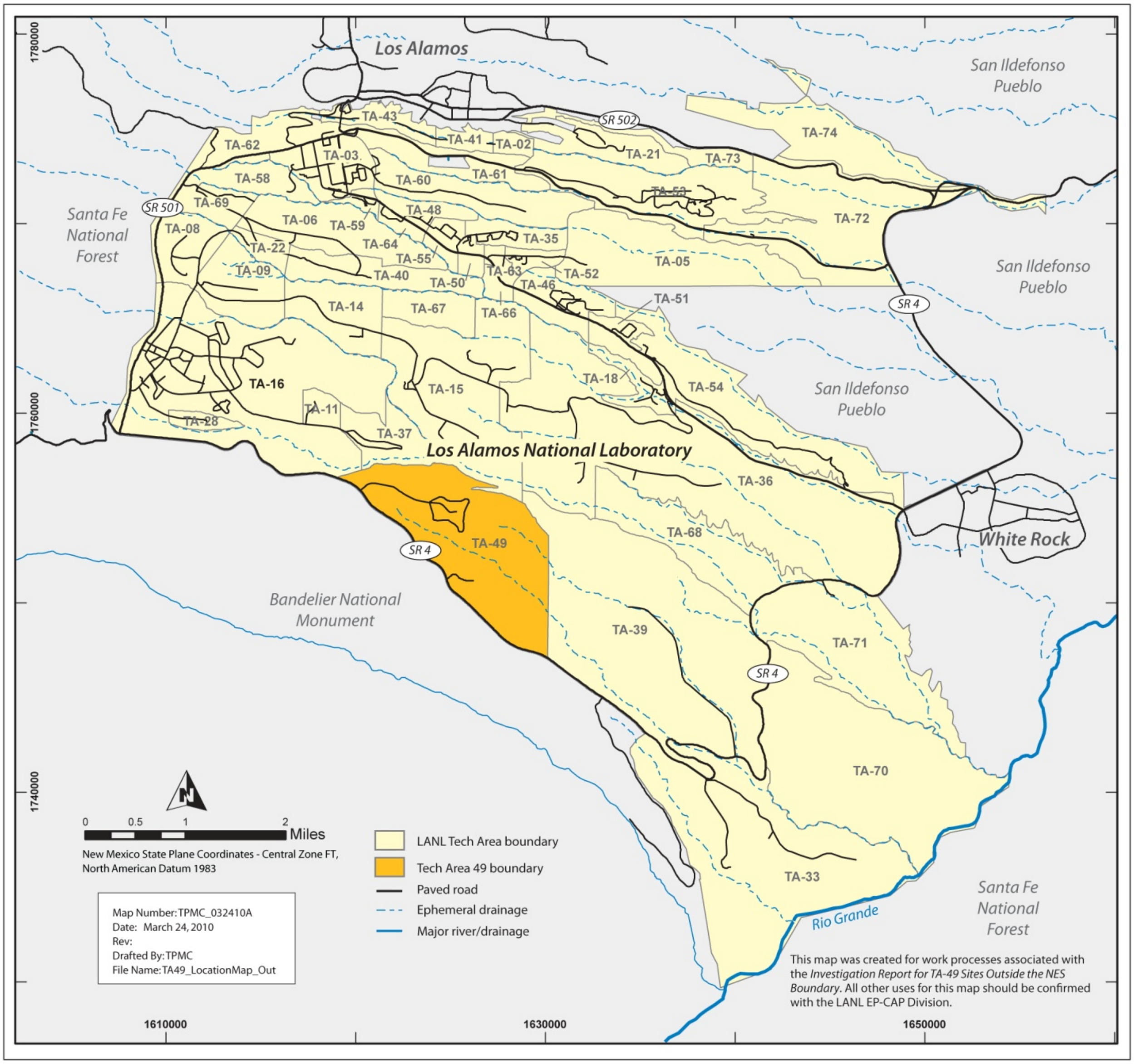
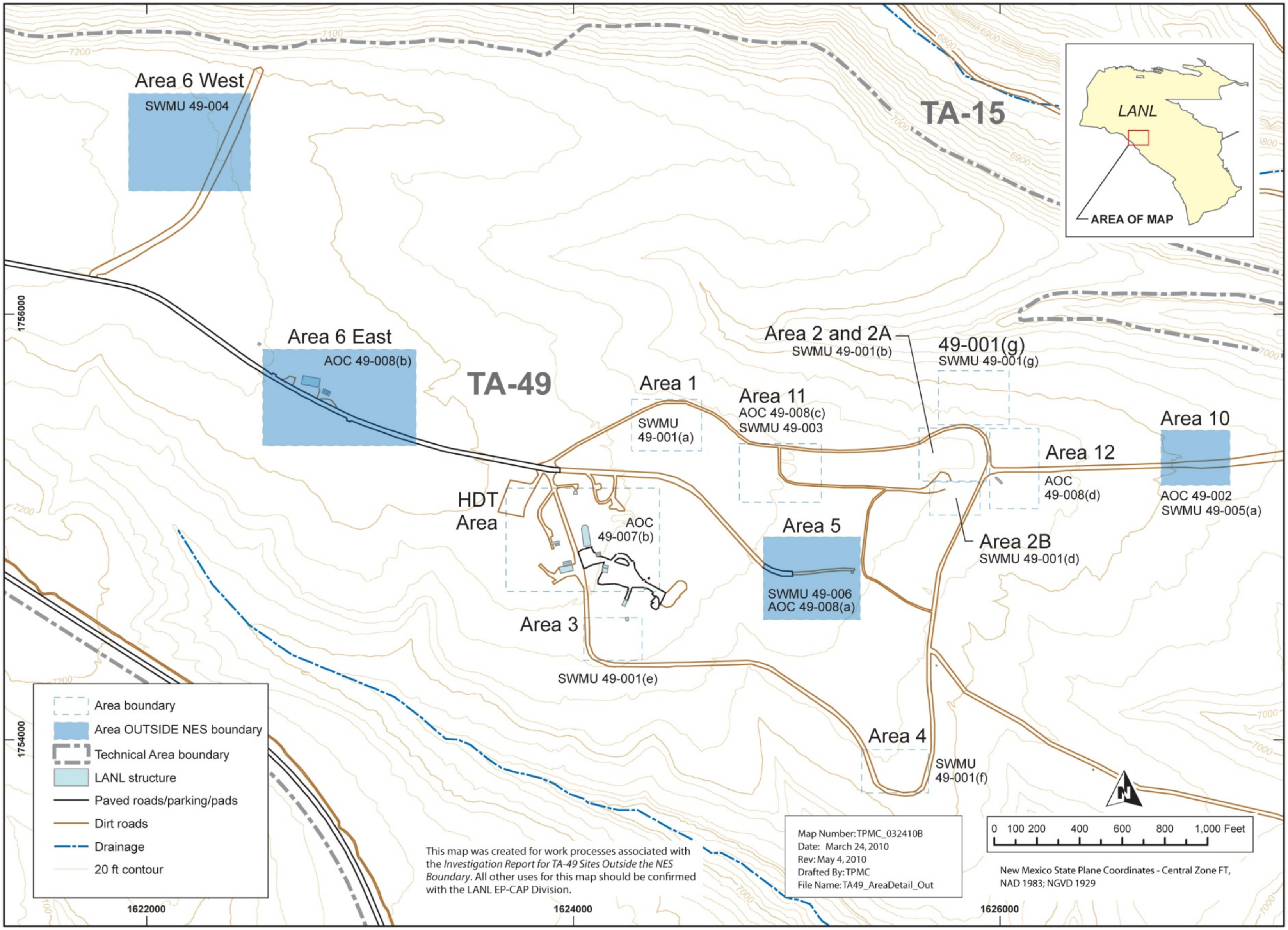


Figure 1.1-1 Location of TA-49 with respect to Laboratory technical areas and surrounding land holdings

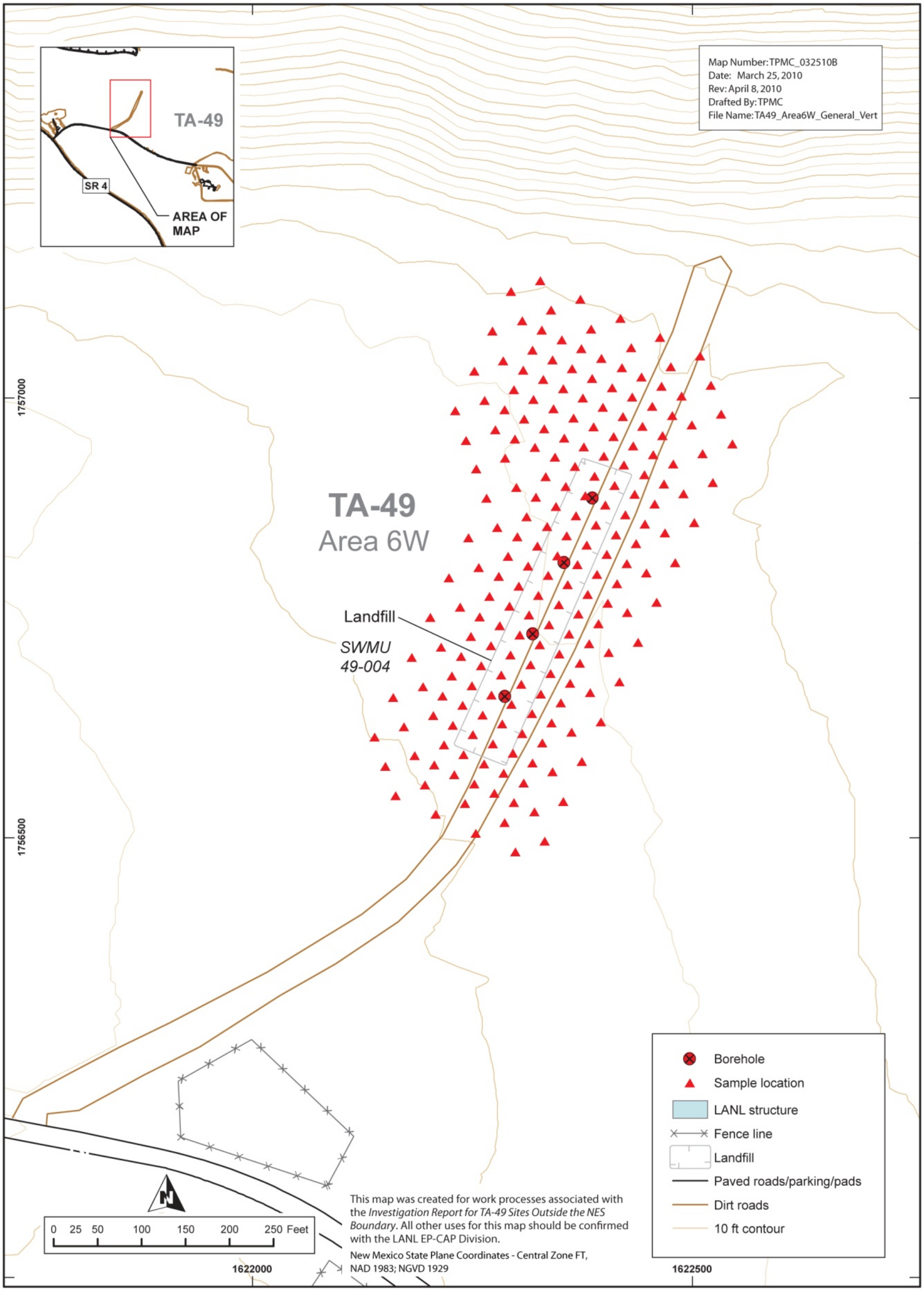


This map was created for work processes associated with the *Investigation Report for TA-49 Sites Outside the NES Boundary*. All other uses for this map should be confirmed with the LANL EP-CAP Division.

Map Number: TPMC_032410B
Date: March 24, 2010
Rev: May 4, 2010
Drafted By: TPMC
File Name: TA49_AreaDetail_Out

New Mexico State Plane Coordinates - Central Zone FT, NAD 1983; NGVD 1929

Figure 1.1-2 Locations of TA-49 SWMUs and AOCs

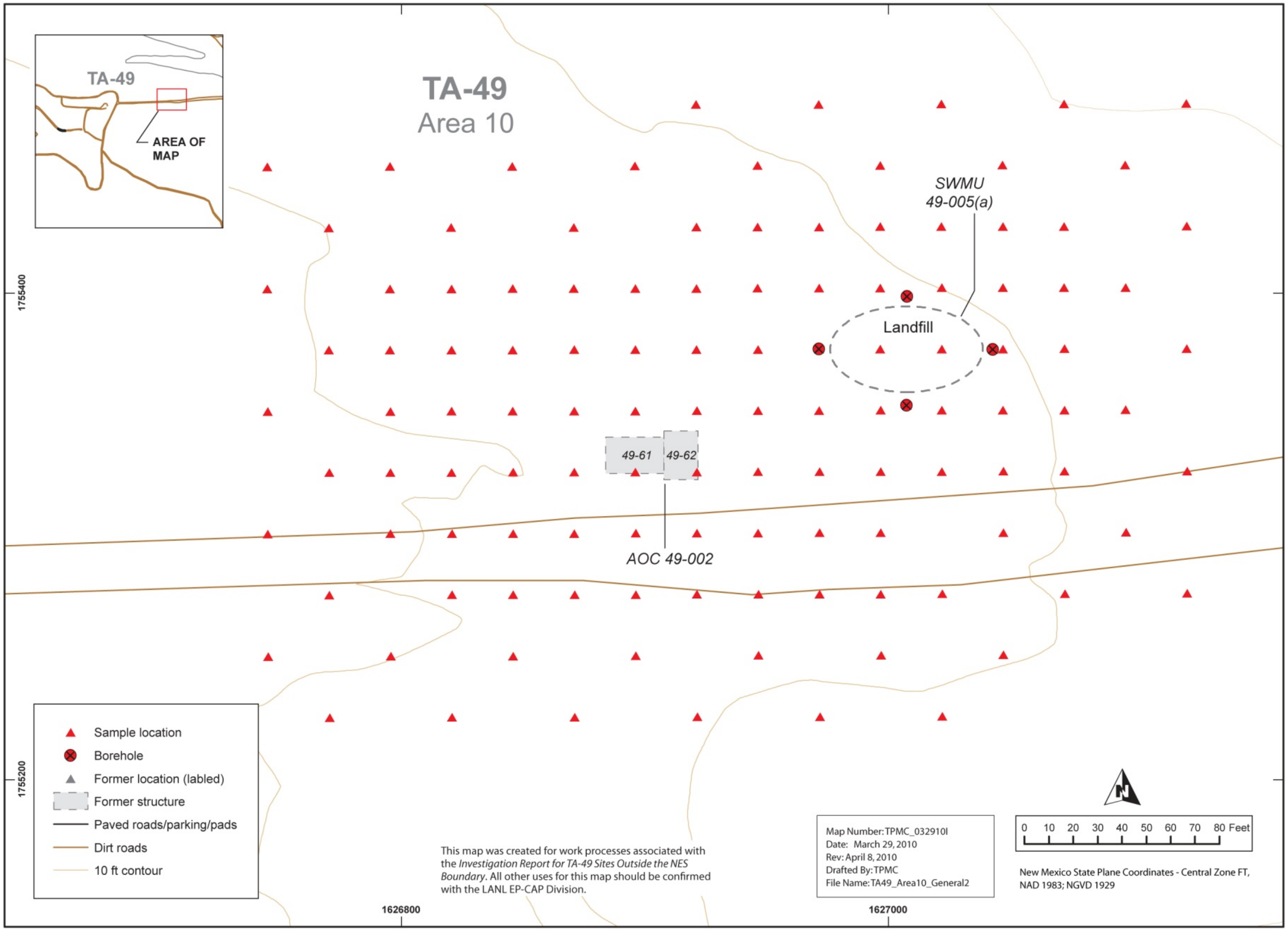


Map Number: TPMC_032510B
Date: March 25, 2010
Rev: April 8, 2010
Drafted By: TPMC
File Name: TA49_Area6W_General_Vert

This map was created for work processes associated with the *Investigation Report for TA-49 Sites Outside the NES Boundary*. All other uses for this map should be confirmed with the LANL EP-CAP Division.

New Mexico State Plane Coordinates - Central Zone FT, NAD 1983; NGVD 1929

Figure 3.1-1 **2009–2010 radiological screening-level sampling locations and boreholes associated with Area 6 West, SWMU 49-004**

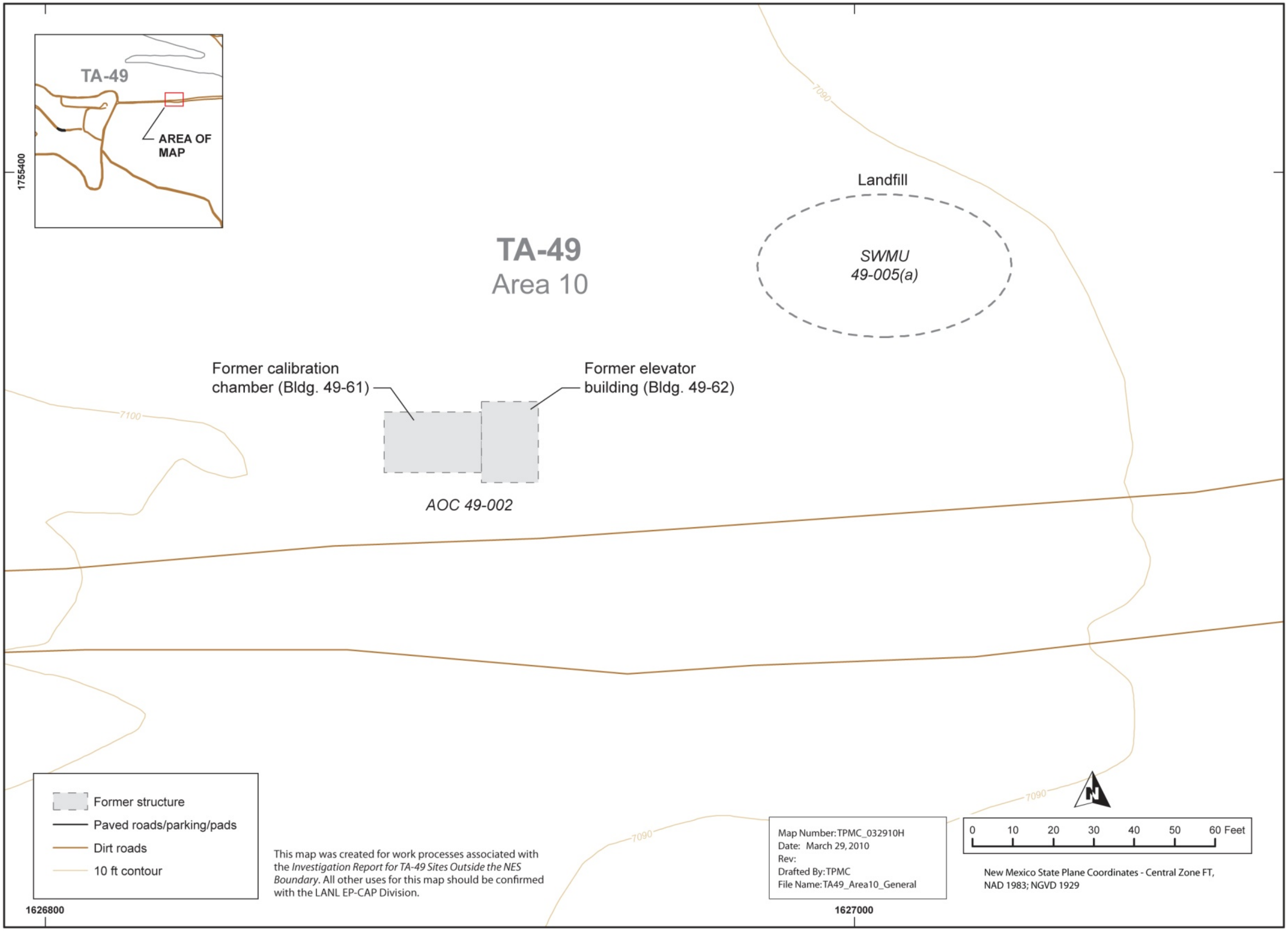


This map was created for work processes associated with the *Investigation Report for TA-49 Sites Outside the NES Boundary*. All other uses for this map should be confirmed with the LANL EP-CAP Division.

Map Number: TPMC_032910I
Date: March 29, 2010
Rev: April 8, 2010
Drafted By: TPMC
File Name: TA49_Area10_General2

New Mexico State Plane Coordinates - Central Zone FT, NAD 1983; NGVD 1929

Figure 3.1-2 **2009–2010 radiological screening-level sampling locations and boreholes associated with Area 10, AOC 49-002 and SWMU 49-005(a)**

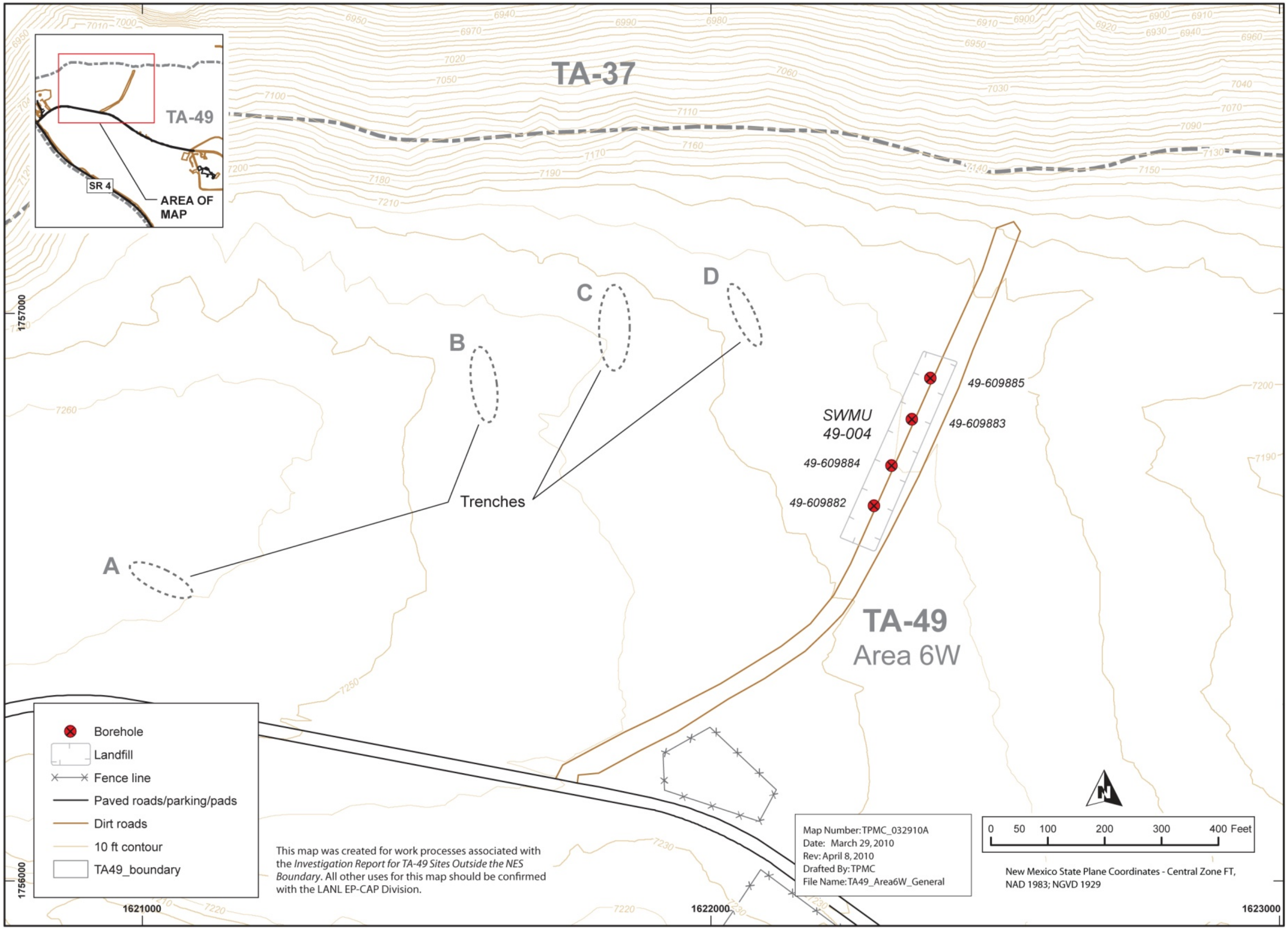


This map was created for work processes associated with the *Investigation Report for TA-49 Sites Outside the NES Boundary*. All other uses for this map should be confirmed with the LANL EP-CAP Division.

Map Number: TPMC_032910H
Date: March 29, 2010
Rev:
Drafted By: TPMC
File Name: TA49_Area10_General

New Mexico State Plane Coordinates - Central Zone FT, NAD 1983; NGVD 1929

Figure 6.2-1 General site layout of Area 10, AOC 49-002 and SWMU 49-005(a)



This map was created for work processes associated with the *Investigation Report for TA-49 Sites Outside the NES Boundary*. All other uses for this map should be confirmed with the LANL EP-CAP Division.

Map Number: TPMC_032910A
Date: March 29, 2010
Rev: April 8, 2010
Drafted By: TPMC
File Name: TA49_Area6W_General

New Mexico State Plane Coordinates - Central Zone FT, NAD 1983; NGVD 1929

Figure 6.3-1 General site layout of Area 6 West

Table 1.1-1
TA-49 Sites Outside the NES under Investigation

Area	SWMU/AOC	Brief Description	2009–2010 Investigation	Current Status
5	AOC 49-005(b)	Small debris landfill	Subsurface and pore-gas samples collected	Certificate of completion without controls (NMED 2011, 111822)
	SWMU 49-006	Former sump	Subsurface samples collected	Certificate of completion without controls (NMED 2011, 111822)
	AOC 49-008(a)	Potential soil contamination from historical central control area	Samples collected for PCBs only; Deferred per Table IV-2 of the Consent Order	Deferred per Table IV-2 of the Consent Order
6 East	AOC 49-008(b)	Former general support area with potential contamination	Deferred per Table IV-2 of the Consent Order	Deferred per Table IV-2 of the Consent Order
	AOC 49-007(a)	Former sanitary septic system	None	NFA approved, 01/21/05; EPA 2005, 088464
	AOC 49-007(b)	Former sanitary leach field	None	NFA approved, 01/21/05; EPA 2005, 088464
6 West	SWMU 49-004	Inactive open-burning area and landfill	Surface, subsurface, and pore-gas samples collected	Supplemental investigation report (section 6.3)
10	AOC 49-002	Underground calibration chamber and elevator shaft	Surface samples collected	Supplemental investigation report (section 6.2)
	SWMU 49-005(a)	Inactive small debris landfill	Surface, subsurface, and pore-gas samples collected	Supplemental investigation report (section 6.4)

Note: Shading denotes no further action approved.

Table 3.1-1
Field-Screening Results for Samples Collected at Area 10, AOC 49-002 and SWMU 49-005(a)

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/Gamma (dpm)
Area 10 Drilling Samples						
49-005(a)	49-609986	0.0–1.0	RE49-10-5403	0.0	65	2150
49-005(a)	49-609988	4.0–5.0	RE49-10-5407	0.0	98	2390
49-005(a)	49-609988	8.0–10.0	RE49-10-5408	0.6	98	2390
49-005(a)	49-609987	0.0–0.5	RE49-10-5404	0.0	91	2170
49-005(a)	49-609986	4.0–5.0	RE49-10-5401	0.0	91	2170
49-005(a)	49-609986	9.0–10.0	RE49-10-5402	0.7	91	2440
49-005(a)	49-609989	0.0–0.6	RE49-10-5414	0.0	78	2290
49-005(a)	49-609989	3.0–4.0	RE49-10-5410	0.0	78	2290
49-005(a)	49-609989	9.0–10.0	RE49-10-5412	0.0	85	1841
49-005(a)	49-609987	0.0–2.0	RE49-10-5409	0.0	65	2160
49-005(a)	49-609987	3.0–5.0	RE49-10-5406	0.0	65	2160
49-005(a)	49-609987	5.0–6.5	RE49-10-5413	0.0	78	2390
49-005(a)	49-609987	6.5–8.0	RE49-10-5411	0.0	78	2390
49-005(a)	49-609987	8.0–10.0	RE49-10-5405	0.0	78	2390
Area 10 Surface and Shallow-Subsurface Samples						
49-002	49-609540	0.0–0.5	RE49-10-4003	NA[b]	85	2750
49-002	49-609540	0.5–1.5	RE49-10-4004	NA	78	2610
49-002	49-609541	0.0–0.5	RE49-10-4005	NA	85	2610
49-002	49-609541	0.5–1.5	RE49-10-4006	NA	98	2480
49-002	49-609542	0.0–0.5	RE49-10-4007	NA	98	2200
49-002	49-609542	0.5–1.5	RE49-10-4008	NA	104	2340
49-002	49-609543	0.0–0.5	RE49-10-4009	NA	91	2600
49-002	49-609543	0.5–1.5	RE49-10-4010	NA	65	2470
49-002	49-609544	0.0–0.5	RE49-10-4011	NA	111	2270
49-002	49-609544	0.5–1.5	RE49-10-4012	NA	85	2530
49-002	49-609545	0.0–0.5	RE49-10-4013	NA	78	2160
49-002	49-609545	0.5–1.5	RE49-10-4014	NA	78	2540
49-002	49-609546	0.0–0.5	RE49-10-4015	NA	98	2500
49-002	49-609546	0.5–1.5	RE49-10-4016	NA	111	2110
49-002	49-609547	0.0–0.5	RE49-10-4017	NA	65	2390
49-002	49-609547	0.5–1.5	RE49-10-4018	NA	104	2330
49-002	49-609548	0.0–0.5	RE49-10-4023	NA	111	2130
49-002	49-609548	0.5–1.5	RE49-10-4024	NA	104	2410
49-002	49-609549	0.0–0.5	RE49-10-4025	NA	104	2270
49-002	49-609549	0.5–1.5	RE49-10-4026	NA	111	2360
49-002	49-609550	0.0–0.5	RE49-10-4027	NA	52	2710

Table 3.1-1 (continued)

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/Gamma (dpm)
49-002	49-609550	0.5–1.5	RE49-10-4028	NA	91	2510
49-002	49-609551	0.0–0.5	RE49-10-4029	NA	98	2350
49-002	49-609551	0.5–1.5	RE49-10-4030	NA	111	2300
49-002	49-609552	0.0–0.5	RE49-10-4031	NA	65	2560
49-002	49-609552	0.5–1.5	RE49-10-4032	NA	111	2330
49-002	49-609553	0.0–0.5	RE49-10-4033	NA	78	2250
49-002	49-609553	0.5–1.5	RE49-10-4034	NA	103	2420
49-002	49-609554	0.0–0.5	RE49-10-4035	NA	29	2300
49-002	49-609554	0.5–1.5	RE49-10-4036	NA	65	2430
49-002	49-609555	0.0–0.5	RE49-10-4037	NA	118	2610
49-002	49-609555	0.5–1.5	RE49-10-4038	NA	85	2300
49-002	49-609556	0.0–0.5	RE49-10-4039	NA	91	2540
49-002	49-609556	0.5–1.5	RE49-10-4040	NA	91	2570
49-002	49-609557	0.0–0.5	RE49-10-4041	NA	118	2580
49-002	49-609557	0.5–1.5	RE49-10-4042	NA	72	2610
49-002	49-609558	0.0–0.5	RE49-10-4043	NA	78	2740
49-002	49-609558	0.5–1.5	RE49-10-4044	NA	81	2200
49-002	49-609559	0.0–0.5	RE49-10-4045	NA	72	2440
49-002	49-609559	0.5–1.5	RE49-10-4046	NA	91	2850
49-002	49-609560	0.0–0.5	RE49-10-4047	NA	91	2510
49-002	49-609560	0.5–1.5	RE49-10-4048	NA	98	2600
49-002	49-609561	0.0–0.5	RE49-10-4055	NA	65	2310
49-002	49-609561	0.5–1.5	RE49-10-4056	NA	104	2270
49-002	49-609562	0.0–0.5	RE49-10-4057	NA	59	2070
49-002	49-609562	0.5–1.5	RE49-10-4058	NA	72	2420
49-002	49-609563	0.0–0.5	RE49-10-4059	NA	98	2410
49-002	49-609563	0.5–1.5	RE49-10-4060	NA	65	2100
49-002	49-609564	0.0–0.5	RE49-10-4061	NA	85	2620
49-002	49-609564	0.5–1.5	RE49-10-4062	NA	85	2330
49-002	49-609565	0.0–0.5	RE49-10-4063	NA	59	2170
49-002	49-609565	0.5–1.5	RE49-10-4064	NA	32	2220
49-002	49-609566	0.0–0.5	RE49-10-4065	NA	91	2110
49-002	49-609566	0.5–1.5	RE49-10-4066	NA	21	2130
49-002	49-609567	0.0–0.5	RE49-10-4067	NA	78	2430
49-002	49-609567	0.5–1.5	RE49-10-4068	NA	32	2270
49-002	49-609568	0.0–0.5	RE49-10-4069	NA	52	2320
49-002	49-609568	0.5–1.5	RE49-10-4070	NA	38	1958
49-002	49-609569	0.0–0.5	RE49-10-4071	NA	78	2460

Table 3.1-1 (continued)

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/Gamma (dpm)
49-002	49-609569	0.5–1.5	RE49-10-4072	NA	48	2090
49-002	49-609570	0.0–0.5	RE49-10-4073	NA	65	1871
49-002	49-609570	0.5–1.5	RE49-10-4074	NA	78	2610
49-002	49-609578	0.0–0.5	RE49-10-4094	NA	45	1981
49-002	49-609600	0.5–1.5	RE49-10-4138	NA	59	2500

[a] dpm = Disintegrations per minute.

[b] NA = Not analyzed.

Table 3.1-2
Field-Screening Results for Samples Collected at Area 6 West, SWMU 49-004

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/Gamma (dpm)
Area 6 West Drilling Samples						
49-004	49-609882	0.0–0.5	RE49-10-4930	0.0	91	2360
49-004	49-609882	9.0–14.0	RE49-10-4934	0.3	72	2320
49-004	49-609882	63.0–65.0	RE49-10-4941	0.0	59	2430
49-004	49-609883	0.0–6.0	RE49-10-4935	0.0	104	2290
49-004	49-609883	9.0–14.0	RE49-10-4940	1.4	104	2290
49-004	49-609883	62.0–64.0	RE49-10-4937	0.0	65	2340
49-004	49-609885	0.0–6.0	RE49-10-4942	0.0	78	2250
49-004	49-609885	9.0–14.0	RE49-10-4939	0.0	59	2970
49-004	49-609885	63.0–65.0	RE49-10-4938	0.0	59	2970
49-004	49-609884	0.0–1.0	RE49-10-4936	0.0	91	2200
49-004	49-609884	7.0–10.0	RE49-10-4932	0.0	52	1882
49-004	49-609884	63.0–65.0	RE49-10-4933	0.0	72	3030
Area 6 West Surface and Shallow-Subsurface Samples						
49-004	49-608961	0.0–0.5	RE49-10-2203	NA[b]	91	2950
49-004	49-609861	0.5–1.5	RE49-10-2204	NA	104	2650
49-004	49-608962	0.0–0.5	RE49-10-2205	NA	98	2490
49-004	49-608962	0.5–1.5	RE49-10-2206	NA	107	2760
49-004	49-608963	0.0–0.5	RE49-10-2207	NA	85	2700
49-004	49-608963	0.5–1.5	RE49-10-2208	NA	108	2460
49-004	49-608964	0.0–0.5	RE49-10-2209	NA	104	2500
49-004	49-608964	0.5–1.5	RE49-10-2210	NA	118	2680
49-004	49-608965	0.0–0.5	RE49-10-2211	NA	98	2640
49-004	49-608965	0.5–1.5	RE49-10-2212	NA	78	2850

Table 3.1-2 (continued)

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/ Gamma (dpm)
49-004	49-608966	0.0–0.5	RE49-10-2213	NA	111	2750
49-004	49-608966	0.5–1.5	RE49-10-2214	NA	78	2710
49-004	49-608967	0.0–0.5	RE49-10-2215	NA	98	2660
49-004	49-608967	0.5–1.5	RE49-10-2216	NA	98	2420
49-004	49-608968	0.0–0.5	RE49-10-2217	NA	101	2910
49-004	49-608968	0.5–1.5	RE49-10-2218	NA	85	2480
49-004	49-608969	0.0–0.5	RE49-10-2219	NA	104	2710
49-004	49-608969	0.5–1.5	RE49-10-2220	NA	111	2600
49-004	49-608970	0.0–0.5	RE49-10-2221	NA	98	2890
49-004	49-608970	0.5–1.5	RE49-10-2222	NA	111	2750
49-004	49-608971	0.0–0.5	RE49-10-2223	NA	65	2740
49-004	49-608971	0.5–1.5	RE49-10-2224	NA	72	2860
49-004	49-608972	0.0–0.5	RE49-10-2225	NA	72	2390
49-004	49-608972	0.5–1.5	RE49-10-2226	NA	98	2780
49-004	49-608973	0.0–0.5	RE49-10-2227	NA	114	2017
49-004	49-608973	0.5–1.5	RE49-10-2228	NA	59	2800
49-004	49-608974	0.0–0.5	RE49-10-2229	NA	85	2530
49-004	49-608974	0.5–1.5	RE49-10-2230	NA	78	2510
49-004	49-608975	0.0–0.5	RE49-10-2231	NA	91	2630
49-004	49-608975	0.5–1.5	RE49-10-2232	NA	78	2850
49-004	49-608976	0.0–0.5	RE49-10-2233	NA	85	2770
49-004	49-608976	0.5–1.5	RE49-10-2234	NA	111	2610
49-004	49-608977	0.0–0.5	RE49-10-2235	NA	26	776
49-004	49-608977	0.5–1.5	RE49-10-2236	NA	49	937
49-004	49-608978	0.0–0.5	RE49-10-2237	NA	11	845
49-004	49-608978	0.5–1.5	RE49-10-2238	NA	0	1000
49-004	49-608979	0.0–0.5	RE49-10-2239	NA	34	1012
49-004	49-608979	0.5–1.5	RE49-10-2240	NA	18	1093
49-004	49-608980	0.0–0.5	RE49-10-2241	NA	34	954
49-004	49-608980	0.5–1.5	RE49-10-2242	NA	0	1144
49-004	49-608981	0.0–0.5	RE49-10-2243	NA	119	908
49-004	49-608981	0.5–1.5	RE49-10-2244	NA	26	1000
49-004	49-608982	0.0–0.5	RE49-10-2245	NA	49	1058
49-004	49-608982	0.5–1.5	RE49-10-2246	NA	57	925
49-004	49-608983	0.0–0.5	RE49-10-2247	NA	57	1093
49-004	49-608983	0.5–1.5	RE49-10-2248	NA	73	1156
49-004	49-608984	0.0–0.5	RE49-10-2249	NA	42	1121
49-004	49-608984	0.5–1.5	RE49-10-2250	NA	0	874

Table 3.1-2 (continued)

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/ Gamma (dpm)
49-004	49-608985	0.0–0.5	RE49-10-2251	NA	34	966
49-004	49-608985	0.5–1.5	RE49-10-2252	NA	34	1139
49-004	49-608986	0.0–0.5	RE49-10-2275	NA	62	2430
49-004	49-608986	0.5–1.5	RE49-10-2276	NA	62	2500
49-004	49-608987	0.0–0.5	RE49-10-2277	NA	54	2530
49-004	49-608987	0.5–1.5	RE49-10-2278	NA	85	2390
49-004	49-608988	0.0–0.5	RE49-10-2279	NA	139	2730
49-004	49-608988	0.5–1.5	RE49-10-2280	NA	85	2490
49-004	49-608989	0.0–0.5	RE49-10-2281	NA	54	2440
49-004	49-608989	0.5–1.5	RE49-10-2282	NA	46	2580
49-004	49-608990	0.0–0.5	RE49-10-2283	NA	155	2500
49-004	49-608990	0.5–1.5	RE49-10-2284	NA	46	2850
49-004	49-608991	0.0–0.5	RE49-10-2285	NA	85	2250
49-004	49-608991	0.5–1.5	RE49-10-2286	NA	116	2730
49-004	49-608992	0.0–0.5	RE49-10-2287	NA	100	2500
49-004	49-608992	0.5–1.5	RE49-10-2288	NA	69	2360
49-004	49-608993	0.0–0.5	RE49-10-2289	NA	46	2290
49-004	49-608993	0.5–1.5	RE49-10-2290	NA	100	2500
49-004	49-608994	0.0–0.5	RE49-10-2291	NA	108	2620
49-004	49-608994	0.5–1.5	RE49-10-2292	NA	85	2540
49-004	49-608995	0.0–0.5	RE49-10-2293	NA	38	2590
49-004	49-608996	0.5–1.5	RE49-10-2294	NA	100	2590
49-004	49-608996	0.0–0.5	RE49-10-2295	NA	131	2570
49-004	49-608996	0.5–1.5	RE49-10-2296	NA	77	2720
49-004	49-608997	0.0–0.5	RE49-10-2297	NA	77	2500
49-004	49-608997	0.5–1.5	RE49-10-2298	NA	77	2380
49-004	49-608998	0.0–0.5	RE49-10-2299	NA	100	2570
49-004	49-608998	0.5–1.5	RE49-10-2300	NA	131	2590
49-004	49-608999	0.0–0.5	RE49-10-2301	NA	108	2690
49-004	49-608999	0.5–1.5	RE49-10-2302	NA	178	2440
49-004	49-609000	0.0–0.5	RE49-10-2303	NA	69	2520
49-004	49-609000	0.5–1.5	RE49-10-2304	NA	108	2350
49-004	49-609001	0.0–0.5	RE49-10-2305	NA	69	2330
49-004	49-609001	0.5–1.5	RE49-10-2306	NA	85	2440
49-004	49-609002	0.0–0.5	RE49-10-2307	NA	116	2530
49-004	49-609002	0.5–1.5	RE49-10-2308	NA	155	2580
49-004	49-609003	0.0–0.5	RE49-10-2309	NA	100	2400
49-004	49-609003	0.5–1.5	RE49-10-2310	NA	131	2550

Table 3.1-2 (continued)

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/ Gamma (dpm)
49-004	49-609004	0.0–0.5	RE49-10-2311	NA	131	2650
49-004	49-609004	0.5–1.5	RE49-10-2312	NA	124	2620
49-004	49-609005	0.0–0.5	RE49-10-2313	NA	116	2810
49-004	49-609005	0.5–1.5	RE49-10-2314	NA	155	3350
49-004	49-609006	0.0–0.5	RE49-10-2315	NA	85	2710
49-004	49-609006	0.5–1.5	RE49-10-2316	NA	131	3130
49-004	49-609007	0.0–0.5	RE49-10-2317	NA	131	2460
49-004	49-609007	0.5–1.5	RE49-10-2318	NA	131	2470
49-004	49-609008	0.0–0.5	RE49-10-2319	NA	93	2700
49-004	49-609008	0.5–1.5	RE49-10-2320	NA	139	2890
49-004	49-609009	0.0–0.5	RE49-10-2329	NA	39	2610
49-004	49-609009	0.5–1.5	RE49-10-2330	NA	59	2410
49-004	49-609010	0.0–0.5	RE49-10-2331	NA	47	1996
49-004	49-609010	0.5–1.5	RE49-10-2332	NA	107	2680
49-004	49-609011	0.0–0.5	RE49-10-2333	NA	61	2130
49-004	49-609011	0.5–1.5	RE49-10-2334	NA	61	2270
49-004	49-609012	0.0–0.5	RE49-10-2335	NA	140	2740
49-004	49-609012	0.5–1.5	RE49-10-2336	NA	102	2180
49-004	49-609013	0.0–0.5	RE49-10-2337	NA	118	2420
49-004	49-609013	0.5–1.5	RE49-10-2338	NA	61	2130
49-004	49-609014	0.0–0.5	RE49-10-2339	NA	118	2670
49-004	49-609014	0.5–1.5	RE49-10-2340	NA	72	2530
49-004	49-609015	0.0–0.5	RE49-10-2341	NA	41	2170
49-004	49-609015	0.5–1.5	RE49-10-2342	NA	137	2540
49-004	49-609016	0.0–0.5	RE49-10-2343	NA	118	2600
49-004	49-609016	0.5–1.5	RE49-10-2344	NA	85	2560
49-004	49-609017	0.0–0.5	RE49-10-2345	NA	20	2090
49-004	49-609017	0.5–1.5	RE49-10-2346	NA	137	2370
49-004	49-609018	0.0–0.5	RE49-10-2347	NA	41	2160
49-004	49-609018	0.5–1.5	RE49-10-2348	NA	98	2650
49-004	49-609019	0.0–0.5	RE49-10-2349	NA	91	2410
49-004	49-609019	0.5–1.5	RE49-10-2350	NA	20	2480
49-004	49-609020	0.0–0.5	RE49-10-2351	NA	85	2590
49-004	49-609020	0.5–1.5	RE49-10-2352	NA	47	2300
49-004	49-609021	0.0–0.5	RE49-10-2353	NA	13	2310
49-004	49-609021	0.5–1.5	RE49-10-2354	NA	111	2710
49-004	49-609022	0.0–0.5	RE49-10-2355	NA	118	2510
49-004	49-609022	0.5–1.5	RE49-10-2356	NA	75	2450

Table 3.1-2 (continued)

SWMU or AOC	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha (dpm[a])	Beta/ Gamma (dpm)
49-004	49-609039	0.0–0.5	RE49-10-2396	NA	69	2490
49-004	49-609090	0.5–1.5	RE49-10-2516	NA	100	2630

[a] dpm = Disintegrations per minute.

[b] NA = Not analyzed.

Table 4.5-1
Henry's Law Constants, Groundwater SLs, and Pore-Gas Screening Levels for Detected VOCs in Pore Gas

VOC	Henry's Law Constant[a] (dimensionless)	Groundwater Screening Level (µg/L)	Pore-Gas Screening Level for Groundwater Protection[b] (µg/m³)
Acetone	0.00144	14100[c]	20300
Benzene	0.228	5[d]	1140
Butanone[2-]	0.00233	5560[c]	13,000
Chloromethane	0.362	20.3[c]	7350
Dichlorodifluoromethane	14.1	197[c]	2,780,000
Ethylbenzene	0.323	700[d]	22,600
Ethyltoluene[4-]	na[e]	na	na
Styrene	0.113	100[d]	11,300
Tetrachloroethene	0.726	5[d]	3630
Toluene	0.272	750[f]	20,400
Trimethylbenzene[1,2,4-]	0.25[g]	15[h]	3750
Trimethylbenzene[1,3,5-]	0.36[g]	120[h]	43,200
Xylene (Total)	0.212	620[f]	131000
Xylene[1,2-]	0.212	620[f]	132,000
Xylene[1,3-]+Xylene[1,4-]	0.294	620[f]	182,000

[a] NMED (2015, 600915, Appendix B) unless otherwise noted.

[b] Derived from denominator of Equation 4.5-3.

[c] Tap-water screening levels from NMED (2015, 600915).

[d] EPA MCL (40 Code of Federal Regulations 141.61).

[e] na = Not available.

[f] NMWQCC groundwater standard (20.6.2.3103 New Mexico Administrative Code).

[g] Henry's law constant from EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

[h] EPA regional tap-water screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

Table 4.5-2
Results of Pore-Gas Screening Based on Maximum Detected Concentrations

Chemical	Maximum Detected Concentration (µg/m^3)	Pore-Gas Screening Level for Groundwater Protection[a] (µg/m^3)	Screening Value
Acetone	31	20,300	0.0015
Benzene	12	1140	0.010
Butanone[2-]	10	13,000	0.00077
Chloromethane	1.7	7350	0.00023
Dichlorodifluoromethane	3.2	2,780,000	0.0000012
Ethylbenzene	13	22,600	0.00058
Ethyltoluene[4-]	17	na[b]	na
Styrene	3.2	11,300	0.00028
Tetrachloroethene	7.3	3630	0.0020
Toluene	34	20,400	0.0017
Trimethylbenzene[1,2,4-]	18	3750	0.049
Trimethylbenzene[1,3,5-]	5.4	43,200	0.00012
Xylene (Total)	50	131,000	0.00038
Xylene[1,2-]	13	132,000	0.0000098
Xylene[1,3-]+Xylene[1,4-]	37	182,000	0.00020

[a] Screening levels from Table 4.5-1.

[b] na = Not available.

Table 6.2-1
Samples Collected and Analyses Requested at Area 10, AOC 49-002

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Pesticides/ PCBs	SVOCs	Uranium
0549-95-0252	49-07536	0.0–0.5	Soil	—*	795	795	—	794, 795	—	—	795
0549-95-0253	49-07537	0.0–0.5	Soil	—	795	795	—	794, 795	—	—	795
0549-95-0254	49-07538	0.0–0.5	Soil	—	795	—	—	—	—	—	—
0549-95-0255	49-07539	0.0–0.5	Soil	—	795	795	—	794, 795	—	—	795
0549-95-0256	49-07542	0.0–0.5	Soil	—	795	795	—	794, 795	—	—	795
0549-95-0257	49-07543	0.0–0.5	Soil	—	795	—	—	—	—	—	—
0549-95-0258	49-07544	0.0–0.5	Soil	—	795	795	—	794, 795	—	—	795
0549-95-0259	49-07545	0.0–0.5	Soil	—	795	—	—	—	—	—	—
0549-95-0260	49-07548	0.0–0.5	Soil	—	795	795	—	794, 795	—	—	795
0549-95-0261	49-07549	0.0–0.5	Soil	—	795	—	—	—	—	—	—
0549-95-0262	49-07550	0.0–0.5	Soil	—	795	—	—	—	—	—	—
0549-95-0263	49-07551	0.0–0.5	Soil	—	795	—	—	—	—	—	—
0549-95-0264	49-07560	0.0–0.5	Soil	—	795	795	—	794, 795	793	793	795
RE49-10-4003	49-609540	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4004	49-609540	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4005	49-609541	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4006	49-609541	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4007	49-609542	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4008	49-609542	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4009	49-609543	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4010	49-609543	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4011	49-609544	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4012	49-609544	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4013	49-609545	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4014	49-609545	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4015	49-609546	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4016	49-609546	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4017	49-609547	0.0–0.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4018	49-609547	0.5–1.5	Soil	10-439	10-439	10-439	10-439	10-439	—	—	—
RE49-10-4023	49-609548	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4024	49-609548	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4025	49-609549	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4026	49-609549	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4027	49-609550	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Pesticides/ PCBs	SVOCs	Uranium
RE49-10-4028	49-609550	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4029	49-609551	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4030	49-609551	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4031	49-609552	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4032	49-609552	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4033	49-609553	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4034	49-609553	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4035	49-609554	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4036	49-609554	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4037	49-609555	0.0–0.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4038	49-609555	0.5–1.5	Soil	10-433	10-433	10-433	10-433	10-433	—	—	—
RE49-10-4039	49-609556	0.0–0.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4040	49-609556	0.5–1.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4041	49-609557	0.0–0.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4042	49-609557	0.5–1.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4043	49-609558	0.0–0.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4044	49-609558	0.5–1.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4045	49-609559	0.0–0.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4046	49-609559	0.5–1.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4047	49-609560	0.0–0.5	Soil	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4048	49-609560	0.5–1.5	Qbt4	10-434	10-434	10-434	10-434	10-434	—	—	—
RE49-10-4055	49-609561	0.0–0.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4056	49-609561	0.5–1.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4057	49-609562	0.0–0.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4058	49-609562	0.5–1.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4059	49-609563	0.0–0.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4060	49-609563	0.5–1.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4061	49-609564	0.0–0.5	Fill	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4062	49-609564	0.5–1.5	Fill	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4063	49-609565	0.0–0.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4064	49-609565	0.5–1.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4065	49-609566	0.0–0.5	Soil	10-431	10-431	10-431	10-431	10-431	—	—	—
RE49-10-4066	49-609566	0.5–1.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4067	49-609567	0.0–0.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4068	49-609567	0.5–1.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Pesticides/ PCBs	SVOCs	Uranium
RE49-10-4069	49-609568	0.0–0.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4070	49-609568	0.5–1.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4071	49-609569	0.0–0.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4072	49-609569	0.5–1.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4073	49-609570	0.0–0.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4074	49-609570	0.5–1.5	Soil	10-432	10-432	10-432	10-432	10-432	—	—	—
RE49-10-4094	49-609578	0.5–1.5	Soil	10-442	10-442	10-442	10-442	10-442	—	—	—
RE49-10-4138	49-609600	0.5–1.5	Soil	10-442	10-442	10-442	10-442	10-442	—	—	—

Note: The numbers in the analytical request columns are analytical request numbers.

*— = Analysis not requested.

Table 6.2-2
Summary of Inorganic Chemicals Detected or Detected above BVs at Area 10, AOC 49-002

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Lead
Qbt 2,3,4 BV[a]				**7340**	**0.5**	**46**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**11.2**
Soil BV[a]				**29,200**	**0.83**	**295**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**22.3**
Residential SSL[b]				**78,000**	**31.3**	**15,600**	**70.5**	**13,000,000**	**96.6[c]**	**23[d]**	**3130**	**400**
Industrial SSL[b]				**1,290,000**	**519**	**255,000**	**1110**	**32,400,000**	**505[c]**	**350[d]**	**51,900**	**800**
Construction Worker SSL[b]				**41,400**	**142**	**4390**	**72.1**	**8,850,000**	**134[c]**	**36.6[e]**	**14,200**	**800**
0549-95-0252	49-07536	0.0–0.5	Soil	—[f]	5.7 (U)	—	0.73 (J)	—	—	—	—	48 (J-)
0549-95-0253	49-07537	0.0–0.5	Soil	—	5.5 (U)	—	0.59 (U)	—	—	—	—	—
0549-95-0255	49-07539	0.0–0.5	Soil	—	5.6 (U)	—	0.6 (U)	—	—	—	20.5	26.7 (J-)
0549-95-0256	49-07542	0.0–0.5	Soil	—	13.9	—	0.59 (U)	—	—	—	—	—
0549-95-0258	49-07544	0.0–0.5	Soil	—	5.5 (U)	—	0.59 (U)	—	—	—	—	—
0549-95-0260	49-07548	0.0–0.5	Soil	—	5.6 (U)	—	0.59 (U)	—	—	—	98.9	—
0549-95-0264	49-07560	0.0–0.5	Soil	—	5.6 (U)	—	0.6 (U)	—	—	—	—	—
RE49-10-4003	49-609540	0.0–0.5	Soil	—	1.17 (U)	—	0.584 (U)	—	—	—	—	—
RE49-10-4004	49-609540	0.5–1.5	Soil	—	1.11 (U)	—	—	—	—	—	—	—
RE49-10-4005	49-609541	0.0–0.5	Soil	—	1.12 (U)	—	0.559 (U)	—	—	—	—	—
RE49-10-4006	49-609541	0.5–1.5	Soil	—	1.08 (U)	—	—	—	—	—	—	—
RE49-10-4007	49-609542	0.0–0.5	Soil	—	1.23 (U)	—	—	—	—	—	—	—
RE49-10-4008	49-609542	0.5–1.5	Soil	—	1.14 (U)	—	—	—	—	—	—	—
RE49-10-4009	49-609543	0.0–0.5	Soil	—	1.18 (U)	—	—	—	—	—	—	—
RE49-10-4010	49-609543	0.5–1.5	Soil	—	1.13 (U)	—	1.49	—	—	—	—	—
RE49-10-4011	49-609544	0.0–0.5	Soil	—	1.31 (U)	—	0.446 (J)	—	—	—	23.2	27.2
RE49-10-4012	49-609544	0.5–1.5	Soil	—	1.26 (U)	—	—	—	—	—	—	—
RE49-10-4013	49-609545	0.0–0.5	Soil	—	1.25 (U)	—	0.576 (J)	—	—	—	—	40.7
RE49-10-4014	49-609545	0.5–1.5	Soil	—	1.31 (U)	—	0.653 (U)	6730	—	—	—	—
RE49-10-4015	49-609546	0.0–0.5	Soil	—	1.16 (U)	—	—	—	—	—	—	—
RE49-10-4016	49-609546	0.5–1.5	Soil	—	1.22 (U)	—	0.609 (U)	—	—	—	—	—
RE49-10-4017	49-609547	0.0–0.5	Soil	—	1.12 (U)	—	—	—	—	—	—	—
RE49-10-4018	49-609547	0.5–1.5	Soil	—	1.08 (U)	—	0.542 (U)	—	—	—	—	—
RE49-10-4023	49-609548	0.0–0.5	Soil	—	2.02 (U)	—	—	—	—	—	—	—
RE49-10-4024	49-609548	0.5–1.5	Soil	—	1.3 (U)	—	—	—	—	10.3	—	—
RE49-10-4025	49-609549	0.0–0.5	Soil	—	1.28 (U)	—	—	—	—	—	—	—
RE49-10-4026	49-609549	0.5–1.5	Soil	—	1.02 (U)	—	—	—	—	—	—	—
RE49-10-4027	49-609550	0.0–0.5	Soil	—	1.36 (U)	—	—	—	—	—	—	—
RE49-10-4028	49-609550	0.5–1.5	Soil	—	1.21 (U)	—	—	—	—	—	—	—
RE49-10-4029	49-609551	0.0–0.5	Soil	—	1.37 (U)	—	—	—	—	—	—	—
RE49-10-4030	49-609551	0.5–1.5	Soil	—	1.52 (U)	—	—	—	—	—	—	—
RE49-10-4031	49-609552	0.0–0.5	Soil	—	1.4 (U)	—	—	—	—	—	—	—
RE49-10-4032	49-609552	0.5–1.5	Soil	—	1.39 (U)	—	—	—	—	—	—	—
RE49-10-4033	49-609553	0.0–0.5	Soil	—	0.934 (U)	—	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Lead
Qbt 2,3,4 BV[a]				**7340**	**0.5**	**46**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**11.2**
Soil BV[a]				**29,200**	**0.83**	**295**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**22.3**
Residential SSL[b]				**78,000**	**31.3**	**15,600**	**70.5**	**13,000,000**	**96.6**[c]	**23**[d]	**3130**	**400**
Industrial SSL[b]				**1,290,000**	**519**	**255,000**	**1110**	**32,400,000**	**505**[c]	**350**[d]	**51,900**	**800**
Construction Worker SSL[b]				**41,400**	**142**	**4390**	**72.1**	**8,850,000**	**134**[c]	**36.6**[e]	**14,200**	**800**
RE49-10-4034	49-609553	0.5–1.5	Soil	—	1.05 (U)	—	—	6270	—	—	—	—
RE49-10-4035	49-609554	0.0–0.5	Soil	—	1.78 (U)	—	—	—	—	—	—	—
RE49-10-4036	49-609554	0.5–1.5	Soil	—	1.46 (U)	—	—	10,000	—	—	—	—
RE49-10-4037	49-609555	0.0–0.5	Soil	—	1.1 (U)	—	—	—	—	—	—	—
RE49-10-4038	49-609555	0.5–1.5	Soil	—	1.67 (U)	—	—	—	—	—	—	—
RE49-10-4039	49-609556	0.0–0.5	Soil	—	1.12 (UJ)	—	0.558 (U)	—	—	—	—	—
RE49-10-4040	49-609556	0.5–1.5	Soil	—	0.981 (UJ)	—	0.491 (U)	—	—	—	—	—
RE49-10-4041	49-609557	0.0–0.5	Soil	—	1.04 (UJ)	—	0.522 (U)	—	—	—	—	—
RE49-10-4042	49-609557	0.5–1.5	Soil	—	1.03 (UJ)	—	—	—	—	—	—	—
RE49-10-4043	49-609558	0.0–0.5	Soil	—	1.17 (UJ)	—	0.587 (U)	—	—	—	—	24.4
RE49-10-4044	49-609558	0.5–1.5	Soil	—	0.991 (UJ)	—	0.495 (U)	—	—	—	—	—
RE49-10-4045	49-609559	0.0–0.5	Soil	—	1.24 (UJ)	—	0.618 (U)	—	—	—	—	—
RE49-10-4046	49-609559	0.5–1.5	Soil	—	1.1 (UJ)	—	0.55 (U)	—	—	—	—	—
RE49-10-4047	49-609560	0.0–0.5	Soil	—	1.1 (UJ)	—	0.551 (U)	—	—	—	—	—
RE49-10-4048	49-609560	0.5–1.5	Qbt4	10,100	1.04 (UJ)	121	—	—	8.35	3.99	5.18	—
RE49-10-4055	49-609561	0.0–0.5	Soil	—	1.01 (U)	—	—	—	—	—	—	—
RE49-10-4057	49-609562	0.0–0.5	Soil	—	1.24 (U)	—	—	—	—	—	—	—
RE49-10-4059	49-609563	0.0–0.5	Soil	—	1.13 (U)	—	—	—	—	—	—	—
RE49-10-4060	49-609563	0.5–1.5	Soil	—	1.02 (U)	—	—	—	—	—	—	—
RE49-10-4061	49-609564	0.0–0.5	Fill	—	1.04 (U)	—	—	—	—	—	—	—
RE49-10-4062	49-609564	0.5–1.5	Fill	—	1.05 (U)	—	0.523 (U)	—	—	—	—	—
RE49-10-4063	49-609565	0.0–0.5	Soil	—	1.1 (U)	—	—	—	—	—	—	—
RE49-10-4064	49-609565	0.5–1.5	Soil	—	1.09 (U)	—	0.545 (U)	—	—	—	—	—
RE49-10-4065	49-609566	0.0–0.5	Soil	—	1.22 (U)	—	—	—	—	—	—	—
RE49-10-4066	49-609566	0.5–1.5	Soil	—	—	—	0.533 (U)	—	—	—	—	—
RE49-10-4067	49-609567	0.0–0.5	Soil	—	1.07 (U)	—	0.536 (U)	—	—	—	—	—
RE49-10-4068	49-609567	0.5–1.5	Soil	—	1.08 (U)	—	0.541 (U)	—	—	—	—	—
RE49-10-4069	49-609568	0.0–0.5	Soil	—	1.18 (U)	—	0.589 (U)	—	—	—	—	—
RE49-10-4070	49-609568	0.5–1.5	Soil	—	1.06 (U)	—	0.531 (U)	—	—	—	—	—
RE49-10-4071	49-609569	0.0–0.5	Soil	—	1.09 (U)	—	0.546 (U)	—	—	—	—	—
RE49-10-4072	49-609569	0.5–1.5	Soil	—	1.09 (U)	—	0.544 (U)	—	—	—	—	—
RE49-10-4073	49-609570	0.0–0.5	Soil	—	1.26 (U)	—	0.628 (U)	—	—	—	—	—
RE49-10-4074	49-609570	0.5–1.5	Soil	—	1.14 (U)	—	0.569 (U)	—	—	—	—	—
RE49-10-4094	49-609578	0.5–1.5	Soil	—	0.977 (U)	—	—	—	—	—	—	—
RE49-10-4138	49-609600	0.5–1.5	Soil	—	1.17 (U)	—	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Manganese	Mercury	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Qbt 2,3,4 BV[a]				**482**	**0.1**	**6.58**	**0.3**	**1.1**	**2.4**	**17**	**63.5**
Soil BV[a]				**671**	**0.1**	**15.4**	**1.52**	**0.73**	**1.82**	**39.6**	**48.8**
Residential SSL[b]				**10,500**	**23.5**	**1560**	**391**	**0.782**	**234**	**394**	**23,500**
Industrial SSL[b]				**160,000**	**389**	**25,700**	**6490**	**13**	**3880**	**6530**	**389,000**
Construction Worker SSL[b]				**464**	**77.1**	**753**	**1750**	**3.54**	**277**	**614**	**1,006,000**
0549-95-0252	49-07536	0.0–0.5	Soil	—	0.72	—	—	—	3.2	—	98.7
0549-95-0253	49-07537	0.0–0.5	Soil	—	—	—	—	—	3.2	—	—
0549-95-0255	49-07539	0.0–0.5	Soil	—	0.11	—	—	—	3.9	—	78.8
0549-95-0256	49-07542	0.0–0.5	Soil	—	—	—	—	—	3.5	—	—
0549-95-0258	49-07544	0.0–0.5	Soil	—	—	—	—	—	3.2	—	—
0549-95-0260	49-07548	0.0–0.5	Soil	—	—	—	—	—	4.2	—	69.9
0549-95-0264	49-07560	0.0–0.5	Soil	—	—	—	—	—	3.4	—	—
RE49-10-4003	49-609540	0.0–0.5	Soil	—	—	—	—	—	NA[g]	—	—
RE49-10-4004	49-609540	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4005	49-609541	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4006	49-609541	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4007	49-609542	0.0–0.5	Soil	—	—	—	—	—	NA	—	85.4
RE49-10-4008	49-609542	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4009	49-609543	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4010	49-609543	0.5–1.5	Soil	—	—	—	—	—	NA	—	296
RE49-10-4011	49-609544	0.0–0.5	Soil	—	—	—	—	—	NA	—	112
RE49-10-4012	49-609544	0.5–1.5	Soil	—	—	—	—	—	NA	—	446
RE49-10-4013	49-609545	0.0–0.5	Soil	—	0.348	—	—	—	NA	—	94.7
RE49-10-4014	49-609545	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4015	49-609546	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4016	49-609546	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4017	49-609547	0.0–0.5	Soil	—	—	—	—	—	NA	—	73.5
RE49-10-4018	49-609547	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4023	49-609548	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4024	49-609548	0.5–1.5	Soil	899 (J-)	—	—	—	—	NA	—	—
RE49-10-4025	49-609549	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4026	49-609549	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4027	49-609550	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4028	49-609550	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4029	49-609551	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4030	49-609551	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4031	49-609552	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4032	49-609552	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4033	49-609553	0.0–0.5	Soil	—	—	—	—	—	NA	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Manganese	Mercury	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Qbt 2,3,4 BV[a]				**482**	**0.1**	**6.58**	**0.3**	**1.1**	**2.4**	**17**	**63.5**
Soil BV[a]				**671**	**0.1**	**15.4**	**1.52**	**0.73**	**1.82**	**39.6**	**48.8**
Residential SSL[b]				**10,500**	**23.5**	**1560**	**391**	**0.782**	**234**	**394**	**23,500**
Industrial SSL[b]				**160,000**	**389**	**25,700**	**6490**	**13**	**3880**	**6530**	**389,000**
Construction Worker SSL[b]				**464**	**77.1**	**753**	**1750**	**3.54**	**277**	**614**	**1,006,000**
RE49-10-4034	49-609553	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4035	49-609554	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4036	49-609554	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4037	49-609555	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4038	49-609555	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4039	49-609556	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4040	49-609556	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4041	49-609557	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4042	49-609557	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4043	49-609558	0.0–0.5	Soil	—	—	—	—	—	NA	—	61.9
RE49-10-4044	49-609558	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4045	49-609559	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4046	49-609559	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4047	49-609560	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4048	49-609560	0.5–1.5	Qbt4	—	—	7.39	1.01 (UJ)	—	NA	18	—
RE49-10-4055	49-609561	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4057	49-609562	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4059	49-609563	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4060	49-609563	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4061	49-609564	0.0–0.5	Fill	—	—	—	—	—	NA	—	—
RE49-10-4062	49-609564	0.5–1.5	Fill	—	—	—	—	—	NA	—	—
RE49-10-4063	49-609565	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4064	49-609565	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4065	49-609566	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4066	49-609566	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4067	49-609567	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4068	49-609567	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4069	49-609568	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4070	49-609568	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4071	49-609569	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4072	49-609569	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4073	49-609570	0.0–0.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4074	49-609570	0.5–1.5	Soil	—	—	—	—	—	NA	—	—
RE49-10-4094	49-609578	0.5–1.5	Soil	—	—	—	—	—	NA	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Manganese	Mercury	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Qbt 2,3,4 BV[a]				**482**	**0.1**	**6.58**	**0.3**	**1.1**	**2.4**	**17**	**63.5**
Soil BV[a]				**671**	**0.1**	**15.4**	**1.52**	**0.73**	**1.82**	**39.6**	**48.8**
Residential SSL[b]				**10,500**	**23.5**	**1560**	**391**	**0.782**	**234**	**394**	**23,500**
Industrial SSL[b]				**160,000**	**389**	**25,700**	**6490**	**13**	**3880**	**6530**	**389,000**
Construction Worker SSL[b]				**464**	**77.1**	**753**	**1750**	**3.54**	**277**	**614**	**1,006,000**
RE49-10-4138	49-609600	0.5–1.5	Soil	—	—	—	—	—	NA	—	—

Notes: All concentrations are in mg/kg. Data qualifiers are defined in Appendix A.

[a] BVs from LANL (1998, 059730).

[b] SSLs from NMED (2015, 600915) unless otherwise noted.

[c] SSL for total chromium.

[d] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

[e] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) and equation and parameters from NMED (2015, 600915).

[f] — = Not detected or not detected above BV.

[g] NA = Not analyzed.

Table 6.2-3
Summary of Radionuclides Detected or Detected above BVs/FVs at Area 10, AOC 49-002

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Plutonium-239/240
Soil BV[a]				**0.013**	**0.054**
Residential SAL[b]				**83**	**79**
Industrial SAL[b]				**1000**	**1200**
Construction Worker SAL[b]				**230**	**200**
RE49-10-4012	49-609544	0.5–1.5	Soil	—[c]	—
RE49-10-4016	49-609546	0.5–1.5	Soil	—	—
RE49-10-4018	49-609547	0.5–1.5	Soil	—	—
RE49-10-4030	49-609551	0.5–1.5	Soil	—	—
RE49-10-4032	49-609552	0.5–1.5	Soil	0.184	—
RE49-10-4038	49-609555	0.5–1.5	Soil	—	—
RE49-10-4040	49-609556	0.5–1.5	Soil	—	—
RE49-10-4046	49-609559	0.5–1.5	Soil	—	0.116
RE49-10-4056	49-609561	0.5–1.5	Soil	—	—
RE49-10-4066	49-609566	0.5–1.5	Soil	—	—
RE49-10-4070	49-609568	0.5–1.5	Soil	—	—
RE49-10-4138	49-609600	0.5–1.5	Soil	—	—

Note: All activities are in pCi/g.

[a] BVs/FVs from LANL (1998, 059730).

[b] SALs from LANL (2015, 600929).

[c] — = Not detected or not detected above BV/FV.

Table 6.3-1
Samples Collected and Analyses Requested at Area 6 West, SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Tritium	High Explosives	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Perchlorate	Strontium-90	SVOCs	Technetium-99	Uranium	VOCs	Wet Chemistry
0549-95-0315	49-06106	0.0–0.5	Soil	—*	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0316	49-06107	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0317	49-06108	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0318	49-06109	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0319	49-06110	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0321	49-06111	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0322	49-06112	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0323	49-06113	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0324	49-06114	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0325	49-06115	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0326	49-06116	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0327	49-06117	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0328	49-06118	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0329	49-06137	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0330	49-06138	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0331	49-06139	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0332	49-06140	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0333	49-06141	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0334	49-06142	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0335	49-06143	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0336	49-06144	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0337	49-06145	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0338	49-06146	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0339	49-06147	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0340	49-06148	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0341	49-06149	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0101	49-06213	2.0–5.0	Soil	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0102	49-06213	5.0–10.0	Soil	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—
0549-95-0103	49-06213	10.0–12.0	Qbt4	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—
0549-95-0104	49-06214	2.0–5.0	Fill	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—
0549-95-0105	49-06214	5.0–9.5	Fill	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—
0549-95-0106	49-06214	10.0–12.5	Qbt4	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0107	49-06215	0.0–5.0	Fill	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—
0549-95-0108	49-06215	6.0–9.5	Fill	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0110	49-06216	1.5–4.0	Fill	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0111	49-06216	18.1–20.0	Fill	—	728	—	—	728	—	727, 728	—	—	726	—	—	—	—
0549-95-0112	49-06216	20.0–22.0	Fill	—	728	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0113	49-06217	3.0–5.0	Soil	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—

Table 6.3-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Tritium	High Explosives	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Perchlorate	Strontium-90	SVOCs	Technetium-99	Uranium	VOCs	Wet Chemistry
0549-95-0114	49-06217	8.0–10.0	Soil	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0117	49-06218	3.0–5.0	Soil	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0118	49-06218	8.0–10.0	Qbt4	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0119	49-06218	12.5–15.0	Qbt4	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—
0549-95-0120	49-06219	3.0–5.0	Soil	—	687	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0121	49-06219	7.5–10.0	Qbt4	—	687	—	—	687	—	683, 687	—	—	682	—	—	—	—
0549-95-0342	49-06220	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0343	49-06221	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0344	49-06222	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0346	49-06223	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0347	49-06224	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0348	49-06225	0.0–0.5	Soil	—	786	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0349	49-06226	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
0549-95-0350	49-06227	0.0–0.5	Soil	—	786	—	—	786	—	783	—	—	—	—	786	—	—
RE49-10-2203	49-608961	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2204	49-608961	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2205	49-608962	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2206	49-608962	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2207	49-608963	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2208	49-608963	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2209	49-608964	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2210	49-608964	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2211	49-608965	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2212	49-608965	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2213	49-608966	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2214	49-608966	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2215	49-608967	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2216	49-608967	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2217	49-608968	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2218	49-608968	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2219	49-608969	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2220	49-608969	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2221	49-608970	0.0–0.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2222	49-608970	0.5–1.5	Soil	10-258	10-258	—	—	10-258	10-258	10-258	—	—	—	—	—	—	—
RE49-10-2223	49-608971	0.0–0.5	Soil	10-260	10-259, 10-260	—	—	10-260	10-260	10-260	—	10-259	—	10-259	—	—	—
RE49-10-2224	49-608971	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2225	49-608972	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2226	49-608972	0.5–1.5	Soil	10-260	10-259, 10-260	—	—	10-260	10-260	10-260	—	10-259	—	10-259	—	—	—
RE49-10-2227	49-608973	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—

Table 6.3-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Tritium	High Explosives	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Perchlorate	Strontium-90	SVOCs	Technetium-99	Uranium	VOCs	Wet Chemistry
RE49-10-2228	49-608973	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2229	49-608974	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2230	49-608974	0.5–1.5	Soil	10-260	10-259, 10-260	—	—	10-260	10-260	10-260	—	10-259	—	10-259	—	—	—
RE49-10-2231	49-608975	0.0–0.5	Soil	10-260	10-259, 10-260	—	—	10-260	10-260	10-260	—	10-259	—	10-259	—	—	—
RE49-10-2232	49-608975	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2233	49-608976	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2234	49-608976	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2235	49-608977	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2236	49-608977	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2237	49-608978	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2238	49-608978	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2239	49-608979	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2240	49-608979	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2241	49-608980	0.0–0.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2242	49-608980	0.5–1.5	Soil	10-260	10-260	—	—	10-260	10-260	10-260	—	—	—	—	—	—	—
RE49-10-2243	49-608981	0.0–0.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2244	49-608981	0.5–1.5	Soil	10-261	10-259, 10-261	—	—	10-261	10-261	10-261	—	10-259	—	10-259	—	—	—
RE49-10-2245	49-608982	0.0–0.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2246	49-608982	0.5–1.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2247	49-608983	0.0–0.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2248	49-608983	0.5–1.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2249	49-608984	0.0–0.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2250	49-608984	0.5–1.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2251	49-608985	0.0–0.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2252	49-608985	0.5–1.5	Soil	10-261	10-261	—	—	10-261	10-261	10-261	—	—	—	—	—	—	—
RE49-10-2275	49-608986	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2276	49-608986	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2277	49-608987	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2278	49-608987	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2279	49-608988	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2280	49-608988	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2281	49-608989	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2282	49-608989	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2283	49-608990	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2284	49-608990	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2285	49-608991	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2286	49-608991	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2287	49-608992	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2288	49-608992	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—

Table 6.3-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Tritium	High Explosives	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Perchlorate	Strontium-90	SVOCs	Technetium-99	Uranium	VOCs	Wet Chemistry
RE49-10-2289	49-608993	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2290	49-608993	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2291	49-608994	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2292	49-608994	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2293	49-608995	0.0–0.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2294	49-608995	0.5–1.5	Soil	10-293	10-293	—	—	10-293	10-293	10-293	—	—	—	—	—	—	—
RE49-10-2295	49-608996	0.0–0.5	Soil	10-294	10-294	—	—	10-294	10-294	10-294	—	—	—	—	—	—	—
RE49-10-2296	49-608996	0.5–1.5	Soil	10-294	10-294	—	—	10-294	10-294	10-294	—	—	—	—	—	—	—
RE49-10-2297	49-608997	0.0–0.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2298	49-608997	0.5–1.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2299	49-608998	0.0–0.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2300	49-608998	0.5–1.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2301	49-608999	0.0–0.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2302	49-608999	0.5–1.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2303	49-609000	0.0–0.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2304	49-609000	0.5–1.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2305	49-609001	0.0–0.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2306	49-609001	0.5–1.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2307	49-609002	0.0–0.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2308	49-609002	0.5–1.5	Soil	10-402	10-402	—	—	10-402	10-402	10-402	—	—	—	—	—	—	—
RE49-10-2309	49-609003	0.0–0.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2310	49-609003	0.5–1.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2311	49-609004	0.0–0.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2312	49-609004	0.5–1.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2313	49-609005	0.0–0.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2314	49-609005	0.5–1.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2315	49-609006	0.0–0.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2316	49-609006	0.5–1.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2317	49-609007	0.0–0.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2318	49-609007	0.5–1.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2319	49-609008	0.0–0.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2320	49-609008	0.5–1.5	Soil	10-401	10-401	—	—	10-401	10-401	10-401	—	—	—	—	—	—	—
RE49-10-2329	49-609009	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2330	49-609009	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2331	49-609010	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2332	49-609010	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2333	49-609011	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2334	49-609011	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2335	49-609012	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—

Table 6.3-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Gamma Spectroscopy	Tritium	High Explosives	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Perchlorate	Strontium-90	SVOCs	Technetium-99	Uranium	VOCs	Wet Chemistry
RE49-10-2336	49-609012	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2337	49-609013	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2338	49-609013	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2339	49-609014	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2340	49-609014	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2341	49-609015	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2342	49-609015	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2343	49-609016	0.0–0.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2344	49-609016	0.5–1.5	Soil	10-400	10-400	—	—	10-400	10-400	10-400	—	—	—	—	—	—	—
RE49-10-2345	49-609017	0.0–0.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2346	49-609017	0.5–1.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2347	49-609018	0.0–0.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2348	49-609018	0.5–1.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2349	49-609019	0.0–0.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2350	49-609019	0.5–1.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2351	49-609020	0.0–0.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2352	49-609020	0.5–1.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2353	49-609021	0.0–0.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2354	49-609021	0.5–1.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2355	49-609022	0.0–0.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2356	49-609022	0.5–1.5	Soil	10-399	10-399	—	—	10-399	10-399	10-399	—	—	—	—	—	—	—
RE49-10-2396	49-609039	0.5–1.5	Soil	10-404	10-404	—	—	10-404	10-404	10-404	—	—	—	—	—	—	—
RE49-10-2516	49-609090	0.5–1.5	Soil	10-403	10-403	—	—	10-403	10-403	10-403	—	—	—	—	—	—	—
RE49-10-4930	49-609882	0.0–0.5	Soil	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4934	49-609882	9.0–19.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4941	49-609882	63.0–65.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4935	49-609883	0.0–0.5	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4940	49-609883	9.0–14.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4937	49-609883	62.0–64.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4936	49-609884	0.0–1.0	Fill	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4932	49-609884	7.5–10.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4933	49-609884	63.0–65.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4942	49-609885	0.0–0.5	Soil	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4939	49-609885	9.0–14.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438
RE49-10-4938	49-609885	63.0–65.0	Qbt4	10-438	—	10-438	10-437	10-438	10-438	10-438	10-438	—	10-437	—	—	10-437	10-438

Note: The numbers in the analytical request columns are analytical request numbers.

*— = Analysis not requested.

Table 6.3-2
Summary of Inorganic Chemicals Detected or Detected above BVs at Area 6 West, SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium
Qbt 2,3,4 BV[a]				**7340**	**0.5**	**46**	**1.21**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**14,500**	**11.2**	**1690**
Soil BV[a]				**29,200**	**0.83**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**21,500**	**22.3**	**4610**
Residential SSL[b]				**78,000**	**31.3**	**15,600**	**156**	**70.5**	**13,000,000**	**96.6[c]**	**23[d]**	**3130**	**54,800**	**400**	**339,000**
Industrial SSL[b]				**1,290,000**	**519**	**255,000**	**2580**	**1110**	**32,400,000**	**505[c]**	**350[d]**	**51,900**	**908,000**	**800**	**5,680,000**
Construction Worker SSL[b]				**41,400**	**142**	**4390**	**148**	**72.1**	**8,850,000**	**134[c]**	**36.6[e]**	**14,200**	**248,000**	**800**	**1,550,000**
0549-95-0315	49-06106	0.0–0.5	Soil	—[f]	—	—	—	—	—	—	—	—	—	—	—
0549-95-0316	49-06107	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0326	49-06116	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0327	49-06117	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0328	49-06118	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0329	49-06137	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0330	49-06138	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0333	49-06141	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0334	49-06142	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0336	49-06144	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0337	49-06145	0.0–0.5	Soil	—	—	—	—	—	—	—	—	15.3	—	—	—
0549-95-0339	49-06147	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0340	49-06148	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0102	49-06213	5.0–10.0	Soil	—	6 (UJ)	—	—	0.69 (U)	—	—	9.1 (J)	—	—	—	—
0549-95-0103	49-06213	10.0–12.0	Qbt4	—	5.7 (UJ)	—	—	—	—	—	—	—	—	—	—
0549-95-0104	49-06214	2.0–5.0	Fill	—	5.8 (UJ)	—	—	0.62 (U)	—	—	—	—	—	—	—
0549-95-0105	49-06214	5.0–9.5	Fill	—	6 (UJ)	—	—	0.64 (U)	—	—	13.4	—	—	—	—
0549-95-0107	49-06215	0.0–5.0	Fill	—	6 (UJ)	—	—	0.64 (U)	—	—	—	16.2	—	—	—
0549-95-0111	49-06216	18.1–20.0	Fill	—	—	—	—	—	—	—	—	112	—	—	—
0549-95-0113	49-06217	3.0–5.0	Soil	—	6.4 (UJ)	—	—	0.68 (U)	—	—	—	—	—	—	—
0549-95-0119	49-06218	12.5–15.0	Qbt4	—	6.5 (UJ)	—	—	—	—	—	—	—	—	—	—
0549-95-0121	49-06219	7.5–10.0	Qbt4	12,400	6.2 (UJ)	143 (J-)	—	—	2450	9.7	6.1 (J)	6.4	—	14.6	2760
0549-95-0343	49-06221	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0344	49-06222	0.0–0.5	Soil	—	—	—	—	—	—	—	—	17.9	—	24.1	—
0549-95-0349	49-06226	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
0549-95-0350	49-06227	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2204	49-608961	0.5–1.5	Soil	—	—	303 (J)	—	—	—	—	14.9	—	—	—	—
RE49-10-2205	49-608962	0.0–0.5	Soil	—	—	—	2	—	—	—	—	—	—	—	—
RE49-10-2210	49-608964	0.5–1.5	Soil	—	—	307 (J)	—	—	—	—	—	—	—	—	—
RE49-10-2213	49-608966	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2215	49-608967	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—

Table 6.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium
Qbt 2,3,4 BV[a]				**7340**	**0.5**	**46**	**1.21**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**14,500**	**11.2**	**1690**
Soil BV[a]				**29,200**	**0.83**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**21,500**	**22.3**	**4610**
Residential SSL[b]				**78,000**	**31.3**	**15,600**	**156**	**70.5**	**13,000,000**	**96.6**[c]	**23**[d]	**3130**	**54,800**	**400**	**339,000**
Industrial SSL[b]				**1,290,000**	**519**	**255,000**	**2580**	**1110**	**32,400,000**	**505**[c]	**350**[d]	**51,900**	**908,000**	**800**	**5,680,000**
Construction Worker SSL[b]				**41,400**	**142**	**4390**	**148**	**72.1**	**8,850,000**	**134**[c]	**36.6**[e]	**14,200**	**248,000**	**800**	**1,550,000**
RE49-10-2216	49-608967	0.5–1.5	Soil	35,100	—	403 (J)	2	—	—	—	—	—	—	—	—
RE49-10-2218	49-608968	0.5–1.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2223	49-608971	0.0–0.5	Soil	—	—	—	—	—	—	—	10.2 (J)	—	—	—	—
RE49-10-2237	49-608978	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2238	49-608978	0.5–1.5	Soil	—	—	—	—	—	—	—	—	—	—	25.9 (J)	—
RE49-10-2239	49-608979	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	31.4 (J)	—
RE49-10-2240	49-608979	0.5–1.5	Soil	—	—	—	—	—	—	—	—	16.8	—	—	—
RE49-10-2241	49-608980	0.0–0.5	Soil	—	—	—	—	—	—	—	—	15.6	—	—	—
RE49-10-2243	49-608981	0.0–0.5	Soil	—	—	—	—	—	—	—	—	14.8	—	—	—
RE49-10-2244	49-608981	0.5–1.5	Soil	—	—	—	—	—	—	—	—	15.4	—	—	—
RE49-10-2245	49-608982	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2246	49-608982	0.5–1.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2247	49-608983	0.0–0.5	Soil	—	—	—	—	—	—	—	—	29.6	—	23	—
RE49-10-2248	49-608983	0.5–1.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2249	49-608984	0.0–0.5	Soil	—	—	—	—	—	—	—	—	19.7	—	—	—
RE49-10-2250	49-608984	0.5–1.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2275	49-608986	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2282	49-608989	0.5–1.5	Soil	—	—	—	—	—	—	—	8.7	—	—	—	—
RE49-10-2285	49-608991	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2293	49-608995	0.0–0.5	Soil	—	—	—	—	—	—	—	—	18.6	—	—	—
RE49-10-2295	49-608996	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2296	49-608996	0.5–1.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-2299	49-608998	0.0–0.5	Soil	—	—	—	—	—	—	—	—	14.8	—	—	—
RE49-10-2300	49-608998	0.5–1.5	Soil	—	—	—	—	—	8190	—	—	120	—	45.5	—
RE49-10-2319	49-609008	0.0–0.5	Soil	—	—	—	—	—	—	—	9.7	—	—	33.8	—
RE49-10-2338	49-609013	0.5–1.5	Soil	—	—	—	—	—	—	—	9.2	—	—	—	—
RE49-10-2343	49-609016	0.0–0.5	Soil	—	—	—	—	—	—	—	8.8	—	—	—	—
RE49-10-2346	49-609017	0.5–1.5	Soil	—	—	—	—	—	—	—	9.3	—	—	—	—
RE49-10-2354	49-609021	0.5–1.5	Soil	—	—	—	—	—	—	—	—	—	—	—	—
RE49-10-4930	49-609882	0.0–0.5	Soil	—	1.15 (U)	—	—	0.576 (U)	—	—	—	—	—	—	—
RE49-10-4934	49-609882	9.0–19.0	Qbt4	—	1.09 (U)	98.9	—	—	10,800 (J-)	—	—	—	—	—	1950
RE49-10-4941	49-609882	63.0–65.0	Qbt4	—	1.01 (U)	—	—	—	—	—	—	—	—	14.3	—
RE49-10-4935	49-609883	0.0–0.5	Qbt4	11,600	1.1 (U)	135	—	—	2490 (J-)	9.45	4.87	22.8	—	16.6	2100
RE49-10-4940	49-609883	9.0–14.0	Qbt4	9070	1.08 (U)	108	—	—	3670 (J-)	10.4	4.39	339	16400	64.5	1760

Table 6.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium
Qbt 2,3,4 BV[a]				**7340**	**0.5**	**46**	**1.21**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**14,500**	**11.2**	**1690**
Soil BV[a]				**29,200**	**0.83**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**21,500**	**22.3**	**4610**
Residential SSL[b]				**78,000**	**31.3**	**15,600**	**156**	**70.5**	**13,000,000**	**96.6[c]**	**23[d]**	**3130**	**54,800**	**400**	**339,000**
Industrial SSL[b]				**1,290,000**	**519**	**255,000**	**2580**	**1110**	**32,400,000**	**505[c]**	**350[d]**	**51,900**	**908,000**	**800**	**5,680,000**
Construction Worker SSL[b]				**41,400**	**142**	**4390**	**148**	**72.1**	**8,850,000**	**134[c]**	**36.6[e]**	**14,200**	**248,000**	**800**	**1,550,000**
RE49-10-4937	49-609883	62.0–64.0	Qbt4	—	1.01 (U)	—	—	—	—	—	—	—	—	—	—
RE49-10-4936	49-609884	0.0–1.0	Fill	—	1.05 (U)	—	—	0.527 (U)	—	—	—	—	—	—	—
RE49-10-4932	49-609884	7.5–10.0	Qbt4	10,200	1.1 (U)	151	—	—	2800 (J-)	8.49	4.46	25.6	—	43.4	1860
RE49-10-4933	49-609884	63.0–65.0	Qbt4	—	0.992 (U)	—	—	—	—	—	—	—	—	—	—
RE49-10-4942	49-609885	0.0–0.5	Soil	—	1.09 (U)	—	—	0.543 (U)	—	—	—	—	—	—	—
RE49-10-4939	49-609885	9.0–14.0	Qbt4	10,200	1.14 (U)	154	—	—	—	8.84	4.52	7.93	—	13	2290
RE49-10-4938	49-609885	63.0–65.0	Qbt4	—	1.07 (U)	—	—	—	—	—	—	—	—	—	—

Table 6.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Manganese	Mercury	Nickel	Perchlorate	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
Qbt 2,3,4 BV[a]				**482**	**0.1**	**6.58**	**na**[g]	**3500**	**0.3**	**1**	**2770**	**1.1**	**2.4**	**17**	**63.5**
Soil BV[a]				**671**	**0.1**	**15.4**	**na**	**3460**	**1.52**	**1**	**915**	**0.73**	**1.82**	**39.6**	**48.8**
Residential SSL[b]				**10,500**	**23.5**	**1560**	**54.8**	**15,600,000**	**391**	**391**	**7,820,000**	**0.782**	**234**	**394**	**23,500**
Industrial SSL[b]				**160,000**	**389**	**25,700**	**908**	**73,000,000**	**6490**	**6490**	**35,700000**	**13**	**3880**	**6530**	**389,000**
Construction Worker SSL[b]				**464**	**77.1**	**753**	**248**	**19,900,000**	**1750**	**1770**	**9,730,000**	**3.54**	**277**	**614**	**1,006,000**
0549-95-0315	49-06106	0.0–0.5	Soil	—	—	—	NA[h]	—	—	—	—	1.2 (U)	2.84	—	—
0549-95-0316	49-06107	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	1.2 (U)	1.85	—	—
0549-95-0326	49-06116	0.0–0.5	Soil	—	0.11	—	NA	—	—	—	—	1.2 (U)	2.12	—	142
0549-95-0327	49-06117	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	1.3 (U)	—	—	96.2
0549-95-0328	49-06118	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	1.2 (U)	—	—	64
0549-95-0329	49-06137	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	1.3 (U)	1.99	—	50.9
0549-95-0330	49-06138	0.0–0.5	Soil	707 (J-)	0.11 (U)	—	NA	—	—	—	—	1.3 (U)	1.86	—	159
0549-95-0333	49-06141	0.0–0.5	Soil	—	—	—	NA	3500	—	—	—	1.3 (U)	—	—	64
0549-95-0334	49-06142	0.0–0.5	Soil	—	—	—	NA	—	—	1.4 (U)	—	1.3 (U)	1.92	—	65.1
0549-95-0336	49-06144	0.0–0.5	Soil	—	—	—	NA	4030	—	1.4 (U)	—	1.3 (U)	2.43	—	812
0549-95-0337	49-06145	0.0–0.5	Soil	—	0.11 (U)	—	NA	4240	—	1.5 (U)	—	1.3 (U)	2.29	—	49.8
0549-95-0339	49-06147	0.0–0.5	Soil	—	—	—	NA	4030	—	1.5 (U)	—	1.3 (U)	2.58	—	—
0549-95-0340	49-06148	0.0–0.5	Soil	—	—	—	NA	—	—	1.4 (U)	—	1.3 (U)	2.57	—	—
0549-95-0102	49-06213	5.0–10.0	Soil	—	NA	—	NA	—	—	—	—	—	3.4	—	—
0549-95-0103	49-06213	10.0–12.0	Qbt4	—	—	—	NA	—	—	—	—	—	3.3	—	—
0549-95-0104	49-06214	2.0–5.0	Fill	—	—	—	NA	—	—	—	—	—	3.5	—	—
0549-95-0105	49-06214	5.0–9.5	Fill	878 (J)	—	—	NA	—	—	—	—	—	3.3	—	—
0549-95-0107	49-06215	0.0–5.0	Fill	—	—	—	NA	—	—	1.7 (J)	—	—	4	—	—
0549-95-0111	49-06216	18.1–20.0	Fill	—	0.12 (U)	—	NA	—	—	—	—	1.4 (U)	—	—	—
0549-95-0113	49-06217	3.0–5.0	Soil	—	—	—	NA	—	—	—	—	—	3.6	—	70.6
0549-95-0119	49-06218	12.5–15.0	Qbt4	—	—	—	NA	—	—	—	—	—	3.6	—	—
0549-95-0121	49-06219	7.5–10.0	Qbt4	—	—	8.3 (J)	NA	—	—	—	—	—	3.6	20.1	—
0549-95-0343	49-06221	0.0–0.5	Soil	—	—	—	NA	3870	—	1.5 (U)	—	1.3 (U)	6.88	—	—
0549-95-0344	49-06222	0.0–0.5	Soil	—	0.11 (U)	—	NA	4310	—	1.6 (U)	—	1.4 (U)	8.1	—	—
0549-95-0349	49-06226	0.0–0.5	Soil	—	—	—	NA	—	—	1.4 (U)	—	1.2 (U)	8.4	—	—
0549-95-0350	49-06227	0.0–0.5	Soil	—	—	—	NA	—	—	1.4 (U)	—	1.3 (U)	10.7	—	—
RE49-10-2204	49-608961	0.5–1.5	Soil	1030 (J-)	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2205	49-608962	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2210	49-608964	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2213	49-608966	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	0.77	NA	—	—
RE49-10-2215	49-608967	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	67.7
RE49-10-2216	49-608967	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2218	49-608968	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	74.8
RE49-10-2223	49-608971	0.0–0.5	Soil	811	—	—	NA	—	—	—	—	—	NA	—	—

Table 6.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Manganese	Mercury	Nickel	Perchlorate	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
Qbt 2,3,4 BV[a]				**482**	**0.1**	**6.58**	**na**[g]	**3500**	**0.3**	**1**	**2770**	**1.1**	**2.4**	**17**	**63.5**
Soil BV[a]				**671**	**0.1**	**15.4**	**na**	**3460**	**1.52**	**1**	**915**	**0.73**	**1.82**	**39.6**	**48.8**
Residential SSL[b]				**10,500**	**23.5**	**1560**	**54.8**	**15,600,000**	**391**	**391**	**7,820,000**	**0.782**	**234**	**394**	**23,500**
Industrial SSL[b]				**160,000**	**389**	**25,700**	**908**	**73,000,000**	**6490**	**6490**	**35,700000**	**13**	**3880**	**6530**	**389,000**
Construction Worker SSL[b]				**464**	**77.1**	**753**	**248**	**19,900,000**	**1750**	**1770**	**9,730,000**	**3.54**	**277**	**614**	**1,006,000**
RE49-10-2237	49-608978	0.0–0.5	Soil	—	—	—	NA	—	—	11.6	—	—	NA	—	—
RE49-10-2238	49-608978	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2239	49-608979	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	0.74	NA	—	62.7
RE49-10-2240	49-608979	0.5–1.5	Soil	—	—	19.6	NA	—	—	—	—	—	NA	—	56.5
RE49-10-2241	49-608980	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	96
RE49-10-2243	49-608981	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	73
RE49-10-2244	49-608981	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	73.6
RE49-10-2245	49-608982	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	87.9
RE49-10-2246	49-608982	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	77
RE49-10-2247	49-608983	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	170
RE49-10-2248	49-608983	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	90.9
RE49-10-2249	49-608984	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2250	49-608984	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	70.1
RE49-10-2275	49-608986	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	0.97 (U)	NA	—	—
RE49-10-2282	49-608989	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2285	49-608991	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	1.2 (U)	NA	—	—
RE49-10-2293	49-608995	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	75.8
RE49-10-2295	49-608996	0.0–0.5	Soil	—	—	—	NA	—	—	—	1010	—	NA	—	—
RE49-10-2296	49-608996	0.5–1.5	Soil	—	—	—	NA	—	—	—	1390	—	NA	—	—
RE49-10-2299	49-608998	0.0–0.5	Soil	819 (J)	—	—	NA	—	—	—	—	—	NA	—	270
RE49-10-2300	49-608998	0.5–1.5	Soil	—	—	—	NA	—	1.9 (J-)	1.9	1840	—	NA	—	446
RE49-10-2319	49-609008	0.0–0.5	Soil	703 (J-)	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2338	49-609013	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2343	49-609016	0.0–0.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2346	49-609017	0.5–1.5	Soil	—	—	—	NA	—	—	—	—	—	NA	—	—
RE49-10-2354	49-609021	0.5–1.5	Soil	—	—	—	NA	—	1.9	—	—	—	NA	—	—
RE49-10-4930	49-609882	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	NA	—	—
RE49-10-4934	49-609882	9.0–19.0	Qbt4	—	—	7.01 (J)	0.00263	—	1.09 (UJ)	—	—	—	NA	—	—
RE49-10-4941	49-609882	63.0–65.0	Qbt4	—	—	—	—	—	1.02 (UJ)	—	—	—	NA	—	—
RE49-10-4935	49-609883	0.0–0.5	Qbt4	—	—	8.55	0.0012 (J)	—	1.14 (UJ)	—	—	—	NA	22.1	80.3
RE49-10-4940	49-609883	9.0–14.0	Qbt4	—	—	6.68 (J)	0.00802	—	1.1 (UJ)	—	—	—	NA	19	216
RE49-10-4937	49-609883	62.0–64.0	Qbt4	—	—	—	0.00161 (J)	—	0.998 (UJ)	—	—	—	NA	—	—
RE49-10-4936	49-609884	0.0–1.0	Fill	—	—	—	0.00139 (J)	—	—	—	—	—	NA	—	—
RE49-10-4932	49-609884	7.5–10.0	Qbt4	—	—	7.33 (J)	0.00303	—	1.12 (UJ)	—	—	—	NA	—	—

Table 6.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Manganese	Mercury	Nickel	Perchlorate	Potassium	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
Qbt 2,3,4 BV[a]				**482**	**0.1**	**6.58**	**na**[g]	**3500**	**0.3**	**1**	**2770**	**1.1**	**2.4**	**17**	**63.5**
Soil BV[a]				**671**	**0.1**	**15.4**	**na**	**3460**	**1.52**	**1**	**915**	**0.73**	**1.82**	**39.6**	**48.8**
Residential SSL[b]				**10,500**	**23.5**	**1560**	**54.8**	**15,600,000**	**391**	**391**	**7,820,000**	**0.782**	**234**	**394**	**23,500**
Industrial SSL[b]				**160,000**	**389**	**25,700**	**908**	**73,000,000**	**6490**	**6490**	**35,700000**	**13**	**3880**	**6530**	**389,000**
Construction Worker SSL[b]				**464**	**77.1**	**753**	**248**	**19,900,000**	**1750**	**1770**	**9,730,000**	**3.54**	**277**	**614**	**1,006,000**
RE49-10-4933	49-609884	63.0–65.0	Qbt4	—	—	—	—	—	1.02 (UJ)	—	—	—	NA	—	—
RE49-10-4942	49-609885	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	NA	—	—
RE49-10-4939	49-609885	9.0–14.0	Qbt4	—	—	7.19 (J)	—	—	1.14 (UJ)	—	—	—	NA	20	—
RE49-10-4938	49-609885	63.0–65.0	Qbt4	—	—	—	—	—	1.02 (UJ)	—	—	—	NA	—	—

Notes: All concentrations are in mg/kg. Data qualifiers are defined in Appendix A.

[a] BVs from LANL (1998, 059730).

[b] SSLs from NMED (2015, 600915) unless otherwise noted.

[c] SSL for total chromium.

[d] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

[e] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) and equation and parameters from NMED (2015, 600915).

[f] — = Not detected or not detected above BV.

[g] na = Not available.

[h] NA = Not analyzed.

Table 6.3-3
Summary of Organic Chemicals Detected at Area 6 West, SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Bis(2-ethylhexyl)phthalate	Chloronaphthalene[2-]	Methylene Chloride	Methylnaphthalene[2-]	Naphthalene	Pyrene
Residential SSL[a]				**380**	**6260**	**409**	**240**[b]	**49.7**	**1740**
Industrial SSL[a]				**1830**	**104,000**	**5130**	**3000**[b]	**241**	**25,300**
Construction Worker SSL[a]				**5380**	**28,300**	**2110**	**1420**[c]	**159**	**7530**
0549-95-0105	49-06214	5.0–9.5	Fill	—[d]	0.36	NA[e]	—	—	—
RE49-10-4940	49-609883	9.0–14.0	Qbt4	10.1 (J)	—	0.00274 (J)	0.0138 (J)	0.0207 (J)	0.0172 (J)

Notes: All concentrations are in mg/kg. Data qualifiers are defined in Appendix A.

[a] SSLs from NMED (2015, 600915) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

[c] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) and equation and parameters from NMED (2015, 600915).

[d] — = Not detected.

[e] NA= Not analyzed.

Table 6.3-4

Summary of Radionuclides Detected or Detected above BVs/FVs at Area 6 West, SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Cesium-134	Cesium-137	Plutonium-238	Plutonium-239/240	Tritium
Qbt 2,3,4 BV[a]				**na**[b]	**na**	**na**	**na**	**na**	**na**
Soil BV[a]				**0.013**	**na**	**1.65**	**0.023**	**0.054**	**na**
Residential SAL[c]				**83**	**5**	**12**	**84**	**79**	**1700**
Industrial SAL[c]				**1000**	**17**	**37**	**1300**	**1200**	**2,400,000**
Construction Worker SAL[c]				**230**	**15**	**18**	**230**	**200**	**1,600,000**
0549-95-0315	49-06106	0.0–0.5	Soil	0.155	NA[d]	—[e]	—	0.134	NA
0549-95-0316	49-06107	0.0–0.5	Soil	—	NA	—	—	0.056	NA
0549-95-0317	49-06108	0.0–0.5	Soil	0.263	NA	—	NA	NA	NA
0549-95-0323	49-06113	0.0–0.5	Soil	—	NA	—	NA	NA	NA
0549-95-0328	49-06118	0.0–0.5	Soil	—	NA	—	—	0.095	NA
0549-95-0329	49-06137	0.0–0.5	Soil	—	NA	—	0.025	—	NA
0549-95-0340	49-06148	0.0–0.5	Soil	—	NA	—	—	—	NA
0549-95-0102	49-06213	5.0–10.0	Soil	—	—	—	—	0.05	NA
0549-95-0103	49-06213	10.0–12.0	Qbt4	—	—	—	—	0.073	NA
0549-95-0104	49-06214	2.0–5.0	Fill	0.43	—	—	—	0.419	NA
0549-95-0105	49-06214	5.0–9.5	Fill	—	—	—	—	0.029	NA
0549-95-0107	49-06215	0.0–5.0	Fill	—	—	—	—	0.039	NA
0549-95-0111	49-06216	18.1–20.0	Fill	—	NA	—	0.007	0.007	NA
0549-95-0113	49-06217	3.0–5.0	Soil	—	—	—	—	0.085	NA
0549-95-0119	49-06218	12.5–15.0	Qbt4	—	—	—	—	0.036	NA
0549-95-0343	49-06221	0.0–0.5	Soil	—	NA	2.02	—	0.07	NA
0549-95-0344	49-06222	0.0–0.5	Soil	—	NA	3.28	—	0.072	NA

Table 6.3-4 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Cesium-134	Cesium-137	Plutonium-238	Plutonium-239/240	Tritium
Qbt 2,3,4 BV[a]				**na**[b]	**na**	**na**	**na**	**na**	**na**
Soil BV[a]				**0.013**	**na**	**1.65**	**0.023**	**0.054**	**na**
Residential SAL[c]				**83**	**5**	**12**	**84**	**79**	**1700**
Industrial SAL[c]				**1000**	**17**	**37**	**1300**	**1200**	**2,400,000**
Construction Worker SAL[c]				**230**	**15**	**18**	**230**	**200**	**1,600,000**
0549-95-0346	49-06223	0.0–0.5	Soil	0.204	NA	—	NA	NA	NA
0549-95-0348	49-06225	0.0–0.5	Soil	—	NA	1.69	NA	NA	NA
0549-95-0349	49-06226	0.0–0.5	Soil	—	NA	—	—	0.066	NA
0549-95-0350	49-06227	0.0–0.5	Soil	—	NA	2.24	—	0.074	NA
RE49-10-2225	49-608972	0.0–0.5	Soil	—	—	—	—	0.061	NA
RE49-10-2238	49-608978	0.5–1.5	Soil	—	—	—	—	0.0306	NA
RE49-10-2242	49-608980	0.5–1.5	Soil	—	—	—	—	0.035	NA
RE49-10-2251	49-608985	0.0–0.5	Soil	0.07 (J)	—	—	—	0.18 (J)	NA
RE49-10-2252	49-608985	0.5–1.5	Soil	0.161 (J)	—	—	—	0.998	NA
RE49-10-2305	49-609001	0.0–0.5	Soil	—	0.073	—	—	—	NA
RE49-10-2319	49-609008	0.0–0.5	Soil	—	—	—	—	0.133	NA
RE49-10-2320	49-609008	0.5–1.5	Soil	—	—	0.19	—	—	NA
RE49-10-2337	49-609013	0.0–0.5	Soil	—	—	—	—	0.083	NA
RE49-10-2339	49-609014	0.0–0.5	Soil	—	—	—	—	0.107	NA
RE49-10-2340	49-609014	0.5–1.5	Soil	—	—	—	—	0.06	NA
RE49-10-4930	49-609882	0.0–0.5	Soil	—	NA	NA	—	0.0618	—
RE49-10-4940	49-609883	9.0–14.0	Qbt4	0.0995	NA	NA	—	0.435	0.0254

Table 6.3-4 (continued)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Cesium-134	Cesium-137	Plutonium-238	Plutonium-239/240	Tritium
Qbt 2,3,4 BV[a]				**na**[b]	**na**	**na**	**na**	**na**	**na**
Soil BV[a]				**0.013**	**na**	**1.65**	**0.023**	**0.054**	**na**
Residential SAL[c]				**83**	**5**	**12**	**84**	**79**	**1700**
Industrial SAL[c]				**1000**	**17**	**37**	**1300**	**1200**	**2,400,000**
Construction Worker SAL[c]				**230**	**15**	**18**	**230**	**200**	**1,600,000**
RE49-10-4936	49-609884	0.0–1.0	Fill	—	NA	NA	—	—	—
RE49-10-4932	49-609884	7.5–10.0	Qbt4	—	NA	NA	—	—	0.0314

Notes: All activities are in pCi/g. Data qualifiers are defined in Appendix A.

[a] BVs/FVs from LANL (1998, 059730).

[b] na = Not available.

[c] SALs from LANL (2015, 600929).

[d] NA = Not analyzed.

[e] — = Not detected or not detected above BV/FV.

Table 6.3-5
Summary of Pore-Gas Samples Collected and Analyses Requested at Area 6 West, SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Tritium	VOCs
RE49-10-11864	49-609882	9.0–11.0	Pore gas	10-1579	10-1578
RE49-10-11863	49-609882	58.0–60.0	Pore gas	10-1579	10-1578

Notes: The numbers in the analytical request columns are analytical request numbers.

Table 6.3-6
Summary of Organic Chemicals Detected in Pore-Gas Samples Collected at Area 6 West, SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Acetone	Benzene	Butanone[2-]	Chloromethane	Dichlorodifluoromethane	Ethylbenzene	Ethyltoluene[4-]	Styrent	Toluene	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
Residential Soil-Gas Vapor Intrusion Screening Level[a]				**323,000**	**36**	**52,100**	**156**	**1040**	**112**	**52,100**[b]	**10,400**	**52,100**	**66**[c]	**na**[d]	**1040**	**1040**	**1040**
RE49-10-11864	49-609882	9.0–11.0	Pore gas	31	20	10	—[e]	2.9	11	17	3.2	34	18	5.4	46	12	34
RE49-10-11863	49-609882	58.0–60.0	Pore gas	29	9	8.2	1.7	3.1	13	15	2.1	31	12	4.5	50	13	37

Note: All concentrations are in $\mu g/m^3$.

[a] Screening levels from NMED (2015, 600915) unless otherwise noted.

[b] Toluene used as a surrogate based on structural similarity.

[c] Residential air screening level from EPA regional screening levels (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) divided by the default attenuation factor of 0.11 (NMED 2015, 600915, p. 47).

[d] na = Not available.

[e] — = Not detected.

Table 6.3-7
Summary of Tritium in Pore-Gas Samples at Area 6 West, SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Tritium
RE49-10-11864	49-609882	9.0–11.0	Pore gas	673.926

Notes: All activities are in pCi/L. Data qualifiers are defined in Appendix A.

Table 6.4-1

Samples Collected and Analyses Requested at Area 10, SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Anions	Gamma Spectroscopy	Tritium	High Explosives	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Perchlorate	SVOCs	Uranium	VOCs	Wet Chemistry
0549-95-0141	49-07512	0.0–0.5	Soil	—*	—	720	—	—	720	—	719	—	718	720	—	—
0549-95-0140	49-07512	4.0–9.0	Qbt4	—	—	728	—	—	728	—	727, 728	—	726	—	—	—
0549-95-0143	49-07527	0.0–0.5	Soil	—	—	720	—	—	720	—	719	—	718	720	—	—
0549-95-0142	49-07527	7.3–10.0	Qbt4	—	—	728	—	—	728	—	727, 728	—	726	—	—	—
RE49-10-5403	49-609986	0.0–1.0	Soil	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5401	49-609986	4.0–5.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5402	49-609986	9.0–10.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5404	49-609987	0.0–0.5	Soil	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5406	49-609987	3.0–5.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5413	49-609987	5.0–6.5	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5411	49-609987	6.5–8.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5405	49-609987	8.0–10.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5409	49-609988	0.0–2.0	Soil	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5407	49-609988	4.0–5.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5408	49-609988	8.0–10.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5414	49-609989	0.0–0.5	Soil	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5410	49-609989	3.0–4.0	Soil	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509
RE49-10-5412	49-609989	9.0–10.0	Qbt4	10-510	10-509	—	10-510	10-508	10-510	10-510	10-509	10-509	10-508	—	10-508	10-509

Notes: The numbers in the analytical request columns are analytical request numbers. Anions refers to nitrate.

*— = Analysis not requested.

Table 6.4-2
Summary of Inorganic Chemicals Detected or Detected above BVs at Area 10, SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Lead
Qbt 2,3,4 BV[a]				**7340**	**0.5**	**2.79**	**46**	**1.21**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**	**11.2**
Soil BV[a]				**29,200**	**0.83**	**8.17**	**295**	**1.83**	**6120**	**19.3**	**8.64**	**14.7**	**0.5**	**22.3**
Residential SSL[b]				**78,000**	**31.3**	**4.25**	**15,600**	**156**	**13,000000**	**96.6[c]**	**23[d]**	**3130**	**11.2**	**400**
Industrial SSL[b]				**1,290,000**	**519**	**21.5**	**255,000**	**2580**	**32,400,000**	**505[c]**	**350[d]**	**51,900**	**63.3**	**800**
Construction Worker SSL[b]				**41,400**	**142**	**57.4**	**4390**	**148**	**88,50,000**	**134[c]**	**36.6[e]**	**14,200**	**12.1**	**800**
0549-95-0141	49-07512	0.0–0.5	Soil	—[f]	—	—	—	—	—	—	—	—	NA[g]	—
0549-95-0140	49-07512	4.0–9.0	Qbt4	12,000	0.75 (UJ)	—	85.6	—	2340	8.4	—	6.7	NA	—
0549-95-0143	49-07527	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	NA	—
0549-95-0142	49-07527	7.3–10.0	Qbt4	21,900	0.81 (UJ)	3.4	112	1.9	3320	11.4	—	8.2	NA	—
RE49-10-5403	49-609986	0.0–1.0	Soil	—	—	—	—	—	—	—	—	—	0.59 (UJ)	—
RE49-10-5401	49-609986	4.0–5.0	Qbt4	8590	—	3.1	161 (J+)	—	2330	18.4	6.1 (J)	7.9	0.54 (UJ)	12.3
RE49-10-5402	49-609986	9.0–10.0	Qbt4	—	—	—	—	—	—	—	—	—	0.52 (UJ)	—
RE49-10-5404	49-609987	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	0.57 (UJ)	—
RE49-10-5406	49-609987	3.0–5.0	Qbt4	10,000	—	3.2	165 (J+)	—	2570	8.5	6.4 (J)	6.9	0.55 (UJ)	11.3
RE49-10-5413	49-609987	5.0–6.5	Qbt4	7720	—	—	87.2 (J+)	—	—	—	3.2 (J)	6.7	0.54 (UJ)	—
RE49-10-5411	49-609987	6.5–8.0	Qbt4	—	—	—	80.6 (J+)	—	—	7.9	—	5.7	0.53 (UJ)	—
RE49-10-5405	49-609987	8.0–10.0	Qbt4	—	—	—	78.9 (J+)	—	—	—	—	—	0.53 (UJ)	—
RE49-10-5409	49-609988	0.0–2.0	Soil	—	—	—	—	—	—	—	—	—	0.53 (UJ)	—
RE49-10-5407	49-609988	4.0–5.0	Qbt4	8860	—	2.9	118 (J+)	—	—	9.6	4.9 (J)	8.5	0.54 (U)	—
RE49-10-5408	49-609988	8.0–10.0	Qbt4	—	—	—	—	—	—	—	—	—	0.51 (UJ)	—
RE49-10-5414	49-609989	0.0–0.5	Soil	—	—	—	—	—	—	—	—	—	0.56 (UJ)	—
RE49-10-5410	49-609989	3.0–4.0	Soil	—	—	—	—	—	—	—	—	—	0.56 (UJ)	—
RE49-10-5412	49-609989	9.0–10.0	Qbt4	—	—	—	—	—	—	—	—	—	0.53 (UJ)	—

Table 6.4-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Magnesium	Mercury	Nickel	Nitrate	Perchlorate	Potassium	Selenium	Thallium	Uranium	Vanadium
Qbt 2,3,4 BV[a]				**1690**	**0.1**	**6.58**	**na**[h]	**na**	**3500**	**0.3**	**1.1**	**2.4**	**17**
Soil BV[a]				**4610**	**0.1**	**15.4**	**na**	**na**	**3460**	**1.52**	**0.73**	**1.82**	**39.6**
Residential SSL[b]				**339,000**	**23.5**	**1560**	**125,000**	**54.8**	**15,600,000**	**391**	**0.782**	**234**	**394**
Industrial SSL[b]				**5,680,000**	**389**	**25,700**	**2,080,000**	**908**	**73,000,000**	**6490**	**13**	**3880**	**6530**
Construction Worker SSL[b]				**1,550,000**	**77.1**	**753**	**566,000**	**248**	**19,900,000**	**1750**	**3.54**	**277**	**614**
0549-95-0141	49-07512	0.0–0.5	Soil	—	0.11 (U)	—	NA	NA	—	—	1.4 (U)	2.51	—
0549-95-0140	49-07512	4.0–9.0	Qbt4	2530	—	9	NA	NA	—	0.81 (U)	1.4 (U)	—	—
0549-95-0143	49-07527	0.0–0.5	Soil	—	0.11 (U)	—	NA	NA	—	—	1.4 (U)	2.3	—
0549-95-0142	49-07527	7.3–10.0	Qbt4	3720	0.12 (U)	12.1	NA	NA	4090	0.88 (U)	1.5 (U)	4.09	—
RE49-10-5403	49-609986	0.0–1.0	Soil	—	—	—	0.9	—	—	—	—	NA	—
RE49-10-5401	49-609986	4.0–5.0	Qbt4	2050	—	8.5	0.095 (J)	—	—	0.91	—	NA	22
RE49-10-5402	49-609986	9.0–10.0	Qbt4	—	—	—	0.16 (J)	—	—	1.1	—	NA	—
RE49-10-5404	49-609987	0.0–0.5	Soil	—	—	—	0.13 (J)	—	—	—	—	NA	—
RE49-10-5406	49-609987	3.0–5.0	Qbt4	1780	—	9	0.35	—	—	0.97	—	NA	18.8
RE49-10-5413	49-609987	5.0–6.5	Qbt4	1910	—	7.6	0.14 (J)	—	—	1.2	—	NA	—
RE49-10-5411	49-609987	6.5–8.0	Qbt4	1920	—	7.8	0.12 (J)	—	—	1.3	—	NA	—
RE49-10-5405	49-609987	8.0–10.0	Qbt4	—	—	—	0.19 (J)	0.0037 (J)	—	1.3	—	NA	—
RE49-10-5409	49-609988	0.0–2.0	Soil	—	—	—	1.7	—	—	—	—	NA	—
RE49-10-5407	49-609988	4.0–5.0	Qbt4	2090	—	8.2	0.18 (J)	—	—	1	—	NA	22.6
RE49-10-5408	49-609988	8.0–10.0	Qbt4	—	—	—	0.17 (J)	—	—	1.3	—	NA	—
RE49-10-5414	49-609989	0.0–0.5	Soil	—	—	—	1.8	—	—	—	—	NA	—
RE49-10-5410	49-609989	3.0–4.0	Soil	—	—	—	0.9	—	—	—	—	NA	—
RE49-10-5412	49-609989	9.0–10.0	Qbt4	—	—	—	0.17 (J)	—	—	1.1	—	NA	—

Notes: All concentrations are in mg/kg. Data qualifiers are defined in Appendix A.

[a] BVs from LANL (1998, 059730).

[b] SSLs from NMED (2015, 600915) unless otherwise noted.

[c] SSL for total chromium.

[d] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

[e] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) and equation and parameters from NMED (2015, 600915).

[f] — = Not detected or not detected above BV.

[g] NA = Not analyzed.

[h] na = Not available.

Table 6.4-3
Summary of Organic Chemicals Detected at Area 10, SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Bis(2-ethylhexyl)phthalate	Butanone[2-]
Residential SSL[a]				**380**	**37,400**
Industrial SSL[a]				**1830**	**411,000**
Construction Worker SSL[a]				**5380**	**91,700**
RE49-10-5408	49-609988	8.0–10.0	Qbt4	0.046 (J)	—[b]
RE49-10-5414	49-609989	0.0–0.5	Soil	0.16 (J)	0.0018 (J)

Notes: All concentrations are in mg/kg. Data qualifiers are defined in Appendix A.

[a] SSLs from NMED (2015, 600915).

[b] — = Not detected.

Table 6.4-4
Summary of Radionuclides Detected or Detected above BVs/FVs at Area 10, SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Plutonium-238	Plutonium-239/240
Qbt 2,3,4 BV[a]				**na**[b]	**na**
Soil BV[a]				**0.023**	**0.054**
Residential SAL[c]				**84**	**79**
Industrial SAL[c]				**1300**	**1200**
Construction Worker SAL[c]				**230**	**200**
0549-95-0141	49-07512	0.0–0.5	Soil	0.032	0.083
0549-95-0142	49-07527	7.3–10.0	Qbt4	0.007	—[d]

Note: All activities are in pCi/g.

[a] BVs/FVs from LANL (1998, 059730).

[b] na = Not available.

[c] SALs from LANL (2015, 600929).

[d] — = Not detected or not detected above BV/FV.

Table 6.4-5
Summary of Pore-Gas Samples Collected and Analyses Requested at Area 10, SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Tritium	VOCs
RE49-10-11860	49-609987	4.0–6.5	Pore gas	10-1579	10-1578

Note: The numbers in the analytical request columns are analytical request numbers.

Table 6.4-6
Summary of Organic Chemicals Detected in Pore-Gas Samples Collected at Area 10, SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Acetone	Benzene	Butanone[2-]	Chloromethane	Dichlorodifluoromethane	Ethylbenzene	Ethyltoluene[4-]	Styrent	Toluene	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
Residential Soil-Gas Vapor Intrusion Screening Level[a]				**323,000**	**36**	**52,100**	**156**	**1040**	**112**	**52100**[b]	**10,400**	**52100**	**66**[c]	**na**[d]	**1040**	**1040**	**1040**
RE49-10-11860	49-609987	4.0–6.5	Pore gas	20	12	7.4	1.7	3.2	6.4	9	2.2	18	10	3.1	25	6.5	18

Note: All concentrations are in μg/m^3.

[a] Screening levels from NMED (2015, 600915) unless otherwise noted.

[b] Toluene used as surrogate based on structural similarity.

[c] Residential air screening level from EPA regional screening levels (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) divided by the default attenuation factor of 0.11 (NMED 2015, 600915, p. 47).

[d] na = Not available.

Table 6.4-7
Summary of Tritium in Pore-Gas Samples Collected at Area 10, SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Tritium
RE49-10-11860	49-609987	4.0–6.5	Pore gas	508.993

Note: All activities are in pCi/L.

Table 8.2-1
Summary of Investigation Results and Recommendations

SWMU/AOC	Brief Description	Extent Defined or No Further Sampling Warranted?	Potential Unacceptable Risk/Dose?	Recommendation
AOC 49-002	Underground calibration chamber and elevator shaft	No	No	Additional sampling and analysis adjacent to shafts
SWMU 49-004	Inactive open-burning area and landfill	No	No	Additional sampling and analysis for dioxins and furans
SWMU 49-005(a)	Inactive small debris landfill	Yes	No	Complete without controls

Appendix A

Acronyms and Abbreviations,
Metric Conversion Table, and Data Qualifier Definitions

A-1.0 ACRONYMS AND ABBREVIATIONS

%R	percent recovery
%RSD	percent risk-specific dose
AK	acceptable knowledge
ALARA	as low as reasonably achievable
amsl	above mean sea level
AOC	area of concern
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
bgs	below ground surface
BV	background value
CCV	continuing calibration verification
COC	chain of custody
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
CVAA	cold vapor atomic absorption
DAF	dilution attenuation factor
DGPS	differential global-positioning system
DL	detection limit
DOE	Department of Energy (U.S.)
DOT	Department of Transportation (U.S.)
Eh	redox potential
EM-LA	Environmental Management Los Alamos Field Office (DOE)
EPA	Environmental Protection Agency (U.S.)
EPC	exposure point concentration
EQL	estimated quantitation limit
ESH	Environment, Safety, and Health
ESL	ecological screening levels
ET	evapotranspiration
eV	electronvolt
FV	fallout value
GC/MS	gas chromatography-mass spectrometry

HDT	hazardous devices team
HE	high explosives
HI	hazard index
HIR	historical investigation report
HQ	hazard quotient
HR	home range
ICS	interference check sample
ICV	initial calibration verification
I.D.	inside diameter
IDW	investigation-derived waste
IP	Individual Permit
K_d	soil-water partition coefficient
K_{oc}	organic carbon partition coefficient
K_{ow}	octanol/water partition coefficient
KPA	kinetic phosphorescence
LAL	lower acceptance limit
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level (EPA)
MDA	material disposal area
MDC	minimum detectable concentration
MDL	method detection limit
MS	matrix spike
MSW	municipal solid waste
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NES	nuclear environmental site
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
NOAEL	no observed adverse effect level
NOD	notice of disapproval
O.D.	outside diameter
PAUF	population area use factor
PCB	polychlorinated biphenyl
PID	photoionization detector

PPE	personal protective equipment
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
QP	quality procedure
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RfD	reference doses
RFI	RCRA facility investigation
RL	reporting limit
RPD	relative percent difference
SAL	screening action level
SCL	sample collection log
SF	slope factor
SL	screening level
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
SSL	soil screening level
SV	screening value
SVOC	semivolatile organic compound
SWMU	solid waste management unit
T&E	threatened and endangered
TA	technical area
TAL	target analyte list (EPA)
TD	total depth
TRV	toxicity reference value
UAL	upper acceptance limit
UCL	upper concentration limit
UTL	upper tolerance limit
VOC	volatile organic compound
WCSF	waste characterization strategy form
XRF	x-ray fluorescence

A-2.0 METRIC CONVERSION TABLE

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

A-3.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
J	The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
UJ	The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.
R	The data are rejected as a result of major problems with quality assurance/quality control parameters.

Appendix B

Field Methods

B-1.0 INTRODUCTION

This appendix summarizes field methods used during the 2009–2010 investigation at Technical Area 49 (TA-49). Table B-1.0-1 provides general method information, and the following sections provide additional details. All activities were conducted in accordance with the applicable standard operating procedures (SOPs) and quality procedures (QPs).

B-2.0 EXPLORATORY DRILLING CHARACTERIZATION

All drilling for the 2009–2010 investigation was conducted for the purpose of collecting investigation samples; no exploratory drilling characterization was conducted.

B-3.0 FIELD-SCREENING METHODS

This section summarizes the field-screening methods used during the 2009–2010 drilling and sampling activities at TA-49. The health- and safety-based field-screening results are presented in tables in the supplemental investigation report. Gross-alpha and –beta radiological screening results that guided selection of surface and shallow-subsurface samples for laboratory analysis are presented in Tables D-1 through D-10 in Appendix D.

B-3.1 Field Screening for Radioactivity

Core, surface, and shallow-subsurface samples were screened for gross-alpha and -beta radiation. Screening was conducted by a Laboratory radiological control technician (RCT) using an Eberline E600 with either a 380AB or SHP360 probe (or equivalent) and an ESP-1 rate meter with a 210 probe (or equivalent) in accordance with the TPMC-SOP-10.07, Field Monitoring for Surface and Volume Radioactivity Levels. Measurements were made by conducting a quick scan to find the location with the highest initial reading, and the probe was held less than 1 in. away from the medium. Following the quick scan, a 1-min reading was collected to determine gross-alpha and -beta radiation levels. After radiological field-screening measurements were established, soil and core material was sampled and/or logged. Field personnel recorded background measurements for gross-alpha and -beta radiation daily. The background measurements are recorded on sample collection logs (SCLs) in Appendix G (on DVD).

B-3.2 Field Screening for Organic Vapors

Organic vapor monitoring of subsurface samples was performed using a MiniRAE 2000, Model PGM-7600 photoionization detector (PID) with an 11.7-electronvolt (eV) bulb. Screening was performed in accordance with the manufacturer’s specifications and SOP-06.33, Headspace Vapor Screening with a Photoionization Detector. Samples were placed in a glass container and covered with aluminum foil. The container was sealed, shaken gently, and allowed to equilibrate for 5 min. The sample was screened by inserting the PID probe into the container and measuring and recording any detected vapors. The workers’ breathing zone was also monitored using the MiniRAE 2000 PID. Field-screening measurements are presented in tables presented in the supplemental investigation report.

B-3.3 Field Screening for Percent Oxygen and Percent Carbon Dioxide

Before each pore-gas sampling event, each sample port was purged and monitored with a LANDTEC GEM 2000 instrument (or equivalent) until the percent oxygen and percent carbon dioxide levels stabilized at values representative of subsurface pore-gas conditions. Field-screening results were recorded on the appropriate SCL and/or in the field logbook. Field SCLs are provided in Appendix G (on DVD).

B-4.0 FIELD INSTRUMENT CALIBRATION

Instrument calibration and/or function check was completed daily. Calibration of the PID was conducted by the site safety officer. Calibration of the Eberline E600 was conducted by the RCT. All calibrations were performed according to the manufacturer’s specifications and requirements.

B-4.1 PID Calibration

The PID was calibrated both to ambient air and a standard reference gas (100 ppm isobutylene). The ambient-air calibration determined the zero point of the instrument sensor calibration curve in ambient air. Calibration with the standard reference gas determined a second point of the sensor calibration curve. Each calibration was within 3% of 100 ppm isobutylene, qualifying the instrument for use.

The following calibration information was recorded daily on operational calibration logs:

- instrument identification number
- final span settings
- date and time
- concentration and type of calibration gas used (isobutylene at 100 ppm)
- name of personnel performing calibration

All daily calibration procedures for the MiniRAE 2000 PID met the manufacturer’s specifications for standard reference gas calibration.

B-4.2 Eberline E600 Instrument Calibration

The Eberline E600 was calibrated daily by the RCT before local background levels for radioactivity were measured. The instrument was calibrated using plutonium-239 and chloride-36 sources for alpha and beta emissions, respectively. The following five checks were performed as part of the calibration procedures: calibration date, physical damage, battery, response to a source of radioactivity, and background. All calibrations performed for the Eberline E600 met the manufacturer’s specifications and the applicable radiation detection instrument manual.

B-5.0 SURFACE, SHALLOW-SUBSURFACE, AND SUBSURFACE SAMPLING

This section summarizes the methods used for collecting samples for laboratory analysis, including surface soil, fill, tuff, and subsurface pore-gas samples. The samples were collected according to the approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465).

B-5.1 Surface and Shallow-Subsurface Soil-Sampling Methods

Surface and shallow-subsurface samples were collected in accordance with SOP-06-10, Hand Auger and Thin-Wall Tube Sampler. A hand auger with a stainless-steel bucket was used to collect material in approximately 6-in. intervals. Samples were transferred to sample-collection jars or bags for transport to the Sample Management Office (SMO) and American Radiation Services.

Samples were labeled, documented, and sealed with custody seals before transportation in accordance with SOP-5057, Handling, Packaging, and Transporting Field Samples, and SOP-5058, Sample Control and Field Documentation. Samples for volatile organic compound (VOC) analysis were collected immediately to minimize the loss of VOCs during the sample-collection process.

All sample-collection tools were decontaminated immediately before collection of each sample in accordance with SOP-5061, Field Decontamination of Drilling and Sampling Equipment.

B-5.2 Borehole Drilling

For the 2009–2010 drilling investigation, nine boreholes were drilled to depths ranging from 10 ft to 65 ft below ground surface (bgs). A Construction Mine Equipment 85 hollow-stem auger (HSA) drill rig was employed for all drilling using 4.50-in.-inside-diameter (I.D.) and nominal 8.25-in.-outside-diameter (O.D.) augers. A hex-rod core retrieval system and 4-in.-O.D. stainless-steel core barrels were used for sampling. A nominal 8.50-in.-diameter drill bit was used for all borings. During drilling, continuous core was recovered using the stainless-steel core barrels through the center of the 4.50-in. drill string. Core was collected in 5-ft sample runs.

B-5.3 Borehole Logging

Borehole lithologic logs were completed for all borehole locations at TA-49 in 2009–2010. All boreholes were continuously cored and logged in 5.0-ft intervals in accordance with SOP-12.01, Field Logging, Handling, and Documentation of Borehole Materials. Information recorded on field boring logs included footage and percent recovery, field-screening results for radioactivity and organic vapors, lithology, depth of samples collected, sample identification and other relevant observations. The borehole logs are presented on CD in Appendix D.

B-5.4 Subsurface Soil- and Rock-Sampling Methods

The subsurface soil and rock samples were continuously cored from a stainless-steel split-spoon core-barrel sampler in accordance with SOP-6.24, Sample Collection from Split-Spoon Samplers and Shelby-Tube Samplers. The core was described for lithologic and structural features per SOP-9.10, Field Sampling of Core and Cuttings for Geological Analysis, and SOP-12.01, Field Logging, Handling, and Documentation of Borehole Materials. The borehole logs are provided in Appendix D (on CD).

Subsurface sampling intervals were selected based on data requirements in the approved investigation work plan (LANL 2008, 102215; NMED 2008, 100465) and/or

- the depth of the highest field-screening result, if applicable;
- the depth of geologically significant features;
- the discretion of the field geologist; and
- the total depth of the borehole.

Samples were submitted for laboratory analysis of some or all of the following analytical suites: explosive compounds, perchlorate, nitrate, target analyte list metals, cyanide, americium-241, isotopic plutonium, isotopic uranium, tritium, VOCs, and semivolatile organic compounds. Samples for VOC analysis were collected immediately to minimize the loss of VOCs during the sample-collection process.

B-5.5 Pore-Gas Sampling

Pore-gas samples were collected from discrete subsurface intervals in open boreholes using a single- and/or double-packer assembly. All total-depth samples were collected with a single-packer system. Samples collected at other discrete depths in open boreholes were collected using a double-packer system. All pore-gas samples were collected in accordance with SOP-5074, Sampling for Sub-Atmospheric Air. Pore-gas samples were collected for analysis of VOCs and tritium.

Before each sampling event, each isolated interval/sample port was purged and monitored with a LANDTEC GEM 2000 instrument (or equivalent) until percent oxygen and percent carbon dioxide levels stabilized at values representative of subsurface pore-gas conditions. In addition, the vapor-sample tubing was purged of stagnant air by drawing air from the sampling interval through the line. To ensure the sample collected was representative of the subsurface air at depth, every sampling activity included a purge cycle.

B-5.6 Quality Assurance/Quality Control Samples

Quality assurance/quality control samples for soils and tuff were collected in accordance with SOP-5059, Field Quality Control Samples. Field duplicate samples were collected at a frequency of at least 1 duplicate sample for every 10 samples. Field rinsate samples were collected from sampling equipment at a frequency of at least 1 rinsate sample for every 10 samples. Field trip blanks also were collected at a frequency of 1 per 10 samples, if applicable.

B-5.7 Sample Documentation and Handling

Field personnel completed an SCL and chain-of-custody (COC) form for each sample set. Sample containers were sealed with COC seals and placed in coolers at approximately 4°C. Samples were packaged with preservatives, as necessary, depending upon the analytical method to be used, packed, handled, and shipped in accordance with SOP-5057, Handling, Packaging, and Transporting Field Samples, and SOP-5056, Sample Containers and Preservation.

B-5.8 Borehole Abandonment

Based on the results of pore-gas sampling for VOCs and tritium, no boreholes were completed as monitoring wells. Boreholes were abandoned in accordance with SOP-5034, Monitor Well and RFI Borehole Abandonment.

B-5.9 Decontamination of Sampling Equipment

Drilling and sampling equipment was decontaminated to minimize the potential for cross-contamination between sampling locations. Decontamination was completed using a dry decontamination method with disposable paper towels and over-the-counter cleaner, such as Fantastik or equivalent. All decontamination procedures followed SOP-1.08, Field Decontamination of Drilling and Sampling Equipment. All heavy equipment, such as backhoes, forklifts, drill rigs, etc., were screened by an RCT and released before entering and exiting TA-49.

B-6.0 GEODETIC SURVEYING

Geodetic surveys were conducted during the TA-49 investigation to establish and mark all sampling and borehole locations. The planned sampling locations were determined based on location and results of historical borehole and surface samples. Geodetic surveys were conducted at the completion of the sampling campaign to establish the spatial coordinates for all sampling locations. Geodetic surveys were conducted in accordance with SOP-5028, Coordinating and Evaluating Geodetic Surveys, using a Trimble 5700 differential global-positioning system (DGPS). All coordinates are expressed in New Mexico State Plane Coordinate System 1983, New Mexico Central. Surveyed coordinates for all sampling locations are presented in Appendix C.

B-7.0 INVESTIGATION-DERIVED-WASTE STORAGE AND DISPOSAL

Management of investigation-derived waste is described in Appendix E. All drill cuttings were stored in less-than-90-day hazardous-waste storage areas and sampled within 10 d. All drill-cutting waste determined to be nonhazardous and was land-applied. Contact waste from sediment samples was stored in two separate less-than-90-day hazardous-waste storage areas and was determined to be nonhazardous based on due diligence. All waste was nonhazardous and either land-applied or disposed of at an appropriate off-site facility.

B-8.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

LANL (Los Alamos National Laboratory), January 2008. "Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1," Los Alamos National Laboratory document LA-UR-08-0449, Los Alamos, New Mexico. (LANL 2008, 102215)

NMED (New Mexico Environment Department), February 14, 2008. "Approval with Modifications, Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2008, 100465)

Table B-1.0-1
Brief Description of Field Investigation Methods

Method	Summary
Hand-Auger Sampling	This method is typically used for sampling soil or sediment at depths of less than 10–15 ft but in some cases may be used to collect samples of weathered or nonwelded tuff. The method involves hand-turning a stainless-steel bucket auger (typically 3–4 in.-I.D.), creating a vertical hole that can be advanced to the desired sample depth. For the 2009–2010 investigation, when the desired depth was reached, the auger was decontaminated before the hole was advanced through the sample depth. The sample material was transferred from the auger bucket to a stainless-steel sampling bowl before the various required sample containers were filled.
Split-Spoon Core-Barrel Sampling	This method involves a stainless-steel core barrel (typically 4 in. I.D., 2.5 ft long), which is advanced using a powered drilling rig and extracts a continuous length of soil and/or rock to be examined as a unit. The split-spoon core barrel is a cylindrical barrel split lengthwise so the two halves can be separated to expose the core sample. Once the core sample was extracted, the section of core was screened for radioactivity and organic vapors, photographed, and described in a geologic log. A portion of the core was collected as a discrete sample from the desired depth.
Headspace Vapor Screening	Individual soil, rock, or sediment samples were field-screened for organic vapors by placing a portion of the sample in a plastic sample bag or in a glass container with a foil-sealed cover. The container was sealed and gently shaken and allowed to equilibrate for 5 min. The sample was then screened by inserting a PID probe into the container and measuring and recording any detected vapors. PIDs must use lamps with voltage of 11.7 eV.
Handling, Packaging, and Shipping of Samples	Field team members sealed and labeled samples before packing and ensured that the sample containers and the containers used for transport were free of external contamination. Field team members packaged all samples to minimize the possibility of breakage during transportation. After all environmental samples were collected, packaged, and preserved, a field team member transported them to either the SMO or an SMO-approved radiation screening laboratory under COC. The SMO arranged for shipping of samples to analytical laboratories. The field team member informed the SMO and/or the radiation screening laboratory coordinator whenever levels of radioactivity were in the action-level or limited-quantity ranges.
Sample Control and Field Documentation	The collection, screening, and transport of samples were documented on standard forms generated by the SMO. These included SCLs, COC forms, and sample container labels. SCLs were completed at the time of sample collection and were signed by the sampler and a reviewer who verified the logs for completeness and accuracy. Corresponding labels were initialed and applied to each sample container, and custody seals were placed around container lids or openings. The COC forms were completed and assigned to verify that the samples were not left unattended.
Field Quality-Control Sample Collection	Field quality-control samples were collected as directed in the Compliance Order on Consent and SOP-5059 as follows: *Field Duplicates*: at a frequency of 10%; collected at the same time as a regular sample and submitted for the same analyses. *Equipment Rinsate Blank*: at a frequency of 10%; collected by rinsing sampling equipment with deionized water, which was collected in a sample container and submitted for laboratory analysis. *Trip Blanks*: required for all field events that include the collection of samples for VOC analysis. Trip blanks are containers of certified clean sand that are opened and kept with the other sample containers during the sampling process.

Table B-1.0-1 (continued)

Method	Summary
Well and Borehole Abandonment	Shallower boreholes were abandoned by filling with bentonite chips or pellets, which were then hydrated. Boreholes with a total depth greater than 20 ft were abandoned with bentonite grout by filling upward from the bottom via tremie pipe to within 2 ft of the surface. The remainder was cemented/grouted to surface grade. After 24 h, the backfilled level was checked for settling and additional concrete/grout added as needed.
Field Decontamination of Drilling and Sampling Equipment	Dry decontamination was the preferred method to minimize the generation of liquid waste. Dry decontamination may include the use of a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by use of a commercial cleaning agent (nonacid, waxless cleaners) and paper wipes. Dry decontamination may be followed by wet decontamination if necessary.
Containers and Preservation of Samples	Specific requirements/processes for sample containers, preservation techniques, and holding times are based on U.S. Environmental Protection Agency guidance for environmental sampling, preservation, and quality assurance. Specific requirements for each sample are printed on SCLs provided by the SMO (size and type of container [e.g., glass, amber glass, and polyethylene]). All samples were preserved by placing them in insulated containers with ice to maintain a temperature of 4°C. Other requirements, such as the use of nitric acid or other preservatives, may apply to different media or analytical requests.
Coordination and Evaluation of Geodetic Surveys	Geodetic surveys focused on obtaining survey data of acceptable quality for use during project investigations. Geodetic surveys were conducted with a Trimble 5700 DGPS. The survey data conformed to Laboratory Information Architecture project standards IA-CB02, GIS Horizontal Spatial Reference System, and IA-D802, Geospatial Positioning Accuracy Standard for A/E/C and Facility Management. All coordinates are expressed in New Mexico State Plain Coordinate System 1983, NM Central, U.S. ft coordinates. All elevation data were reported relative to the National Geodetic Vertical Datum of 1983.
Management of Waste and Waste Characterization	Investigation-derived waste (IDW) was managed, characterized, and stored in accordance with an approved waste characterization strategy form that documented site history, field activities, and the characterization approach for each waste stream managed. Waste characterization was adequate to comply with on- or off-site waste acceptance criteria. All stored IDW was marked with appropriate signage and labels. Drummed IDW was stored on pallets to prevent deterioration of containers. Generators were required to reduce the volume of waste generated by as much as was technically and economically feasible. The means to store, control, and transport each potential waste type and its classification was determined before the start of field operations that generated waste. A waste storage area was established before waste was generated. Waste storage areas located in controlled areas of the Laboratory were controlled as needed to prevent inadvertent addition or management of wastes by unauthorized personnel. Each container of waste generated was individually labeled with waste classification, item identification number, and radioactivity (if applicable), immediately following containerization. All waste was segregated by classification and compatibility to prevent cross-contamination. Management of IDW is discussed in Appendix E.

Appendix C

Geodetic Survey Coordinates

Table C-1
Surveyed Coordinates for 2009 Locations at Area 6, SWMU 49-004

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
Area 6 Drilling			
49-004	49-609882	1622287.472	1756661.486
49-004	49-609883	1622354.581	1756813.742
49-004	49-609884	1622318.736	1756732.418
49-004	49-609885	1622386.778	1756886.791
Area 6 Surface and Shallow Subsurface			
49-004	49-608961	1622273.551	1756607.425
49-004	49-608962	1622283.93	1756630.129
49-004	49-608963	1622294.633	1756652.735
49-004	49-608964	1622305.66	1756675.114
49-004	49-608965	1622316.104	1756697.656
49-004	49-608966	1622337.51	1756743.063
49-004	49-608967	1622358.592	1756788.794
49-004	49-608968	1622390.701	1756856.191
49-004	49-608969	1622401.015	1756879.121
49-004	49-608970	1622411.718	1756901.5
49-004	49-608971	1622410.421	1756956.897
49-004	49-608972	1622388.041	1756967.924
49-004	49-608973	1622365.338	1756977.979
49-004	49-608974	1622398.615	1756990.239
49-004	49-608975	1622375.911	1757000.942
49-004	49-608976	1622353.208	1757011.645
49-004	49-608977	1622389.014	1756912.204
49-004	49-608978	1622378.636	1756889.5
49-004	49-608979	1622357.294	1756844.19
49-004	49-608980	1622346.591	1756821.552
49-004	49-608981	1622336.213	1756799.173
49-004	49-608982	1622314.806	1756754.09
49-004	49-608983	1622304.103	1756731.386
49-004	49-608984	1622282.632	1756685.817
49-004	49-608985	1622271.929	1756663.114
49-004	49-608986	1622297.552	1756540.612
49-004	49-608987	1622318.634	1756586.019
49-004	49-608988	1622350.743	1756654.032
49-004	49-608989	1622393.296	1756744.36
49-004	49-608990	1622436.108	1756835.109
49-004	49-608991	1622478.207	1756925.761

Table C-1 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-004	49-608992	1622349.186	1756709.656
49-004	49-608993	1622391.998	1756800.47
49-004	49-608994	1622252.145	1756562.018
49-004	49-608995	1622348.213	1756765.766
49-004	49-608996	1622465.104	1757014.24
49-004	49-608997	1622261.551	1756640.41
49-004	49-608998	1622367.997	1756866.894
49-004	49-608999	1622420.021	1757035.321
49-004	49-609000	1622206.738	1756583.425
49-004	49-609001	1622205.44	1756639.437
49-004	49-609002	1622248.318	1756729.765
49-004	49-609003	1622290.806	1756820.579
49-004	49-609004	1622308.904	1756976.746
49-004	49-609005	1622351.91	1757067.106
49-004	49-609006	1622307.801	1757032.727
49-004	49-609007	1622377.014	1756945.286
49-004	49-609008	1622333.229	1756911.231
49-004	49-609009	1622353.337	1756541.91
49-004	49-609010	1622396.15	1756632.724
49-004	49-609011	1622438.703	1756723.278
49-004	49-609012	1622480.542	1756813.703
49-004	49-609013	1622545.539	1756948.724
49-004	49-609014	1622253.766	1756505.908
49-004	49-609015	1622150.952	1756582.03
49-004	49-609016	1622266.48	1756887.003
49-004	49-609017	1622223.668	1756796.254
49-004	49-609018	1622181.44	1756705.926
49-004	49-609019	1622294.179	1757121.854
49-004	49-609020	1622230.739	1756986.152
49-004	49-609021	1622418.399	1757091.367
49-004	49-609022	1622521.214	1757015.472
49-004	49-609023	1622308.255	1756563.316
49-004	49-609024	1622329.661	1756608.398
49-004	49-609025	1622340.04	1756631.426
49-004	49-609026	1622361.186	1756676.574
49-004	49-609027	1622372.214	1756699.277
49-004	49-609028	1622382.593	1756721.656
49-004	49-609029	1622403.999	1756767.388
49-004	49-609030	1622414.377	1756789.443

Table C-1 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-004	49-609031	1622425.405	1756812.406
49-004	49-609032	1622446.422	1756857.391
49-004	49-609033	1622457.125	1756880.094
49-004	49-609034	1622467.828	1756902.798
49-004	49-609035	1622274.848	1756551.64
49-004	49-609036	1622285.551	1756574.019
49-004	49-609037	1622296.254	1756596.722
49-004	49-609038	1622306.957	1756619.426
49-004	49-609039	1622317.661	1756641.708
49-004	49-609040	1622328.039	1756664.411
49-004	49-609041	1622338.807	1756687.277
49-004	49-609042	1622359.889	1756732.359
49-004	49-609043	1622370.592	1756755.063
49-004	49-609044	1622381.295	1756777.766
49-004	49-609045	1622402.701	1756822.784
49-004	49-609046	1622413.404	1756845.488
49-004	49-609047	1622423.718	1756868.094
49-004	49-609048	1622434.421	1756891.122
49-004	49-609049	1622445.449	1756913.501
49-004	49-609050	1622455.828	1756936.14
49-004	49-609051	1622466.401	1756958.129
49-004	49-609052	1622477.104	1756980.833
49-004	49-609053	1622263.172	1756584.722
49-004	49-609054	1622326.807	1756720.359
49-004	49-609055	1622369.295	1756811.173
49-004	49-609056	1622379.998	1756833.812
49-004	49-609057	1622422.421	1756924.528
49-004	49-609058	1622433.124	1756946.518
49-004	49-609059	1622443.697	1756968.508
49-004	49-609060	1622454.4	1756991.212
49-004	49-609061	1622229.441	1756572.722
49-004	49-609062	1622240.144	1756595.425
49-004	49-609063	1622250.847	1756618.129
49-004	49-609064	1622293.4	1756708.683
49-004	49-609065	1622325.185	1756776.469
49-004	49-609066	1622399.717	1756934.583
49-004	49-609067	1622420.994	1756979.536
49-004	49-609068	1622431.697	1757001.915
49-004	49-609069	1622442.4	1757024.618

Table C-1 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-004	49-609070	1622217.765	1756606.128
49-004	49-609071	1622228.144	1756628.507
49-004	49-609072	1622238.847	1756651.113
49-004	49-609073	1622249.55	1756673.817
49-004	49-609074	1622260.253	1756696.52
49-004	49-609075	1622271.021	1756719.062
49-004	49-609076	1622281.4	1756741.765
49-004	49-609077	1622292.103	1756764.144
49-004	49-609078	1622302.806	1756786.848
49-004	49-609079	1622313.509	1756809.876
49-004	49-609080	1622323.888	1756832.255
49-004	49-609081	1622334.915	1756854.893
49-004	49-609082	1622345.294	1756877.597
49-004	49-609083	1622355.932	1756900.203
49-004	49-609084	1622366.635	1756922.907
49-004	49-609085	1622408.993	1757012.618
49-004	49-609086	1622216.468	1756661.817
49-004	49-609087	1622226.847	1756684.52
49-004	49-609088	1622237.55	1756706.899
49-004	49-609089	1622258.696	1756752.144
49-004	49-609090	1622269.399	1756775.172
49-004	49-609091	1622280.103	1756797.875
49-004	49-609092	1622301.184	1756842.958
49-004	49-609093	1622311.887	1756865.597
49-004	49-609094	1622322.59	1756888.3
49-004	49-609095	1622343.932	1756933.61
49-004	49-609096	1622354.635	1756955.34
49-004	49-609097	1622386.29	1757023.321
49-004	49-609098	1622396.993	1757046.024
49-004	49-609099	1622321.228	1756944.637
49-004	49-609100	1622331.931	1756966.043
49-004	49-609101	1622342.31	1756988.682
49-004	49-609102	1622363.586	1757034.024
49-004	49-609103	1622373.965	1757056.727
49-004	49-609104	1622298.525	1756954.043
49-004	49-609105	1622330.504	1757022.024
49-004	49-609106	1622319.607	1756999.385
49-004	49-609107	1622341.207	1757044.403
49-004	49-609108	1622286.524	1756987.385

Table C-1 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-004	49-609109	1622297.227	1757010.088
49-004	49-609110	1622318.504	1757055.43
49-004	49-609111	1622329.207	1757078.134
49-004	49-609112	1622332.256	1756496.827
49-004	49-609113	1622374.744	1756587.641
49-004	49-609114	1622417.296	1756677.871
49-004	49-609115	1622459.784	1756768.685
49-004	49-609116	1622502.207	1756859.013
49-004	49-609117	1622523.614	1756904.679
49-004	49-609118	1622298.849	1756484.827
49-004	49-609119	1622320.58	1756530.234
49-004	49-609120	1622341.337	1756575.641
49-004	49-609121	1622362.743	1756621.048
49-004	49-609122	1622383.89	1756665.871
49-004	49-609123	1622405.296	1756711.278
49-004	49-609124	1622426.378	1756756.685
49-004	49-609125	1622447.784	1756801.702
49-004	49-609126	1622468.801	1756847.336
49-004	49-609127	1622490.207	1756892.095
49-004	49-609128	1622511.483	1756937.696
49-004	49-609129	1622532.89	1756982.455
49-004	49-609130	1622286.849	1756518.233
49-004	49-609131	1622241.766	1756539.639
49-004	49-609132	1622463.482	1757069.96
49-004	49-609133	1622508.889	1757048.879
49-004	49-609134	1622499.807	1756970.454
49-004	49-609135	1622487.807	1757002.888
49-004	49-609136	1622475.482	1757036.554
49-004	49-609137	1622208.359	1756527.315
49-004	49-609138	1622196.359	1756560.721
49-004	49-609139	1622430.4	1757057.96
49-004	49-609140	1622184.359	1756594.128
49-004	49-609141	1622162.953	1756548.721
49-004	49-609142	1622172.358	1756627.21
49-004	49-609143	1622193.764	1756672.52
49-004	49-609144	1622214.587	1756717.764
49-004	49-609145	1622236.317	1756762.847
49-004	49-609146	1622257.399	1756808.254
49-004	49-609147	1622278.481	1756853.596

Table C-1 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-004	49-609148	1622299.887	1756899.003
49-004	49-609149	1622385.317	1757079.042
49-004	49-609150	1622138.952	1756615.534
49-004	49-609151	1622160.033	1756660.519
49-004	49-609152	1622202.586	1756751.171
49-004	49-609153	1622245.399	1756841.661
49-004	49-609154	1622287.497	1756932.312
49-004	49-609155	1622372.992	1757112.773
49-004	49-609156	1622254.415	1756920.312
49-004	49-609157	1622276.146	1756964.746
49-004	49-609158	1622339.586	1757100.772
49-004	49-609159	1622242.739	1756952.421
49-004	49-609160	1622263.821	1756998.088
49-004	49-609161	1622285.097	1757043.105
49-004	49-609162	1622306.503	1757088.512
49-004	49-609163	1622327.585	1757134.179
49-004	49-609164	1622252.145	1757031.494
49-004	49-609165	1622273.097	1757076.836

Table C-2
Surveyed Coordinates for 2009 Locations at Area 10, AOC 49-002 and SWMU 49-005(a)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
Area 10 Drilling			
49-005(a)	49-609986	1627042.921	1755376.95
49-005(a)	49-609987	1626971.578	1755377.105
49-005(a)	49-609988	1627007.714	1755398.796
49-005(a)	49-609989	1627007.624	1755354.111
Area 10 Surface and Shallow Subsurface			
49-002	49-609540	1626996.735	1755377.155
49-002	49-609541	1627021.891	1755377.205
49-002	49-609542	1626845.847	1755351.7
49-002	49-609543	1626896.159	1755351.8
49-002	49-609544	1626921.316	1755351.849
49-002	49-609545	1626946.472	1755351.899
49-002	49-609546	1626871.053	1755326.594
49-002	49-609547	1626946.522	1755326.743

Table C-2 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-002	49-609548	1626996.635	1755427.468
49-002	49-609549	1627072.104	1755427.617
49-002	49-609550	1626795.435	1755401.913
49-002	49-609551	1626870.904	1755402.063
49-002	49-609552	1626946.373	1755402.212
49-002	49-609553	1626971.628	1755351.949
49-002	49-609554	1627072.254	1755352.148
49-002	49-609555	1626795.584	1755326.444
49-002	49-609556	1626896.209	1755326.643
49-002	49-609557	1627021.991	1755326.892
49-002	49-609558	1626820.84	1755276.182
49-002	49-609559	1626896.309	1755276.331
49-002	49-609560	1626971.777	1755276.48
49-002	49-609561	1627021.692	1755477.83
49-002	49-609562	1626745.023	1755452.127
49-002	49-609563	1626971.877	1755226.167
49-002	49-609564	1626895.96	1755452.425
49-002	49-609565	1627122.417	1755427.716
49-002	49-609566	1626745.222	1755351.501
49-002	49-609567	1627122.616	1755327.091
49-002	49-609568	1626770.527	1755276.082
49-002	49-609569	1627047.296	1755251.473
49-002	49-609570	1626871.252	1755225.968
49-002	49-609571	1626946.323	1755427.368
49-002	49-609572	1626971.479	1755427.418
49-002	49-609573	1627021.792	1755427.517
49-002	49-609574	1627046.948	1755427.567
49-002	49-609575	1626820.591	1755401.963
49-002	49-609576	1626845.747	1755402.013
49-002	49-609577	1626896.06	1755402.112
49-002	49-609578	1626921.216	1755402.162
49-002	49-609579	1626971.529	1755402.262
49-002	49-609580	1626996.685	1755402.311
49-002	49-609581	1627021.841	1755402.361
49-002	49-609582	1627046.998	1755402.411
49-002	49-609583	1627072.154	1755402.46
49-002	49-609584	1626795.484	1755376.757
49-002	49-609585	1626820.641	1755376.807
49-002	49-609586	1626845.797	1755376.857

Table C-2 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-002	49-609587	1626870.953	1755376.906
49-002	49-609588	1626896.11	1755376.956
49-002	49-609589	1626921.266	1755377.006
49-002	49-609590	1626946.422	1755377.055
49-002	49-609591	1626971.579	1755377.105
49-002	49-609592	1627047.047	1755377.254
49-002	49-609593	1627072.204	1755377.304
49-002	49-609594	1626795.534	1755351.601
49-002	49-609595	1626820.69	1755351.651
49-002	49-609596	1626871.003	1755351.75
49-002	49-609597	1626996.785	1755351.999
49-002	49-609598	1627021.941	1755352.048
49-002	49-609599	1627047.097	1755352.098
49-002	49-609600	1626820.74	1755326.494
49-002	49-609601	1626845.896	1755326.544
49-002	49-609602	1626921.365	1755326.693
49-002	49-609603	1626971.678	1755326.793
49-002	49-609604	1626996.834	1755326.842
49-002	49-609605	1627047.147	1755326.942
49-002	49-609606	1627072.303	1755326.992
49-002	49-609607	1626795.634	1755301.288
49-002	49-609608	1626820.79	1755301.338
49-002	49-609609	1626845.946	1755301.388
49-002	49-609610	1626871.103	1755301.437
49-002	49-609611	1626896.259	1755301.487
49-002	49-609612	1626921.415	1755301.537
49-002	49-609613	1626946.571	1755301.587
49-002	49-609614	1626971.728	1755301.636
49-002	49-609615	1626996.884	1755301.686
49-002	49-609616	1626845.996	1755276.231
49-002	49-609617	1626871.152	1755276.281
49-002	49-609618	1626921.465	1755276.381
49-002	49-609619	1626946.621	1755276.43
49-002	49-609620	1626996.934	1755276.53
49-002	49-609621	1626921.067	1755477.631
49-002	49-609622	1626971.38	1755477.73
49-002	49-609623	1627072.005	1755477.929
49-002	49-609624	1627122.317	1755478.029
49-002	49-609625	1626845.648	1755452.325

Table C-2 (continued)

SWMU or AOC	Location ID	Easting (ft)	Northing (ft)
49-002	49-609626	1626946.273	1755452.524
49-002	49-609627	1626996.586	1755452.624
49-002	49-609628	1627046.898	1755452.723
49-002	49-609629	1627097.211	1755452.823
49-002	49-609630	1626795.335	1755452.226
49-002	49-609631	1626770.229	1755427.02
49-002	49-609632	1626820.541	1755427.119
49-002	49-609633	1626870.854	1755427.219
49-002	49-609634	1626921.166	1755427.318
49-002	49-609635	1626745.122	1755401.814
49-002	49-609636	1626770.328	1755376.707
49-002	49-609637	1626770.428	1755326.395
49-002	49-609638	1626745.321	1755301.189
49-002	49-609639	1627047.197	1755301.785
49-002	49-609640	1627097.509	1755301.885
49-002	49-609641	1627097.41	1755352.198
49-002	49-609642	1627122.516	1755377.404
49-002	49-609643	1627097.31	1755402.51
49-002	49-609644	1627022.09	1755276.579
49-002	49-609645	1627072.403	1755276.679
49-002	49-609646	1627122.715	1755276.778
49-002	49-609647	1626745.42	1755250.876
49-002	49-609648	1626795.733	1755250.976
49-002	49-609649	1626846.046	1755251.075
49-002	49-609650	1626896.358	1755251.174
49-002	49-609651	1626946.671	1755251.274
49-002	49-609652	1626996.984	1755251.373
49-002	49-609653	1626770.626	1755225.77
49-002	49-609654	1626820.939	1755225.869
49-002	49-609655	1626921.564	1755226.068
49-002	49-609656	1627022.19	1755226.267

Appendix D

Gross-Alpha and Gross-Beta
Radiological Screening Results and Borehole Logs
(on CD included with this document)

Appendix E

Investigation-Derived Waste Management

E-1.0 INTRODUCTION

This appendix contains the waste management records for the investigation-derived waste (IDW) generated during the implementation of the 2009–2010 investigation work plan of the Technical Area 49 (TA-49) sites outside the nuclear environmental site (NES) boundary at Los Alamos National Laboratory (LANL or the Laboratory).

All IDW generated during the TA-49 investigation was managed in accordance with the IDW management plan in the approved work plan (LANL 2008, 102215) and Standard Operating Procedure (SOP) 5238, Characterization and Management of Environmental Program Waste. SOP-5238 incorporates the requirements of applicable U. S. Environmental Protection Agency and New Mexico Environment Department (NMED) waste regulations, U.S. Department of Energy orders, and other Laboratory procedures.

Consistent with SOP-5238, a waste characterization strategy form (WCSF) was prepared before IDW generation to address characterization approaches, on-site management, and final disposition options for wastes. Analytical data and information on wastes generated during previous investigations and/or acceptable knowledge (AK) were used to complete the WCSF. A copy of the signed WCSF is included in this appendix as Attachment E-1 (on CD).

Wastes were staged in clearly marked and appropriately constructed waste accumulation areas. Waste accumulation area postings, regulated storage duration, and inspection requirements were based on the type of IDW and its classification. Container and storage requirements were detailed in the WCSF and approved before waste was generated.

Investigation activities were conducted in a manner that minimized the generation of waste. Waste minimization was accomplished by implementing the most recent version of the Los Alamos National Laboratory Hazardous Waste Minimization Plan (LANL 2009, 109324).

E-2.0 WASTE STREAMS

The IDW streams generated and managed during the 2009–2010 investigation of TA-49 are described below and are summarized in Table E-2.0-1.

The waste numbers correspond with those identified in the WCSF, which is included in this appendix as Attachment E-1 (on CD). Waste types 3 (decontamination fluids), 5 (New Mexico special waste), and 6 (returned or excess samples) were not generated and therefore are not listed below.

- *Waste #1: Drill Cuttings (IDW)* − This waste stream includes soil and rock cuttings generated from boreholes. Approximately 10 yd^3 of cuttings were generated and stored in Wrangler bags or 55-gal. drums. All containers were directly sampled. The cuttings were land-applied in accordance with the NMED-approved Notice of Intent decision tree, Land Application of IDW Solids from Construction of Wells and Boreholes, and the Laboratory radiological decision tree.
- *Waste #2: Contact Waste* – This waste stream includes personal protective equipment, contaminated sampling supplies, and dry decontamination waste that may have come in contact with contaminated environmental media and cannot be decontaminated. These wastes were containerized at the point of generation and were characterized based on AK of the waste materials, the methods of generation, and analytical data for the media with which they came into contact. These wastes were disposed of off-site as industrial waste or Green-Is-Clean wastes.

- *Waste #4: Municipal Solid Waste (MSW)* – This waste stream consists of noncontact trash and debris. All MSW was stored in plastic trash bags and disposed of at the Los Alamos County transfer station.

E-3.0 REFERENCES

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

LANL (Los Alamos National Laboratory), January 2008. "Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1," Los Alamos National Laboratory document LA-UR-08-0449, Los Alamos, New Mexico. (LANL 2008, 102215)

LANL (Los Alamos National Laboratory), November 2009. "Los Alamos National Security, LLC, Hazardous Waste Minimization Plan," Los Alamos National Laboratory document LA-UR-09-07682, Los Alamos, New Mexico. (LANL 2009, 109324)

Table E-2.0-1
Summary of IDW Generation and Management

Waste Stream	Waste Type	Volume	Characterization Method	On-Site Management	Disposition
Drill Cuttings	Industrial	10 yd^3	Direct sampling	Wrangler bags or 55-gal. drums	Land application
Contact Waste	Green-Is-Clean	<2 yd^3	AK and analytical results of site investigation samples	30- or 55-gal. drums	Authorized off-site disposal facility
Municipal Solid Waste	MSW	<2 yd^3	AK	Plastic trash bags	Off-site municipal landfill

Attachment E-1

Waste Characterization Strategy Form
(on CD included with this document)

Appendix F

Analytical Program

F-1.0 INTRODUCTION

This appendix discusses the analytical methods and data quality assessment for samples collected during investigations at Technical Area 49 (TA-49) sites outside the nuclear environmental site (NES) boundary. Additionally, this appendix summarizes the effects of data-quality issues on the acceptability of the analytical data.

Quality assurance (QA), quality control (QC), and data validation procedures were implemented in accordance with the Quality Assurance Project Plan Requirements for Sampling and Analysis (LANL 1996, 054609), and Los Alamos National Laboratory's statements of work (SOWs) for analytical laboratories (LANL 1995, 049738; LANL 2000, 071233). The results of the QA/QC procedures were used to estimate the accuracy, bias, and precision of the analytical measurements. Samples for QC include method blanks, matrix spikes (MSs), laboratory control samples (LCSs), internal standards, initial calibration verifications (ICVs) and continuing calibration verifications (CCVs), surrogates, and tracers.

The type and frequency of laboratory QC analyses are described in the SOWs for analytical laboratories (LANL 1995, 049738; LANL 2000, 071233). Other QC factors, such as sample preservation and holding times, were also assessed in accordance with the requirements outlined in Standard Operating Procedure (SOP) EP-ERSS-SOP-5056, Sample Containers and Preservation.

The following SOPs were used for data validation:

- SOP-5161, Routine Validation of Volatile Organic Data
- SOP-5162, Routine Validation of Semivolatile Organic Compound (SVOC) Analytical Data
- SOP-5163, Routine Validation of Organochlorine Pesticides and PCB Analytical Data
- SOP-5164, Routine Validation of High Explosives Analytical Data
- SOP-5165, Routine Validation of Metals Analytical Data
- SOP-5166, Routine Validation of Gamma Spectroscopy Data, Chemical Separation Alpha Spectrometry, Gas Proportional Counting, and Liquid Scintillation Analytical Data
- SOP-5168, Routine Validation of LC/MS/MS High Explosive Analytical Data

Routine data validation was performed for each data package (also referred to as request numbers), and analytical data were reviewed and evaluated based on U.S. Environmental Protection Agency (EPA) National Functional Guidelines, where applicable (EPA 1994, 048639; EPA 1999, 066649). As a result of the data validation and assessment efforts, qualifiers are assigned to the analytical records as appropriate. The data-qualifier definitions are provided in Appendix A.

F-2.0 ANALYTICAL DATA ORGANIZATION

The investigation of the TA-49 sites outside the NES boundary consisted of Areas 6 West and 10. For purposes of analytical data presentation and review, the TA-49 outside NES boundary analytical data are included in Appendix G (on DVD) as three separate databases corresponding to the two main areas investigated: Area 6 West [Solid Waste Management Unit (SWMU) 49-004] and Area 10 [Area of Concern (AOC) 49-002 and SWMU 49-005(a)].

All historical investigation samples were submitted to and analyzed by approved off-site laboratories. These data were determined to be of sufficient quality for decision-making purposes and have been reviewed and revalidated to current QA standards.

F-3.0 INORGANIC CHEMICAL ANALYSES

The analytical methods used for inorganic chemical analyses are summarized in Table F-3.0-1.

Area 6 West

At SWMU 49-004, a total of 164 samples (152 soil/fill and 12 tuff), plus 14 field duplicates, were collected during 1995 and 2009–2010 investigations. All samples were analyzed for target analyte list (TAL) metals; 17 samples were analyzed for uranium; and 12 samples were analyzed for cyanide, nitrate, and perchlorate.

Area 10

At AOC 49-002, a total of 71 samples (70 soil/fill and 1 tuff), plus 8 field duplicates, were collected in 1995 and 2009–2010 investigations. All samples were analyzed for TAL metals only.

At SWMU 49-005(a), a total of 18 samples (7 soil/fill and 11 tuff), plus 8 field duplicates, were collected in 1995 and 2009–2010 investigations. All samples were analyzed for TAL metals; 14 samples were analyzed for cyanide, nitrate, and perchlorate. Two samples were analyzed for uranium only.

F-3.1 Inorganic Chemical QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of specific parts of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. To assess the accuracy and precision of inorganic chemical analyses, LCSs, preparation blanks, MSs, laboratory duplicate samples, interference check samples (ICSs), and serial dilution samples were analyzed as part of the investigations at TA-49 for sites outside of the NES boundary. Each of these QA/QC sample types is defined in the analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233) and is described briefly in the sections below. For some of the analyses performed before the 1995 SOW was implemented, slightly different QA/QC procedures may have been followed.

The LCS serves as a monitor of the overall performance of each step during the analysis, including sample digestion. For inorganic chemicals in soil/tuff, LCS percent recoveries (%R) should fall within the control limits of 75%–125% (LANL 1995, 049738; LANL 2000, 071233).

The preparation blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing; it is extracted and analyzed in the same manner as the corresponding environmental samples. Preparation blanks are used to measure bias and potential cross-contamination. All inorganic chemical results should be below the method detection limit (MDL).

The MS samples assess the accuracy of inorganic chemical analyses. These samples are designed to provide information about the effect of the sample matrix on the sample preparation procedures and analytical technique. The MS acceptance criterion is 75%–125%, inclusive, for all spiked analytes (LANL 1995, 049738; LANL 2000, 071233).

Laboratory duplicate samples assess the precision of inorganic chemical analyses. All relative percent differences (RPDs) between the sample and laboratory duplicate should be ±35% (LANL 1995, 049738; LANL 2000, 071233).

The ICSs assess the accuracy of the analytical laboratory’s interelement and background correction factors used for inductively coupled plasma emission spectroscopy. The ICS %R should be within the acceptance range of 80%–120%. The QC acceptance limits are ±20%.

Serial dilution samples measure potential physical or chemical interferences and correspond to a sample dilution ratio of 1:5. The chemical concentration in the undiluted sample must be at least 50 times the MDL (100 times for inductively coupled plasma mass spectroscopy) for valid comparison. For sufficiently high concentrations, the RPD should be within 10%.

Details regarding the quality of the inorganic chemical analytical data included in the datasets are summarized in the following sections.

F-3.2 Data Quality Results for Inorganic Chemicals

The majority of the analytical results are qualified as not detected (U) because the analytes were not detected by the respective analytical methods or were not qualified. These data do not have any quality issues associated with the values presented.

F-3.2.1 Chain of Custody

Sample collection log (SCL)/chain-of-custody (COC) forms were maintained properly for all samples analyzed for inorganic chemicals (Appendix G on DVD).

F-3.2.2 Sample Documentation

All samples analyzed for inorganic chemicals were properly documented on SCL/COCs in the field (Appendix G on DVD).

F-3.2.3 Sample Dilutions

Some samples were diluted for inorganic chemical analyses. No qualifiers were applied to any inorganic chemical sample results because of dilutions.

F-3.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for inorganic chemicals.

F-3.2.5 Holding Times

Holding-time criteria were met for all samples analyzed for inorganic chemicals.

F-3.2.6 Initial and Continuing Calibration Verifications

F-3.2.6.1 Area 10

Initial and continuing calibration verification criteria were met for all samples analyzed for inorganic chemicals.

F-3.2.6.2 Area 6 West

One TAL metal result was qualified as estimated (J) because the ICV and/or CCV were recovered outside the method-specific limits.

F-3.2.7 Interference Check Sample and/or Serial Dilutions

Interference check sample and serial dilution criteria were met for all samples analyzed for inorganic chemicals.

F-3.2.8 Laboratory Duplicate Samples

F-3.2.8.1 Area 6 West

A total of 129 TAL metals results were qualified as estimated (J) because the sample and the duplicate sample results were greater than or equal to 5 times the reporting limit (RL) and the duplicate RPD was greater than 35% for soil samples.

F-3.2.8.2 Area 10

A total of 28 TAL metals results were qualified as estimated (J) because the sample and the duplicate sample results were greater than or equal to 5 times the RL and the duplicate RPD was greater than 35% for soil samples.

F-3.2.9 Blanks

F-3.2.9.1 Area 6 West

A total of 55 TAL metals results were qualified as not detected (U). The sample results were less than or equal to 5 times the concentration of the related analytes in the method blank.

A total of 38 TAL metals results were qualified as not detected (U). The sample results were less than or equal to 5 times the concentration of the related analytes in initial calibration blank and or continuing calibration blank.

A total of eight TAL metals results were qualified as not detected (U). The sample results were less than or equal to 5 times the concentration of the related analyte in the equipment or rinsate blank.

A total of 27 TAL metals results were qualified as estimated (J) because the sample results were greater than 5 times the concentration of the related analytes in the method blank.

F-3.2.9.2 Area 10

A total of 14 TAL metals results were qualified as not detected (U). The sample results were less than or equal to 5 times the concentration of the related analytes in the method blank.

A total of 68 metals results were qualified as not detected (U). The sample results were less than or equal to 5 times the concentration of the related analytes in initial calibration blank and/or continuing calibration blank.

A total of 14 TAL metals results were qualified as not detected (U).The sample results were less than or equal to 5 times the concentration of the related analytes in the method blank.

A total of 48 TAL metals results were qualified as not detected (U). The sample results were less than or equal to 5 times the concentration of the related analyte in the equipment or rinsate blank.

A total of 28 TAL metals results were qualified as estimated (J) because the sample results were greater than 5 times the concentration of the related analytes in the method blank.

F-3.2.10 MS Samples

F-3.2.10.1 Area 6 West

A total of 27 TAL metals results were qualified as estimated not detected (UJ) because of low recovery (%R <75%) for these analytes in the associated spike sample.

A total of 221 TAL metals results were qualified as estimated and biased low (J-) because of low recovery (%R <75%) for these analytes in the associated spike sample.

A total of 179 TAL metals results were qualified as estimated and biased high (J+) because of high recovery (%R >125%) for these analytes in the associated spike sample.

F-3.2.10.2 Area 10

A total of 129 TAL metals results and 13 total cyanide results were qualified as estimated not detected (UJ) because of low recovery (%R <75%) for these analytes in the associated spike sample.

A total of 70 TAL metals results were qualified as estimated and biased low (J-) because of low recovery (%R <75%) for these analytes in the associated spike sample.

A total of 192 TAL metals results were qualified as estimated and biased high (J+) because of high recovery (%R >125%) for these analytes in the associated spike sample.

F-3.2.11 LCS Recoveries

LCS recovery criteria were met for all samples analyzed for inorganic chemicals.

F-3.2.12 Detection Limits

F-3.2.12.1 Area 6 West

A total of 111 TAL metals results were qualified as estimated (J) because the sample result was reported as detected between the estimated detection limit (EDL) and the MDL.

A total of 369 TAL metals results and 3 perchlorate results were qualified as estimated (J) because the sample result was reported as detected between the PQL and the MDL.

F-3.2.12.2 Area 10

A total of 51 TAL metals results were qualified as estimated (J) because the sample result was reported as detected between the EDL and the MDL.

A total of 9 nitrate results, 253 TAL metals results, and 1 perchlorate result were qualified as estimated (J) because the sample result was reported as detected between the practical quantitation limit (PQL) and the MDL.

F-3.2.13 Rejected Results

F-3.2.13.1 Area 10

No inorganic chemical sample results were qualified as rejected.

F-3.2.13.2 Area 6 West

A total of 16 manganese results and 2 mercury results were qualified as rejected (R) because of less than 10% recovery in the associated MS analysis.

The rejected data were not used to characterize the nature and extent or the human health and ecological risk-screening assessments. However, sufficient data of good quality were available to characterize the site(s) and conduct the risk assessments. The results of other qualified data were used as reported and do not affect the usability of the sampling results.

F-4.0 ORGANIC CHEMICAL ANALYSES

Soil, tuff, and pore-gas samples collected during the 1995 and 2009–2010 investigations were analyzed for one or more of the following organic chemical analytical suites: explosive compounds, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs), and polychlorinated biphenyl (PCB) compounds. Samples were analyzed using SW-846 Methods 8260B (VOCs), 8270C (SVOCs), 8321A (explosive compounds), 8082 (PCBs), and EPA Method TO-15 (VOCs in pore gas).

Area 6 West

At SWMU 49-004, a total of 21 soil, fill, and tuff samples, plus 1 field duplicate, and 2 pore-gas samples, plus 1 field duplicate, were collected during the 1995 and 2009–2010 investigations. All the samples were analyzed for SVOCs, and 12 samples were also analyzed for explosive compounds and VOCs. Pore-gas samples were analyzed for VOCs only.

Area 10

At AOC 49-002, one sample was collected during historical investigations and analyzed for SVOCs and PCBs.

At AOC 49-005(a), a total of 18 soil, fill, and tuff samples and 1 pore-gas sample were collected during the 1995 and 2009–2010 investigations. Each sample was analyzed for SVOCs, and 14 samples were also analyzed for explosive compounds and VOCs. The pore-gas sample was analyzed for VOCs only.

All QC procedures were followed as required by the analytical laboratory SOWs (LANL 1995, 049738; LANL 2000, 071233). The analytical methods used for organic chemicals are listed in Table F-3.0-1.

F-4.1 Organic Chemical QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of specific parts of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. Calibration verifications, LCSs, method blanks, MSs, surrogates, and internal standards were analyzed to assess the accuracy and precision of organic chemical analyses. Each of these QA/QC sample types is defined in the analytical services SOW (LANL 2000, 071233) and is described briefly below.

Calibration verification is the establishment of a quantitative relationship between the response of the analytical procedure and the concentration of the target analyte. There are two aspects of calibration verification: initial and continuing. The initial calibration verifies the accuracy of the calibration curve as well as the individual calibration standards used to perform the calibration. The continuing calibration ensures that the initial calibration is still holding and correct as the instrument is used to process samples. The continuing calibration also serves to determine that analyte identification criteria such as retention times and spectral matching are being met.

The LCS is a sample of a known matrix that has been spiked with compounds that are representative of the target analytes, and it serves as a monitor of overall performance. The LCS is the primary demonstration, on a daily basis, of the ability to analyze samples with good qualitative and quantitative accuracy. The LCS recoveries should be within the method-specific acceptance criteria.

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing; it is extracted and analyzed in the same manner as the corresponding environmental samples. Method blanks are used to assess the potential for sample contamination during extraction and analysis. All target analytes should be below the contract required detection limit in the method blank (LANL 2000, 071233).

MS samples are used to measure the ability to recover prescribed analytes from a native sample matrix and consist of aliquots of the submitted samples spiked with a known concentration of the target analyte(s). Spiking typically occurs before sample preparation and analysis. The spike sample recoveries should be between the lower acceptance limit (LAL) and upper acceptance limit (UAL).

A surrogate compound (surrogate) is an organic compound used in the analyses of target analytes that is similar in composition and behavior to the target analytes but is not normally found in environmental samples. Surrogates are added to every blank, sample, and spike to evaluate the efficiency with which analytes are recovered during extraction and analysis. The recovery percentage of the surrogates must be within specified ranges or the sample may be rejected or assigned a qualifier.

Internal standards are chemical compounds added to every blank, sample, and standard extract at a known concentration. They are used to compensate for (1) analyte concentration changes that might occur during storage of the extract, and (2) quantitation variations that can occur during analysis. Internal standards are used as the basis for quantitation of target analytes. The %R for internal standards should be within the range of 50%–200%.

Details regarding the quality of the organic chemical analytical data included in the data sets are summarized in the following subsections.

F-4.2 Data Quality Results for Organic Chemicals

The majority of the analytical results are qualified as not detected (U) because the analytes were not detected by the respective analytical methods. These data do not have any quality issues associated with the values presented.

F-4.2.1 Maintenance of Chain of Custody

COC forms were maintained properly for all samples analyzed for organic chemicals.

F-4.2.2 Sample Documentation

All samples analyzed for organic chemicals were properly documented on the SCLs in the field (Appendix G on DVD).

F-4.2.3 Sample Dilutions

Some samples were diluted for organic chemical analyses. No qualifiers were applied to any organic chemical sample results because of dilutions.

F-4.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for organic chemicals.

F-4.2.5 Holding Times

F-4.2.5.1 Area 6 West

Holding-time criteria were met for all samples analyzed for organic chemicals.

F-4.2.5.2 Area 10

A total of 56 explosive compounds were qualified as estimated not detected (UJ) because the extraction/analytical holding time was exceeded by less than 2 times the published method for holding times.

F-4.2.6 Initial and Continuing Calibration Verifications

F-4.2.6.1 Area 6

Four VOC results were qualified as estimated not detected (UJ) because the affected analytes were analyzed with an initial calibration curve that exceeded the percent of risk-specific dose (%RSD) criteria and/or the associated multipoint calibration correlation coefficient is less than 0.995.

A total of 48 VOC results and 45 SVOC results were qualified as estimated not detected (UJ) because the ICV and/or CCV were recovered outside the method-specific limits.

Two SVOC results were qualified as estimated (J) because the ICV and/or CCV were recovered outside the method-specific limits.

F-4.2.6.2 Area 10

Two VOC results were qualified as estimated not detected (UJ) because the affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria and/or the associated multipoint calibration correlation coefficient is less than 0.995.

A total of 28 explosive compound results were qualified as estimated not detected (UJ). The affected analytes were analyzed with a relative retention factor of <0.05 in the initial calibration and/or CCV.

A total of 28 explosive compound results, 28 SVOC results, and 28 VOC results were qualified as estimated not detected (UJ) because the ICV and/or CCV were recovered outside the method-specific limits.

F-4.2.7 Surrogate Recoveries

F-4.2.7.1 Area 6 West

Surrogate recovery criteria were met for all samples analyzed for organic compounds.

F-4.2.7.2 Area 10

A total of 61 VOC results were qualified as estimated not detected (UJ) because the surrogate recovery is less than the LAL but is greater than or equal to 10%.

F-4.2.8 Internal Standard Responses

Internal standard response criteria were met for all samples analyzed for organic compounds.

F-4.2.9 Method Blanks

Three VOC results were qualified as not detected (U) because the sample result is less than or equal to 5 times the concentration of the related analyte in the trip blank, rinsate blank, or equipment blank.

F-4.2.9.1 Area 6 West and Area 10

Results for samples analyzed for organic chemicals were not qualified because of blank contamination.

F-4.2.10 Laboratory Duplicate Samples

Laboratory duplicates collected for organic chemical analyses indicated acceptable precision for all samples.

F-4.2.11 LCS Recoveries

LCS recovery criteria were met for all samples analyzed for organic chemicals.

F-4.2.12 Quantitation and Method Detection Limits

F-4.2.12.1 Area 6 West

Two SVOC results and one VOC result were qualified estimated (J) because the results were between the PQL and the MDL.

F-4.2.12.2 Area 10

Two SVOC results and one VOC result were qualified estimated (J) because the results were between the PQL and the MDL.

F-4.2.13 Rejected Data

F-4.2.13.1 Area 6 West

Sample results for organic chemical analysis were not qualified as rejected (R).

F-4.2.13.2 Area 10

A total of 14 tris(o-cresyl)phosphate results were qualified as rejected (R) because the ICV and/or CCV for this analyte were recovered outside the method-specific limits.

The rejected data were not used to characterize the nature and extent or the human health and ecological risk-screening assessments. However, sufficient data of good quality are available to characterize the site(s) and conduct the risk assessments. The results of other qualified data were used as reported and do not affect the usability of the sampling results.

F-5.0 RADIONUCLIDE ANALYSES

Soil and tuff samples were analyzed for radionuclides by gamma spectroscopy using EPA Method 901.1; and for americium-241, isotopic plutonium, and isotopic uranium by alpha spectroscopy (HASL-300 Methods), strontium-90 using EPA Method 905.0, technetium-99 using HASL 300 Methods, and tritium using EPA Method 906.0. Pore-gas samples were collected and analyzed for tritium using EPA Method 906.0. All QC procedures were followed as required by the analytical laboratories SOW (LANL 2000, 071233). The methods used for analyzing radionuclides are listed in Table F-3.0-1.

Area 6 West

At SWMU 49-004, a total of 190 samples plus 15 field duplicates, and 2 pore gas samples, plus 1 field duplicate, were collected during the 1995 and 2009–2010 investigations. Analyses included 138 samples for americium-241 and isotopic uranium; 178 samples by gamma spectroscopy; 12 samples for tritium; 14 samples for isotopic plutonium; and 5 samples for strontium-90 and technetium-99. Pore-gas samples were analyzed for tritium only.

Area 10

At AOC 49-002, a total of 77 samples, plus 8 field duplicates, were collected during the 1995 and 2009–2010 investigations. All samples were analyzed by gamma spectroscopy; 71 samples were analyzed for isotopic plutonium; and 64 samples were also analyzed for americium-241 and isotopic uranium.

At AOC 49-005(a) a total of 82 samples, plus 8 field duplicates, and 1 pore-gas sample were collected during the 1995 and 2009–2010 investigations. Analyses included all 82 samples for isotopic plutonium; 78 samples for americium-241 and isotopic uranium; 14 samples for tritium; and 68 samples were analyzed by gamma spectroscopy. The pore-gas sample was analyzed for tritium only.

F-5.1 Radionuclide QA/QC Samples

All procedures were followed as required by the analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233). Some sample results were qualified as not detected (U) because the associated sample concentration was less than or equal to the minimum detectable concentration (MDC). Some sample results were qualified as not detected (U) because the associated sample concentration was less than or equal to 3 times the total propagated uncertainty. This data qualification is related to detection status only and not to data quality issues.

To assess the accuracy and precision of radionuclide analyses, LCSs, method blanks, MS samples, laboratory duplicate samples, and tracers were analyzed as part of the investigations. Each of these QA/QC sample types is defined in the analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233) and is described briefly below.

The LCS serves as a monitor of the overall performance of each step during the analysis, including sample digestion. For radionuclides in soil/tuff, LCS %Rs should fall between the control limits of 80%–120%.

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing; it is analyzed in the same manner as the corresponding environmental samples. Method blanks are used to assess the potential for sample contamination during analysis. All radionuclide results should be below the MDC.

MS samples assess the accuracy of inorganic chemical analyses. These samples are designed to provide information about the effect of the sample matrix on the sample preparation procedures and analytical technique. The MS acceptance criterion is 75%–125%.

Tracers are radioisotopes added to a sample for the purposes of monitoring losses of the target analyte. The tracer is assumed to behave in the same manner as the target analytes. The tracer recoveries should fall between the LAL and UAL.

Laboratory duplicate samples assess the precision of inorganic chemical analyses. All RPDs between the sample and laboratory duplicate should be ±35% for soil (LANL 1995, 049738; LANL 2000, 071233).

Details regarding the quality of the radionuclide analytical data included in the dataset are summarized in the following subsections.

F-5.2 Data Quality Results for Radionuclides

F-5.2.1 Chain of Custody

COC forms were maintained properly for all samples.

F-5.2.2 Sample Documentation

All samples were properly documented on the SCLs in the field.

F-5.2.3 Sample Dilutions

Some samples were diluted for radionuclide analyses. No qualifiers were applied to any radionuclide sample results because of dilutions.

F-5.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for radionuclides.

F-5.2.5 Holding Times

Holding-time criteria were met for all samples analyzed for radionuclides.

F-5.2.6 Method Blanks

F-5.2.6.1 Area 10

Results for samples analyzed for radionuclides were not qualified because of blank contamination.

F-5.2.6.2 Area 6

One americium-241 result, one plutonium-239/240 result, and one uranium-234 result were qualified as not detected (U) because the sample result was less than or equal to 5 times the concentration of the related analyte in the method blank.

Two americium-241 results and one plutonium-239/240 result were qualified as estimated (J) because the sample results were greater than 5 times the concentration of the related analytes in the method blank.

F-5.2.7 MS Samples

F-5.2.7.1 Area 6

MS criteria were met for all samples analyzed for radionuclides.

F-5.2.7.2 Area 10

A total of 14 tritium results were qualified as estimated not detected (UJ) because the associated MS recovery was greater than 125%.

F-5.2.8 Tracer Recoveries

F-5.2.8.1 Area 6 West

Tracer recovery criteria were met for all samples analyzed for radionuclides.

F-5.2.8.2 Area 10

A total of six isotopic uranium results were qualified as estimated and potentially biased low (J-) because the associated tracer recovery was less than the LAL but greater than 10%.

F-5.2.9 LCS Recoveries

LCS recovery criteria were met for all samples analyzed for radionuclides.

F-5.2.10 Laboratory Duplicate Samples Recoveries

F-5.2.10.1 Area 6 West

Laboratory duplicate sample recovery criteria were met for all samples analyzed for radionuclides.

F-5.2.10.2 Area 10

A total of three americium-241 results were qualified as estimated not detected (UJ) because the duplicate sample was not prepared and/or analyzed with the samples for unspecified reasons. The duplicate information is missing.

F-5.2.11 Rejected Data

F-5.2.11.1 Area 6 West

No radionuclide sample results were qualified as rejected (R).

F-5.2.11.2 Area 10

A total of 66 gamma spectroscopy results (58 cesium-134 and 8 cesium-137) were qualified as rejected (R) because spectral interferences prevent positive identification of the analytes.

The rejected data were not used to characterize the nature and extent or the human health and ecological risk-screening assessments. However, sufficient data of good quality were available to characterize the sites and conduct the risk assessments. The results of other qualified data were used as reported and do not affect the usability of the sampling results.

F-6.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

EPA (U.S. Environmental Protection Agency), February 1994. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review," EPA-540/R-94/013, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1994, 048639)

EPA (U.S. Environmental Protection Agency), October 1999. "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review," EPA540/R-99/008, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1999, 066649)

LANL (Los Alamos National Laboratory), July 1995. "Statement of Work (Formerly Called "Requirements Document") - Analytical Support, (RFP number 9-XS1-Q4257), (Revision 2 - July, 1995)," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1995, 049738)

LANL (Los Alamos National Laboratory), March 1996. "Quality Assurance Project Plan Requirements for Sampling and Analysis," Los Alamos National Laboratory document LA-UR-96-441, Los Alamos, New Mexico. (LANL 1996, 054609)

LANL (Los Alamos National Laboratory), December 2000. "University of California, Los Alamos National Laboratory (LANL), I8980SOW0-8S, Statement of Work for Analytical Laboratories," Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2000, 071233)

Table F-3.0-1
Inorganic Chemical, Organic Chemical, and Radionuclide Analytical Methods for Samples Collected from TA-49

Analytical Method	Analytical Description	Analytical Suite
EPA 300.0	Ion chromatography	Nitrate
EPA 905.0	Precipitation, alpha/beta counting	Strontium-90
EPA 906.0	Distillation and liquid scintillation	Tritium
EPA SW-846: 6010/6010B	Inductively coupled plasma emission spectroscopy—atomic emission spectroscopy	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, uranium, vanadium, and zinc (TAL metals)
EPA SW-846:6020	Inductively coupled plasma mass spectrometry	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc (TAL metals)
EPA SW-846: 9012A	Automated colorimetric/off-line distillation	Total cyanide
EPA SW-846:6850	Liquid chromatography-mass spectrometry/mass spectrometry	Perchlorate
EPA SW-846:7470A	Cold vapor atomic absorption (CVAA)	Mercury
EPA SW-846:7471	CVAA	Mercury
EPA SW-846:7471A	CVAA	Mercury
EPA SW-846: 8260 and 8260B	Gas chromatography-mass spectrometry (GC/MS)	VOCs
EPA TO-15	GC/MS	VOCs (pore gas)
EPA SW-846: 8270 and 8270C	GC/MS	SVOCs
EPA SW-846: 8321A	High performance liquid chromatography	Explosive compounds
Generic: gamma spectroscopy	Gamma spectroscopy	Cesium-134, cesium-137, cobalt-60, sodium-22
Generic: kinetic phosphorescence (KPA)	KPA	Uranium
HASL Method 300	Chemical separation alpha spectrometry	Isotopic uranium, isotopic plutonium, americium-241, technetium-99

Appendix G

Analytical Suites and Results and Analytical Reports
(on DVD included with this document)

Appendix H

Box Plots and Statistical Results

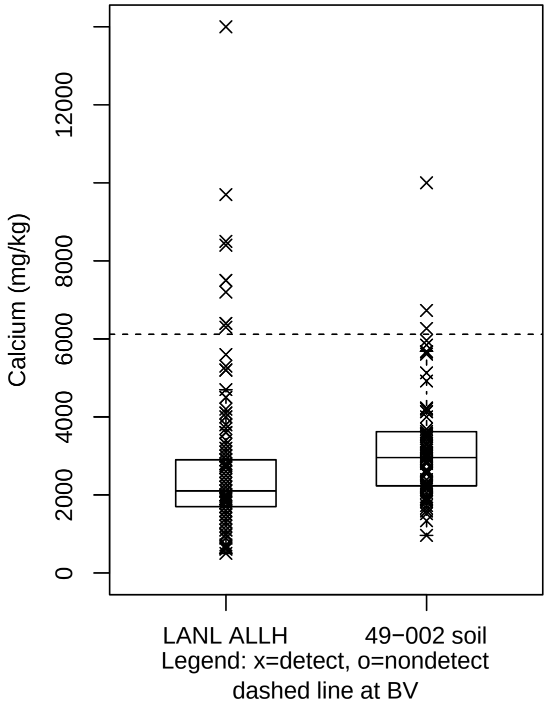


Figure H-1 **Box plot for calcium in soil at Area of Concern (AOC) 49-002**

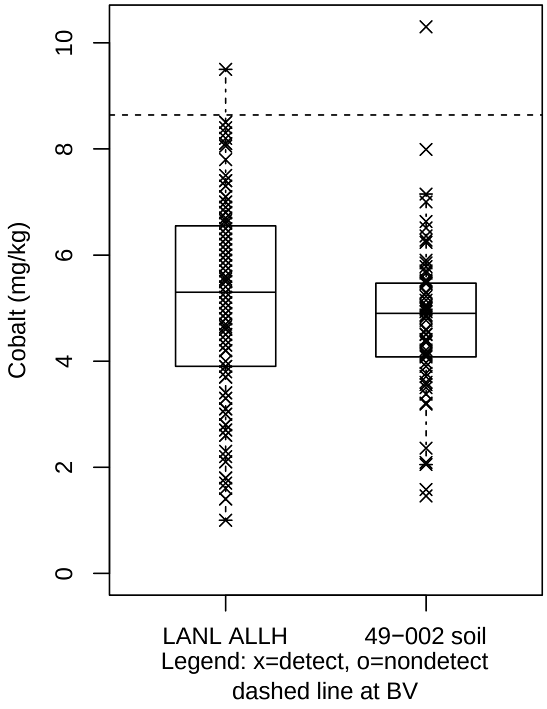


Figure H-2 **Box plot for cobalt in soil at AOC 49-002**

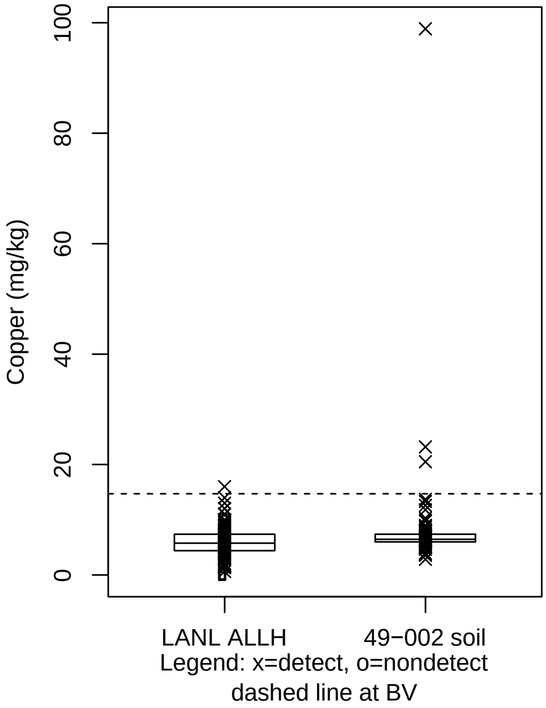


Figure H-3 **Box plot for copper in soil at AOC 49-002**

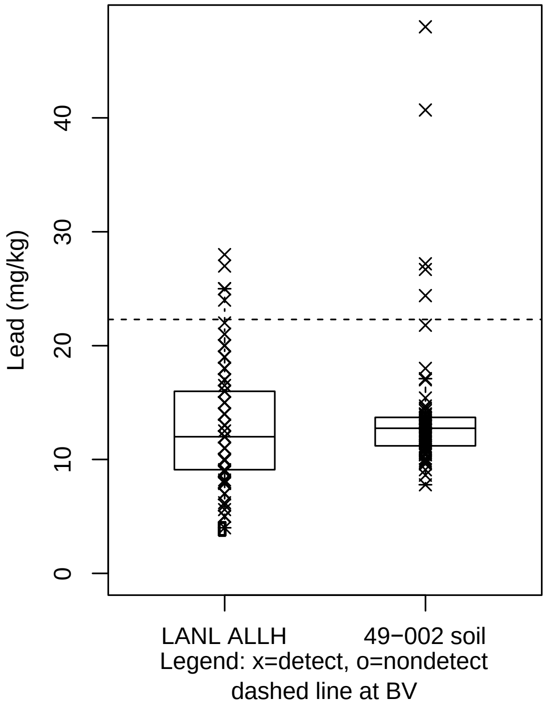


Figure H-4 **Box plot for lead in soil at AOC 49-002**

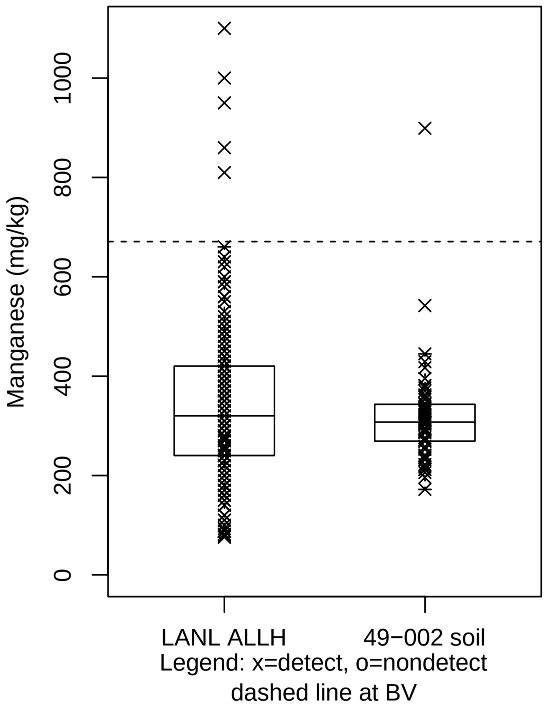


Figure H-5 **Box plot for manganese in soil at AOC 49-002**

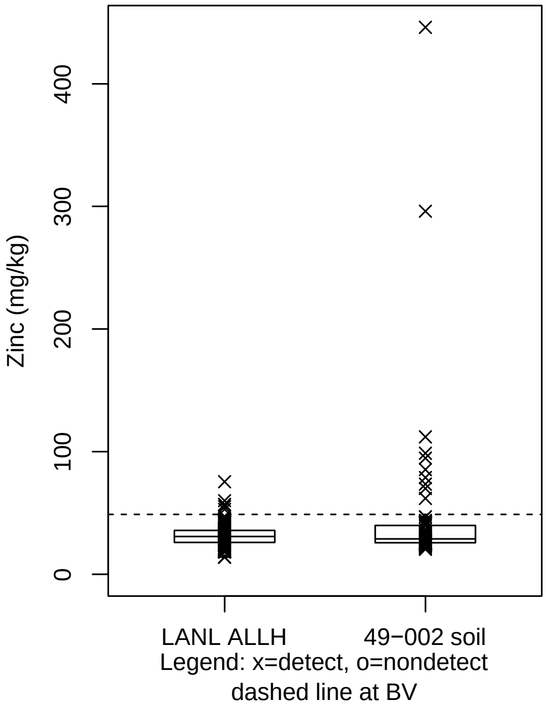


Figure H-6 **Box plot for zinc in soil at AOC 49-002**

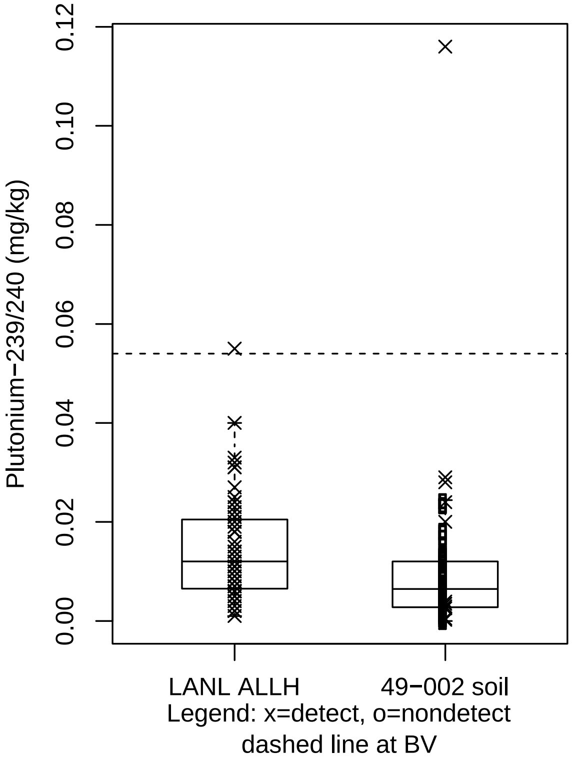


Figure H-7 Box plot for plutonium-239/240 in soil at AOC 49-002

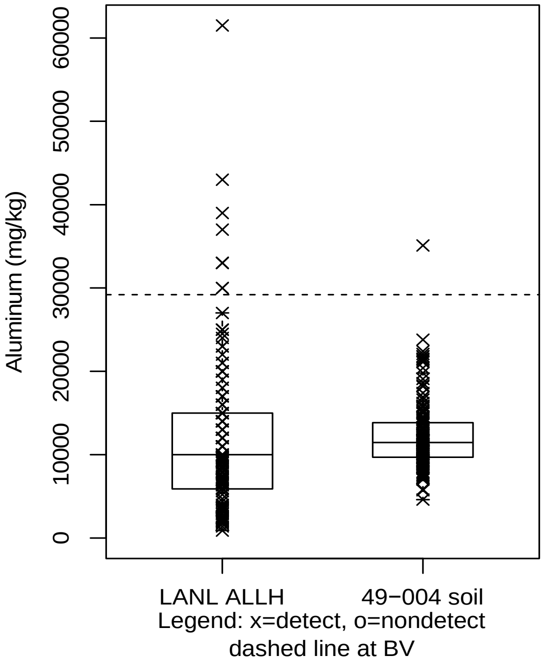


Figure H-8 Box plot for aluminum in soil at Solid Waste Management Unit (SWMU) 49-004

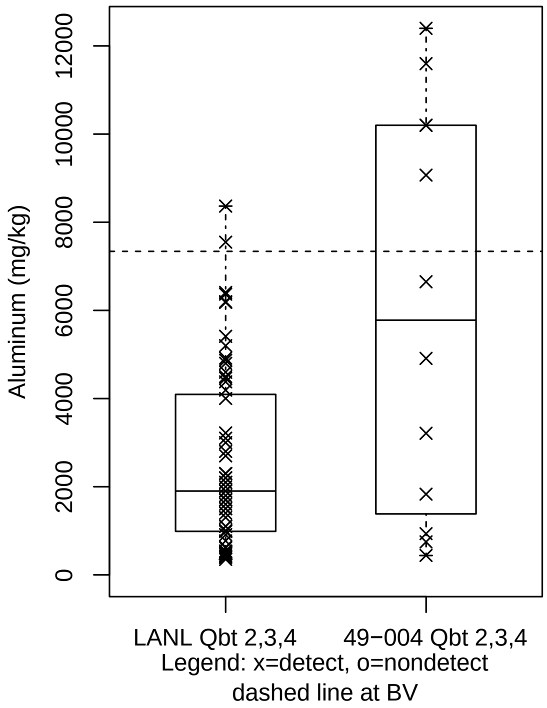


Figure H-9 Box plot for aluminum in tuff at SWMU 49-004

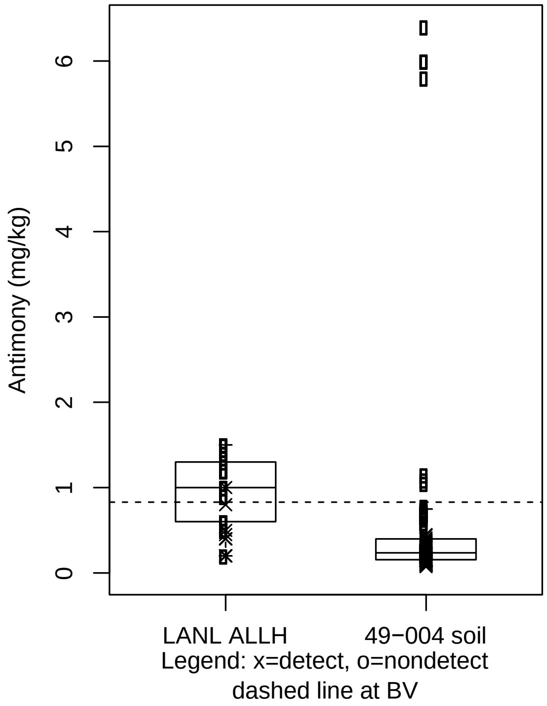


Figure H-10 Box plot for antimony in soil at SWMU 49-004

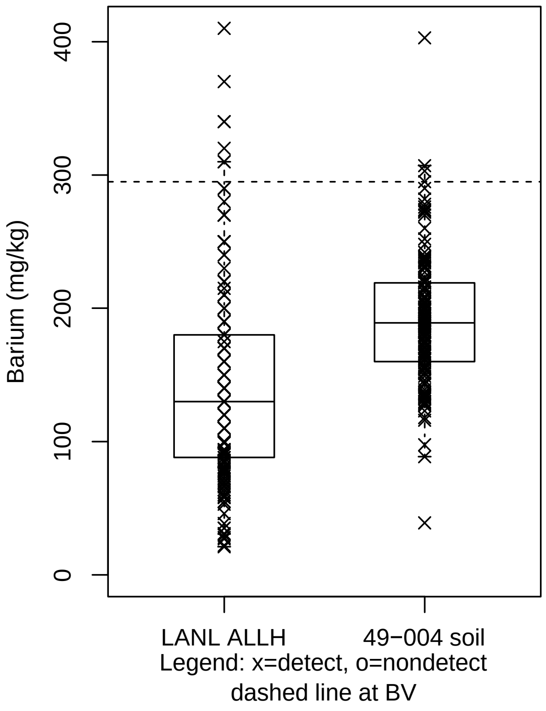


Figure H-11 Box plot for barium in soil at SWMU 49-004

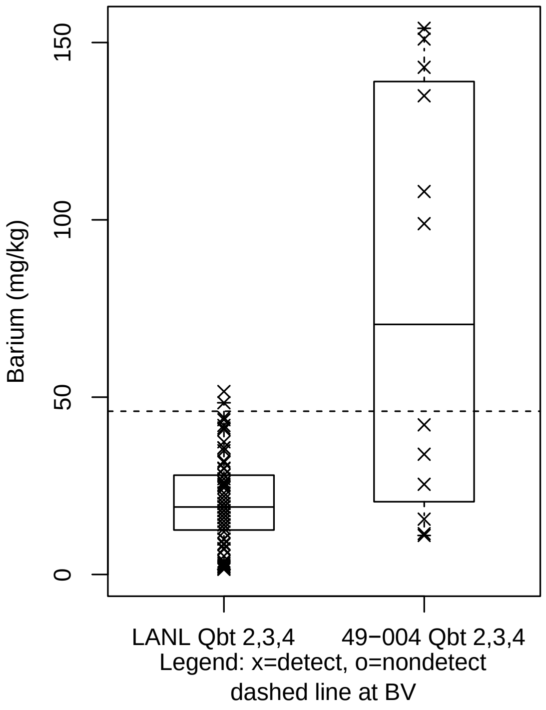


Figure H-12 Box plot for barium in tuff at SWMU 49-004

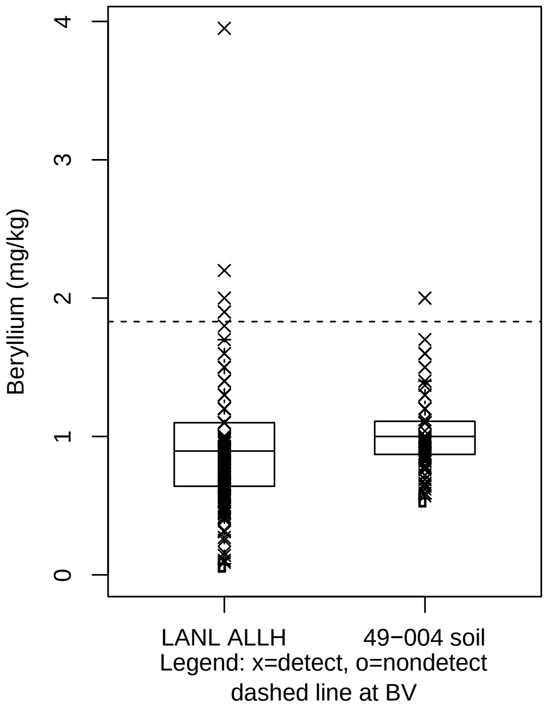


Figure H-13 Box plot for beryllium in soil at SWMU 49-004

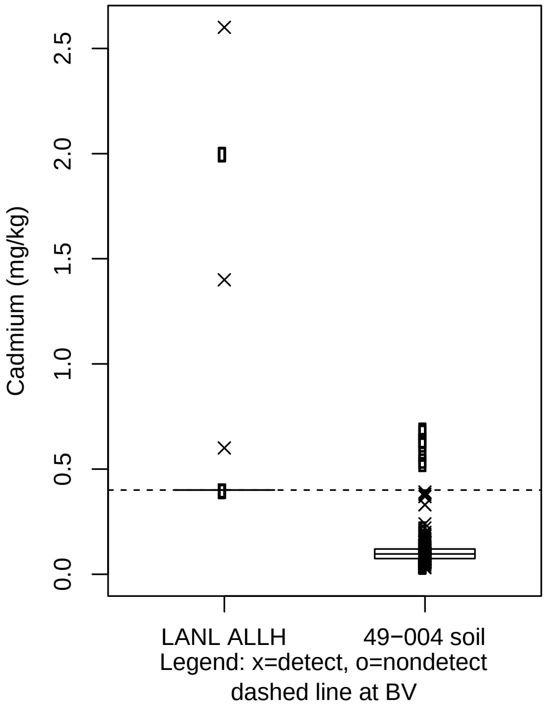


Figure H-14 Box plot for cadmium in soil at SWMU 49-004

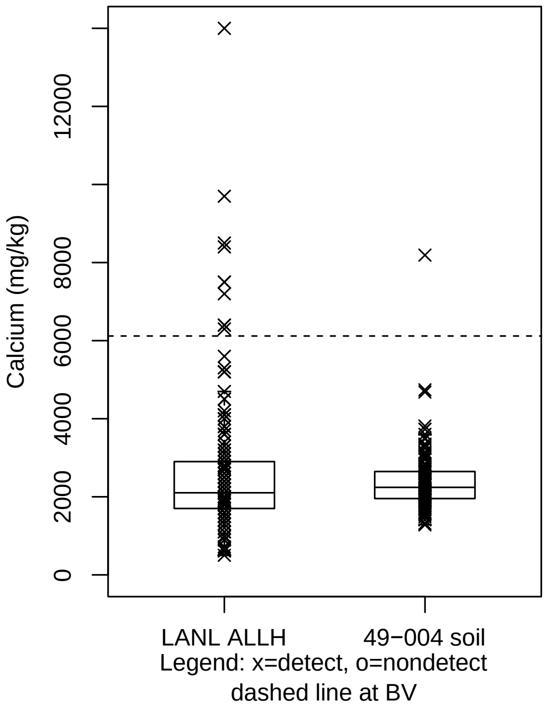


Figure H-15 Box plot for calcium in soil at SWMU 49-004

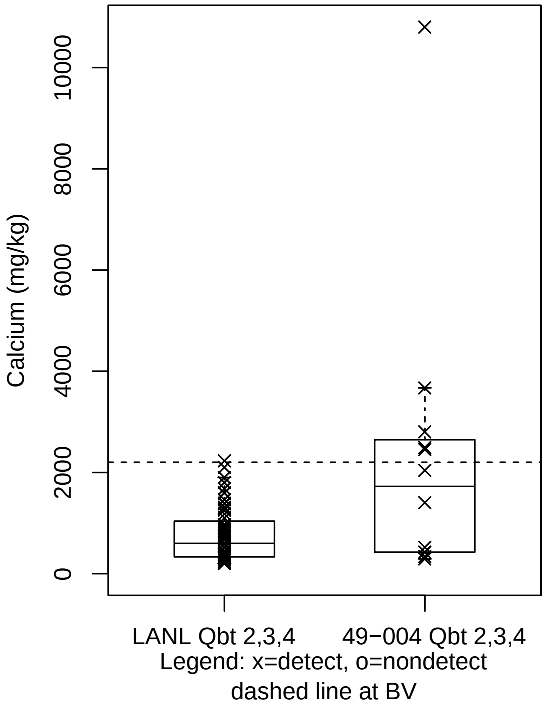


Figure H-16 Box plot for calcium in tuff at SWMU 49-004

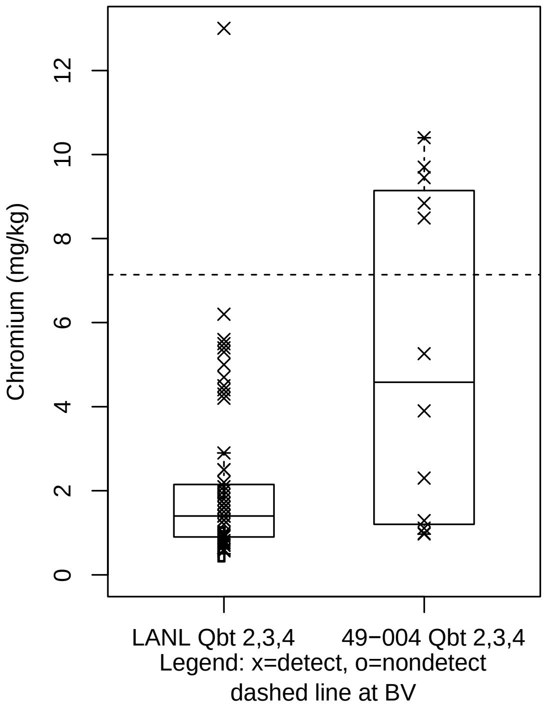


Figure H-17 Box plot for chromium in tuff at SWMU 49-004

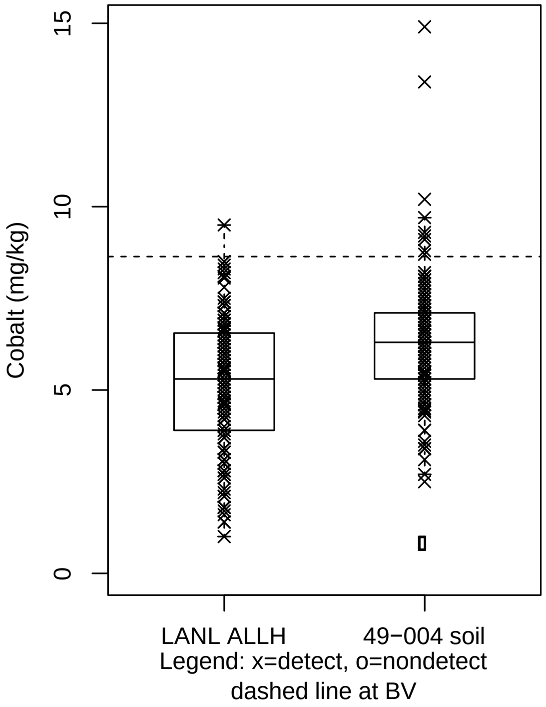


Figure H-18 Box plot for cobalt in soil at SWMU 49-004

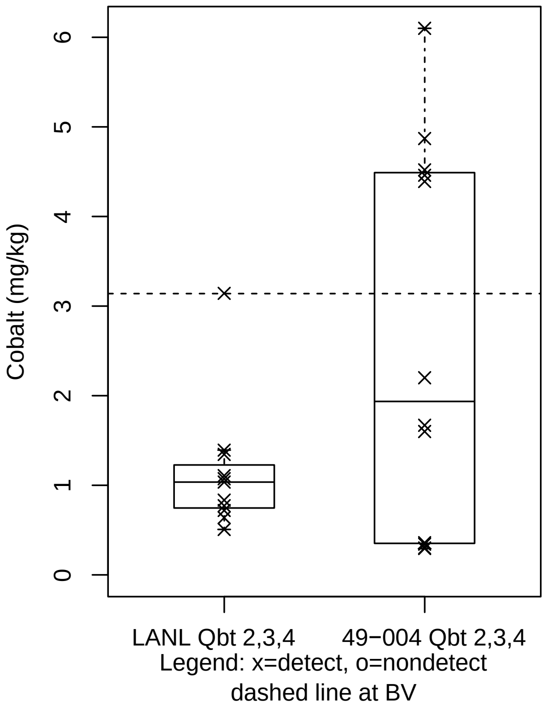


Figure H-19 Box plot for cobalt in tuff at SWMU 49-004

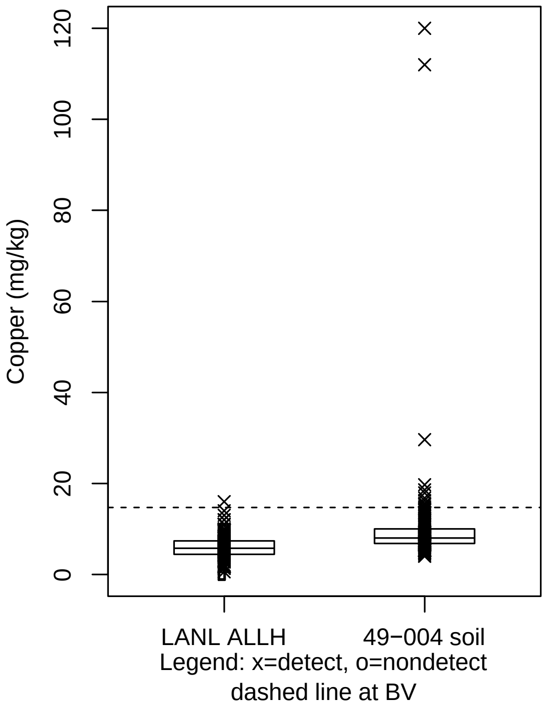


Figure H-20 Box plot for copper in soil at SWMU 49-004

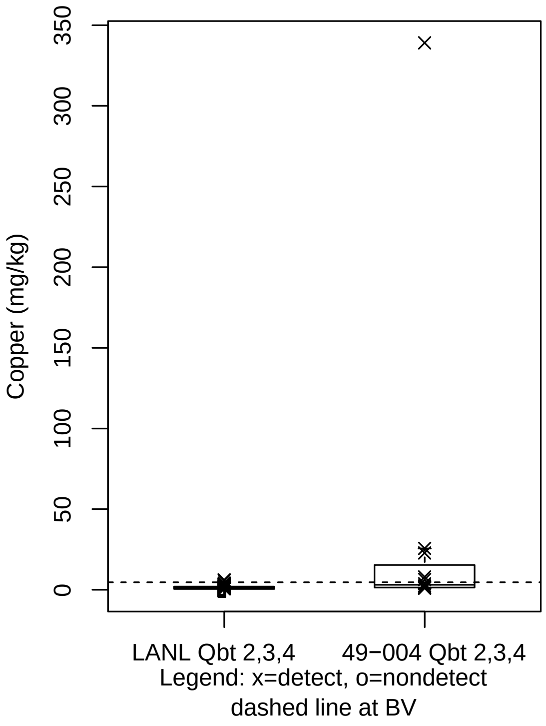


Figure H-21 Box plot for copper in tuff at SWMU 49-004

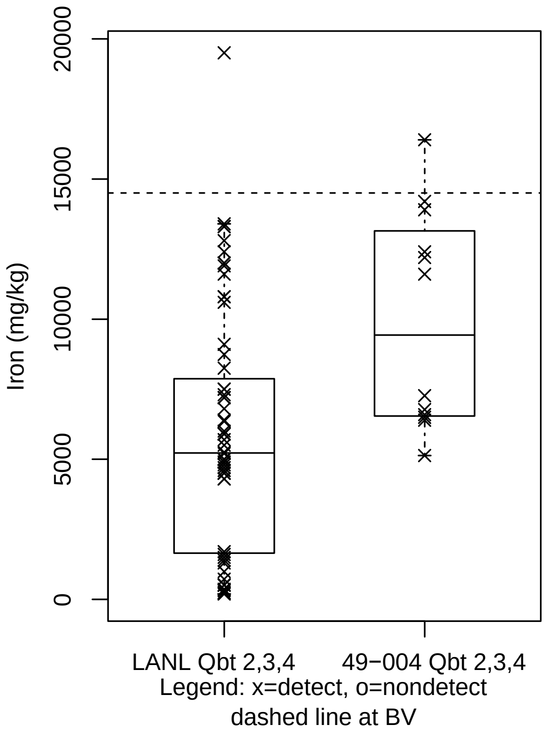


Figure H-22 Box plot for iron in tuff at SWMU 49-004

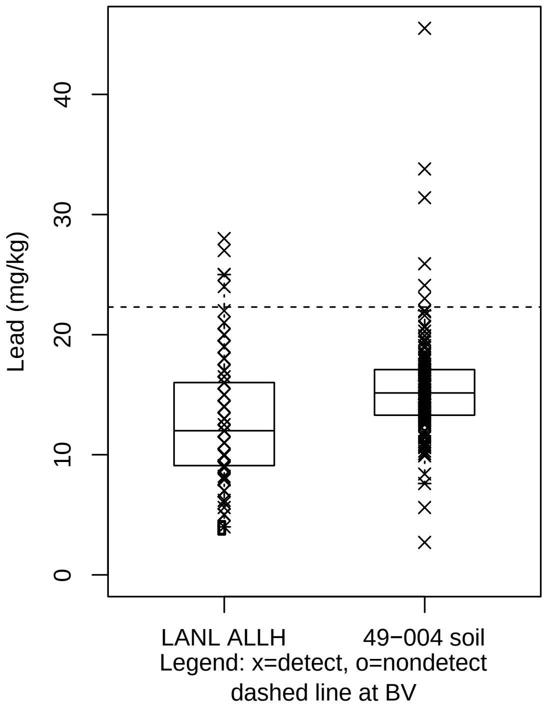


Figure H-23 Box plot for lead in soil at SWMU 49-004

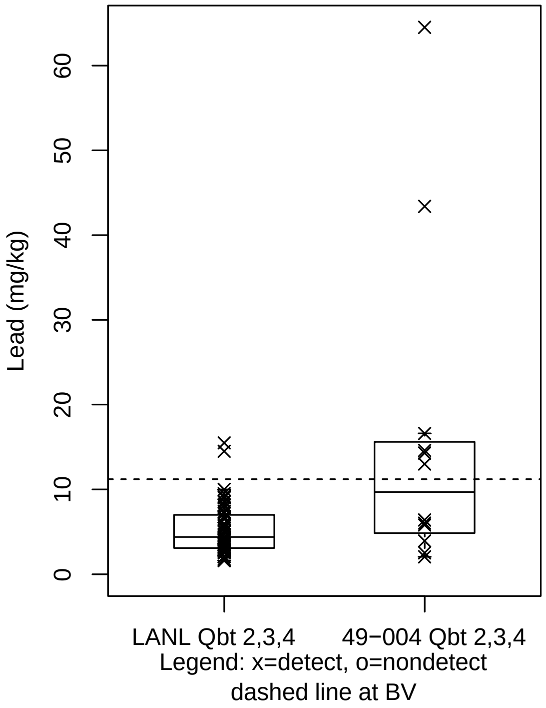


Figure H-24 Box plot for lead in tuff at SWMU 49-004

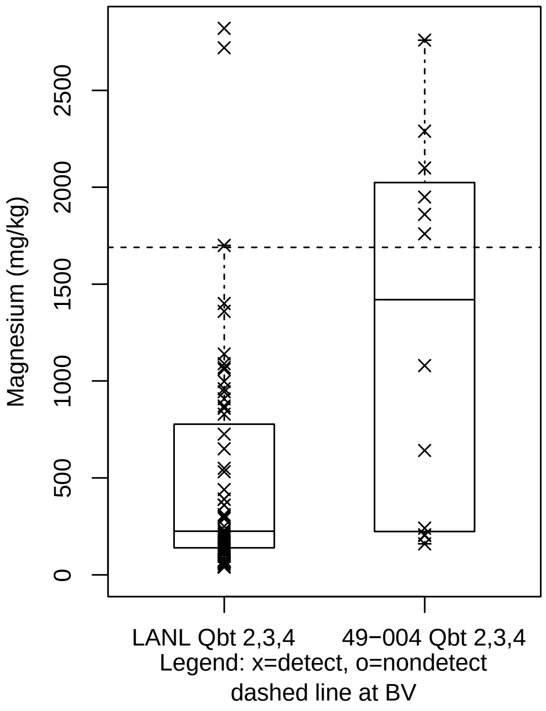


Figure H-25 **Box plot for magnesium in tuff at SWMU 49-004**

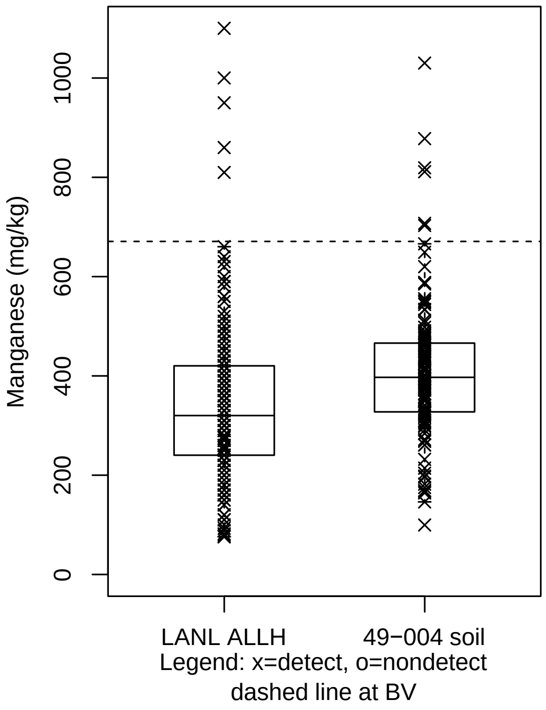


Figure H-26 **Box plot for manganese in soil at SWMU 49-004**

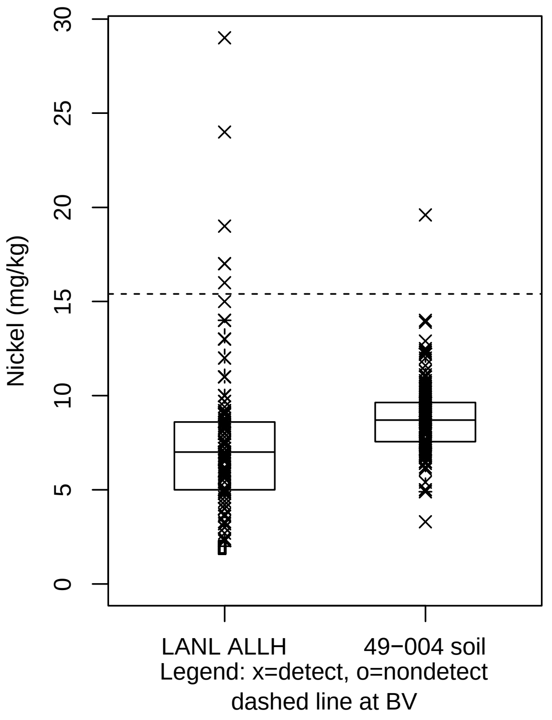


Figure H-27 **Box plot for nickel in soil at SWMU 49-004**

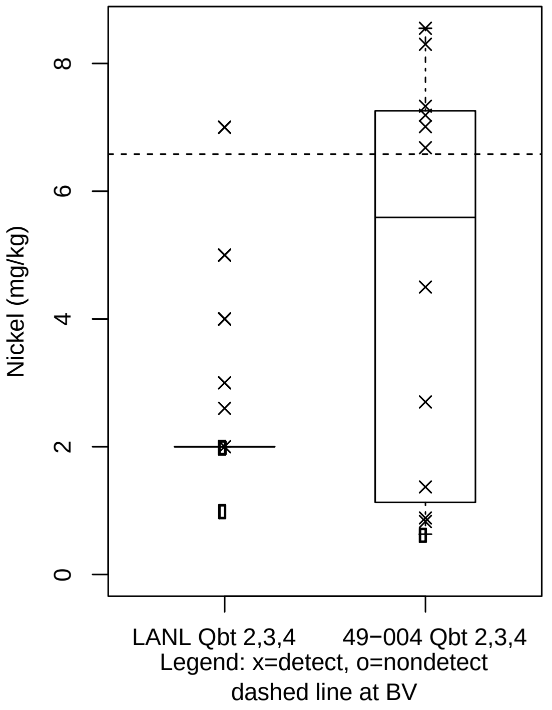


Figure H-28 **Box plot for nickel in tuff at SWMU 49-004**

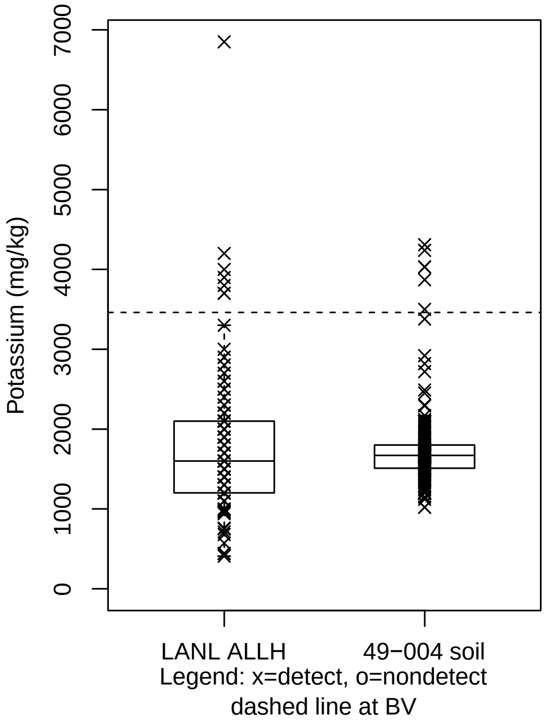


Figure H-29 **Box plot for potassium in soil at SWMU 49-004**

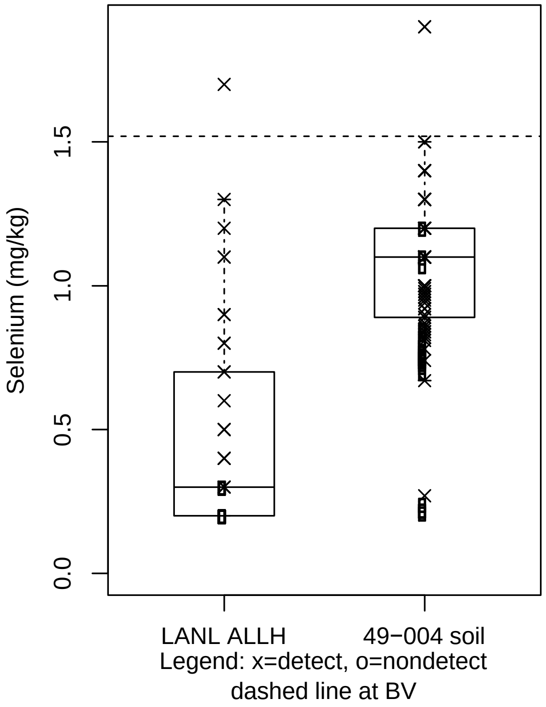


Figure H-30 **Box plot for selenium in soil at SWMU 49-004**

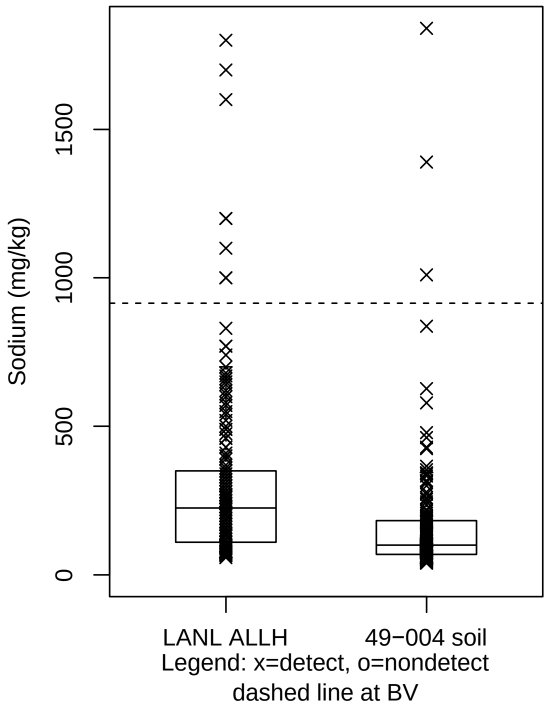


Figure H-31 **Box plot for sodium in soil at SWMU 49-004**

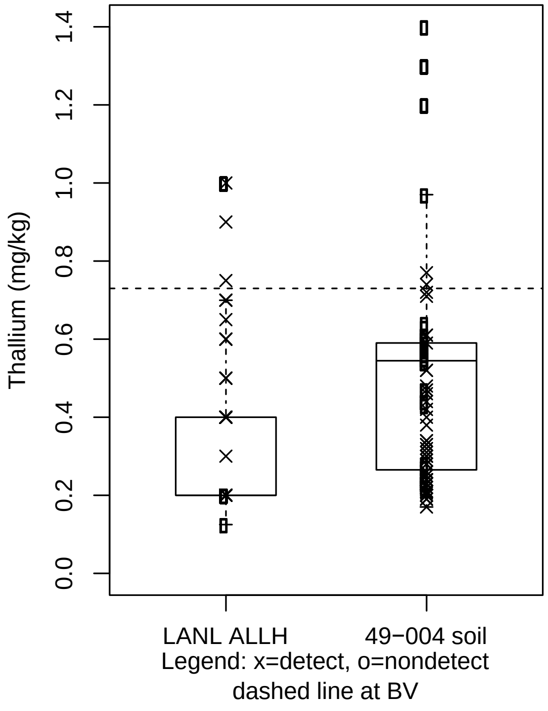


Figure H-32 **Box plot for thallium in soil at SWMU 49-004**

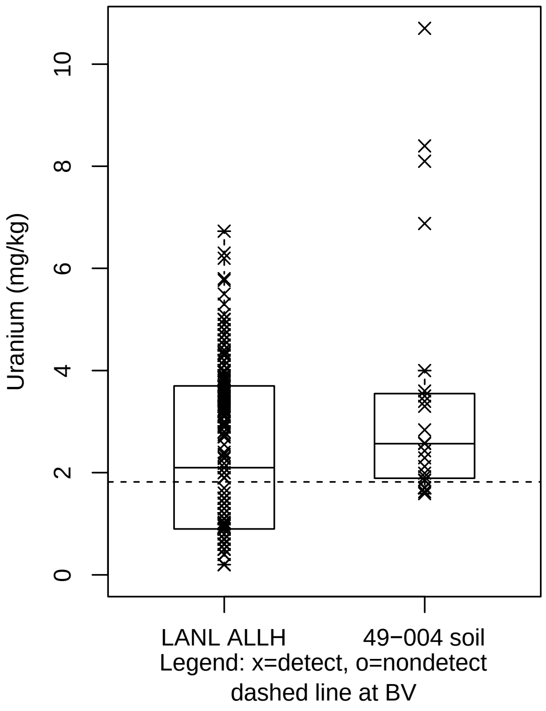


Figure H-33 **Box plot for uranium in soil at SWMU 49-004**

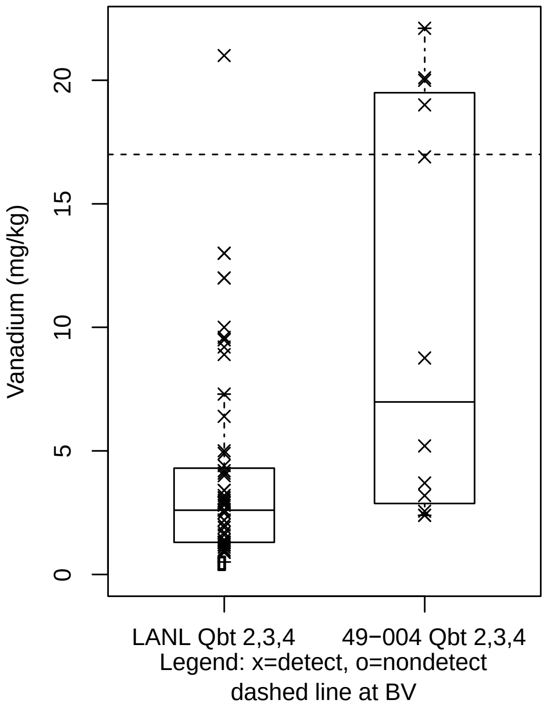


Figure H-34 **Box plot for vanadium in tuff at SWMU 49-004**

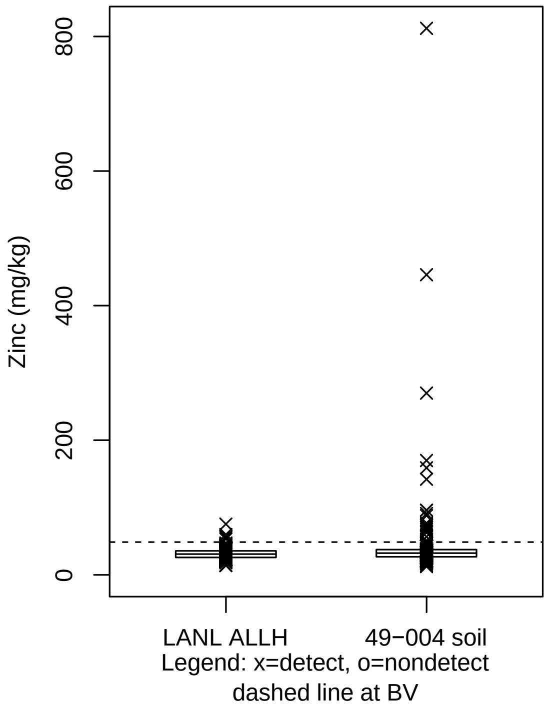


Figure H-35 Box plot for zinc in soil at SWMU 49-004

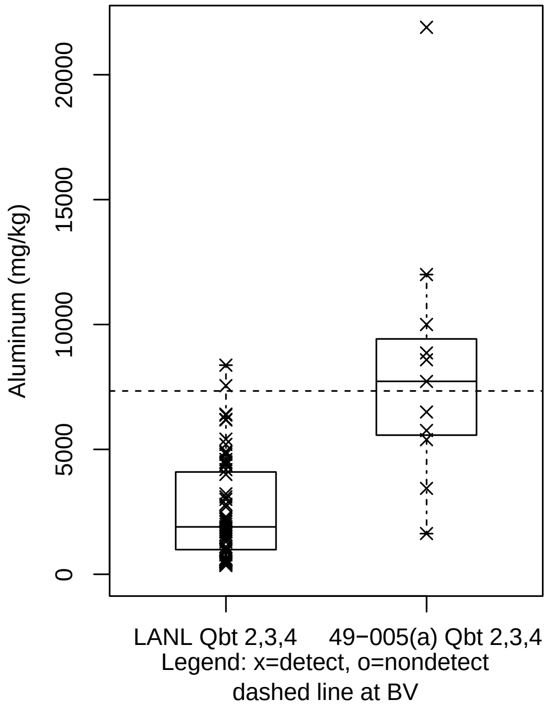


Figure H-36 Box plot for aluminum in tuff at SWMU 49-005(a)

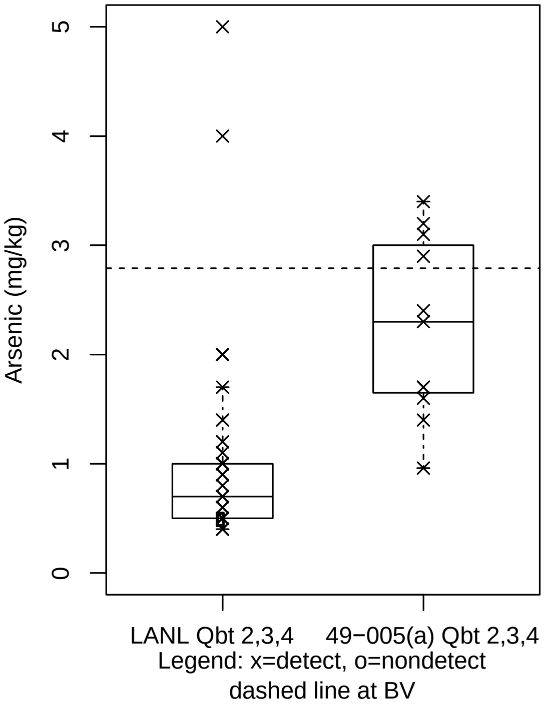


Figure H-37 Box plot for arsenic in tuff at SWMU 49-005(a)

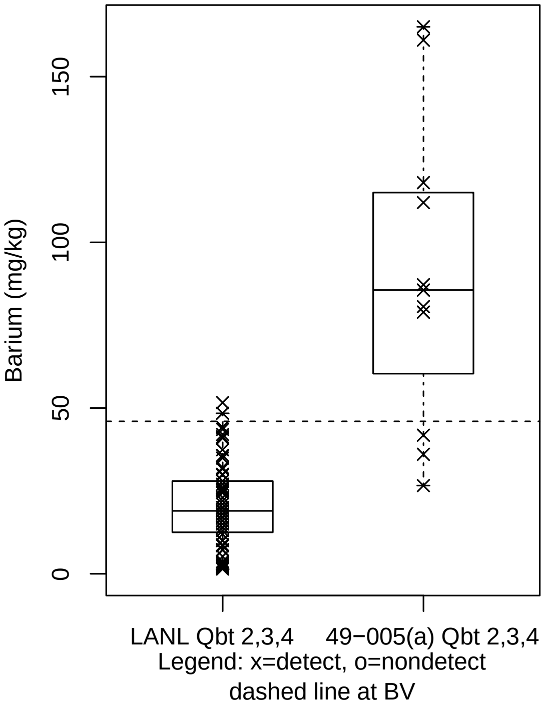


Figure H-38 Box plot for barium in tuff at SWMU 49-005(a)

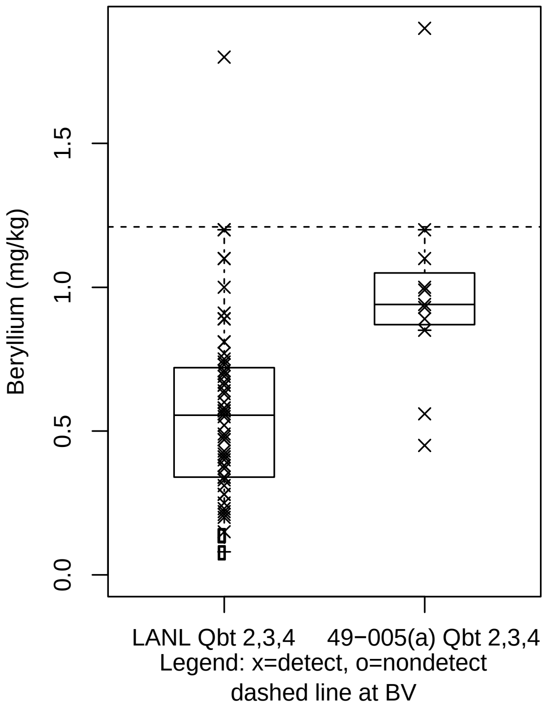


Figure H-39 Box plot for beryllium in tuff at SWMU 49-005(a)

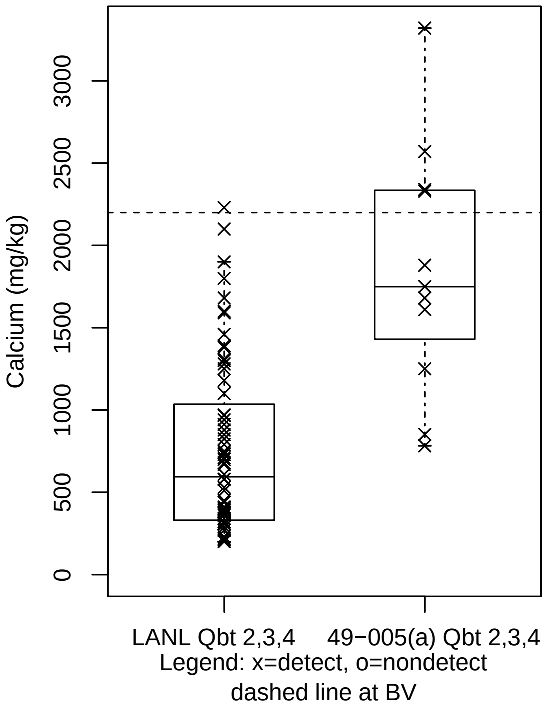


Figure H-40 Box plot for calcium in tuff at SWMU 49-005(a)

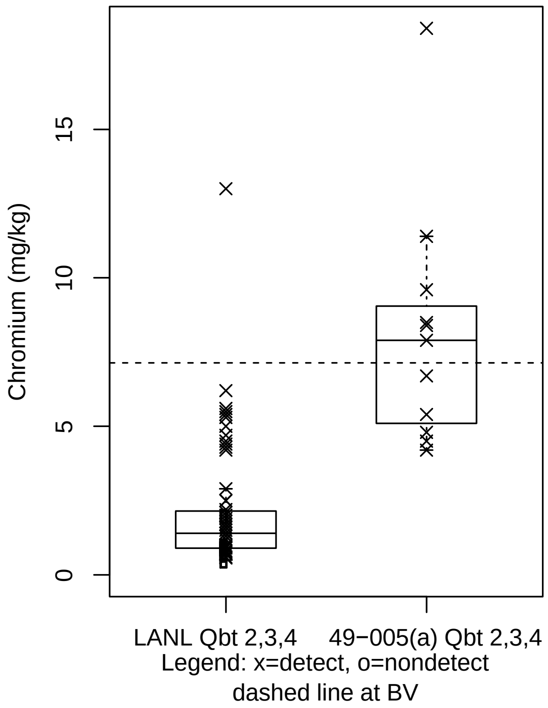


Figure H-41 Box plot for chromium in tuff at SWMU 49-005(a)

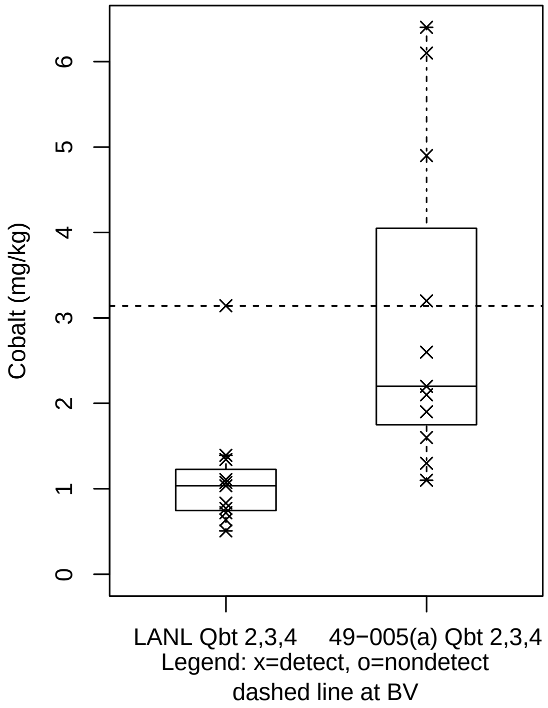


Figure H-42 Box plot for cobalt in tuff at SWMU 49-005(a)

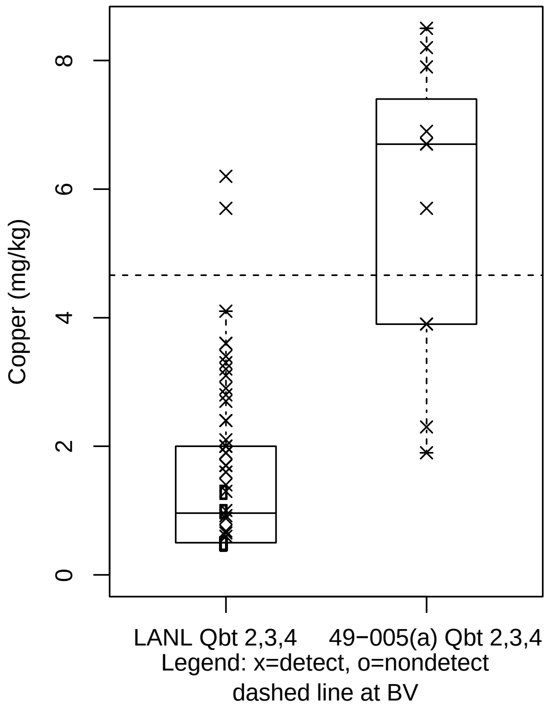


Figure H-43 **Box plot for copper in tuff at SWMU 49-005(a)**

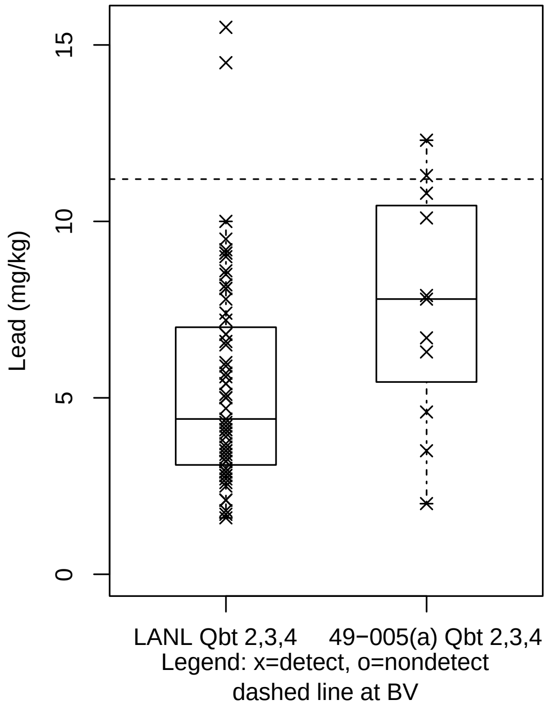


Figure H-44 **Box plot for lead in tuff at SWMU 49-005(a)**

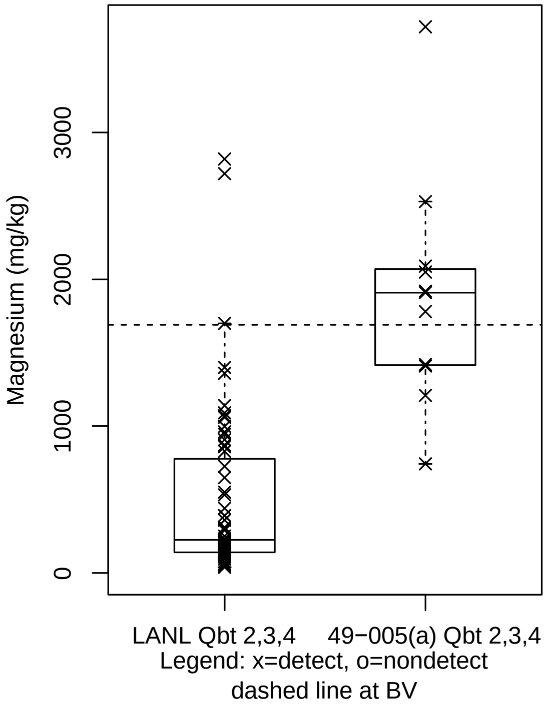


Figure H-45 **Box plot for magnesium in tuff at SWMU 49-005(a)**

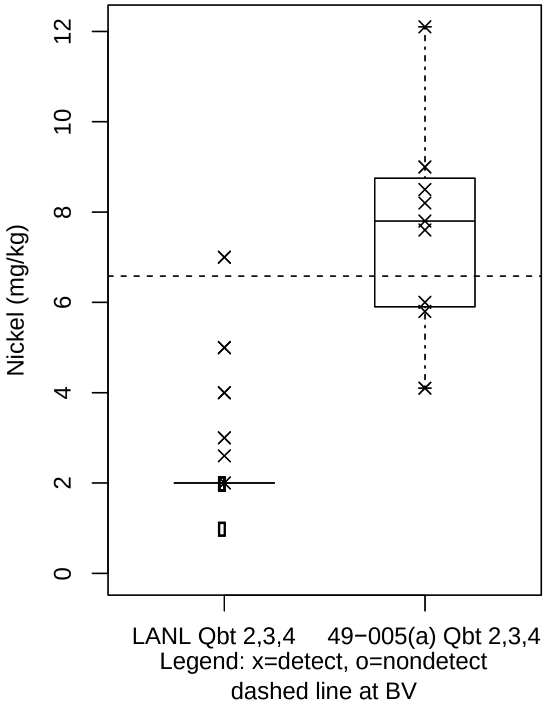


Figure H-46 **Box plot for nickel in tuff at SWMU 49-005(a)**

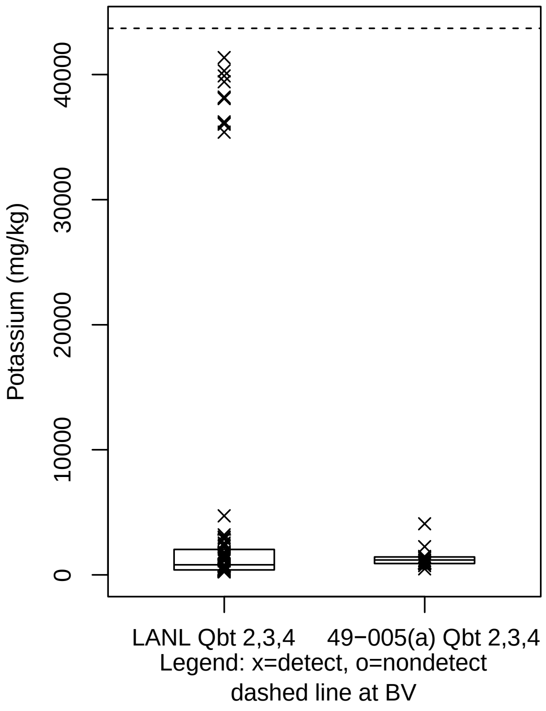


Figure H-47 **Box plot for potassium in tuff at SWMU 49-005(a)**

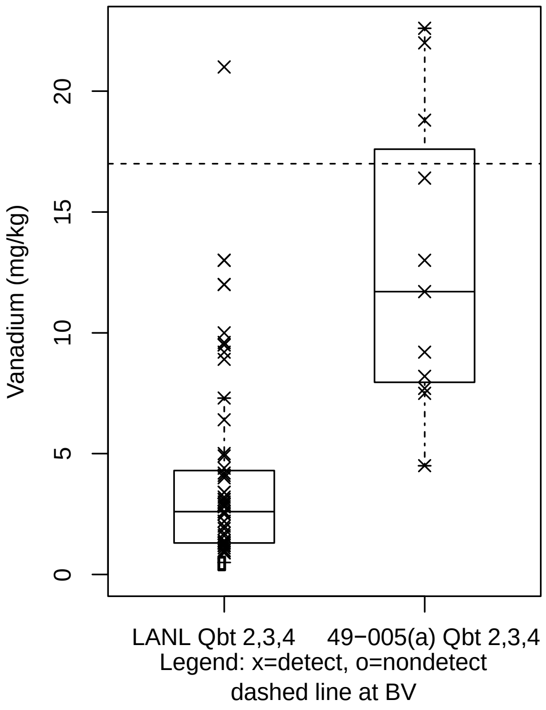


Figure H-48 **Box plot for vanadium in tuff at SWMU 49-005(a)**

Table H-1
Results for Statistical Tests for Inorganic Chemicals in Soil at AOC 49-002

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-Value	COPC?
Calcium	<0.001	0.14	1.00	No
Cobalt	0.98	1.00	n/a*	No
Copper	<0.001	0.43	0.023	Yes
Lead	0.22	0.97	n/a	No
Manganese	0.83	1.00	n/a	No
Zinc	0.40	0.065	n/a	No
Plutonium-239/240	n/a	1.00	0.56	No

*n/a = Not applicable.

Table H-2
Results for Statistical Tests for Inorganic Chemicals in Soil at SWMU 49-004

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-Value	COPC?
Aluminum	0.002	0.93	1.00	No
Antimony	n/a*	0.0021	1.00	Yes
Barium	<0.001	0.033	1.00	Yes
Beryllium	<0.001	0.44	1.00	No
Cadmium	n/a	0.055	1.00	No
Calcium	0.12	0.99	n/a	No
Cobalt	<0.001	0.0065	0.082	Yes
Copper	<0.001	<0.001	0.0020	Yes
Lead	<0.001	0.24	0.10	No
Manganese	<0.001	0.052	1.00	No
Mercury	n/a	0.0056	0.79	Yes
Nickel	<0.001	0.043	1.00	Yes
Potassium	0.14	1.00	n/a	No
Selenium	<0.001	0.015	0.63	Yes
Sodium	1.00	1.00	n/a	No
Thallium	n/a	1.00	1.00	No
Uranium	0.020	0.46	<0.001	Yes
Zinc	0.040	0.047	<0.001	Yes

*n/a = Not applicable.

Table H-3
Results for Statistical Tests for Inorganic Chemicals in Tuff at SWMU 49-004

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-Value	COPC?
Aluminum	0.011	0.011	<0.001	Yes
Barium	0.0016	0.0015	<0.001	Yes
Calcium	0.012	0.0013	<0.001	Yes
Chromium	0.0022	0.010	1.00	Yes
Cobalt	0.13	0.056	n/a*	No
Copper	<0.001	0.010	<0.001	Yes
Iron	<0.001	0.038	1.00	Yes
Lead	0.011	0.011	0.0033	Yes
Magnesium	<0.001	0.0013	1.00	Yes
Nickel	n/a	<0.001	<0.001	Yes
Vanadium	0.0016	0.053	0.16	No

*n/a = Not applicable.

Table H-4
Results for Statistical Tests for Inorganic Chemicals in Tuff at SWMU 49-005(a)

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-Value	COPC?
Aluminum	<0.001	<0.001	<0.001	Yes
Arsenic	<0.001	<0.001	1.00	Yes
Barium	<0.001	<0.001	<0.001	Yes
Beryllium	<0.001	<0.001	0.15	Yes
Calcium	<0.001	<0.001	<0.001	Yes
Chromium	<0.001	<0.001	0.15	Yes
Cobalt	<0.001	0.045	0.045	Yes
Copper	<0.001	<0.001	<0.001	Yes
Lead	0.016	0.12	1.00	No
Magnesium	<0.001	<0.001	0.15	Yes
Nickel	n/a*	<0.001	<0.001	Yes
Potassium	0.20	0.93	n/a	No
Vanadium	<0.001	0.0063	0.020	Yes

*n/a = Not applicable.

Appendix I

Risk Assessments

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Attachments

I-1.0 INTRODUCTION

This appendix presents the results of the human health and ecological risk-screening evaluations conducted in support of the environmental characterization of Technical Area 49 (TA-49) sites outside the nuclear environmental site (NES) boundary, located in the southern portion of Los Alamos National Laboratory (LANL or the Laboratory). The evaluations of potential risk at two solid waste management units (SWMUs) and one area of concern (AOC) are based on decision-level data from historical (1995) and 2009–2010 investigations.

I-2.0 BACKGROUND

Brief descriptions of the TA-49 SWMUs and AOC outside the NES boundary assessed for potential risks and doses are presented below.

I-2.1 Site Descriptions and Operational History

TA-49, also known as the Frijoles Mesa Site, occupies approximately 1280 acres along the south-central boundary of the Laboratory. The mesa is centrally located on the Pajarito Plateau at an average elevation of approximately 7140 ft above mean sea level. The plateau is roughly midway between the Jemez Mountains to the west and the White Rock Canyon of the Rio Grande to the east. TA-49 is located within the Ancho, North Ancho, and Water Canyon watersheds. The northern boundary of TA-49 is defined by the edge of the Frijoles Mesa, which overlooks Water Canyon, and forms the southern boundaries of TA-15 and TA-37. State highway NM 4 forms the southwest boundary of TA-49 as well as the Laboratory’s boundary. The southeast boundary of TA-49 is formed by TA-39.

Between 1959 and 1961, hydronuclear and related experiments took place at TA-49 that deposited plutonium, uranium, lead, and beryllium in underground shafts. These experiments were conducted in subsurface shafts located at Material Disposal Area (MDA) AB (Areas 2, 2A, and 2B) and Areas 1, 3, and 4. These areas are the subject of the “Investigation Work Plan for the TA-49 Sites Inside the Nuclear Environmental Site Boundary” (LANL 2008, 102691). Investigation results for TA-49 sites inside the NES boundary are presented in a separate supplemental investigation report (LANL 2016, 601561).

Facilities in Areas 5 and 10 were used to support the experiments at the test shaft areas. Uncontaminated materials generated at these facilities were deposited into a landfill in Area 6 West. Additionally, general site cleanups conducted in 1971 and 1984 resulted in the disposal of uncontaminated structure debris and materials into the Area 6 West landfill and the creation of small landfills at Areas 5 and 10 (LANL 1992, 007670, pp. 6-4–6-9).

I-2.1.1 AOC 49-002

AOC 49-002 is an underground experimental calibration chamber and two associated shafts located in Area 10. This site was used for calibration tests associated with hydronuclear experiments performed elsewhere at TA-49 in 1960 and 1961. Each shaft is approximately 6 ft to 7 ft wide × 64 ft deep. One is an elevator shaft used to transport personnel and equipment; an elevator building previously located over the elevator shaft has been removed. The other shaft is the calibration shaft. The shafts are connected at the bottom by a tunnel or gallery that is 4 ft wide × 7 ft high × 12 ft deep. The calibration room, which is 14 ft wide × 10 ft long, was lined with 8 in. of reinforced concrete faced with a 1-in. steel plate. The calibration shaft was used to place a portable pulse neutron source over calibration samples placed in the calibration room. A hydraulic lift platform at the bottom of the calibration room was connected to a hydraulic oil reservoir at the surface. Concrete radiation shields at the top of the calibration shaft are still in place. A concrete pad around the top of both shafts served as a foundation for the elevator building and shielding wall and is still in place.

The entrances to both shafts have been covered with concrete blocks. The elevator shaft is believed to still be open, while the calibration shaft was reportedly backfilled with soil and crushed tuff. Other surface features, including the hydraulic oil reservoir, have been removed. Small amounts (e.g., milligram quantities) of enriched uranium were occasionally released through spallation from critical assemblies during tests, although this material generally was cleaned up. Operation of the pulse neutron source may have activated surrounding soil and structures, but by now activation products have decayed to undetectable levels. The total volume of hydraulic oil in the lift system was estimated to be less than 100 gal. and is not believed to contain polychlorinated biphenyls. Use of the site after 1961 did not involve hazardous materials other than small radioactive sources used for radiochemical counting (LANL 1992, 007670, pp. 6.5-1–6.5-6).

I-2.1.2 SWMU 49-004

SWMU 49-004 is a landfill in Area 6 West used from 1959 to 1961 for open-pit burning of combustible construction materials and for the burial of uncontaminated residues generated from other areas at TA-49 (Purtymun and Stoker 1987, 006688). Wastes disposed of at this site were reportedly screened for radioactivity before burial (LANL 1992, 007670, p. 6.3-6). No documentation exists concerning disposal of hazardous chemicals, but this is unlikely based on the nature of activities conducted at TA-49. During the 1971 cleanup of TA-49, the landfill was reopened for disposal of uncontaminated materials, principally from Area 11. Similarly, the site was reopened during the 1984 general cleanup of TA-49 when a trench measuring 30 ft wide × 100 ft long × 15 ft deep was excavated at the site for the disposal of uncontaminated solid materials (LANL 1992, 007670, p. 6.3-7).

The RFI work plan (LANL 1992, 007670) describes four open trenches located west of SWMU 49-004, although not part of SWMU 49-004. The work plan also indicates that these previously undocumented trenches were identified from a review of historical aerial photographs. The trenches were not present in photographs taken in 1935 but were present in photographs taken in 1954, 1965, and 1977. Construction of these trenches, therefore, appears to predate activities at TA-49. The trenches were examined during a 1991 field inspection and noted to be approximately 10 ft wide × 6 ft deep × 100 ft long. One trench appeared to have been backfilled, and one passed through a prehistoric ruin. No evidence of debris was present in or around the trenches. The work plan also noted that interviews and archival searches did not identify additional information concerning these trenches (LANL 1992, 007670, pp. 6.3-11–6.3-12). The possibility that the trenches were utilized by the Laboratory for material disposal or other purposes cannot be categorically excluded (LANL 1997, 056594, p. 52).

In 2009, the Laboratory Cultural Resources Team evaluated the possible origin and nature of the four open trenches located west of SWMU 49-004 and concluded that two of the trenches (Trenches B and C) are directly associated with visible ancestral pueblo masonry room blocks sites (LA 15861 and LA 15866A, respectively) and were purposely placed to gain information and/or artifacts from the trench excavations. The Laboratory Cultural Resources Team memorandum, included in Appendix J of this supplemental investigation report, states that Trenches A and D could have also been used to explore ancestral field house structures; however, this does not preclude the possibility that one of these two trenches (Trench D), was later used for disposal of debris from TA-49.

I-2.1.3 SWMU 49-005(a)

SWMU 49-005(a) is an inactive landfill located within Area 10. The landfill, described as a small pit, was constructed north of the road that runs east from Area 10 and is approximately 50 to 100 ft northeast of the Area 10 experimental chamber and shafts (AOC 49-002). SWMU 49-005(a) was constructed in 1984 as a disposal area for nonradiologically contaminated debris generated during the 1984 general surface cleanup of TA-49 (LANL 1997, 056594, p. 25).

I-2.2 Investigation Sampling

The final data set used to identify chemicals of potential concern (COPCs) for the TA-49 sites outside the NES boundary and used in this appendix to evaluate the potential risks to human health and the environment are the qualified analytical results from historical sampling activities (1995–1998) and the 2009–2010 investigation. Only those data determined to be of decision-level quality following the data quality assessment (Appendix F) are included in the final data set evaluated in this appendix.

I-2.3 Determination of COPCs

Section 5.0 of the supplemental investigation report summarizes the COPC selection process. Only COPCs detected above background (inorganic chemicals and naturally occurring radionuclides), with detection limits greater than background values (BVs) (inorganic chemicals), and detected (organic chemicals, inorganic chemicals with no BVs, and fallout radionuclides were retained. The industrial scenario and the ecological screening used data for samples collected from 0.0 to 1.0 ft and 0.0 to 5.0 ft below ground surface (bgs), respectively. The residential and construction worker scenarios used data for samples collected from 0.0 to 10.0 ft bgs. However, sampling depths often overlapped because of multiple investigations; therefore, samples with a starting depth less than the lower bound of the interval were included in the risk-screening assessments for a given scenario, as appropriate.

Tables I-2.3-1 to I-2.3-7 summarize the COPCs evaluated for potential risk for each of the TA-49 sites outside the NES boundary. Some of the COPCs identified in this report may not be evaluated for potential risk under one or more scenarios because they were not within the specified depth intervals associated with a given scenario.

I-3.0 CONCEPTUAL SITE MODEL

The primary mechanisms of release related to historical contaminant sources are described in detail in historical investigation report (HIR) for the TA-49 sites outside the NES boundary (LANL 2007, 098492) and summarized in section 2.0 of the approved investigation work plans (LANL 2008, 102215; NMED 2008, 100465; LANL 2011, 201570; NMED 2011, 204345). Releases from TA-49 sites outside the NES boundary may have occurred as a result of air emissions, surface releases, subsurface leaks, or waste disposal. Previous sampling results indicated contamination from inorganic chemicals, organic chemicals, and radionuclides (LANL 2010, 110654.16; NMED 2010, 110859).

I-3.1 Receptors and Exposure Pathways

The primary exposure pathway for human receptors is surface soil and subsurface soil/tuff that may be brought to the surface through intrusive activities. Migration of contamination to groundwater through the vadose zone is unlikely given the depth to groundwater (greater than 1000 ft bgs). Human receptors may be exposed through direct contact with soil or suspended particulates by ingestion, inhalation, dermal contact, and external irradiation pathways. Direct contact exposure pathways from subsurface contamination to human receptors are complete for the resident and the construction worker, where appropriate. Migration of contamination to groundwater through the vadose zone is unlikely given the depth to groundwater (greater than 1000 ft bgs) at the site. The exposure pathways are the same as those for surface soil. Sources, exposure pathways, and receptors are shown in the conceptual site model (CSM) (Figure I-3.1-1).

New Mexico Environment Department (NMED) guidance (NMED 2015, 600915) requires that sites larger than two acres be evaluated to determine if beef ingestion is a plausible and complete exposure pathway. One of the TA-49 sites outside the NES boundary [SWMU 49-005(a)] is smaller than 2 acres, and the other two sites (AOC 49-002 and SWMU 49-004) are larger than 2 acres. However, grazing is not allowed on Laboratory property. Therefore, further evaluation of the beef ingestion pathway is not necessary.

The TA-49 sites outside the NES boundary are former industrial areas on Laboratory property. Structures have been removed and the sites are currently inactive. Currently, they provide habitat for ecological receptors. Weathering of tuff is the only viable natural process that may result in the exposure of receptors to COPCs in tuff. However, because of the slow rate of weathering expected for tuff, exposure to COPCs in tuff is negligible, although it is included in the assessments. Exposure pathways to subsurface contamination below 5.0 ft (ecological) or 10.0 ft (human health) are not complete unless contaminated soil or tuff were excavated and brought to the surface.

Considering unpaved sites or areas where potential habitat is present, exposure pathways are complete to surface soil and tuff for ecological receptors. The potential pathways are root uptake by plants, inhalation of vapors (burrowing animals only), inhalation of dust, dermal contact, incidental ingestion of soil, external irradiation, and food web transport. Pathways from subsurface releases may be complete for plants. Surface water exposure was not evaluated because of the lack of surface water features. Sources, exposure pathways, and receptors are presented in the CSM (Figure I-3.1-1).

I-3.2 Environmental Fate and Transport

The evaluation of environmental fate addresses the chemical processes affecting the persistence of chemicals in the environment, and the evaluation of transport addresses the physical processes affecting mobility along a migration pathway. Migration into soil and tuff depends on precipitation or snowmelt, soil moisture content, depth of soil, soil hydraulic properties, and properties of the COPCs. Migration into and through tuff also depends on the unsaturated flow properties of the tuff and the presence of joints and fractures.

The most important factor with respect to the potential for COPCs to migrate to groundwater is the presence of saturated conditions. Downward migration in the vadose zone is also limited by a lack of hydrostatic pressure as well as the lack of a source for the continued release of contamination. Without sufficient moisture and a source, little or no potential migration of materials through the vadose zone to groundwater occurs.

Contamination at depth is addressed in the discussion of nature and extent in the supplemental investigation report. Results from the deepest samples collected at most sites showed either no detected concentrations of COPCs or low- to trace-level concentrations of only a few inorganic, radionuclide, and/or organic COPCs in tuff. The limited extent of contamination is related to the absence of the key factors that facilitate migration, as discussed above. Given how long the contamination has been present in the subsurface, the physical and chemicals properties of the COPCs, and the lack of saturated conditions, the potential for contaminant migration to groundwater is very low.

NMED guidance (NMED 2015, 600915) contains screening levels that consider the potential for contaminants in soil to result in groundwater contamination. These screening levels consider equilibrium partitioning of contaminants among solid, aqueous, and vapor phases and account for dilution and attenuation in groundwater through the use of dilution attenuation factors (DAFs). These DAF soil screening levels (SSLs) may be used to identify chemical concentrations in soil that have the potential to contaminate groundwater (EPA 1996, 059902). Screening contaminant concentrations in soil against these DAF SSLs does not, however, provide an indication of the potential for contaminants to migrate to groundwater. The assumptions used in the development of these DAF SSLs include an assumption of uniform contaminant concentrations from the contaminant source to the water table (i.e., it is assumed that migration to groundwater has already occurred). Furthermore, this assumption is inappropriate for cases such as these TA-49 sites outside the NES boundary where sampling has shown that contamination is vertically bounded near the surface and the distance from the surface to the water table is large. For these reasons, screening of contaminant concentrations in soil against the DAF SSLs was not performed.

The relevant release and transport processes of the COPCs are a function of chemical-specific properties that include the relationship between the physical form of the constituents and the nature of the constituent transport processes in the environment. Specific properties include the degree of saturation and the potential for ion exchange (barium and other inorganic chemicals) or sorption and the potential for natural bioremediation. The transport of volatile organic compounds (VOCs) occurs primarily in the vapor phase by diffusion or advection in subsurface air.

Current potential transport mechanisms that may lead to exposure include

- dissolution and/or particulate transport of surface contaminants during precipitation and runoff events,
- airborne transport of contaminated surface soil,
- continued dissolution and advective/dispersive transport of chemical contaminants contained in subsurface soil and tuff as a result of past operations,
- disturbance of contaminants in shallow soil and subsurface tuff by Laboratory operations, and
- disturbance and uptake of contaminants in shallow soil by plants and animals.

Contaminant distributions at the sites indicate that after the initial deposition of contaminants from operational activities and historical remediation efforts, elevated levels of COPCs tend to remain concentrated in the vicinity of the original release points. The primary potential release and transport mechanisms identified for TA-49 sites outside the NES boundary include direct discharge; precipitation, sorption, and mechanical transport; dissolution and advective transport in water; and volatilization, diffusion, and dispersion. Less significant transport mechanisms include wind entrainment and, given the asphalt pavement covering most sites, dispersal of surface soil and uptake of contaminants from soil and water by biota.

Gas or vapor-phase contaminants such as VOCs are likely to volatilize to the atmosphere from near-surface soil and sediment and/or migrate by diffusion through air-filled pores in the vadose zone. Migration of vapor-phase contaminants from tuff into ambient air may occur by diffusion or advection driven by barometric pressure changes.

I-3.2.1 Inorganic Chemicals

In general, and particularly in a semiarid climate, inorganic chemicals are not highly soluble or mobile in the environment, although there are exceptions. The physical and chemical factors that determine the distribution of inorganic COPCs within the soil and tuff at TA-49 sites outside the NES boundary are the soil-water partition coefficient (K_d) of the inorganic chemicals, the pH of the soil, soil characteristics (such as sand or clay content), and the redox potential (Eh). The interaction of these factors is complex, but the K_d values provide a general assessment of the potential for migration through the subsurface; chemicals with higher K_d values are less likely to be mobile than those with lower ones. Chemicals with K_d values greater than 40 are very unlikely to migrate through soil towards the water table (Kincaid et al. 1998, 093270). Table I-3.2-1 presents the K_d values and water solubility for the inorganic COPCs for the TA-49 sites outside the NES boundary. Based on this criterion, the following COPCs have a low potential to mobilize and migrate through soil and the vadose zone: aluminum, antimony, barium, beryllium, cadmium, chromium, cobalt, lead, mercury, nickel, thallium, vanadium, and zinc. The K_d values for arsenic, copper, iron, perchlorate, selenium, and uranium are less than 40 and may indicate a greater potential to mobilize and migrate through soil and the vadose zone beneath the sites.

It is important to note that other factors besides the K_d values (e.g., speciation in soil, oxidation-reduction potential, pH, and soil mineralogy) also play significant roles in the likelihood that inorganic chemicals will migrate. The COPCs with K_d values less than 40 are discussed further below. Information about the fate and transport properties of inorganic chemicals was obtained from individual chemical profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR) (ATSDR 1997, 056531, and http://www.atsdr.cdc.gov/toxpro2).

Arsenic may undergo a variety of reactions, including oxidation-reduction reactions, ligand exchange, precipitation, and biotransformation. Arsenic forms insoluble complexes with iron, aluminum, and magnesium oxides found in soil, and in this form arsenic is relatively immobile. However, under low pH and reducing conditions, arsenic can become soluble and may potentially leach into groundwater or result in runoff of arsenic into surface waters. Arsenic is expected to have low mobility under the environmental conditions (neutral to slightly alkaline soil pH and oxidizing near-surface conditions) present at the TA-49 sites outside the NES boundary.

Copper movement in soil is determined by physical and chemical interactions with the soil components. Most copper deposited in soil will be strongly adsorbed and remains in the upper few centimeters of soil. Copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron, and manganese oxides. In most temperate soil, pH, organic matter, and ionic strength of the soil solutions are the key factors affecting adsorption. Soil pH in the area is neutral to slightly alkaline, so the leaching of copper is not a concern at this site. Copper binds to soil much more strongly than other divalent cations, and the distribution of copper in the soil solution is less affected by pH than other metals. Copper is expected to be bound to the soil and move in the system by way of transport of soil particles by water as opposed to movement as dissolved species.

Cyanide tends to adsorb onto various natural media, including clay and sediment; however, sorption is insignificant relative to the potential for cyanide to volatilize and/or biodegrade. At soil surfaces, volatilization of hydrogen cyanide is a significant mechanism for cyanide loss. Cyanide at low concentrations in subsurface soil is likely to biodegrade under both aerobic and anaerobic conditions. Cyanide is present at the site in trace to low levels and is not expected to be mobile.

Iron is naturally occurring in soil and tuff and may be relatively mobile under reducing conditions. Iron is sensitive to soil pH conditions, occurring in two oxidation states, iron(III), the insoluble oxidized form, and iron(II), the reduced soluble form. Most iron in well-drained neutral-to-alkaline soil is present as precipitates of iron(III) hydroxides and oxides. With time, these precipitates are mineralized and form various iron minerals, such as lepidcrocite, hematite, and goethite. Iron is not expected to be mobile in the neutral to slightly alkaline, well-drained soil at the TA-49 sites outside the NES boundary.

Perchlorate is somewhat soluble in water and may migrate with water molecules in saturated soil. As noted above, the subsurface material beneath the sites has low moisture content, which inhibits the mobility of nitrate and perchlorate as well as most other inorganic chemicals.

Selenium is not often found in the environment in its elemental form but is usually combined with sulfide minerals or with silver, copper, lead, and nickel minerals. In soil, pH and Eh are determining factors in the transport and partitioning of selenium. In soil with a pH of greater than 7.5, selenates, which have high solubility and a low tendency to adsorb onto soil particles, are the major selenium species and are very mobile. The soil pH at the TA-49 sites outside the NES boundary is neutral to slightly alkaline, indicating that selenium is not likely to migrate.

Uranium is a natural and commonly occurring radioactive element that is present in nearly all rock and soil. The mobility of uranium in soil and its vertical transport to groundwater depend on properties of the soil such as pH, Eh, concentration of complexing anions, porosity of the soil, soil-particle size, and sorption properties as well as the amount of water available. In general, the actinide nuclides form comparatively insoluble compounds in the environment and therefore are not considered biologically mobile. The actinides are transported in ecosystems mainly by physical and sometimes chemical processes. They tend to attach, sometimes strongly, to surfaces; and tend to accumulate in soil and sediment, which ultimately serve as strong reservoirs. Subsequent movement is largely associated with geological processes such as erosion and sometimes leaching.

I-3.2.2 Organic Chemicals

Table I-3.2-2 presents the physical and chemical properties (organic carbon partition coefficient [K_{oc}], logarithm to the base 10 octanol/water partition coefficient [log K_{ow}], and solubility) of the organic COPCs identified for the TA-49 sites outside the NES boundary. The physical and chemical properties of organic chemicals are important when evaluating their fate and transport. The following physiochemical property information illustrates some aspects of the fate and transport of COPCs at the TA-49 sites outside the NES boundary. The information is summarized from Ney (1995, 058210).

Water solubility may be the most important chemical characteristic used to assess mobility of organic chemicals. The higher the water solubility of a chemical, the more likely it is to be mobile and the less likely it is to accumulate, bioaccumulate, volatilize, or persist in the environment. A highly soluble chemical (water solubility greater than 1000 mg/L) is prone to biodegradation and metabolism that may detoxify the parent chemical. Several detected at the TA-49 sites outside the NES boundary have water solubilities greater than 1000 mg/L, including acetone, benzene, 2-butanone, chloromethane, 2-chloronaphthalene, dichlorodifluoromethane, and methylene chloride.

The lower the water solubility of a chemical, especially below 10 mg/L, the more likely it will be immobilized by adsorption. Chemicals with lower water solubilities are more likely to accumulate or bioaccumulate and persist in the environment, are slightly prone to biodegradation, and are metabolized in plants and animals. Bis(2-ethylhexyl)phthalate and pyrene have water solubilities less than 10 mg/L.

Vapor pressure is a chemical characteristic used to evaluate the tendency of organic chemicals to volatize. Chemicals with vapor pressure greater than 0.01 mm Hg are likely to volatilize and, therefore, concentrations at the site are reduced over time; vapors of these chemicals are more likely to travel toward the atmosphere and not migrate towards groundwater. Acetone; benzene; 2-butanone;

chloromethane; 2-chloronaphthalene; dichlorodifluoromethane; ethylbenzene; 4-ethyltoluene; methylene chloride; 2-methylnaphthalene; naphthalene; styrene; toluene; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; total xylene; 1,2-xylene; and 1,3-xylene+1,4-xylene have vapor pressures greater than 0.01 mm Hg.

Chemicals with vapor pressures less than 0.000001 mm Hg are less likely to volatilize and, therefore, tend to remain immobile. Bis(2-ethylhexyl)phthalate has a vapor pressure less than 0.000001 mm Hg.

The K_{ow} is an indicator of a chemical's potential to bioaccumulate or bioconcentrate in the fatty tissues of living organisms. The unitless K_{ow} value is an indicator of water solubility, mobility, sorption, and bioaccumulation. The higher the K_{ow} above 1000, the greater the affinity the chemical has for bioaccumulation/bioconcentration in the food chain, the greater the potential for sorption in the soil, and the lower the mobility (Ney 1995, 058210). Ethylbenzene, 4-ethyltoluene, bis(2-ethylhexyl)phthalate, 2-methylnaphthalene, naphthalene, pyrene, tetrachloroethene, trimethylbenzenes, and xylenes have a K_{ow} greater than 1000. A K_{ow} of less than 500 indicates high water solubility, mobility, little to no affinity for bioaccumulation, and degradability by microbes, plants, and animals. Acetone, benzene, 2-butanone, chloromethane, dichlorodifluoromethane, methylene chloride all have a K_{ow} much less than 500.

The K_{oc} measures the tendency of a chemical to adsorb to organic carbon in soil. K_{oc} values above 500 cm^3/g indicate a strong tendency to adsorb to soil, leading to low mobility (NMED 2015, 600915). Most organic COPCs have K_{oc} values above 500 cm^3/g, indicating a very low potential to migrate toward groundwater. The organic COPCs with K_{oc} values less than 500 cm^3/g include acetone; benzene; 2-butanone; chloromethane; 2-chloronaphthalene; dichlorodifluoromethane; methylene chloride; toluene; total xylene; 1,2-xylene; and 1,3-xylene+1,4-xylene.

Bis(2-ethylhexyl)phthalate and pyrene are the least mobile and are the most likely to bioaccumulate. Acetone, 2-butanone, benzoic acid, methylene chloride, and toluene are more soluble and volatile and are more likely to travel toward the atmosphere and not migrate toward groundwater. Because the organic COPCs were detected at low concentrations and extent is defined, they are not likely to migrate to groundwater.

I-3.2.3 Radionuclides

Radionuclides are generally not highly soluble or mobile in the environment, particularly in the semiarid climate of the Laboratory. The physical and chemical factors that determine the distribution of radionuclides within soil and tuff are the K_d, the pH of the soil and other soil characteristics (e.g., sand or clay content), and the Eh. The interaction of these factors is complex, but K_d values provide a general assessment of the potential for migration through the subsurface: chemicals with higher K_d values are less likely to be mobile than those with lower values. Radionuclides with K_d values greater than 40 are very unlikely to migrate through soil towards the water table (Kincaid et al. 1998, 093270).

Table I-3.2-3 gives physical and chemical properties of the radionuclide COPCs identified at the TA-49 sites outside the NES boundary. Based on K_d values, americium-241, cesium-134, plutonium-238, and plutonium-239 have a very low potential to migrate towards groundwater at the TA-49 sites outside the NES boundary. The K_d values for tritium are less than 40 and indicate a potential to migrate towards groundwater.

Tritium's initial behavior in the environment is determined by the source. If it is released as a gas or vapor to the atmosphere, substantial dispersion can be expected, and the rapidity of deposition is dependent on climatic factors. If tritium is released in liquid form, it is diluted in surface water and is subject to physical dispersion, percolation, and evaporation (Whicker and Schultz 1982, 058209, p. 147). Tritium activities in the subsurface at the area of elevated radioactivity are low (generally <1 pCi/g), indicating the area of elevated radioactivity is not a significant source of tritium, although this radionuclide is relatively mobile. Because tritium migrates in association with moisture, the low moisture content of the subsurface limits the potential for tritium to migrate to groundwater.

I-3.3 Exposure Point Concentration Calculations

The exposure point concentrations (EPCs) represent upper bound concentrations of COPCs. For comparison to risk-screening levels, the upper confidence limit (UCL) of the arithmetic mean was calculated when possible and used as the EPC. The UCLs were calculated using all available decision-level data within the depth range of interest. If an appropriate UCL of the mean could not be calculated or if the UCL exceeded the maximum concentration, the maximum detected concentration of the COPC was used as the EPC (maximum detection limits were used as the EPCs for some inorganic COPCs). The summary statistics, including the EPC for each COPC for the human health and the ecological risk-screening assessments and the distribution used for the calculation, are presented in Tables I-2.3-1 to I-2.3-7.

Calculation of UCLs of the mean concentrations was done using the U.S. Environmental Protection Agency (EPA) ProUCL 5.0.00 software (EPA 2013, 251074), which is based on EPA guidance (EPA 2002, 085640). The ProUCL program calculates 95%, 97.5%, and 99% UCLs and recommends a distribution and UCL. The 95% UCL for the recommended calculation method was used as the EPC. The ProUCL software performs distributional tests on the data set for each COPC and calculates the most appropriate UCL based on the distribution of the dataset. Environmental data may have a normal, lognormal, or gamma distribution but are often nonparametric (no definable shape to the distribution). The ProUCL documentation strongly recommends against using the maximum detected concentration for the EPC. The maximum detected concentration was used to represent the EPC for COPCs only when there were too few detects to calculate a UCL. Input and output data files for ProUCL calculations are provided on CD as Attachment I-1.

I-4.0 HUMAN HEALTH RISK-SCREENING EVALUATIONS

The human health risk-screening assessments were conducted for TA-49 sites outside the NES boundary. All sites were screened for the residential and construction worker scenarios using data from 0.0 to 10.0 ft bgs. Sites were also screened for the industrial scenario using data from 0.0 to 1.0 ft bgs, where available. The human health risk-screening assessments compared either the 95% UCL of the mean concentration, the maximum detected concentration, or the maximum detection limit of each COPC with SSLs for chemicals and screening action levels (SALs) for radionuclides.

I-4.1 Human Health SSLs and SALs

Human health risk-screening assessments were conducted using SSLs for the industrial, construction worker, and residential scenarios obtained from NMED guidance (NMED 2015, 600915). The NMED SSLs are based on a target hazard quotient (HQ) of 1 and a target cancer risk of 1×10^{-5} (NMED 2015, 600915). If SSLs were not available from NMED guidance, the May 2016 EPA regional screening tables were used. EPA regional screening levels are not available for construction workers; therefore, when regional screening levels were used for a COPC, the construction worker SSLs were calculated using toxicity values from May 2016 EPA regional screening tables and exposure parameters from NMED guidance (NMED 2015, 600915). The EPA regional screening levels for carcinogens were multiplied by 10 to adjust from a 10^{-6} cancer risk level to the NMED target cancer risk level of 10^{-5}. Surrogate chemicals were also used for some COPCs without an SSL based on structural similarity or because the COPC is a breakdown product (NMED 2003, 081172). Exposure parameters used to calculate the industrial, construction worker, and residential SSLs are presented in Table I-4.1-1.

Radionuclide SALs were used for comparison with radionuclide COPC EPCs and were derived using the RESRAD model, Version 7.0 (LANL 2015, 600929). The SALs are based on a 25-mrem/yr dose as authorized by U.S. Department of Energy (DOE) Order 458.1. Exposure parameters used to calculate the SALs are presented in Tables I-4.1-2 and I-4.1-3.

I-4.2 Results of Human Health Screening Evaluation

The EPC of each COPC was compared with the SSLs for the industrial, construction worker, and residential scenarios, as appropriate. For carcinogenic chemicals, the EPCs were divided by the SSL and multiplied by 1×10^{-5}. The sum of the carcinogenic risks was compared with the NMED target cancer risk level of 1×10^{-5}. For noncarcinogenic chemicals, an HQ was generated for each COPC by dividing the EPC by the SSL. The HQs were summed to generate a hazard index (HI). The HI was compared with the NMED target HI of 1. The radionuclide EPCs were divided by the SAL and multiplied by 25 mrem/yr. The total doses were compared with the DOE target level of 25 mrem/yr, as authorized by DOE Order 458.1. The results are presented in Tables I-4.2-1 to I-4.2-22 and are described below for each SWMU and AOC evaluated.

I-4.2.1 AOC 49-002

The results of the risk-screening assessment for the industrial scenario are presented in Tables I-4.2-1 and I-4.2-2. No carcinogenic COPCs were identified in the 0.0 to 1.0–ft depth interval. The industrial HI is 0.04, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.005 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the construction worker scenario are presented in Tables I-4.2-3 and I-4.2-4. No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The construction worker HI is 0.4, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.02 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the residential scenario are presented in Tables I-4.2-5 and I-4.2-6. No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The residential HI is approximately 0.6, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.06 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

I-4.2.2 SWMU 49-004

The results of the risk-screening assessment for the industrial scenario are presented in Tables I-4.2-7, I-4.2-8, and I-4.2-9. The total excess cancer risk for the industrial scenario is 2×10^{-7}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2015, 600915). The industrial HI is 0.05, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.3 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the construction worker scenario are presented in Tables I-4.2-10 and I-4.2-11. No carcinogenic COPCs were identified in the 0.0 to 10.0-ft depth interval. The construction worker HI is 0.7, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.5 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the residential scenario are presented in Tables I-4.2-12, I-4.2-13, and I-4.2-14. The total excess cancer risk for the residential scenario is 1 × 10^{-6}, which is less than the NMED target risk level of 1 × 10^{-5} (NMED 2015, 600915). The residential HI is 0.8, which is less than to the NMED target HI of 1 (NMED 2015, 600915). The total dose is 1 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

I-4.2.3 SWMU 49-005(a)

The results of the risk-screening assessment for the industrial scenario are presented in Tables I-4.2-15, I-4.2-16, and I-4.2-17. The total excess cancer risk for the industrial scenario is 9 × 10^{-10}, which is less than the NMED target risk level of 1 × 10^{-5} (NMED 2015, 600915). The industrial HI is 0.0006, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.002 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the construction worker scenario are presented in Tables I-4.2-18 and I-4.2-19. No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The construction worker HI is 0.6, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.01 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

The results of the risk-screening assessment for the residential scenario are presented in Tables I-4.2-20, I-4.2-21, and I-4.2-22. The total excess cancer risk for the residential scenario is 7 × 10^{-6}, which is less than the NMED target risk level of 1 × 10^{-5} (NMED 2015, 600915). The residential HI is 0.4, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.04 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1.

I-4.3 Vapor Intrusion Pathway

NMED guidance (NMED 2015, 600915) requires an evaluation of the vapor-intrusion pathway for the residential scenario. The vapor intrusion pathway of VOCs into a building was evaluated where appropriate. The evaluation can be qualitative for a potentially complete pathway if the following criteria are met:

- Volatile and toxic compounds are minimally detected
- Concentrations are below NMED's vapor intrusion screening levels for soil-gas and/or groundwater. There is no suspected source(s) for volatile and toxic compounds, and
- Concentrations are decreasing with depth (for soil).

Soil-gas data are available for SWMUs 49-004 and 49-005(a) and the NMED vapor intrusion screening levels are applicable for both sites (NMED 2015, 600915). The maximum detected concentrations of VOC COPCs for each site were compared with the vapor intrusion screening levels. HQs and HIs were calculated for noncarcinogenic COPCs and total excess cancer risks were calculated for carcinogenic COPCs. The NMED target risk level of 1 × 10^{-5} and target HI of 1 were applied.

The vapor intrusion pathway was also qualitatively evaluated as part of the residential scenario for SWMUs 49-004 and 49-005(a). AOC 49-002 is an underground experimental calibration chamber and two associated shafts with no history of volatile and toxic chemical use, and samples from AOC 49-002 were not analyzed for VOCs per the approved investigation work plan (LANL 2008, 102691; NMED 2008, 100465). The vapor intrusion pathway for AOC 49-002 is incomplete and was not evaluated.

I-4.3.1 SWMU 49-004

SWMU 49-004 is a landfill in Area 6 West used from 1959 to 1961 for open-pit burning of combustible construction materials and for the burial of uncontaminated residues generated from other areas at TA-49 (Purtymun and Stoker 1987, 006688). Wastes disposed of at this site were reportedly screened for radioactivity before burial (LANL 1992, 007670, p. 6.3-6). No documentation exists concerning disposal of hazardous chemicals, but disposal of such chemicals is unlikely based on the nature of activities conducted at TA-49. The site description does not indicate a history of solvent use.

All 14 COPCs detected in soil-gas were screened versus the vapor intrusion screening levels. The results of the residential vapor intrusion screening assessment are presented in Tables I-4.3-1 and I-4.3-2. The HI is approximately 0.5, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total excess cancer risk is 7×10^{-6}, which is less than the NMED target risk of 1×10^{-5} (NMED 2014, 600115).

The vapor intrusion pathway is therefore potentially complete based on NMED guidance (NMED 2015, 600915), but no additional evaluation is necessary.

I-4.3.2 SWMU 49-005(a)

SWMU 49-005(a) is an inactive landfill located east of Area 10. The landfill, described as a small pit, was constructed north of the road that runs east from Area 10 and is approximately 50 to 100 ft northeast of the Area 10 experimental chamber and shafts (AOC 49-002). SWMU 49-005(a) was constructed in 1984 as a disposal area for nonradiologically contaminated debris generated during the 1984 general surface cleanup of TA-49 (LANL 1997, 056594, p. 25). This site description does not indicate a history of solvent use.

All 14 COPCs detected in soil-gas were screened versus the vapor intrusion screening levels. The results of the residential vapor intrusion screening assessment are presented in Tables I-4.3-3 and I-4.3-4. The HI is approximately 0.3, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total excess cancer risk is 4×10^{-6}, which is less than the NMED target risk of 1×10^{-5} (NMED 2014, 600115).

The vapor intrusion pathway is therefore potentially complete based on NMED guidance (NMED 2015, 600915) but no additional evaluation is necessary.

I-4.4 Essential Nutrients

NMED guidance (NMED 2015, 600915) has SSLs for evaluation of essential nutrients. The maximum concentrations of calcium and magnesium were compared to the appropriate NMED SSLs at sites where they were identified as COPCs (Table I-4.4-1). The results of the comparisons found calcium and magnesium concentrations to be substantially less than the SSLs. Further evaluation of calcium and magnesium is not necessary.

I-4.5 Uncertainty Analysis

I-4.5.1 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 when it is actually not a COPC or that a chemical may not be identified as a COPC when it actually should be identified as a COPC. Inorganic chemicals are appropriately identified as COPCs because only the chemicals detected or that have detection limits above background are retained for further analysis. No established BVs for organic chemicals, and all detected organic chemicals are identified as COPCs and are retained for further analysis. Other uncertainties may include errors in sampling, laboratory analysis, and data analysis. However, because concentrations used in the risk-screening evaluations include those detected below the estimated quantitation limits and nondetects above BVs, data evaluation uncertainties are expected to have little effect on the risk-screening results.

I-4.5.2 Exposure Evaluation

The current and reasonably foreseeable future land use is industrial. To the degree actual activity patterns are not represented by those activities assumed by the industrial scenario, uncertainties are introduced in the assessment, and the evaluation presented in this assessment overestimates potential risk. An individual may be subject to exposures in a different manner than the exposure assumptions used to derive the industrial SSLs. For the sites evaluated, individuals may not be on-site at present or in the future for that frequency and duration. The construction worker assumptions for the SSLs are that the potentially exposed individual is outside on-site for 8 h/d, 250 d/yr, and 1 yr (NMED 2015, 600915). The industrial assumptions for the SSLs are that the potentially exposed individual is outside on-site for 8 h/d, 225 d/yr, and 25 yr (NMED 2015, 600915). The residential SSLs are based on exposure of 24 h/d, 350 d/yr, and 30 yr (NMED 2015, 600915). As a result, the industrial and residential scenarios evaluated at these sites likely overestimate the exposure and risk.

A number of assumptions are made relative to exposure pathways, including input parameters, completeness of a given pathway, 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 default values (NMED 2015, 600915). When several upper-bound values (as are found in NMED 2015, 600915) are combined to estimate exposure for any one pathway, the resulting risk estimate can exceed the 99th percentile, and therefore, can exceed the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and result in exposure in the same manner as if they were in soil overestimates the potential exposure and risk to receptors.

Uncertainty is introduced in the concentration aggregation of data for estimating the EPCs at a site. Risk from a single location or area with relatively high COPC concentrations may be underestimated by using a representative site-wide value. The use of a UCL is intended to provide a protective upper-bound (i.e., conservative) COPC concentration and is assumed to be representative of the average exposure to a COPC across the entire site. Potential risk and exposure from a single location or area with relatively high COPC concentrations may be overestimated if a representative site-wide value is used. The use of the maximum detected concentration for the EPC overestimates the exposure to contamination because receptors are not consistently exposed to the maximum detected concentration across the site. In addition, the maximum detection limit was used as the EPC for some inorganic COPCs with elevated detection limits above BVs.

The potential risk is overestimated for SWMU 49-004 because of uncertainties associated with the EPCs and the COPCs.

The residential HI for SWMU 49-004 is 0.8 largely from aluminum, cobalt, and iron (HI = 0.7). In addition, the HI includes lead. Because the lead SSL is based upon blood lead levels, lead is evaluated separately from the other noncarcinogenic COPCs. The lead EPC (17 mg/kg) is less than the residential SSL (400 mg/kg). Without lead, the residential HI is approximately 0.7. Iron was detected in a tuff sample above the Qbt 2,3,4 BV at 16,400 mg/kg. Although statistical comparisons indicated that iron was statistically different from Qbt 2,3,4 background, the concentration above BV did not exceed the maximum Qbt 2,3,4 background concentration (19,500 mg/kg). In addition, the maximum site concentration was 19,000 mg/kg in soil, which is below the soil BV (21,500 mg/kg) and above the maximum Qbt 2,3,4 background concentration. Therefore, iron concentrations were not different from background concentrations at this site. The residential HI without iron and lead becomes approximately 0.5, which is less than the NMED target HI of 1.

I-4.5.3 Toxicity Evaluation

The primary uncertainty associated with the SSLs is related to the derivation of toxicity values used in their calculation. Toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SSLs used in this risk-screening evaluation (NMED 2015, 600915). Uncertainties were identified in five areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) interindividual variability in the human population, (3) the derivation of RfDs and SFs, (4) the chemical form of the COPC, and (5) the use of surrogate chemicals.

Extrapolation from Animals to Humans. The SFs and RfDs are often determined by 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. Differences in body weight, surface area, and pharmacokinetic relationships between animals and humans are taken into account 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.

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 evaluation; this factor of 10 is generally considered to result in a conservative estimate of risk to noncarcinogenic COPCs.

Derivation of RfDs and SFs. The RfDs and SFs for different chemicals are derived from experiments conducted by different laboratories that may have different accuracy and precision that could lead to an over- or underestimation of the risk. The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. For carcinogens, the weight of evidence classification indicates the likelihood that a contaminant is a human carcinogen. Toxicity values with high uncertainties may change as new information is evaluated.

Arsenic

The May 2016 EPA regional screening values for arsenic employ a relative bioavailability value of 60% in calculating the industrial and residential soil screening levels (http://www.epa.gov/risk/risk-based-screening-table-generic-tables). The EPA document “Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil” (EPA 2012, 262543) provides supporting information and the EPA policy memorandum “Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil” (EPA 2012, 262542*)* recommends using this value, recognizing the default value is an estimate not likely to be exceeded at most sites and is preferable to the assumption of a relative bioavailability equal to 100%.

The use of the May 2016 EPA regional residential screening value for arsenic of 6.8 mg/kg changes the total excess cancer risk results for one site evaluated in this appendix. The change is as follows:

SWMU 49-005(a)—Residential cancer risk becomes 4×10^{-6} and the total excess cancer risk becomes 5×10^{-6} (Table I-4.2-20).

Chemical Form of the COPC. COPCs may be bound to the environment matrix and not available for absorption into the human body. However, it is assumed that the COPCs are bioavailable. This assumption can lead to an overestimation of the total risk.

Use of Surrogate Chemicals. Surrogates were used to provide vapor intrusion screening levels for 4-ethyltoluene, 1,3,5-trimethylbenzene, and 1,3-xylene+1,4-xylene based on structural similarity. The overall impact of surrogates on the risk assessment is minimal because these COPCs were detected at low concentrations.

I-4.5.4 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 may be overestimated for individual COPCs that act by different mechanisms or by different modes of action but are addressed additively.

I-4.6 Interpretation of Human Health Risk Screening Results

I-4.6.1 AOC 49-002

Industrial Scenario

No carcinogenic COPCs were identified in the 0.0 to 1.0–ft depth interval. The industrial HI is 0.04, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.005 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the industrial scenario is equivalent to a total risk of 4×10^{-8}, based on conversion from dose using RESRAD Version 7.0.

Construction Worker Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The construction worker HI is 0.4, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.02 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the construction worker scenario is equivalent to a total risk of 4 × 10^{-9}, based on conversion from dose using RESRAD Version 7.0.

Residential Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The residential HI is approximately 0.6, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.06 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the residential scenario is equivalent to a total risk of 1 × 10^{-7}, based on conversion from dose using RESRAD Version 7.0.

I-4.6.2 SWMU 49-004

Industrial Scenario

The total excess cancer risk for the industrial scenario is 2 × 10^{-7}, which is less than the NMED target risk level of 1 × 10^{-5} (NMED 2015, 600915). The industrial HI is 0.05, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.3 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the industrial scenario is equivalent to a total risk of 4 × 10^{-7}, based on conversion from dose using RESRAD Version 7.0.

Construction Worker Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The construction worker HI is 0.7, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.5 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the construction worker scenario is equivalent to a total risk of 1 × 10^{-7}, based on conversion from dose using RESRAD Version 7.0.

Residential Scenario

The total excess cancer risk (soil plus vapor intrusion screening results) for the residential scenario is 8 × 10^{-6}, which is less than the NMED target risk level of 1 × 10^{-5} (NMED 2015, 600915). The residential HI (soil plus vapor intrusion screening results) is approximately 1 (see section I-4.5.2, Uncertainty Analysis), which is equivalent to the NMED target HI of 1 (NMED 2015, 600915). The total dose is 1 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the residential scenario is equivalent to a total risk of 5 × 10^{-6}, based on conversion from dose using RESRAD Version 7.0.

I-4.6.3 SWMU 49-005(a)

Industrial Scenario

The total excess cancer risk for the industrial scenario is 9 × 10^{-10}, which is less than the NMED target risk level of 1 × 10^{-5} (NMED 2015, 600915). The industrial HI is 0.0006, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.002 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the industrial scenario is equivalent to a total risk of 3 × 10^{-9}, based on conversion from dose using RESRAD Version 7.0.

Construction Worker Scenario

No carcinogenic COPCs were identified in the 0.0 to 10.0–ft depth interval. The construction worker HI is 0.6, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.01 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the construction worker scenario is equivalent to a total risk of 2×10^{-9}, based on conversion from dose using RESRAD Version 7.0.

Residential Scenario

The total excess cancer risk (soil plus vapor intrusion screening results) for the residential scenario is 9×10^{-6} based on the EPA arsenic SSL (see section I-4.5.2, Uncertainty Analysis), which is less than the NMED target risk level of 1×10^{-5} (NMED 2015, 600915). The residential HI (soil plus vapor intrusion screening results) is 0.7, which is less than the NMED target HI of 1 (NMED 2015, 600915). The total dose is 0.04 mrem/yr, which is less than the target dose of 25 mrem/yr as authorized by DOE Order 458.1. The total dose for the residential scenario is equivalent to a total risk of 1×10^{-7}, based on conversion from dose using RESRAD Version 7.0.

I-5.0 ECOLOGICAL RISK-SCREENING EVALUATIONS

The approach for conducting ecological evaluations is described in the “Screening Level Ecological Risk Evaluation Methods, Revision 4” (LANL 2015, 600982). The evaluation consists of four parts: a scoping evaluation, a screening evaluation, an uncertainty analysis, and an interpretation of the results.

I-5.1 Scoping Evaluation

The scoping evaluation establishes the breadth and focus of the screening evaluation. The ecological scoping checklist (Attachment I-2) is a useful tool for organizing existing ecological information. The information was used to determine whether ecological receptors may be affected, identify the types of receptors that may be present, and develop the ecological conceptual site model for TA-49 sites outside the NES boundary (Attachment I-2). None of the sites are currently active and they provide habitat for ecological receptors. The quality of the habitat varies but most of the site areas have native grasses, forbs, and trees that can be suitable habitat for ecological receptors.

The scoping evaluation indicated that terrestrial receptors were appropriate for evaluating the concentrations of COPCs in soil and tuff. Exposure is assessed across a site to a depth of 0.0 to 5.0 ft bgs. Aquatic receptors were not evaluated because no aquatic communities and no aquatic habitat or perennial source of water exist at any of the sites. The depth of the regional aquifer (greater than 1000 ft bgs) and the semiarid climate limit transport to groundwater. The potential exposure pathways for terrestrial receptors in soil and tuff are root uptake, inhalation, soil ingestion, dermal contact, and food web transport (Attachment I-2). The weathering of tuff is the only viable natural process that may result in the exposure of receptors to contaminants in tuff. Because of the slow rate of weathering expected for tuff, exposure in tuff is negligible, although it is included in the assessment. Plant exposure in tuff is largely limited to fractures near the surface, which does not produce sufficient biomass to support an herbivore population. Consequently, the contaminants in tuff are unavailable to receptors.

The potential risk was evaluated in the risk-screening assessments for the following ecological receptors representing several trophic levels:

- plants
- soil dwelling invertebrates (represented by the earthworm)
- the deer mouse (mammalian omnivore)
- the montane shrew (mammalian insectivore)
- desert cottontail (mammalian herbivore)
- red fox (mammalian carnivore)
- pocket gopher (burrowing mammal air pathway only)
- American robin (avian insectivore, avian omnivore, and avian herbivore)
- American kestrel (avian insectivore and avian carnivore [surrogate for threatened and endangered [T&E] species (primarily the Mexican spotted owl)]

The rationale for using these receptors is presented in “Screening Level Ecological Risk Evaluation Methods, Revision 4” (LANL 2015, 600982). The Mexican spotted owl is the only T&E species known to frequent the area and may use TA-49 sites outside the NES boundary for foraging.

I-5.2 Assessment Endpoints

An assessment endpoint is an explicit expression of the environmental value to be protected. The endpoints are ecologically relevant and help sustain the natural structure, function, and biodiversity of an ecosystem or its components (EPA 1998, 062809). In a screening-level ecological evaluation, receptors represent the populations and/or communities, and assessment endpoints are any adverse effects on the chosen ecological receptors. The purpose of the ecological evaluation is to protect populations and communities of biota rather than individual organisms, except for listed or candidate T&E species and treaty-protected species, when individuals must be protected (EPA 1999, 070086). Populations of protected species tend to be small, and the loss of an individual adversely affects the species as a whole (EPA 1997, 059370).

In accordance with this guidance, the Laboratory developed generic assessment endpoints (LANL 1999, 064137) to ensure that values at all levels of ecological organization are considered in the ecological screening process. These general assessment endpoints can be measured using impacts on reproduction, growth, and survival to represent categories of effects that may adversely impact populations. In addition, specific receptor species were chosen to represent each functional group. The receptor species were chosen because of their presence at the site, their sensitivity to the COPCs, and their potential for exposure to those COPCs. These categories of effects and the chosen receptor species were used to select the types of effects seen in toxicity studies considered in the development of the toxicity reference values (TRVs). Toxicity studies used in the development of TRVs included only studies in which the adverse effect evaluated affected reproduction, survival, and/or growth.

The selection of receptors and assessment endpoints is designed to be protective of both the representative species used as screening receptors and the other species within their feeding guilds and the overall food web for the terrestrial and aquatic ecosystems. Focusing the assessment endpoints on the general characteristics of species that affect populations (rather than the biochemical and behavioral changes that may affect only the studied species) also ensures the applicability to the ecosystem of concern.

I-5.3 Ecological Risk-Screening Evaluation

The ecological screening evaluation identifies chemicals of potential ecological concern (COPECs) and is based on the comparison of EPCs (95% UCLs, maximum detected concentrations, or maximum detection limits) to ecological screening levels (ESLs). The EPCs used in the assessments for TA-49 sites outside the NES boundary are presented in Tables I-2.3-1 through Table I-2.3-7.

The ESLs were obtained from the ECORISK Database, Release 3.3 (LANL 2015, 600921) and are presented in Table I-5.3-1. The ESLs are based on similar species and are derived from experimentally determined NOAELs, lowest observed adverse effect levels (LOAELs), or doses determined lethal to 50% of the test population. Information relevant to the calculation of ESLs, including concentration equations, dose equations, bioconcentration factors, transfer factors, and TRVs, are presented in the ECORISK Database, Release 3.3 (LANL 2015, 600921).

The analysis begins with a comparison of the minimum ESL for a given COPC to the EPC. The HQ is defined as the ratio of the EPC to the concentration that has been determined to be acceptable to a given ecological receptor (i.e., the ESL). 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 used to identify COPECs requiring additional evaluation (LANL 2015, 600982). Individual HQs for a receptor are summed to derive an HI; COPCs without ESLs are retained as COPECs and evaluated further in the uncertainty section. An HI greater than 1 indicates further assessment may be needed to ensure exposure to multiple COPECs at a site will not lead to potential adverse impacts to a given receptor population. The HQ and HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential of overlooking possible COPECs at the site.

I-5.3.1 AOC 49-002

The results of the minimum ESL comparisons are presented in Table I-5.3-2. Antimony, barium, copper, mercury, and zinc are retained as COPECs because the HQs were greater than 0.3.

Potential ecological risks associated with aluminum are based on soil pH. Aluminum is retained only in soil with a pH lower than 5.5, in accordance with EPA guidance (EPA 2003, 085645). Aluminum was eliminated as a COPEC and was not evaluated further because the soil pH at the TA-49 sites outside the NES boundary is neutral to slightly alkaline.

The HQs and HIs for each COPEC and receptor combination are presented in Table I-5.3-3. The HI analysis indicates that the robin (omnivore and insectivore), cottontail, shrew, deer mouse, earthworm, and plant have HIs greater than 1. The HIs for the kestrel (intermediate carnivore) and robin (herbivore) were equivalent to 1 and the HIs for the red fox and kestrel (top carnivore) were less than 1. The COPECs and receptors are discussed in the uncertainty section.

I-5.3.2 SWMU 49-004

The results of the minimum ESL comparisons are presented in Table I-5.3-4. Barium, chromium, cobalt, copper, lead, nickel, selenium, and zinc are retained as COPECs because the HQs were greater than 0.3.

Potential ecological risks associated with aluminum are based on soil pH. Aluminum is retained only in soil with a pH lower than 5.5, in accordance with EPA guidance (EPA 2003, 085645). Aluminum was eliminated as a COPEC and was not evaluated further because the soil pH at the TA-49 sites outside the NES boundary is neutral to slightly alkaline.

Calcium, magnesium, and perchlorate do not have ESLs, are retained as COPECs, and are discussed in the uncertainty section.

The HQs and HIs for each COPEC and receptor combination are presented in Table I-5.3-5. The HI analysis indicates that the robin (all feeding guilds), shrew, deer mouse, earthworm, and plant have HIs greater than 1. The HI for the kestrel (intermediate carnivore) was equivalent to 1 and the HIs for the red fox, kestrel (top carnivore), and cottontail were less than 1. The COPECs and receptors are discussed in the uncertainty section.

I-5.3.3 SWMU 49-005(a)

The results of the minimum ESL comparisons are presented in Table I-5.3-6. Antimony, arsenic, barium, chromium, cobalt, copper, lead, nickel, selenium, vanadium, and bis(2-ethylhexyl)phthalate are retained as COPECs because the HQs were greater than 0.3.

Potential ecological risks associated with aluminum are based on soil pH. Aluminum is retained only in soil with a pH lower than 5.5, in accordance with EPA guidance (EPA 2003, 085645). Aluminum was eliminated as a COPEC and was not evaluated further because the soil pH at the TA-49 sites outside the NES boundary is neutral to slightly alkaline.

Calcium and magnesium do not have ESLs, are retained as COPECs, and are discussed in the uncertainty section.

The HQs and HIs for each COPEC and receptor combination are presented in Table I-5.3-7. The HI analysis indicates that the kestrel (intermediate carnivore), robin (all feeding guilds), shrew, deer mouse, and plant have HIs greater than 1. The HI for the earthworm was equivalent to 1 and the HIs for the red fox, kestrel (top carnivore), and cottontail were less than 1. The COPECs and receptors are discussed in the uncertainty section.

I-5.3.4 Evaluation of Burrow Air Pathway

Pore gas data are available for SWMUs 49-004 and 49-005(a). As a conservative screen of this pathway the maximum soil gas concentrations were compared with the burrow air ESLs (based on the pocket gopher). This comparison and the HI for this pathway are provided in Table I-5.3-8 and shows that the HI was 0.004 for the inhalation of burrow air pathway. Burrow air ESLs are not available for 2-butanone and styrene. However, given the low concentrations for these VOCs (maximum concentrations of 10 µg/m^3 and 3.2 µg/m^3, respectively), no additional evaluation is warranted.

I-5.4 Uncertainty Analysis

The uncertainty analysis describes the key sources of uncertainty related to the screening evaluations. This analysis can result in either adding or removing chemicals from the list of COPECs for sites. The following narrative contains a qualitative uncertainty analysis of the issues relevant to evaluating the potential ecological risk at these TA-49 sites outside the NES boundary.

I-5.4.1 Chemical Form

The assumptions used in the ESL derivations were conservative and not necessarily representative of actual conditions. These assumptions include maximum chemical bioavailability, maximum receptor ingestion rates, minimum body weight, and additive effects of multiple COPECs. Most of these factors tend to result in conservative estimates of the ESLs, which may lead to an overestimation of the potential risk. The assumption of additive effects for multiple COPECs may result in an over- or underestimation of the potential risk to receptors.

The chemical form of the individual COPECs was not determined as part of the investigation, largely a limitation on analytical quantitation of individual chemical species. Toxicological data are typically based on the most toxic and bioavailable chemical species not likely found in the environment. The inorganic, organic, and radionuclide, COPECs are generally not 100% bioavailable to receptors in the natural environment because of the adsorption of chemical constituents to matrix surfaces (e.g., soil), or rapid oxidation or reduction changes that render harmful chemical forms unavailable to biotic processes. The ESLs were calculated to ensure a conservative indication of potential risk (LANL 2015, 600982), and the values were biased toward overestimating the potential risk to receptors.

I-5.4.2 Exposure Assumptions

The EPCs used in the calculations of HQs were the 95% UCL, the maximum detected concentration, or the maximum detection limit to a depth of 5.0 ft, thereby conservatively estimating the exposure to each COPEC. As a result, the exposure of individuals within a population was evaluated using this specific concentration, which was assumed constant throughout the exposure area. The sampling also focused on areas of known contamination, and receptors were assumed to ingest 100% of their food and spend 100% of their time at the site. The assumptions made regarding exposure for terrestrial receptors results in an overestimation of the potential exposure and risk because COPECs varied across the site and were infrequently detected.

I-5.4.3 Toxicity Values

The HQs were calculated using ESLs, which are based on NOAELs as threshold effect levels; actual risk for a given COPEC/receptor combination occurs at a higher level, somewhere between the NOAEL-based threshold and the threshold based on the LOAEL. The use of NOAELs leads to an overestimation of potential risk to ecological receptors. ESLs are based on laboratory studies requiring extrapolation to wildlife receptors. Laboratory studies are typically based on “artificial” and maintained populations with genetically similar individuals and are limited to single chemical exposures in isolated and controlled conditions using a single exposure pathway. Wild species are concomitantly exposed to a variety of chemical and environmental stressors, potentially rendering them more susceptible to chemical stress. On the other hand, wild populations are likely more genetically diverse than laboratory populations, making wild populations, as a whole, less sensitive to chemical exposure than laboratory populations. The uncertainties associated with the ESLs may result in an under- or overestimation of potential risk.

I-5.4.4 Area Use Factors

In addition to the direct comparison of the EPC with the ESLs, area use factors (AUF) are used to account for the amount of time a receptor is likely to spend within the contaminated areas based on the size of the receptor’s home range (HR). The AUF for individual organisms is calculated by dividing the size of the site by the HR for that receptor. Because T&E species must be assessed on an individual basis (EPA 1999, 070086), the AUF is used for the Mexican spotted owl. The HR for the Mexican spotted owl is 366 ha (EPA 1993, 059384). The site areas and AUFs for each site are presented in Table I-5.4-1. The kestrel (top carnivore) is used as the surrogate receptor for the Mexican spotted owl.

I-5.4.5 Population Area Use Factors

EPA guidance is to manage the ecological risk to populations rather than to individuals, with the exception of T&E species (EPA 1999, 070086). One approach to address the potential effects on populations at these TA-49 sites outside the NES boundary is to estimate the spatial extent of the area inhabited by the local population that overlaps with the contaminated area. The population area for a receptor is based on the individual receptor HR and its dispersal distance. Bowman et al. (2002, 073475) estimate that the median dispersal distance for mammals is 7 times the linear dimension of the HR (i.e., the square root of the HR area). If only the dispersal distances for the mammals with HRs within the range of the screening receptors are used (Bowman et al. 2002, 073475), the median dispersal distance becomes 3.6 times the square root of the HR (R^2=0.91). If it is assumed that the receptors can disperse the same distance in any direction, the population area is circular and the dispersal distance is the radius of the circle. Therefore, the population area can be derived by $\pi(3.6\sqrt{HR})^2$ or approximately 40 HR.

I-5.4.5.1 AOC 49-002

The area of AOC 49-002 is approximately 7.85 ha. The population area use factors (PAUFs) are estimated by dividing the site area by the population area of each receptor population (Table I-5.4-2). The HQs and HIs are recalculated, except for the deer mouse, using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for AOC 49-002 are less than 1 for the red fox, kestrel (both feeding guilds), robin (herbivore), and cottontail (Table I-5.4-3). The robin (omnivore) had an adjusted HI of 2, the robin (insectivore) had an adjusted HI of 3, the shrew had an adjusted HI of 3, and the deer mouse had an unadjusted HI of 7. The plant had an unadjusted HI of 3 and the earthworm had an unadjusted HI of 2 (Table I-5.4-3).

I-5.4.5.2 SWMU 49-004

The area of SWMU 49-004 is approximately 14.8 ha. The PAUFs are estimated by dividing the site area by the population area of each receptor population (Table I-5.4-4). The HQs and HIs are recalculated, except for the deer mouse, using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for SWMU 49-004 are less than 1 for the red fox, kestrel (both feeding guilds), and cottontail. The robin (herbivore) had an adjusted HI of 2, robin (omnivore) had an adjusted HI of 4, the robin (insectivore) had an adjusted HI of 5, the shrew had an adjusted HI of 4, and the deer mouse had an unadjusted HI of 3. The plant had an unadjusted HI of 5 and the earthworm had an unadjusted HI of 2 (Table I-5.4-5).

I-5.4.5.3 SWMU 49-005(a)

The area of SWMU 49-005(a) is approximately 0.159 ha. The PAUFs are estimated by dividing the site area by the population area of each receptor population (Table I-5.4-6). The HQs and HIs are recalculated using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for SWMU 49-005(a) are less than 1 for all receptors. The plant had an unadjusted HI of 5 and the earthworm had an unadjusted HI of approximately 1 (Table I-5.4-7).

I-5.4.6 LOAEL Analysis

Some of these sites has HIs greater than 1 for one or more receptors. To address the HIs and reduce the associated uncertainty, analyses were conducted using ESLs calculated based on a LOAEL rather than a NOAEL. The LOAEL-based ESLs were calculated based on toxicity information in the ECORISK Database, Release 3.3 (LANL 2015, 600921) and are presented in Table I-5.4-8. The analyses address some of the uncertainties and conservativeness of the ESLs used in the initial screening assessments. HI analyses and adjusted HI analyses were conducted using the LOAEL-based ESLs.

I-5.4.7 Site Discussions

I-5.4.7.1 AOC 49-002

The PAUF-adjusted and unadjusted HIs for AOC 49-002 are greater than 1 for the robin (omnivore and insectivore), shrew, deer mouse, earthworm, and plant, with antimony, barium, copper, mercury, and zinc being the primary COPECs for one or several receptors (Table 5.4-3). The HI analysis using LOAEL-based ESLs resulted in HIs less than or equivalent to 1 for all receptors (Table I-5.4-9).

I-5.4.7.2 SWMU 49-004

The PAUF-adjusted and unadjusted HIs for SWMU 49-004 are greater than 1 for the robin (all feeding guilds), shrew, deer mouse, earthworm, and plant, with barium, chromium, cobalt, copper, lead, nickel, selenium, and zinc being the primary COPECs for one or several receptors (Table 5.4-5). The HI analysis using LOAEL-based ESLs resulted in HIs of 2 for the robin (insectivore) and shrew, HIs equivalent to 1 for the robin (omnivore), deer mouse, and plant, and HIs less than 1 for the robin (herbivore) and earthworm (Table I-5.4-10). The PAUF-adjusted HI analysis using LOAEL-based ESLs did not change the robin (omnivore and insectivore), shrew, and deer mouse HIs (Table I-5.4-11).

The LOAEL-based plant HI is primarily from barium (0.8). Barium was detected in all 150 samples in the 0.0 to 5.0–ft depth interval with an EPC of 198 mg/kg. The EPC, which represents the average exposure concentration, is within less than the maximum soil background concentration (410 mg/kg) and is slightly above the average soil background concentration of 143 mg/kg (LANL 1998, 059730). In addition, the maximum soil concentrations are below the maximum soil background concentration and all tuff concentrations are below the soil BV (295 mg/kg). The plant LOAEL-based ESL for barium is 260 mg/kg, which is less than the soil BV and below the maximum soil background concentration. The EPC indicates exposure to barium across the site is similar to background and the screening level is also similar to background. Therefore, the potential risk to the plant is overestimated.

The LOAEL-based HIs for the robin (omnivore and insectivore) are primarily from lead and selenium (1.1 and 1.3), and the shrew and deer mouse LOAEL-based HIs are primarily from selenium (1.1 and 0.9). Lead was detected in all 150 samples in the 0.0 to 5.0–ft depth interval with an EPC of 16.3 mg/kg. The EPC, which represents the average exposure concentration, is below the soil BV (22.3 mg/kg), less than the maximum soil background concentration (28 mg/kg), slightly above the maximum of Qbt 2,3,4 background concentration (15.5 mg/kg), and slightly above the average soil background concentration of 12.7 mg/kg. The robin (omnivore and insectivore) LOAEL-based ESLs are 33 mg/kg and 28 mg/kg, respectively, which are equivalent to or slightly above the maximum soil background concentration. Selenium was detected in 126 of the 150 samples and the EPC, which represents the average exposure concentration, is below the soil BV (1.52 mg/kg) and the maximum soil background concentration (1.7 mg/kg). The selenium LOAEL-based ESLs range from 0.99 mg/kg (shrew) to 1.7 mg/kg (robin [omnivore]), which are below or similar to the soil BV and/or the maximum soil background concentration.

The maximum site concentration is 1.9 mg/kg, which was reported in 2 of 150 samples and are only 0.2 mg/kg above the maximum soil background concentration; all other detected concentrations are below the soil BV. The EPCs indicate exposure to lead and selenium across the site is similar to background and the screening levels are also similar to background. Therefore, the potential ecological risks to the robin, shrew, and deer mouse are overestimated.

In addition, field observations made during the site visit found no indication of adverse effects from COPECs on the plant community (Attachment I-2). The site currently has minimal active operations and is becoming naturalized, with abundant habitat for ecological receptors, including plants. Therefore, the HI does not indicate potential risks to plants or other biota.

I-5.4.7.3 SWMU 49-005(a)

The unadjusted HIs for SWMU 49-005(a) are equivalent to or greater than 1 for the earthworm and plant, with arsenic, barium, beryllium, cobalt, selenium, and vanadium being the primary COPECs for one or both receptors (Table 5.4-7). The HI analysis using LOAEL-based ESLs resulted in an HI of 0.09 for the earthworm and approximately 1 for the plant (Table I-5.4-12).

The LOAEL-based plant HI is primarily from barium and selenium (0.9). Barium was detected in all 11 samples in the 0.0 to 5.0–ft depth interval with an EPC of 164 mg/kg. The EPC, which represents the average exposure concentration, is below the soil BV (295 mg/kg), less than the maximum soil background concentration (410 mg/kg), and slightly above the average soil background concentration of 143 mg/kg (LANL 1998, 059730). Barium concentrations exceeded only the Qbt 2,3,4 BV and are less than the soil BV. The plant LOAEL-based ESL for barium is 260 mg/kg, which is less than the soil BV and below the maximum soil background concentration. Selenium was detected in 10 of the 11 samples in the 0.0 to 5.0–ft depth interval with an EPC of 0.915 mg/kg. The EPC, which represents the average exposure concentration, is below the soil BV (1.52 mg/kg) and below the maximum soil background concentration (1.7 mg/kg). Selenium concentrations only exceeded the Qbt 2,3,4 BV and are less than the soil BV and the maximum soil background concentration; the maximum detected concentration is 1 mg/kg. The EPCs indicate exposure to barium and selenium across the site is similar to background and the barium LOAEL-based ESL is also similar to background. Therefore, the potential ecological risk to the plant is overestimated.

In addition, field observations made during the site visit found no indication of adverse effects from COPECs on the plant community (Attachment I-2). The site currently has minimal active operations and is becoming naturalized, with abundant habitat for ecological receptors, including plants. Therefore, the HI does not indicate potential unacceptable risk to plants.

I-5.4.8 Chemicals without ESLs

Several COPECs do not have ESLs for any receptor in release 3.3 of the ECORISK Database (LANL 2015, 600921). In an effort to address this uncertainty and to provide a quantitative assessment of potential ecological risk, several online toxicity databases searches were conducted to determine if any relevant toxicity information is available. The online searches of the following databases were conducted: EPA Ecotox Database, EPA Office of Pesticide Programs Aquatic Life Benchmarks, U.S. Army Corps of Engineers/EPA Environmental Residue-Effects, California Cal/Ecotox Database, Pesticide Action Network Pesticide Database, U.S. Army Wildlife Toxicity Assessment Program, U.S. Department of Agriculture Integrated Pesticide Management Database, American Bird Conservancy Pesticide Toxicity Database, and Oak Ridge National Laboratory Risk Assessment Information System. Some COPECs without ESLs do not have chemical-specific toxicity data or surrogate chemicals to be used in the screening assessments and cannot be assessed quantitatively for potential ecological risk.

In the absence of a chemical-specific ESL, COPEC concentrations can be compared with ESLs for a surrogate chemical. Comparison to surrogate ESLs provides an estimate of potential effects of a chemically related compound and a line of evidence to indicate the likelihood that ecological receptors are potentially impacted.

Some COPECs without ESLs do not have chemical-specific toxicity data or surrogate chemicals to be used in the screening assessments and cannot be assessed quantitatively for potential ecological risk. These COPECs are often infrequently detected across the site. In these cases, comparisons to residential human health SSLs are presented as part of a qualitative assessment. The comparison of COPEC concentrations to residential human health SSLs is a viable alternative for several reasons. Animal studies are used to infer effects on humans and is the basic premise of modern toxicology (EPA 1989, 008021). In addition, toxicity values derived for the calculation of human health SSLs are often based on potential effects that are more sensitive than the ones used to derive ESLs (e.g., cellular effects for humans versus survival or reproductive effects for terrestrial animals). The EPA also applies uncertainty factors or modifying factors to ensure that the toxicity values are protective (i.e., they are adjusted by uncertainty factors to values much lower than the study results). COPEC concentrations compared with these values are an order of magnitude or more below the SSLs, which corresponds to uncertainty factors of 10 or more. Therefore, it is assumed the differences in toxicity would not be more than an order of magnitude for any given chemical. The relative difference between values provides a weight of evidence that the potential toxicity of the COPEC is likely to be low or very low to the receptor(s). The COPECs without ESLs were common to many of the sites and are discussed below for each site.

No ESLs are available for calcium, magnesium, and perchlorate, and no surrogate or other toxicity information are available.

Calcium was detected above BVs from 0.0 to 5.0 ft in five samples at SWMUs 49-004 and 49-005(a), with concentrations ranging from 2330 mg/kg to 8190 mg/kg. Concentrations were below the maximum soil background concentration (14,000 mg/kg). As presented in Table I-4.4-1, concentrations of calcium are substantially less than the NMED essential nutrient SSLs. Calcium is eliminated as a COPEC.

Magnesium was detected above BV from 0.0 to 5.0 ft in five samples at SWMUs 49-004 and 49-005(a), with concentrations ranging from 1780 mg/kg to 2530 mg/kg. Concentrations were below the maximum soil and Qbt 2,3,4 background concentrations (10,000 mg/kg and 2820 mg/kg). As presented in Table I-4.4-1, concentrations of magnesium are substantially less than the NMED essential nutrient SSLs. Magnesium is eliminated as a COPEC.

Perchlorate was detected from 0.0 to 5.0 ft at SWMU 49-004 in two samples with concentrations of 0.0012 mg/kg and 0.00139 mg/kg. The NMED residential SSL for perchlorate is 54.5 mg/kg, indicating that potential toxicity is low. Because of the potential low toxicity and infrequent detection, perchlorate is eliminated as a COPEC.

I-5.5 Interpretation of Ecological Risk Screening Results

I-5.5.1 Receptor Lines of Evidence

Based on the ecological risk-screening assessments, several COPECs (including COPECs without an ESL) were identified at the TA-49 sites outside the NES boundary. Receptors were evaluated using several lines of evidence: minimum ESL comparisons, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of detected concentrations, EPCs, and screening levels to background concentrations.

Plant

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the plant, were less than 0.3.
- The HIs for the plant were greater than 1 at all sites.
- The HI analyses using the LOAEL-based ESLs resulted in HIs less than or equivalent to 1 at all sites.
- Field observations made during the site visits found no indication of adverse effects on the plant community. In addition, most of the areas in and/or around the TA-49 sites outside the NES boundary were former industrial areas and the structures have been removed. The land has been undergoing naturalization with good quality habitat for plants and other biota.
- As discussed in section I-5.4.7, the potential risks to the plant were overestimated at SWMUs 49-004 and 49-005(a).

These lines of evidence support the conclusion no potential ecological risk to the plant exists at the TA-49 sites outside the NES boundary.

Earthworm (Invertebrate)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the earthworm, were less than 0.3.
- The HIs for the earthworm were greater than or equivalent to 1 at all sites.
- The HI analyses using the LOAEL-based ESLs resulted in HIs less than 1 for all sites.

These lines of evidence support the conclusion no potential ecological risk to the earthworm exists at the TA-49 sites outside the NES boundary.

Montane Shrew (Insectivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the shrew, were less than 0.3.
- The HIs for the shrew were greater than 1 at all sites.
- The HIs were adjusted by the PAUFs, which is the ratio of the site area to the shrew's population area. The adjusted HI was less than 1 at SWMU 49-005(a).

- The LOAEL-based ESL analyses adjusted by the PAUFs resulted in an HI less than 1 at AOC 49-002.
- As discussed in section I-5.4.7, the potential risk to the shrew was overestimated at SWMU 49-004.

These lines of evidence support the conclusion that no potential ecological risk to the montane shrew exists at the TA-49 sites outside the NES boundary.

Deer Mouse (Omnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the deer mouse, were less than 0.3.
- The HIs for the deer mouse were greater than 1 at all sites.
- The HIs were adjusted by the PAUFs, which is the ratio of the site area to the deer mouse's population area. The adjusted HI at SWMU 49-005(a) was less than 1. The HIs at the other sites could not be adjusted by a PAUF because the site areas were greater than the population area.
- The LOAEL-based ESL analysis resulted in an HI less than 1 at AOC 49-002.
- The LOAEL-based ESL analysis adjusted by the PAUF resulted in an HI equivalent to 1 at SWMU 49-004.
- As discussed in section I-5.4.7, the potential risk to the deer mouse was overestimated at SWMU 49-004.

These lines of evidence support the conclusion that no potential ecological risk to the deer mouse exists at the TA-49 sites outside the NES boundary.

Desert Cottontail (Herbivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the cottontail, were less than 0.3.
- The HIs for the cottontail were greater than 1 at AOC 49-002, equivalent to 1 at SWMU 49-004, and less than 1 at SWMU 49-005(a).
- The HIs were adjusted by the PAUFs, which is the ratio of the site area to the cottontail's population area. The adjusted HIs were less than 1 for all sites.

These lines of evidence support the conclusion that no potential ecological risk to the cottontail exists at the TA-49 sites outside the NES boundary.

Red Fox (Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the fox, were less than 0.3.
- The HIs for the red fox were less than 1 at all sites.

These lines of evidence support the conclusion that no potential ecological risk to the red fox exists at the TA-49 sites outside the NES boundary.

Pocket Gopher (Burrowing Mammal, Air Pathway Only)

- Initial screening using the minimum ESLs eliminated all soil gas COPECs because the HQs for the pocket gopher were less than 0.3.
- The HI for the pocket gopher was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the gopher exists at the TA-49 sites outside the NES boundary.

Robin (All Feeding Guilds)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the robin, were less than 0.3.
- The HIs for the robin (all feeding guilds) were greater than or equivalent to 1 at all sites.
- The HIs were adjusted by the PAUFs, which is the ratio of the site area to the robin's population area. The adjusted HIs were less than 1 for the robin (herbivore) at AOC 49-002 and less than 1 for all feeding guilds at SWMU 49-005(a).
- The LOAEL-based ESL analysis resulted in HIs less than 1 for all feeding guilds at AOC 49-002 and less than 1 for the robin (herbivore) at SWMU 49-004.
- The LOAEL-based ESL analyses adjusted by the PAUFs resulted in HIs equivalent to 1 for the robin (omnivore) and greater than 1 for the robin (insectivore) at SWMU 49-004.
- As discussed in section I-5.4.7, the potential risks to the robin were overestimated at SWMU 49-004.

These lines of evidence support the conclusion that no potential ecological risk to the robin (all feeding guilds) exists at the TA-49 sites outside the NES boundary.

Kestrel (Intermediate Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (intermediate carnivore), were less than 0.3.
- The HIs for the kestrel (intermediate carnivore) were greater than or equivalent to 1 at all sites.
- The HIs were adjusted by the PAUFs, which is the ratio of the site area to the kestrel's population area. The adjusted HIs were less than 1 for all sites.

These lines of evidence support the conclusion that no potential ecological risk to the kestrel (intermediate carnivore) exists at the TA-49 sites outside the NES boundary.

Kestrel (Top Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (top carnivore), were less than 0.3.
- The HIs for the kestrel (top carnivore) were less than 1 at all sites.
- The kestrel (top carnivore) is a surrogate for the Mexican spotted owl. The HIs were adjusted by the Mexican spotted owl AUFs. The adjusted HIs were less than 1 at all sites.

These lines of evidence support the conclusion that no potential ecological risks to the kestrel (top carnivore) and the Mexican spotted owl exist at the TA-49 sites outside the NES boundary.

I-5.5.2 COPECs with No ESLs

COPECs without ESLs were eliminated based on comparisons to human health SSLs and frequency of detection. The analysis of COPECs without ESLs supports the conclusion that no potential ecological risk to receptors exists at the TA-49 sites outside the NES boundary.

I-5.5.3 Summary

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, the relationship of EPCs and screening levels to background, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, red fox, pocket gopher, and Mexican spotted owl exist at the TA-49 sites outside the NES boundary.

I-6.0 CONCLUSIONS

I-6.1 Human Health Risk

No potential unacceptable risks for the TA-49 sites outside the NES boundary exist under the industrial, construction worker, and residential scenarios. The total excess cancer risks were less than the 1×10^{-5} target risk level and the HIs were less than or equivalent to 1.

The total doses were below the target dose limit of 25 mrem/yr as authorized by DOE Order 458.1 for the industrial, construction worker, and residential scenarios at all sites. The total doses were equivalent to total risks ranging from 2×10^{-9} to 1×10^{-7} for the construction worker scenario, from 1×10^{-8} to 4×10^{-7} for the industrial scenario, and from 3×10^{-8} to 1×10^{-6} for the residential scenario, based on conversion from dose using RESRAD Version 7.0.

Sites at TA-49 are not accessible by the public and are not planned for release by DOE in the foreseeable future. Therefore, an as low as reasonably achievable (ALARA) evaluation for radiological exposure to the public is not currently required. Should DOE’s plans for releasing these areas change, an ALARA evaluation will be conducted at that time. It should be noted that the Laboratory addresses considerations for radiation exposures to workers under the Laboratory’s occupational radiological protection program in compliance with 10 Code of Federal Regulations 835. The Laboratory’s radiation protection program implements ALARA and consists of the following elements: management commitment, training, design review, radiological work review, performance assessments, and documentation.

I-6.2 Ecological Risk

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, the relationship of EPCs and screening levels to background, no potential unacceptable ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, red fox, pocket gopher, and Mexican spotted owl exist at the TA-49 sites outside the NES boundary.

I-7.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

ATSDR (Agency for Toxic Substances and Disease Registry), 1997. ATSDR's Toxicology Profiles on CD-ROM. (ATSDR 1997, 056531)

Bowman, J., J.A.G. Jaeger, and L. Fahrig, 2002. "Dispersal Distance of Mammals is Proportional to Home Range Size," *Ecology,* Vol. 83, No. 7, pp. 2049-2055. (Bowman et al. 2002, 073475)

EPA (U.S. Environmental Protection Agency), December 1989. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A), Interim Final," EPA/540/1-89/002, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1989, 008021)

EPA (U.S. Environmental Protection Agency), December 1993. "Wildlife Exposure Factors Handbook," Vol. I of II, EPA/600/R-93/187a, Office of Research and Development, Washington, D.C. (EPA 1993, 059384)

EPA (U.S. Environmental Protection Agency), May 1996. "Soil Screening Guidance: Technical Background Document," EPA/540/R-95/128, Office of Solid Waste and Emergency Response, Washington, D.C. (EPA 1996, 059902)

EPA (U.S. Environmental Protection Agency), 1996. "Superfund Chemical Data Matrix," EPA/540/R-96/028, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1996, 064708)

EPA (U.S. Environmental Protection Agency), June 5, 1997. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final," Office of Emergency and Remedial Response, Washington, D.C. (EPA 1997, 059370)

EPA (U.S. Environmental Protection Agency), April 1998. "Guidelines for Ecological Risk Assessment," EPA/630/R-95/002F, Risk Assessment Forum, Washington, D.C. (EPA 1998, 062809)

EPA (U.S. Environmental Protection Agency), October 7, 1999. "Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites," OSWER Directive No. 9285.7-28 P, Office of Solid Waste and Emergency Response, Washington, D.C. (EPA 1999, 070086)

EPA (U.S. Environmental Protection Agency), December 2002. "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites," OSWER Directive No. 9285.6-10, Office of Emergency and Remedial Response, Washington, D.C. (EPA 2002, 085640)

EPA (U.S. Environmental Protection Agency), November 2003. “Ecological Soil Screening Level for Aluminum, Interim Final,” OSWER Directive No. 9285.7-60, Office of Solid Waste and Emergency Response, Washington, D.C. (EPA 2003, 085645)

EPA (U.S. Environmental Protection Agency), September 2011. “Exposure Factors Handbook: 2011 Edition,” EPA/600/R-09/052F, Office of Research and Development, Washington, D.C. (EPA 2011, 208374)

EPA (U.S. Environmental Protection Agency), December 2012. “Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil,” OSWER 9200.1-113, Washington, D.C. (EPA 2012, 262543)

EPA (U.S. Environmental Protection Agency), December 2012. “Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil,” OSWER 9200.1-113, Washington, D.C. (EPA 2012, 262542)

EPA (U.S. Environmental Protection Agency), September 2013. “ProUCL Version 5.0.00 User Guide,” Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations, EPA/600/R-07/041, Office of Research and Development, Washington, D.C. (EPA 2013, 251074)

Kincaid, C.T., M.P. Bergeron, C.R. Cole, M.D. Freshley, N. Hassig, V.G. Johnson, D.I. Kaplan, R.J. Serne, G.P. Steile, D.L. Strenge, P.D. Thorne, L.W. Vail, G.A. Whyatt, and S.K. Wurstner, March 1998. “Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site,” Pacific Northwest Laboratory report PNNL-11800, Richland, Washington. (Kincaid et al. 1998, 093270)

LANL (Los Alamos National Laboratory), May 1992. “RFI Work Plan for Operable Unit 1144,” Los Alamos National Laboratory document LA-UR-92-900, Los Alamos, New Mexico. (LANL 1992, 007670)

LANL (Los Alamos National Laboratory), June 1999. “General Assessment Endpoints for Ecological Risk Assessment at Los Alamos National Laboratory,” report prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1999, 064137)

LANL (Los Alamos National Laboratory), October 2007. “Historical Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary,” Los Alamos National Laboratory document LA-UR-07-6078, Los Alamos, New Mexico. (LANL 2007, 098492)

LANL (Los Alamos National Laboratory), January 2008. “Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1,” Los Alamos National Laboratory document LA-UR-08-0449, Los Alamos, New Mexico. (LANL 2008, 102215)

LANL (Los Alamos National Laboratory), January 2008. “Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary, Revision 1,” Los Alamos National Laboratory document LA-UR-08-0447, Los Alamos, New Mexico. (LANL 2008, 102691)

LANL (Los Alamos National Laboratory), September 2010. “Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1,” Los Alamos National Laboratory document LA-UR-10-6033, Los Alamos, New Mexico. (LANL 2010, 110654.16)

LANL (Los Alamos National Laboratory), March 2011. “Phase II Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary,” Los Alamos National Laboratory document LA-UR-11-1818, Los Alamos, New Mexico. (LANL 2011, 201570)

LANL (Los Alamos National Laboratory), September 2015. “Derivation and Use of Radionuclide Screening Action Levels, Revision 4,” Los Alamos National Laboratory document LA-UR-15-24859, Los Alamos, New Mexico. (LANL 2015, 600929)

LANL (Los Alamos National Laboratory), October 2015. “Screening-Level Ecological Risk Assessment Methods, Revision 4,” Los Alamos National Laboratory document LA-UR-15-27577, Los Alamos, New Mexico. (LANL 2015, 600982)

LANL (Los Alamos National Laboratory), October 2015. “ECORISK Database (Release 3.3),” on CD, LA-UR-15-27397, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2015, 600921)

LANL (Los Alamos National Laboratory), July 2016. “Supplemental Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary,” Los Alamos National Laboratory document LA-UR-16-25263, Los Alamos, New Mexico. (LANL 2016, 601561)

Ney, R.E., 1995. Excerpted pages from *Fate and Transport of Organic Chemicals in the Environment: A Practical Guide*, 2nd Ed., Government Institutes, Inc., Rockville, Maryland. (Ney 1995, 058210)

NMED (New Mexico Environment Department), November 24, 2003. “LANL's Risk Reduction and Environmental Stewardship (RRES) Remediation Services Project Use of Surrogate Chemicals in Risk Assessments,” New Mexico Environment Department letter to D. Gregory (DOE-LASO) and G.P. Nanos (LANL Director) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2003, 081172)

NMED (New Mexico Environment Department), February 14, 2008. “Approval with Modifications, Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary,” New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2008, 100465)

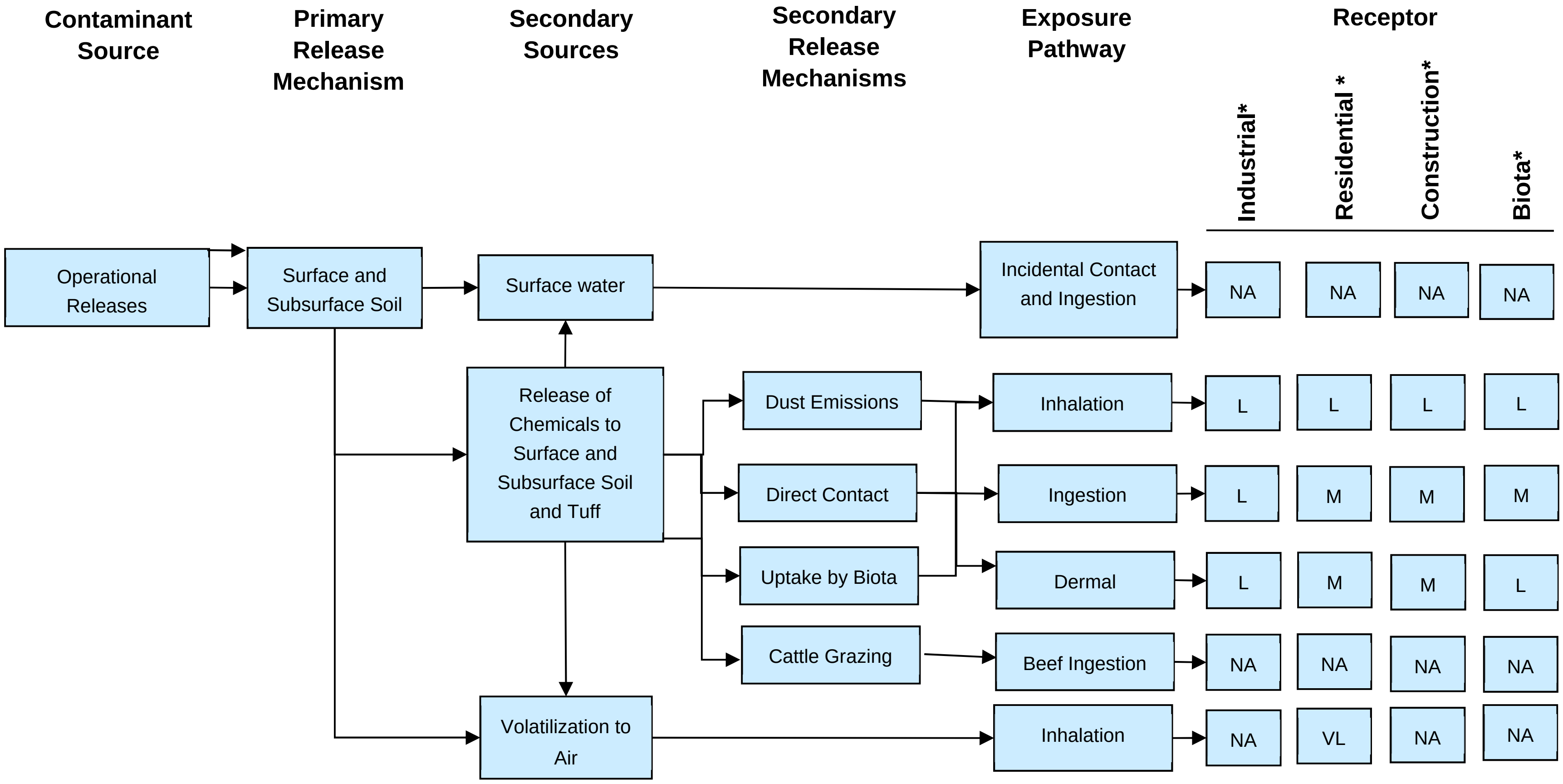
NMED (New Mexico Environment Department), September 22, 2010. “Approval with Modifications, Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1,” New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 110859)

NMED (New Mexico Environment Department), June 30, 2011. “Approval, Phase II Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary,” New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 204345)

NMED (New Mexico Environment Department), July 2015. “Risk Assessment Guidance for Site Investigations and Remediation,” Hazardous Waste Bureau and Ground Water Quality Bureau, Santa Fe, New Mexico. (NMED 2015, 600915)

Purtymun, W.D., and A.K. Stoker, November 1987. “Environmental Status of Technical Area 49, Los Alamos, New Mexico,” Los Alamos National Laboratory report LA-11135-MS, Los Alamos, New Mexico. (Purtymun and Stoker 1987, 006688)

Whicker, F., and V. Schultz, 1982. Excerpted pages from *Radioecology: Nuclear Energy and the Environment*, Vol. 1, CRC Press, Boca Raton, Florida. (Whicker and Schultz 1982, 058209)



Exposure Pathway	Industrial*	Residential *	Construction*	Biota*
Incidental Contact and Ingestion	NA	NA	NA	NA
Inhalation	L	L	L	L
Ingestion	L	M	M	M
Dermal	L	M	M	L
Beef Ingestion	NA	NA	NA	NA
Inhalation	NA	VL	NA	NA

* Very Low (VL), Low (L), and Moderate (M) designations indicate the pathway is a potentially complete pathway and is evaluated in the risk assessments.
Not Applicable (NA) indicates the pathway is incomplete and is not evaluated in the risk assessments.

Figure I-3.1-1 CSM for TA-49 sites outside the NES boundary

Table I-2.3-1
EPCs at AOC 49-002 for the Industrial, Construction Worker, and Residential Scenarios and Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Aluminum	71	71	3210	20,500	Normal	11600	95% Student's-t
Antimony	71	2	0.413(U)	13.9	n/a*	13.9	Maximum detected concentration
Barium	71	71	41.3	247	Normal	165	95% Student's-t
Copper	71	71	2.82	98.9	Nonparametric	10.8	95% Student's-t
Mercury	71	59	0.00533	0.72	Lognormal	0.0533	95% KM (BCA)
Zinc	71	71	20.3	446	Nonparametric	76.7	95% Chebyshev (Mean, Sd)
Radionuclides (pCi/g)							
Americium-241	71	1	-0.00905(U)	0.34(U)	n/a	0.184	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table I-2.3-2
EPCs at SWMU 49-004 for the Industrial Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Aluminum	148	148	5740	35,100	Nonparametric	12900	95% Student's-t
Antimony	148	96	0.074	6(UJ)	Lognormal	0.208	95% KM (BCA)
Barium	148	148	88.7	403	Normal	199	95% Student's-t
Chromium (Total)	148	148	4.9	14.4	Normal	9.85	95% Student's-t
Cobalt	148	148	2.5	14.9	Nonparametric	6.47	95% Student's-t
Copper	148	148	4	120	Nonparametric	11	95% Student's-t
Lead	148	148	5.6	45.5	Nonparametric	16.3	95% Student's-t
Nickel	148	148	4.9	19.6	Gamma	9.02	95% Approximate gamma

Table I-2.3-2 (continued)

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Perchlorate	4	2	0.0012	0.0024(U)	n/a*	0.00139	Maximum detected concentration
Selenium	148	126	0.22(UJ)	1.9	Lognormal	1.11	95% KM (BCA)
Silver	148	94	0.028	11.6	Lognormal	0.368	95% KM (BCA)
Uranium	18	18	1.59	10.7	Nonparametric	6.54	95% Chebyshev (Mean, Sd)
Zinc	148	148	12.3	812	Nonparametric	75.6	95% Chebyshev (Mean, Sd)
Radionuclides (pCi/g)							
Americium-241	165	5	-0.251(U)	0.263	Normal	0.263	Maximum detected concentration
Cesium-134	127	1	-0.109(U)	0.073	n/a	0.073	Maximum detected concentration
Cesium-137	161	38	-0.036(U)	3.28	Nonparametric	0.243	95% KM Chebyshev
Plutonium-238	148	8	-0.027(U)	0.04(U)	Normal	0.025	Maximum detected concentration
Plutonium-239/240	148	31	-0.0319(U)	0.998	Nonparametric	0.0275	95% KM Chebyshev

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table I-2.3-3
EPCs at SWMU 49-004 for the Construction Worker and Residential Scenarios

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Aluminum	157	157	5740	35,100	Nonparametric	12900	95% Student's-t
Antimony	157	96	0.074	6.4(UJ)	Lognormal	0.208	95% KM (BCA)
Barium	157	157	88.7	403	Normal	196	95% Student's-t
Chromium (Total)	157	157	4.9	14.4	Normal	9.86	95% Student's-t
Cobalt	157	157	1.67	14.9	Nonparametric	6.49	95% Student's-t
Copper	157	157	3.69	339	Nonparametric	21.6	95% Chebyshev (Mean, Sd)
Iron	157	157	5750	19,000	Normal	12800	95% Student's-t

Table I-2.3-3 (continued)

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Lead	157	157	5.6	64.5	Nonparametric	17	95% Student's-t
Nickel	157	157	4.9	19.6	Gamma	9.02	95% Approximate gamma
Perchlorate	8	5	0.0012	0.00802	Normal	0.00415	95% KM (t)
Selenium	157	128	0.21(UJ)	1.9	Lognormal	1.05	95% KM (BCA)
Silver	157	99	0.028	11.6	Lognormal	0.373	95% KM (BCA)
Uranium	23	23	1.59	10.7	Lognormal	5.86	95% Chebyshev (Mean, Sd)
Zinc	157	157	12.3	812	Nonparametric	75	95% Chebyshev (Mean, Sd)
Organic Chemicals (mg/kg)							
Bis(2-ethylhexyl)phthalate	14	1	0.35(U)	10.1	n/a*	10.1	Maximum detected concentration
Chloronaphthalene[2-]	14	1	0.0368(U)	0.4(U)	n/a	0.36	Maximum detected concentration
Methylene chloride	8	1	0.00274	0.00577(U)	n/a	0.00274	Maximum detected concentration
Methylnaphthalene[2-]	14	1	0.0138	0.4(U)	n/a	0.0138	Maximum detected concentration
Naphthalene	14	1	0.0207	0.4(U)	n/a	0.0207	Maximum detected concentration
Pyrene	14	1	0.0172	0.4(U)	n/a	0.0172	Maximum detected concentration
Radionuclides (pCi/g)							
Americium-241	181	7	-0.251(U)	0.43	Normal	0.43	Maximum detected concentration
Cesium-134	139	1	-0.109(U)	0.13(U)	n/a	0.073	Maximum detected concentration
Cesium-137	173	38	-0.036(U)	3.28	Nonparametric	0.224	95% KM Chebyshev
Plutonium-238	157	8	0.005	0.04(U)	Normal	0.025	Maximum detected concentration
Plutonium-239/240	157	36	-0.0319(U)	0.998	Nonparametric	0.036	95% KM Chebyshev
Tritium	8	2	0.00186(U)	0.0314	n/a	0.0314	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table I-2.3-4
EPCs at SWMU 49-004 for Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	150	96	0.074	6.4(UJ)	Lognormal	0.206	95% KM (BCA)
Barium	150	150	88.7	403	Normal	198	95% Student's-t
Chromium (Total)	150	150	4.9	14.4	Normal	9.85	95% Student's-t
Cobalt	150	150	2.5	14.9	Nonparametric	6.48	95% Student's-t
Copper	150	150	4	120	Nonparametric	11	95% Student's-t
Lead	150	150	5.6	45.5	Nonparametric	16.3	95% Student's-t
Nickel	150	150	4.9	19.6	Gamma	9.01	95% Approximate gamma
Selenium	150	126	0.21(UJ)	1.9	Lognormal	1.08	95% KM (BCA)
Silver	150	95	0.028	11.6	Lognormal	0.373	95% KM (BCA)
Uranium	20	20	1.59	10.7	Nonparametric	6.23	95% Chebyshev (Mean, Sd)
Zinc	150	150	12.3	812	Nonparametric	75.3	95% Chebyshev (Mean, Sd)
Radionuclides (pCi/g)							
Americium-241	171	6	-0.251(U)	0.43	Normal	0.43	Maximum detected concentration
Cesium-134	133	1	-0.109(U)	0.12(U)	n/a*	0.073	Maximum detected concentration
Cesium-137	167	38	-0.036(U)	3.28	Nonparametric	0.233	95% KM Chebyshev
Plutonium-238	150	8	0.005	0.04(U)	Normal	0.025	Maximum detected concentration
Plutonium-239/240	150	33	-0.0319(U)	0.998	Nonparametric	0.0328	95% KM Chebyshev

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table I-2.3-5
EPCs at SWMU 49-005(a) for the Industrial Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Uranium	2	2	2.3	2.51	n/a*	2.51	Maximum detected concentration
Organic Chemicals (mg/kg)							
Bis(2-ethylhexyl)phthalate	6	1	0.16	0.39(U)	n/a	0.16	Maximum detected concentration
Butanone[2-]	4	1	0.0018	0.024(U)	n/a	0.0018	Maximum detected concentration
Radionuclides (pCi/g)							
Plutonium-238	6	1	-0.012(U)	0.032	n/a	0.032	Maximum detected concentration
Plutonium-239/240	6	2	0.0114(U)	0.083	n/a	0.083	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table I-2.3-6
EPCs at SWMU 49-005(a) for the Construction Worker and Residential Scenarios

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Aluminum	18	18	1630	21,900	Normal	10600	95% Student's-t
Antimony	18	2	0.08(U)	0.81(UJ)	n/a*	0.79	Maximum detected concentration
Arsenic	18	16	0.96	3.4	Normal	2.49	95% KM (t)
Barium	18	18	26.6	207	Normal	132	95% Student's-t
Beryllium	18	16	0.45	1.9	Nonparametric	1.25	95% KM (Chebyshev)
Chromium (Total)	18	18	4.2	18.4	Normal	9.05	95% Student's-t
Cobalt	18	18	1.1	6.4	Normal	3.97	95% Student's-t
Copper	18	18	1.9	8.5	Normal	6.23	95% Student's-t
Nickel	18	18	3.9	12.1	Normal	7.89	95% Student's-t

Table I-2.3-6 (continued)

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Perchlorate	14	1	0.0037	0.0059(U)	n/a	0.0037	Maximum detected concentration
Selenium	18	16	0.77	1.3	Normal	1.06	95% KM (t)
Uranium	4	4	2.13	4.09	n/a	4.09	Maximum detected concentration
Vanadium	18	18	4.5	22.6	Normal	16.5	95% Student’s-t
Organic Chemicals (mg/kg)							
Bis(2-ethylhexyl)phthalate	18	2	0.046	0.39(U)	n/a	0.16	Maximum detected concentration
Butanone[2-]	14	1	0.0018	0.024(U)	n/a	0.0018	Maximum detected concentration
Radionuclides (pCi/g)							
Plutonium-238	18	2	-0.014(U)	0.032	n/a	0.032	Maximum detected concentration
Plutonium-239/240	18	2	-0.0012(U)	0.083	n/a	0.083	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table I-2.3-7
EPCs at SWMU 49-005(a) for Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	11	2	0.16(U)	0.79	n/a*	0.79	Maximum detected concentration
Arsenic	11	9	1.2(U)	3.2	Normal	2.72	95% KM (t)
Barium	11	11	62.1	207	Normal	164	95% Student’s-t
Beryllium	11	9	0.51(U)	1.2	Normal	0.98	95% KM (t)
Chromium (Total)	11	11	4.4	18.4	Gamma	11	95% Adjusted gamma
Cobalt	11	11	2.1	6.4	Normal	4.97	95% Student’s-t
Copper	11	11	4.3	8.5	Normal	6.74	95% Student’s-t
Nickel	11	11	3.9	9	Normal	8.11	95% Student’s-t
Selenium	11	10	0.77	1	Normal	0.915	95% KM (t)

Table I-2.3-7 (continued)

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Uranium	3	3	2.13	2.51	n/a	2.51	Maximum detected concentration
Vanadium	11	11	8.9	22.6	Normal	19.7	95% Student's-t
Organic Chemicals (mg/kg)							
Bis(2-ethylhexyl)phthalate	11	1	0.16	0.39(U)	n/a	0.16	Maximum detected concentration
Butanone[2-]	8	1	0.0018	0.024(U)	n/a	0.0018	Maximum detected concentration
Radionuclides (pCi/g)							
Plutonium-238	11	1	-0.012(U)	0.032	n/a	0.032	Maximum detected concentration
Plutonium-239/240	11	2	-0.0012(U)	0.083	n/a	0.083	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table I-3.2-1
Physical and Chemical Properties of Inorganic COPCs for TA-49 Sites Outside the NES Boundary

COPC	K_d[a] (cm^3/g)	Water Solubility[a,b] (g/L)
Aluminum	1500	Insoluble
Antimony	45	Insoluble
Arsenic	29	Insoluble
Barium	41	Insoluble
Beryllium	790	Insoluble
Chromium (Total)	850	Insoluble
Cobalt	45	Insoluble
Copper	35	Insoluble
Iron	25	Insoluble
Lead	900	Insoluble
Mercury	52	Insoluble
Nickel	65	Insoluble
Perchlorate	na[c]	245
Selenium	5	Insoluble
Uranium	0.4	Insoluble
Vanadium	1000	Insoluble
Zinc	62	Insoluble

[a] Information from http://rais.ornl.gov/cgi-bin/tox/TOX_select?select=nrad.

[b] Denotes reference information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] na = Not available.

Table I-3.2-2
Physical and Chemical Properties of Organic COPCs for TA-49 Sites Outside the NES Boundary

COPC	Water Solubility[a] (mg/L)	Organic Carbon Coefficient K_{oc}[a] (L/kg)	Log Octanol-Water Partition Coefficient K_{ow}[a]	Vapor Pressure[a] (mm Hg at 25°C)
Acetone	1.00E+06[b]	1.98E+00	-2.40E-01[b]	2.31E+02[b]
Benzene	1.79E+03	1.66E+02	2.13E+00	1.79E+03
Bis(2-ethylhexyl)phthalate	2.70E-01[b]	1.65E+05	7.60E+00[b]	1.42E-07[b]
Butanone[2-]	2.23E+05	3.83E+00	2.90E-01	9.06E+01
Chloromethane	5.32E+03	1.43E+01	9.10E-01	4.30E+03
Chloronaphthalene[2-]	2.98E+03	3.98E+00	1.17E+01	9.03E-03
Dichlorodifluoromethane	2.70E+03	3.18E+01	2.16E+00	4.85E+03
Ethylbenzene	1.69E+02	5.18E+02	3.15E+00	9.60E+00
Ethyltoluene[4-]	4.00E+01	na[c]	3.63E+00	6.66E+02
Methylene chloride	1.30E+04[b]	2.37E+01	1.30E+00[b]	4.30E+02[b]
Methylnaphthalene[2-]	2.46E+01	2.98E+03	3.86E+00	5.50E-02
Naphthalene	3.10E+01	1.84E+03	3.30E+00	8.50E-02
Pyrene	1.35E-01[b]	6.94E+04	4.88E+00[b]	4.50E-06[b]
Styrene	3.10E+02	5.18E+02	2.95E+00	6.40E+00
Toluene	5.26E+02	2.68E+02	2.73E+00	2.84E+01
Trimethylbenzene[1,2,4-]	5.70E+01	7.18E+02	3.63E+00	2.10E+00
Trimethylbenzene[1,3,5-]	4.82E+01	6.02E+02	3.42E+00	2.10E+00
Xylene (Total)	1.78E+02	3.83E+02	3.12E+00	7.99E+00
Xylene[1,2-]	1.61E+02	4.34E+02	3.20E+00	8.29E+00
Xylene[1,3-]+1,4-xylene[d]	1.78E+02	3.83E+02	3.12E+00	7.99E+00

[a] Information from http://rais.ornl.gov/cgi-bin/tools/TOX_search, unless noted otherwise.

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] na = Not available.

[d] Xylenes used as a surrogate.

Table I-3.2-3
Physical and Chemical Properties of Radionuclide COPCs for TA-49 Sites Outside the NES Boundary

COPC	Soil-Water Partition Coefficient, K_d[a] (cm^3/g)	Water Solubility[b] (g/L)
Americium-241	680	Insoluble
Cesium-134	1000	Insoluble
Cesium-137	1000	Insoluble
Plutonium-238	4500	Insoluble
Plutonium-239/240	4500	Insoluble
Tritium	9.9	Soluble

[a] Superfund Chemical Data Matrix (EPA 1996, 064708).

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

Table I-4.1-1
Exposure Parameters Used to Calculate Chemical SSLs for the Industrial, Construction Worker, and Residential Scenarios

Parameters	Industrial Values	Construction Worker Values	Residential Values
Target HQ	1	1	1
Target cancer risk	10^{-5}	10^{-5}	10^{-5}
Averaging time (carcinogen/mutagen)	70 yr × 365 d	70 yr × 365 d	70 yr × 365 d
Averaging time (noncarcinogen)	ED × 365 d	ED × 365 d	ED × 365 d
Skin absorption factor	Semivolatile organic compound (SVOC) = 0.1	SVOC = 0.1	SVOC = 0.1
	Chemical-specific	Chemical-specific	Chemical-specific
Adherence factor–child	n/a[a]	n/a	0.2 mg/cm^2
Body weight–child	n/a	(mg/kg-d)$^{-1}$	15 kg (0–6 yr of age)
Cancer slope factor–oral (chemical-specific)	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$
Inhalation unit risk (chemical-specific)	(µg/m^3)	(µg/m^3)	(µg/m^3)
Exposure frequency	225 d/yr	250 d/yr	350 d/yr
Exposure time	8 h/day	n/a	24 h/d
Exposure duration–child	n/a	n/a	6 yr[b]
Age-adjusted ingestion factor for carcinogens	n/a	n/a	36,750 mg/kg
Age-adjusted ingestion factor for mutagens	n/a	n/a	25,550 mg/kg
Soil ingestion rate–child	n/a	n/a	200 mg/d
Particulate emission factor	6.61×10^9 m^3/kg	2.1×10^6 m^3/kg	6.61×10^9 m^3/kg
Reference dose–oral (chemical-specific)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)
Reference dose–inhalation (chemical-specific)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)
Exposed surface area–child	n/a	n/a	2690 cm^2/d
Age-adjusted skin contact factor for carcinogens	n/a	n/a	112266 mg/kg
Age-adjusted skin contact factor for mutagens	n/a	n/a	166833 mg/kg
Volatilization factor for soil (chemical-specific)	(m^3/kg)	(m^3/kg)	(m^3/kg)
Body weight–adult	80 kg	80 kg	80 kg
Exposure duration[c]	25 yr	1 yr	30 yr[d]
Adherence factor–adult	0.12 mg/cm^2	0.3 mg/cm^2	0.07 mg/cm^2
Soil ingestion rate–adult	100 mg/d	330 mg/d	100 mg/d
Exposed surface area–adult	3470 cm^2/d	3300 cm^2/d	6032 cm^2/d

Note: Parameter values from NMED (2015, 600915).

[a] n/a = Not applicable.

[b] The child exposure duration for mutagens is subdivided into 0–2 yr and 2–6 yr.

[c] Exposure duration for lifetime resident is 26 yr. For carcinogens, the exposures are combined for child (6 yr) and adult (20 yr).

[d] The adult exposure duration for mutagens is subdivided into 6–16 yr and 16–30 yr.

Table I-4.1-2
Parameter Values Used to Calculate Radionuclide SALs for the Residential Scenario

Parameters	Residential, Child	Residential, Adult
Inhalation rate (m^3/yr)	4712[a]	7780[b]
Mass loading (g/m^3)	1.51×10^{-7} [c]	1.51×10^{-7} [c]
Outdoor time fraction	0.0926[d]	0.0934[e]
Indoor-time fraction	0.8656[f]	0.8648[g]
Soil ingestion (g/yr)	73[h]	36.5[i]

[a] Calculated as 12.9 m^3/d × 365.25 d/yr, where 12.9 m^3/d is the mean upper percentile daily inhalation rate of a child (EPA 2011, 208374, Table 6-1).

[b] Calculated as 21.3 m^3/d × 365.25 d/yr, where 21.3 m^3/d is the mean upper percentile daily inhalation rate of an adult from 21 yr to less than 61 yr old (EPA 2011, 208374, Table 6-1).

[c] Calculated as ($1 / 6.6 \times 10^9$ m^3/kg) × 1000 g/kg, where 6.6×10^9 m^3/kg is the particulate emission factor (NMED 2015, 600915).

[d] Calculated as (2.32 h/d × 350 d/yr) / 8766 h/yr, where 2.32 h/d (139 min) is the largest amount of time spent outdoors for child age groups between 1 to less than 3 mo and 3 to less than 6 yr (EPA 2011, 208374, Table 16-1) and is comparable with the adult time spent outdoors at a residence.

[e] Calculated as (2.34 h/d × 350 d/yr) / 8766 h/yr, where 4.68 h/d is the average total time spent outdoors for adults age 18 to less than 65 yr in all environments (EPA 2011, 208374, Table 16-1); 50% of this value (2.34 h/d) was applied to time spent outdoors at a residence and is similar to mean time outdoors at a residence for this age group (EPA 2011, 208374, Table 16-22).

[f] Calculated as [(24 h/d–2.32 h/d) × 350 d/yr] / 8766 h/yr.

[g] Calculated as [(24 h/d–2.34 h/d) × 350 d/yr] / 8766 h/yr.

[h] The soil ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil ingestion pathway. Calculated as [0.2 g/d × 350 d/yr] / [indoor + outdoor time fractions], where 0.2 g/d is the upper percentile site-related daily child soil ingestion rate (NMED 2015, 600915; EPA 2011, 208374, Table 5-1).

[i] The soil ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil ingestion pathway. Calculated as [0.1 g/d × 350 d/yr] / [indoor + outdoor time fractions], where 0.1 g/d is the site-related daily adult soil ingestion rate (NMED 2015, 600915).

Table I-4.1-3
Parameter Values Used to Calculate Radionuclide SALs for the Industrial and Construction Worker Scenarios

Parameters	Industrial, Adult	Construction Worker, Adult
Inhalation rate (m^3/yr)	7780[a]	7780[a]
Mass loading (g/m^3)	1.51×10^{-7} [b]	4.76×10^{-7} [c]
Outdoor time fraction	0.2053[d]	0.2282[e]
Indoor time fraction	0[f]	0
Soil ingestion (g/yr)	109.6[g]	362[h]

[a] Calculated as [21.3 m^3/d × 365.25 d/yr], where 21.3 m^3/d is the upper percentile daily inhalation rate of an adult from 21 to less than 61 yr old (EPA 2011, 208374, Table 6-1).

[b] Calculated as (1 / 6.6×10^9 m^3/kg) x 1000 g/kg, where 6.6×10^9 m^3/kg is the particulate emission factor (NMED 2015, 600915).

[c] Calculated as (1 / 2.1×10^6 m^3/kg) x 1000 g/kg, where 6.6×10^9 m^3/kg is the particulate emission factor (NMED 2015, 600915).

[d] Calculated as (8 h/d × 225 d/yr) / 8766 h/yr, where 8 h/d is an estimate of the average length of the work day and 225 d/yr is the exposure frequency (NMED 2015, 600915).

[e] Calculated as (8 h/d × 250 d/yr) / 8766 h/yr, where 8 h/d is an estimate of the average length of the work day and 250 d/yr is the exposure frequency (NMED 2015, 600915).

[f] The commercial/industrial worker is defined as someone who “spends most of the work day conducting maintenance or manual labor activities outdoors” (NMED 2015, 600915).

[g] The soil-ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil-ingestion pathway. Calculated as [0.1 g/d × 225 d/yr] / [indoor + outdoor time fractions], where 0.1 g/d is the site-related daily adult soil-ingestion rate (NMED 2015, 600915).

[h] The soil-ingestion rate compensates for the time-based occupancy factor applied by RESRAD in calculating exposure from the soil-ingestion pathway. Calculated as [0.33 g/d × 250 d/yr] / [indoor + outdoor time fractions], where 0.33 g/d is the site-related daily adult soil-ingestion rate (NMED 2015, 600915).

Table I-4.2-1
Industrial Noncarcinogenic Screening Evaluation for AOC 49-002

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	HQ
Aluminum	11,600	1,290,000	8.99E-03
Antimony	13.9	519	2.68E-02
Barium	165	255,000	6.47E-04
Copper	10.8	51,900	2.08E-04
Mercury	0.0533	389	1.37E-04
Zinc	76.7	389,000	1.97E-04
		HI	**0.04**

*SSLs from NMED (2015, 600915).

Table I-4.2-2
Industrial Radionuclide Screening Evaluation for AOC 49-002

COPC	EPC (pCi/g)	Industrial SAL* (pCi/g)	Dose (mrem/yr)
Americium-241	0.184	1000	4.60E-03
		Total Dose	**0.005**

*SALs from LANL (2015, 600929).

Table I-4.2-3
Construction Worker Noncarcinogenic Screening Evaluation for AOC 49-002

COPC	EPC (mg/kg)	Construction Worker SSL* (mg/kg)	HQ
Aluminum	11,600	41,400	2.80E-01
Antimony	13.9	142	9.79E-02
Barium	165	4390	3.76E-02
Copper	10.8	14,200	7.61E-04
Mercury	0.0559	20.7	2.70E-03
Zinc	76.7	1,006,000	7.62E-05
		HI	**0.4**

*SSLs from NMED (2015, 600915).

Table I-4.2-4
Construction Worker Radionuclide Screening Evaluation for AOC 49-002

COPC	EPC (pCi/g)	Construction Worker SAL* (pCi/g)	Dose (mrem/yr)
Americium-241	0.184	230	2.00E-02
		Total Dose	**0.02**

*SALs from LANL (2015, 600929).

Table I-4.2-5
Residential Noncarcinogenic Screening Evaluation for AOC 49-002

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	HQ
Aluminum	11,600	78,000	1.49E-01
Antimony	13.9	31.3	4.44E-01
Barium	165	15,600	1.06E-02
Copper	10.8	3130	3.45E-03
Mercury	0.0559	23.5	2.38E-03
Zinc	76.7	23,500	3.26E-03
		HI	**0.6**

*SSLs from NMED (2015, 600915).

Table I-4.2-6
Residential Radionuclide Screening Evaluation for AOC 49-002

COPC	EPC (pCi/g)	Residential SAL* (pCi/g)	Dose (mrem/yr)
Americium-241	0.184	83	5.54E-02
		Total Dose	**0.06**

*SALs from LANL (2015, 600929).

Table I-4.2-7
Industrial Carcinogenic Screening Evaluation for SWMU 49-004

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	Cancer Risk
Chromium (Total)	9.85	505	1.95E-07
		Total Excess Cancer Risk	**2E-07**

*SSLs from NMED (2015, 600915).

Table I-4.2-8
Industrial Noncarcinogenic Screening Evaluation for SWMU 49-004

COPC	EPC (mg/kg)	Industrial SSL[a] (mg/kg)	HQ
Aluminum	12,900	1,290,000	1.00E-02
Antimony	0.208	519	4.01E-04
Barium	199	255,000	7.80E-04
Cobalt	6.47	350[b]	1.85E-02
Copper	11	51,900	2.12E-04
Lead	16.3	800	2.04E-02
Nickel	9.02	25,700	3.51E-04
Perchlorate	0.00139	908	1.53E-06
Selenium	1.11	6490	1.71E-04
Silver	0.368	6490	5.67E-05
Uranium	6.54	3880	1.69E-03
Zinc	75.6	389,000	1.94E-04
		HI	**0.05**

[a] SSLs from NMED (2015, 600915) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

Table I-4.2-9
Industrial Radionuclide Screening Evaluation for SWMU 49-004

COPC	EPC (pCi/g)	Industrial SAL* (pCi/g)	Dose (mrem/yr)
Americium-241	0.263	1000	6.58E-03
Cesium-134	0.073	17	1.07E-01
Cesium-137	0.243	37	1.64E-01
Plutonium-238	0.025	1300	4.81E-04
Plutonium-239/240	0.0275	1200	5.73E-04
		Total Dose	**0.3**

*SALs from LANL (2015, 600929).

Table I-4.2-10
Construction Worker Noncarcinogenic Screening Evaluation for SWMU 49-004

COPC	EPC (mg/kg)	Construction Worker SSL* (mg/kg)	HQ
Aluminum	12900	41,400	3.12E-01
Antimony	0.208	142	1.46E-03
Barium	196	4390	4.46E-02
Chromium (Total)	9.86	134	7.36E-02
Cobalt	6.49	36.6[b]	1.77E-01
Copper	21.6	14,200	1.52E-03
Iron	12,800	248,000	5.16E-02
Lead	17	800	2.13E-02
Nickel	9.02	753	1.20E-02
Perchlorate	0.00415	248	1.67E-05
Selenium	1.05	1750	6.00E-04
Silver	0.368	1770	2.08E-04
Uranium	5.86	277	2.12E-02
Zinc	75	106,000	7.08E-04
Bis(2-ethylhexyl)phthalate	10.1	5380	1.88E-03
Chloronaphthalene[2-]	0.36	28,300	1.27E-05
Methylene chloride	0.00274	1210	2.26E-06
Methylnaphthalene[2-]	0.0138	1420[b]	9.72E-06
Naphthalene	0.0207	159	1.30E-04
Pyrene	0.0172	7530	2.28E-06
		HI	**0.7**

[a] SSLs from NMED (2015, 600915) unless otherwise noted.

[b] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) and equation and parameters from NMED (2015, 600915).

Table I-4.2-11
Construction Worker Radionuclide Screening Evaluation for SWMU 49-004

COPC	EPC (pCi/g)	Construction Worker SAL* (pCi/g)	Dose (mrem/yr)
Americium-241	0.43	230	4.67E-02
Cesium-134	0.073	15	1.22E-01
Cesium-137	0.224	18	3.11E-01
Plutonium-238	0.025	230	2.72E-03
Plutonium-239/240	0.036	200	4.50E-03
Tritium	0.0314	1,600,000	4.91E-07
		Total Dose	**0.5**

*SALs from LANL (2015, 600929).

Table I-4.2-12
Residential Carcinogenic Screening Evaluation for SWMU 49-004

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	Cancer Risk
Chromium (Total)	9.86	96.6	1.02E-06
Bis(2-ethylhexyl)phthalate	10.1	380	2.66E-07
Naphthalene	0.0207	49.7	4.16E-09
		Total Excess Cancer Risk	**1E-06**

*SSLs from NMED (2015, 600915).

Table I-4.2-13
Residential Noncarcinogenic Screening Evaluation for SWMU 49-004

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	HQ
Aluminum	12,900	78,000	1.65E-01
Antimony	0.208	31.3	6.65E-03
Barium	196	15,600	1.26E-02
Cobalt	6.49	23[b]	2.82E-01
Copper	21.6	3130	6.90E-03
Iron	12,800	54,800	2.34E-01
Lead	17	400	4.25E-02
Nickel	9.02	1560	5.78E-03
Perchlorate	0.00415	54.8	7.57E-05
Selenium	1.05	391	2.69E-03
Silver	0.368	391	9.41E-04
Uranium	5.86	234	2.50E-02
Zinc	75	23,500	3.19E-03
Chloronaphthalene[2-]	0.36	6260	5.75E-05
Methylene chloride	0.00274	409	6.70E-06
Methylnaphthalene[2-]	0.0138	240[b]	5.75E-05
Pyrene	0.0172	1740	9.89E-06
		HI	**0.8**

[a] SSLs from NMED (2015, 600915) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

Table I-4.2-14
Residential Radionuclide Screening Evaluation for SWMU 49-004

COPC	EPC (pCi/g)	Residential SAL* (pCi/g)	Dose (mrem/yr)
Americium-241	0.43	83	1.30E-01
Cesium-134	0.073	5	3.65E-01
Cesium-137	0.224	12	4.67E-01
Plutonium-238	0.025	84	7.44E-03
Plutonium-239/240	0.036	79	1.14E-02
Tritium	0.0314	1700	4.62E-04
		Total Dose	**1**

*SALs from LANL (2015, 600929).

Table I-4.2-15
Industrial Carcinogenic Screening Evaluation for SWMU 49-005(a)

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	Cancer Risk
Bis(2-ethylhexyl)phthalate	0.16	1830	8.74E-10
		Total Excess Cancer Risk	**9E-10**

*SSLs from NMED (2015, 600915).

Table I-4.2-16
Industrial Noncarcinogenic Screening Evaluation for SWMU 49-005(a)

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	HQ
Uranium	2.51	3880	6.47E-04
Butanone[2-]	0.0018	411,000	4.38E-09
		HI	**0.0006**

*SSLs from NMED (2015, 600915).

Table I-4.2-17
Industrial Radionuclide Screening Evaluation for SWMU 49-005(a)

COPC	EPC (pCi/g)	Industrial SAL* (pCi/g)	Dose (mrem/yr)
Plutonium-238	0.032	1300	6.15E-04
Plutonium-239/240	0.083	1200	1.73E-03
		Total Dose	**0.002**

*SALs from LANL (2015, 600929).

Table I-4.2-18
Construction Worker Noncarcinogenic Screening Evaluation for SWMU 49-005(a)

COPC	EPC (mg/kg)	Construction Worker SSL[a] (mg/kg)	HQ
Aluminum	10,600	41,400	2.56E-01
Antimony	0.79	142	5.56E-03
Arsenic	2.49	57.4	4.34E-02
Barium	132	4390	3.01E-02
Beryllium	1.25	148	8.45E-03
Chromium (Total)	9.05	134	6.75E-02
Cobalt	3.97	36.6[b]	1.08E-01
Copper	6.23	14,200	4.39E-04
Nickel	7.89	753	1.05E-02
Perchlorate	0.0037	248	1.49E-05
Selenium	1.06	1750	6.06E-04
Uranium	4.09	277	1.48E-02
Vanadium	16.5	614	2.69E-02
Bis(2-ethylhexyl)phthalate	0.16	5380	2.97E-05
Butanone[2-]	0.0018	91,700	1.96E-08
		HI	**0.6**

[a] SSLs from NMED (2015, 600915) unless otherwise noted.

[b] Construction worker SSL calculated using toxicity value from EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) and equation and parameters from NMED (2015, 600915).

Table I-4.2-19
Construction Worker Radionuclide Screening Evaluation for SWMU 49-005(a)

COPC	EPC (pCi/g)	Construction Worker SAL* (pCi/g)	Dose (mrem/yr)
Plutonium-238	0.032	230	3.48E-03
Plutonium-239/240	0.083	200	1.04E-02
		Total Dose	**0.01**

*SALs from LANL (2015, 600929).

Table I-4.2-20
Residential Carcinogenic Screening Evaluation for SWMU 49-005(a)

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	Cancer Risk
Arsenic	2.49	4.25/6.8[b]	5.86E-06/3.66E-06
Chromium (Total)	9.05	96.6	9.37E-07
Bis(2-ethylhexyl)phthalate	0.16	380	4.21E-09
		Total Excess Cancer Risk	**7E-06/5E-06**

[a] SSLs from NMED (2015, 600915) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

Table I-4.2-21
Residential Noncarcinogenic Screening Evaluation for SWMU 49-005(a)

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	HQ
Aluminum	10,600	78,000	1.36E-01
Antimony	0.79	31.3	2.52E-02
Barium	132	15,600	8.46E-03
Beryllium	1.25	156	8.01E-03
Cobalt	3.97	23[b]	1.73E-01
Copper	6.23	3130	1.99E-03
Nickel	7.89	1560	5.06E-03
Perchlorate	0.0037	54.8	6.75E-05
Selenium	1.06	391	2.71E-03
Uranium	4.09	234	1.75E-02
Vanadium	16.5	394	4.19E-02
Butanone[2-]	0.0018	37,400	4.81E-08
		HI	**0.4**

[a] SSLs from NMED (2015, 600915) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

Table I-4.2-22
Residential Radionuclide Screening Evaluation for SWMU 49-005(a)

COPC	EPC (pCi/g)	Residential SAL* (pCi/g)	Dose (mrem/yr)
Plutonium-238	0.032	84	9.52E-03
Plutonium-239/240	0.063	79	2.63E-02
		Total Dose	**0.04**

*SALs from LANL (2015, 600929).

Table I-4.3-1
Residential Noncarcinogenic Screening of Vapor Intrusion for SWMU 49-004

COPC	EPC[a] (µg/m^3)	Vapor Intrusion Screening Level[b] (µg/m^3)	HQ
Acetone	31	323,000	9.60E-05
Butanone[2-]	10	52,100	1.92E-04
Dichlorodifluoromethane	3.1	1040	2.98E-03
Ethyltoluene[4-]	17	52,100[c]	3.26E-04
Styrene	3.2	10,400	3.08E-04
Toluene	34	52,100	6.53E-04
Trimethylbenzene[1,2,4-]	18	66[d]	2.73E-01
Trimethylbenzene[1,3,5-]	5.4	66[e]	8.18E-02
Xylene[1,2-]	13	1040	1.25E-02
Xylene[1,3-]+1,4-Xylene	37	1040	3.56E-02
Xylene (Total)	50	1040	4.81E-02
		HI	**0.5**

[a] Maximum detected concentration.

[b] Vapor intrusion screening levels from NMED (2015, 600915) unless otherwise noted.

[c] Toluene used as a surrogate based on structural similarity.

[d] Screening value is from the EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) divided by the default attenuation factor of 0.11 (NMED 2015, 600915, p. 47).

[e] Trimethylbenzene[1,2,4-] used as a surrogate based on structural similarity.

Table I-4.3-2
Residential Carcinogenic Screening of Vapor Intrusion for SWMU 49-004

COPC	EPC[a] (µg/m^3)	Vapor Intrusion Screening Level[b] (µg/m^3)	Cancer Risk
Benzene	20	36	5.56E-06
Chloromethane	1.7	156	1.09E-07
Ethylbenzene	13	112	1.16E-06
		Total Excess Cancer Risk	**7E-06**

[a] Maximum detected concentration.

[b] Vapor intrusion screening levels from NMED (2015, 600915).

Table I-4.3-3
Residential Noncarcinogenic Screening of Vapor Intrusion for SWMU 49-005(a)

COPC	EPC[a] (µg/m³)	Vapor Intrusion Screening Level[b] (µg/m³)	HQ
Acetone	20	323,000	6.19E-05
Butanone[2-]	7.4	52,100	1.42E-04
Dichlorodifluoromethane	3.2	1040	3.08E-03
Ethyltoluene[4-]	9	52,100[c]	1.73E-04
Styrene	2.2	10,400	2.12E-04
Toluene	18	52,100	3.45E-04
Trimethylbenzene[1,2,4-]	10	66[d]	1.52E-01
Trimethylbenzene[1,3,5-]	3.1	66[e]	4.70E-02
Xylene[1,2-]	25	1040	2.40E-02
Xylene[1,3-]+1,4-Xylene	6.5	1040	6.25E-03
Xylene (Total)	18	1040	1.73E-02
		HI	**0.3**

[a] Maximum detected concentration.

[b] Vapor intrusion screening levels from NMED (2015, 600915) unless otherwise noted.

[c] Toluene used as a surrogate based on structural similarity.

[d] Screening value is from the EPA regional screening tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables) divided by the default attenuation factor of 0.11 (NMED 2015, 600915, p. 47).

[e] Trimethylbenzene[1,2,4-] used as a surrogate based on structural similarity.

Table I-4.3-4
Residential Carcinogenic Screening of Vapor Intrusion for SWMU 49-005(a)

COPC	EPC[a] (µg/m³)	Vapor Intrusion Screening Level[b] (µg/m³)	Cancer Risk
Benzene	12	36	3.33E-06
Chloromethane	1.7	156	1.09E-07
Ethylbenzene	6.4	112	5.71E-07
		Total Excess Cancer Risk	**4E-06**

[a] Maximum detected concentration.

[b] Vapor intrusion screening levels from NMED (2015, 600915).

Table I-4.4-1
Essential Nutrient Screening Assessment

SWMU	Scenario	COPC	Maximum Concentration (mg/kg)	SSL* (mg/kg)	Ratio
SWMU 49-004	Construction worker	Calcium	10,800	8,850,000	0.0012
SWMU 49-004	Construction worker	Magnesium	2760	1,550,000	0.0018
SWMU 49-004	Industrial	Calcium	8190	32,400,000	0.00025
SWMU 49-004	Industrial	Magnesium	2100	5,680,000	0.00037
SWMU 49-004	Residential	Calcium	10,800	13,000,000	0.00083
SWMU 49-004	Residential	Magnesium	2760	339,000	0.0081
SWMU 49-005(a)	Construction worker	Calcium	3320	8,850,000	0.00038
SWMU 49-005(a)	Construction worker	Magnesium	3720	1,550,000	0.0024
SWMU 49-005(a)	Residential	Calcium	3320	13,000,000	0.00026
SWMU 49-005(a)	Residential	Magnesium	3720	339,000	0.011

*SSLs from NMED (2015, 600915).

Table I-5.3-1
Ecological Screening Levels for Terrestrial Receptors

COPEC	Red Fox (mammalian top carnivore)	American Kestrel (avian Top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Generic Plant (terrestrial autotroph-producer)
Inorganic Chemicals (mg/kg)											
Antimony	46	na*	na	na	na	na	2.6	2.6	2.4	78	11
Arsenic	820	850	120	42	26	18	140	15	32	6.8	18
Barium	41,000	28,000	8600	820	930	1000	2900	1300	1800	330	110
Beryllium	420	na	na	na	na	na	150	18	56	40	2.5
Chromium (Total)	1800	1000	200	68	40	28	750	45	110	na	na
Cobalt	5500	2700	720	170	120	96	1600	160	400	na	13
Copper	4000	1300	92	38	22	15	240	38	64	80	70
Lead	3700	630	95	21	16	14	330	72	120	1700	120
Mercury	61	0.29	0.066	0.07	0.022	0.013	20	1.7	3	0.05	34
Nickel	1200	2300	120	160	38	21	440	9.7	20	280	38
Selenium	90	81	4.3	1	0.87	0.75	1.9	0.66	0.83	4.1	0.52
Thallium	5.3	120	56	9.2	7.5	6.3	2.5	0.22	0.73	na	0.05
Uranium	4800	30,000	16,000	1900	1700	1600	1800	220	750	na	25
Vanadium	3300	130	64	8.9	7.6	6.7	1300	140	480	na	60
Zinc	7800	2400	250	350	85	48	1600	98	170	120	160
Organic Chemicals (mg/kg)											
Bis(2-ethylhexyl)phthalate	380	8.1	0.1	20	0.04	0.02	2400	0.59	1.1	na	na
Butanone[2-]	1,300,000	na	na	na	na	na	380	2600	360	na	na

Table I-5.3-1 (continued)

COPEC	Red Fox (mammalian top carnivore)	American Kestrel (avian Top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Generic Plant (terrestrial autotroph-producer)
Radionuclides (pCi/g)											
Americium-241	26,000	59,000	47,000	5000	6900	11,000	20,000	33,000	33,000	190	500
Cesium-134	730	1000	1000	690	1200	2100	550	1100	1100	1000	700
Cesium-137	1500	3900	4300	1400	2600	4800	1200	2300	2300	1500	1500
Plutonium-238	45,000	130,000	120,000	5200	7700	14,000	53,000	160,000	170,000	820	1800
Plutonium-239/240	51,000	160,000	140,000	5400	7900	14,000	62,000	270,000	280,000	870	1900

*na = Not available.

Table I-5.3-2
Minimum ESL Comparison for AOC 49-002

COPC	EPC (mg/kg)	ESL (mg/kg)	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	13.9	2.4	Deer mouse	**5.79**
Barium	165	110	Plant	**1.5**
Copper	10.8	15	Robin (insectivore)	**0.72**
Mercury	0.0533	0.013	Robin (insectivore)	**4.09**
Zinc	76.7	48	Robin (insectivore)	**1.6**
Radionuclides (pCi/g)				
Americium-241	0.184	190	Earthworm	0.00097

Note: Bolded values indicate HQs greater than 0.3.

Table I-5.3-3
HI Analysis for AOC 49-002

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Plant (terrestrial autotroph-producer)
Antimony	13.9	0.3	na*	na	na	na	na	**5.35**	**5.35**	**5.79**	0.18	**1.26**
Barium	165	4.0E-03	5.9E-03	0.019	0.2	0.18	0.17	0.057	0.13	0.092	**0.5**	**1.5**
Copper	10.8	2.7E-03	8.3E-03	0.12	0.28	**0.49**	**0.72**	0.045	0.28	0.17	0.14	0.15
Mercury	0.0533	8.7E-04	0.18	**0.81**	**0.76**	**2.42**	**4.09**	2.7E-03	0.031	0.018	**1.06**	1.6E-03
Zinc	76.7	9.83E-03	0.032	**0.31**	0.22	**0.9**	**1.6**	4.79E-02	**0.78**	**0.45**	**0.64**	**0.48**
	HI	0.3	0.2	1	1	**4**	**7**	**5**	**7**	**7**	**2**	**3**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.

*na = Not available.

Table I-5.3-4
Minimum ESL Comparison for SWMU 49-004

COPC	EPC (mg/kg)	ESL (mg/kg)	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	0.206	2.4	Deer mouse	0.086
Barium	198	110	Plant	**1.8**
Chromium (Total)	9.85	28	Robin (insectivore)	**0.35**
Cobalt	6.48	13	Plant	**0.5**
Copper	11	15	Robin (insectivore)	**0.73**
Lead	16.3	14	Robin (insectivore)	**1.16**
Nickel	9.01	9.7	Shrew	**0.93**
Selenium	1.08	0.52	Plant	**2.08**
Silver	0.373	2.6	Robin (insectivore)	0.14
Uranium	6.23	25	Plant	0.25
Zinc	75.3	48	Robin (insectivore)	**1.57**
Radionuclides (pCi/g)				
Americium-241	0.43	190	Earthworm	0.0023
Cesium-134	0.073	550	Cottontail	0.00013
Cesium-137	0.233	1200	Cottontail	0.00019
Plutonium-238	0.025	820	Earthworm	0.00003
Plutonium-239/240	0.0328	870	Earthworm	0.000038

Note: Bolded values indicate HQs greater than 0.3.

Table I-5.3-5
HI Analysis for SWMU 49-004

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Plant (terrestrial autotroph-producer)
Barium	198	4.8E-03	7.1E-03	0.023	0.24	0.21	0.2	0.068	0.15	0.11	**0.6**	**1.8**
Chromium (Total)	9.85	5.5E-03	9.9E-03	0.049	0.14	0.25	**0.35**	0.013	0.22	0.09	na*	na
Cobalt	6.48	1.2E-03	2.4E-03	9.0E-03	0.038	0.054	0.068	4.1E-03	0.041	0.016	na	**0.5**
Copper	11	2.8E-03	8.5E-03	0.12	0.29	**0.5**	**0.73**	0.046	0.29	0.17	0.14	0.16
Lead	16.3	4.4E-03	0.026	0.17	**0.78**	**1.02**	**1.16**	0.049	0.23	0.14	9.6E-03	0.14
Nickel	9.01	7.5E-03	3.9E-03	0.075	0.056	0.24	**0.43**	0.02	**0.93**	**0.45**	0.032	0.24
Selenium	1.08	0.012	0.013	0.25	**1.08**	**1.24**	**1.44**	**0.57**	**1.64**	**1.3**	0.26	**2.08**
Zinc	75.3	9.7E-03	0.031	0.3	0.22	**0.89**	**1.57**	0.047	**0.77**	**0.44**	**0.63**	**0.47**
HI		0.05	0.1	1	**3**	**4**	**6**	0.8	**4**	**3**	**2**	**5**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.

*na = Not available.

Table I-5.3-6
Minimum ESL Comparison for SWMU 49-005(a)

COPC	EPC (mg/kg)	ESL (mg/kg)	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	0.79	2.4	Deer mouse	**0.33**
Arsenic	2.72	6.8	Earthworm	**0.4**
Barium	164	110	Plant	**1.49**
Beryllium	0.98	2.5	Plant	**0.39**
Chromium (Total)	11	28	Robin (insectivore)	**0.39**
Cobalt	4.97	13	Plant	**0.38**
Copper	6.74	15	Robin (insectivore)	**0.45**
Nickel	8.11	9.7	Shrew	**0.84**
Selenium	0.915	0.52	Plant	**1.76**
Uranium	2.51	25	Plant	0.1
Vanadium	19.7	6.7	Robin (insectivore)	**2.94**
Organic Chemicals (mg/kg)				
Bis(2-ethylhexyl)phthalate	0.16	0.02	Robin (insectivore)	**8**
Butanone[2-]	0.0018	360	Deer mouse	0.000005
Radionuclides (pCi/g)				
Plutonium-238	0.032	820	Earthworm	0.000039
Plutonium-239/240	0.083	870	Earthworm	0.0001

Note: Bolded values indicate HQs greater than 0.3.

Table I-5.3-7
HI Analysis for SWMU 49-005(a)

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Plant (terrestrial autotroph-producer)
Antimony	0.79	0.017	na*	na	na	na	na	0.3	0.3	**0.33**	0.01	0.072
Arsenic	2.72	3.3E-03	3.2E-03	0.023	0.065	0.1	0.15	0.019	0.18	0.085	**0.4**	0.15
Barium	164	4.0E-03	5.9E-03	0.019	0.2	0.18	0.16	0.057	0.13	0.091	**0.5**	**1.49**
Beryllium	0.98	2.3E-03	na	na	na	na	na	6.5E-03	0.054	0.018	0.025	**0.39**
Chromium (Total)	11	6.1E-03	0.011	0.055	0.16	0.28	**0.39**	0.015	0.24	0.1	na	na
Cobalt	4.97	9.0E-04	1.8E-03	6.9E-03	0.029	0.041	0.052	3.1E-03	0.031	0.012	na	**0.38**
Copper	6.74	1.7E-03	5.2E-03	0.073	0.18	**0.31**	**0.45**	0.028	0.18	0.11	0.084	0.096
Nickel	8.11	6.8E-03	3.5E-03	0.068	0.051	0.21	**0.39**	0.018	**0.84**	**0.41**	0.029	0.21
Selenium	0.915	0.01	0.011	0.21	**0.92**	**1.05**	**1.22**	**0.48**	**1.39**	**1.1**	0.22	**1.76**
Vanadium	19.7	6.0E-03	0.15	**0.31**	**2.21**	**2.59**	**2.94**	0.015	0.14	0.041	na	**0.33**
Bis(2-ethylhexyl)phthalate	0.16	4.2E-04	0.02	**1.6**	8.0E-03	**4**	**8**	6.7E-05	0.27	0.15	na	na
HI		0.06	0.2	**2**	**4**	**9**	**14**	0.9	**4**	**2**	1	**5**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.
*na = Not available.

Table I-5.3-8
Burrow Air Screening

COPC	EPC[a] (µg/m^3)	Gopher Burrow Air ESL (µg/m^3)[b]	HQ
Acetone	31	530,000	5.85E-05
Benzene	20	25,000	8.00E-04
Chloromethane	1.7	21,000	8.10E-05
Dichlorodifluoromethane	3.2	2,600,000	1.23E-06
Ethylbenzene	13	25,000[c]	5.20E-04
Ethyltoluene[4-]	17	60,000[d]	2.83E-04
Toluene	34	60,000	5.67E-04
Trimethylbenzene[1,2,4-]	18	25,000[c]	7.20E-04
Trimethylbenzene[1,3,5-]	5.4	25,000[c]	2.16E-04
Xylene[1,2-]	13	87,000[e]	1.49E-04
Xylene[1,3-]+1,4-xylene	37	87,000[e]	4.25E-04
Xylene (Total)	50	87,000	5.75E-04
		HI	**0.004**

[a] Maximum detected concentration.

[b] Burrow air ESLs are from (LANL 2015, 600921) using parameters in (LANL 2015, 600982).

[c] Used benzene as a surrogate based on structural similariaty.

[d] Used toluene as a surrogate based on structural similariaty.

[e] Used total xylene as a surrogate based on structural similariaty.

Table I-5.4-1
Mexican Spotted Owl AUFs for TA-49 Sites Outside the NES

Site	Site Area (ha)	AUF[a]	American Kestrel (avian top carnivore) HI[b]	AUF adjusted HI for the Mexican Spotted Owl
AOC 49-002	7.85	0.021	0.2	0.004
SWMU 49-004	14.8	0.04	0.1	0.004
SWMU 49-005(a)	0.159	0.00044	0.2	0.000088

[a] AUF is calculated as the area of the site divided by the owl home range of 366 ha.

[b] Using the American kestrel (avian top carnivore) as a surrogate for the Mexican spotted owl.

Table I-5.4-2
PAUFs for Ecological Receptors for AOC 49-002

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	1.85E-03
American Robin	0.42	16.8	4.67E-01
Deer Mouse	0.077	3	1.00E+00
Desert Cottontail	3.1	124	6.33E-02
Montane Shrew	0.39	15.6	5.03E-01
Red Fox	1038	41520	1.89E-04

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (7.85 ha) divided by the population area.

Table I-5.4-3
Adjusted HIs for AOC 49-002

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian Top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Plant (terrestrial autotroph-producer)
Antimony	13.9	5.7E-05	na*	na	na	na	na	**0.34**	**2.69**	**5.79**	0.18	**1.26**
Barium	165	7.6E-07	1.1E-05	3.6E-05	0.094	0.083	0.077	3.6E-03	0.064	0.092	**0.5**	**1.5**
Copper	10.8	5.1E-07	1.5E-05	2.2E-04	0.13	0.23	**0.34**	2.8E-03	0.14	0.17	0.14	0.15
Mercury	0.0532	1.6E-07	3.4E-04	1.5E-03	**0.35**	**1.13**	**1.91**	1.7E-04	0.016	0.018	**1.06**	0.0016
Zinc	76.7	na	na	5.74E-04	na	**0.42**	**0.75**	na	**0.39**	**0.45**	**0.64**	**0.48**
Adjusted HI		0.00006	0.0004	0.002	0.6	**2**	**3**	0.3	**3**	**7**	**2**	**3**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.

*na = Not available.

Table I-5.4-4
PAUFs for Ecological Receptors for SWMU 49-004

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	3.48E-03
American Robin	0.42	16.8	8.79E-01
Deer Mouse	0.077	3	1.00E+00
Desert Cottontail	3.1	124	1.19E-01
Montane Shrew	0.39	15.6	9.47E-01
Red Fox	1038	41,520	3.56E-04

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (14.8 ha) divided by the population area.

Table I-5.4-5
Adjusted HIs for SWMU 49-004

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian Top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Plant (terrestrial autotroph-producer)
Barium	198	1.7E-06	2.5E-05	8.0E-05	0.21	0.19	0.17	8.1E-03	0.14	0.11	**0.6**	**1.8**
Chromium (Total)	9.85	1.9E-06	3.4E-05	1.7E-04	0.13	0.22	**0.31**	1.6E-03	0.21	0.09	na*	na
Cobalt	6.48	4.2E-07	8.4E-06	3.1E-05	0.034	0.047	0.059	4.8E-04	0.038	0.016	na	**0.5**
Copper	11	9.8E-07	2.9E-05	4.2E-04	0.25	**0.44**	**0.64**	5.5E-03	0.27	0.17	0.14	0.16
Lead	16.3	1.6E-06	9.0E-05	6.0E-04	**0.68**	**0.9**	**1.02**	5.9E-03	0.21	0.14	9.6E-03	0.14
Nickel	9.01	2.7E-06	1.4E-05	2.6E-04	0.05	0.21	**0.38**	2.4E-03	**0.88**	**0.45**	0.032	0.24
Selenium	1.08	4.3E-06	4.6E-05	8.8E-04	**0.95**	**1.09**	**1.27**	0.068	**1.55**	**1.3**	0.26	**2.08**
Zinc	75.3	3.4E-06	1.1E-04	1.0E-03	0.19	**0.78**	**1.38**	5.6E-03	**0.73**	**0.44**	**0.63**	**0.47**
Adjusted HI		2E-05	4E-04	3E-03	**2**	**4**	**5**	0.1	**4**	**3**	**2**	**5**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.

*na = Not available.

Table I-5.4-6
PAUFs for Ecological Receptors for SWMU 49-005(a)

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	3.76E-05
American Robin	0.42	16.8	9.49E-03
Deer Mouse	0.077	3	5.31E-02
Desert Cottontail	3.1	124	1.29E-03
Montane Shrew	0.39	15.6	1.02E-02
Red Fox	1038	41,520	3.84E-06

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (0.159 ha) divided by the population area.

Table I-5.4-7
Adjusted HIs for SWMU 49-005(a)

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian Top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate)	Plant (terrestrial autotroph-producer)
Antimony	0.79	6.6E-08	na*	na	na	na	na	3.9E-04	3.1E-03	0.017	0.01	0.072
Arsenic	2.72	1.3E-08	1.2E-07	8.5E-07	6.1E-04	9.9E-04	1.4E-03	2.5E-05	1.9E-03	4.5E-03	**0.4**	0.15
Barium	164	1.5E-08	2.2E-07	7.2E-07	1.9E-03	1.7E-03	1.6E-03	7.3E-05	1.3E-03	4.8E-03	**0.5**	**1.49**
Beryllium	0.98	8.8E-09	na	na	na	na	na	8.4E-06	5.5E-04	9.6E-04	0.025	**0.39**
Chromium (Total)	11	2.3E-08	4.1E-07	2.1E-06	1.5E-03	2.6E-03	3.7E-03	1.9E-05	2.5E-03	5.3E-03	na	na
Cobalt	4.97	3.5E-09	6.9E-08	2.6E-07	2.8E-04	3.9E-04	4.9E-04	4.0E-06	3.2E-04	6.6E-04	na	**0.38**
Copper	6.74	6.5E-09	1.9E-07	2.8E-06	1.7E-03	2.9E-03	4.3E-03	3.6E-05	1.8E-03	5.6E-03	0.084	0.096
Nickel	8.11	2.6E-08	1.3E-07	2.5E-06	4.8E-04	2.0E-03	3.7E-03	2.4E-05	8.5E-03	0.022	0.029	0.21
Selenium	0.915	3.9E-08	4.2E-07	8.0E-06	8.7E-03	0.01	0.012	6.2E-04	0.014	0.059	0.22	**1.76**
Vanadium	19.7	2.3E-08	5.7E-06	1.2E-05	0.021	0.025	0.028	1.9E-05	1.4E-03	2.2E-03	na	**0.33**
Bis(2-ethylhexyl)phthalate	0.16	1.6E-09	7.4E-07	6.0E-05	7.6E-05	0.038	0.076	8.6E-08	2.8E-03	7.7E-03	na	na
Adjusted HI		5E-07	9E-06	9E-05	0.04	0.09	0.1	0.001	0.06	0.2	1	**5**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.

*na = Not available.

Table I-5.4-8
Summary of LOAEL-Based ESLs for Terrestrial Receptors

COPEC	Receptor	LOAEL-Based ESL* (mg/kg)
Antimony	Deer Mouse	24
	Deer Mouse	24
	Montane shrew	26
	Plant	58
Arsenic	Earthworm	68
Barium	Earthworm	3200
	Plant	260
Beryllium	Plant	25
Chromium (Total)	Robin–insectivore	280
Cobalt	Plant	130
Copper	Robin (insectivore)	46
	Robin (omnivore)	66
Lead	Robin (herbivore)	42
	Robin (insectivore)	28
	Robin (omnivore)	33
Mercury	Robin (insectivore)	0.13
	Robin (omnivore)	0.22
	Earthworm	0.5
Nickel	Robin (insectivore)	210
	Deer mouse	41
	Montane shrew	19
Selenium	Robin (herbivore)	2
	Robin (insectivore)	1.5
	Robin (omnivore)	1.7
	Deer mouse	1.2
	Montane shrew	0.99
	Plant	3
Vanadium	Plant	80
Zinc	Robin (insectivore)	480
	Robin (omnivore)	850
	Deer mouse	1700
	Earthworm	930
	Montane shrew	980
	Plant	810

*LOAEL-based ESLs from ECORISK Database, Release 3.3 (LANL 2015, 600929).

Table I-5.4-9

HI Analysis Using LOAEL-Based ESLs for AOC 49-002

COPEC	EPC (mg/kg)	Robin (omnivore)	Robin (insectivore)	Montane Shrew	Deer Mouse	Earthworm	Plant
Antimony	13.9	n/a*	n/a	**0.53**	**0.58**	n/a	0.24
Barium	165	n/a	n/a	n/a	n/a	0.052	**0.63**
Copper	10.8	n/a	0.23	n/a	n/a	n/a	n/a
Mercury	0.0532	0.24	**0.41**	n/a	n/a	0.11	n/a
Zinc	76.7	0.09	0.16	0.078	0.045	0.082	0.095
	HI	0.3	0.8	0.6	0.6	0.2	1

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1.

*n/a = Not applicable.

Table I-5.4-10

HI Analysis Using LOAEL-Based ESLs for SWMU 49-004

COPEC	EPC (mg/kg)	Robin (herbivore)	Robin (omnivore)	Robin (insectivore)	Montane Shrew	Deer Mouse	Earthworm	Plant
Barium	198	n/a[a]	n/a	n/a	n/a	n/a	0.062	**0.76**
Chromium (Total)	9.85	n/a	n/a	0.035	n/a	n/a	na[b]	na
Cobalt	6.48	n/a	n/a	n/a	n/a	n/a	n/a	0.05
Copper	11	n/a	0.17	0.24	n/a	n/a	n/a	n/a
Lead	16.3	**0.39**	**0.49**	**0.58**	n/a	n/a	n/a	n/a
Nickel	9.01	n/a	n/a	0.043	**0.47**	0.22	n/a	n/a
Selenium	1.08	**0.54**	**0.64**	**0.72**	**1.09**	**0.9**	n/a	**0.36**
Zinc	75.3	n/a	0.089	0.16	0.077	0.044	0.081	0.093
	HI	0.9	1	**2**	**2**	1	0.1	1

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1.

[a] n/a = Not applicable.

[b] na = Not available.

Table I-5.4-11
Adjusted HI Analysis Using LOAEL-Based ESLs for SWMU 49-004

COPEC	EPC (mg/kg)	Robin (omnivore)	Robin (insectivore)	Montane Shrew	Deer Mouse
Chromium (Total)	9.85	n/a*	0.031	n/a	n/a
Copper	11	0.15	0.21	n/a	n/a
Lead	16.3	**0.43**	**0.51**	n/a	n/a
Nickel	9.01	n/a	0.038	**0.45**	0.22
Selenium	1.08	**0.56**	**0.63**	**1.03**	**0.9**
Zinc	75.3	0.078	0.18	0.073	0.044
	Adjusted HI	1	**2**	**2**	1

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1.
*n/a = Not applicable.

Table I-5.4-12
HI Analysis Using LOAEL-Based ESLs for SWMU 49-005(a)

COPEC	EPC (mg/kg)	Earthworm	Plant
Arsenic	2.72	0.04	n/a[a]
Barium	164	0.051	**0.63**
Beryllium	0.98	n/a	0.039
Cobalt	4.97	na[b]	0.038
Selenium	0.915	n/a	**0.31**
Vanadium	19.7	na	0.25
	HI	0.09	1

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1.

[a] n/a = Not applicable.

[b] na = Not available.

Attachment I-1

ProUCL Files
(on CD included with this document)

Attachment I-2

Ecological Scoping Checklist

I2-1.0 PART A—SCOPING MEETING DOCUMENTATION

Site IDs	Area of Concern (AOC) 49-002, Solid Waste Management Units (SWMUs) 49-004 and 49-005(a)
Form of site releases (solid, liquid, vapor). Describe all relevant known or suspected mechanisms of release (spills, dumping, material disposal, outfall, explosive testing, etc.), and describe potential areas of release. Reference locations on a map as appropriate.	Hydronuclear and related experiments were conducted at Technical Area 49 (TA-49) between 1959 and 1961. The experiments deposited plutonium, uranium, lead, and beryllium in underground shafts. AOC 49-002 is an underground experimental calibration chamber and two associated shafts located in Area 10. This site was used for calibration tests associated with hydronuclear experiments performed elsewhere at TA-49 in 1960 and 1961. SWMU 49-004 consists of an inactive open burning area/landfill used from 1959 to 1961 for open-pit burning of combustible construction materials and burial of uncontaminated residues. The landfill was reopened in 1971 and 1984 for disposal of uncontaminated materials resulting from a cleanup effort. SWMU 49-005(a) is an inactive landfill, described as a small pit, located east of Area 10. It was constructed in 1984 as a disposal area for nonradiologically contaminated debris generated during the 1984 general surface cleanup of TA-49.
List of Primary Impacted Media **(Indicate all that apply.)**	**Surface soil –** X **Surface water/sediment –** NA **Subsurface –** X **Groundwater –** NA **Other, explain –** NA
Vegetation Class Based on GIS Vegetation Coverage **(Indicate all that apply.)**	**Water** – NA **Bare ground/unvegetated** – X **Spruce/fir/aspen/mixed conifer** – NA **Ponderosa pine –** NA **Piñon juniper/juniper savannah** – X **Grassland/shrubland** – X **Developed** – X **Burned –** NA
Is T&E habitat present? **If applicable, list species known or suspected of using the site for breeding or foraging.**	No threatened and endangered (T&E) species nesting habitat is present at the site. However, the area is within the foraging range of the Mexican spotted owl.
Provide list of neighboring/ contiguous/upgradient sites, include a brief summary of COPCs and the form of releases for relevant sites, and reference a map as appropriate. **(Use this information to evaluate the need to aggregate sites for screening.)**	TA-49 is geographically isolated from other Los Alamos National Laboratory TAs. However, several groups of SWMUs and AOCs are associated with TA-49 and are located inside the nuclear environmental site (NES) boundary. They include SWMUs 49-001(a), 49-001(b), 49-001(c), 49-001(d), 49-001(e), 49-001(f), 49-001(g), and 49-003 and AOCs 49-008(c) and 49-008(d).
Surface Water Erosion Potential Information Surface water erosion potential is based on site observations	The sites are relatively flat. There is no visible evidence of run-on or runoff. The potential for surface water transport is therefore low for this site.

I2-2.0 PART B—SITE VISIT DOCUMENTATION

Site ID	AOC 49-002, SWMUs 49-004 and 49-005(a)
Dates of Site Visits	3/15/2010 and 3/31/2016
Site Visits Conducted by	Pattie Baucom, Win Cromec; Randall Ryti, Kent Rich, Richard Mirenda, Tracy McFarland, Joe English, Larry Salazar

Receptor Information:

Estimate cover.	**Relative vegetative cover (high, medium, low, none)** = Medium **Relative wetland cover (high, medium, low, none)** = None **Relative structures/asphalt, etc., cover (high, medium, low, none)** = Low, gravel roads surround the site and a gravel road leads to the entrance of TA-49
Field Notes on the GIS Vegetation Class to Assist in Verifying the Arcview Information	In general, the TA-49 complex has been disturbed and consists primarily of soil intermixed with patches of bedrock, which occurs predominantly near the edges of the mesa east of developed areas Removal actions have taken place and there are numerous roadways throughout the area. The dominant overstory vegetation type surrounding the area is ponderosa pine, with minor vegetation components of fir (white and Douglas) and piñon. The understory contains mostly native and nonnative grasses and ruderal species indicative of disturbance, with a few shrubs and forbs. Habitat fragmentation at the site is high. The general habitat quality in undisturbed areas is sufficient to support grazing and foraging by terrestrial receptors.
Are ecological receptors present at the site (yes/ no/uncertain)? **Describe the general types of receptors present at the site (terrestrial and aquatic), and make notes on the quality of habitat present at the site.**	Yes. The vegetation at the site is healthy and varied. No adverse impacts on plants were noted during field activities, and the habitat is sufficient for supporting foraging of terrestrial receptors. Small mammals and birds are present within the area. The following wildlife has been observed or known to be present while fieldwork was conducted at the site: bobcat, elk, mule deer, coyotes, rabbits, mice, and birds. Mountain lion and bear were not spotted, but tracks were identified.

Contaminant Transport Information:

Surface Water Transport/Field Notes on the Erosion Potential, Including a Discussion of the Terminal Point of Surface Water Transport (if applicable)	Surface water transport and erosion potential on the mesa top is low because of the relatively flat terrain (<10% slope). Surface water transport and erosion potential is higher near the slopes. The terminal point of surface water transport is northward to Water Canyon, eastward into a tributary canyon to Ancho Canyon, or southward into Ancho Canyon.
Are there any off-site transport pathways (surface water, air, or groundwater) (yes/no/uncertain)? **Provide explanation.**	Yes. Surface water run-on to the sites and runoff leaving the sites generally enters Water or Ancho Canyons. There may be some air dispersion when the area is dry, but it is a minor transport pathway. A pathway to groundwater is unlikely because regional groundwater is greater than 1000 ft below ground surface (bgs) to the aquifer. No intermediate or alluvial groundwater is in the vicinity of the sites.

Ecological Effects Information:

Physical Disturbance **(Provide list of major types of disturbances, including erosion and construction activities; review historical aerial photos where appropriate.)**	No. There is little evidence of disturbances or erosion on mesa tops.
Are there obvious ecological effects (yes/ no/uncertain)? **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No. The habitat is healthy and wildlife is abundant.

No Exposure/Transport Pathways:

If there are no complete exposure pathways to ecological receptors on-site and no transport pathways to off-site receptors, the remainder of the checklist should not be completed. Stop here, and provide additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). At a minimum, the potential for future transport should include the likelihood that future construction activities could make contamination more available for exposure or transport. Not applicable

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature and extent of contamination (yes/ no/uncertain)? **Provide explanation (consider whether the maximum value was captured by existing sample data).**	Yes. The sampling approach in the approved work plans (LANL 2008, 102215; NMED 2010, 110859; LANL 2011, 111691; NMED 2011, 203824) included biased sampling to determine the nature and extent of contamination within the aggregate area.
Do existing or proposed data for the site address potential transport pathways of site contamination (yes/ no/uncertain)? **Provide explanation (consider whether other sites should be aggregated to characterize potential ecological risk).**	Yes. Data from samples collected within the SWMUs and AOCs address potential transport pathways and characterize the potential ecological risk. The results indicate the nature and extent of contamination at the sites has been defined except for SWMU 49-004 that will have sampling conducted for dioxins and furans. This additional information will be addressed in an update to the SWMU 49-004 risk assessment presented in the supplemental investigation report.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors. **AOC 49-002**. Former building, the concrete pad still present but structure removed. Large ponderosa pines growing directly adjacent to concrete pad. Grasses, forbs, shrubs, burrowing activity evident. Formerly utilized site being naturalized with habitat for terrestrial receptors. **SWMU 49-004**. Former landfill. Large ponderosa pines, shrubs, oaks, forbs, grasses, bioturbation. Observed elk sign (tracks and scat), coyote tracks. Formerly utilized site being naturalized with habitat for terrestrial receptors. **SWMU 49-005(a)**. Inactive landfill. Shrubs, oaks, forbs, grasses, burrowing activity evident.

I2-3.0 PART C—ECOLOGICAL PATHWAYS CONCEPTUAL EXPOSURE MODEL

Provide answers to Questions A to V to develop the Ecological Pathways Conceptual Exposure Model

Question A:

Could soil contaminants reach receptors through vapors?

- **Volatility of the hazardous substance (volatile chemicals generally have Henry's law constant >10^{-5} atm-m^3/mol and molecular weight <200 g/mol).**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: Volatile organic compounds (VOCs) were detected in soil and pore gas. Most of the detected concentrations were below or similar to the estimated quantitation limits (EQLs).

Question B:

Could the soil contaminants reach receptors through fugitive dust carried in air?

- **Soil contamination would have to be on the actual surface of the soil to become available for dust.**
- **In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.**

Answer (likely/unlikely/uncertain): Likely

Provide explanation: Some chemicals of potential concern (COPCs) were detected in the surface interval.

Question C:

Can contaminated soil be transported to aquatic ecological communities (use SOP 2.01 run-off score and terminal point of surface water runoff to help answer this question)?

- **If the SOP 2.01 run-off score* for each SWMU and/or AOC included in the site is equal to zero, this suggests that erosion at the site is not a transport pathway. (*Note that the runoff score is not the entire erosion potential score; rather, it is a subtotal of this score with a maximum value of 46 points.)**
- **If erosion is a transport pathway, evaluate the terminal point to see whether aquatic receptors could be affected by contamination from this site.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: No aquatic communities are present at the sites or in close proximity to them.

Question D:

Is contaminated groundwater potentially available to biological receptors through seeps, springs, or shallow groundwater?

- **Known or suspected presence of contaminants in groundwater.**
- **The potential exists for contaminants to migrate through groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The depth to regional groundwater is greater than 1000 ft. There are no seeps, springs, or shallow groundwater at the sites.

Question E:

Is infiltration/percolation from contaminated subsurface material a viable transport and exposure pathway?

- **The potential exists for contaminants to migrate to groundwater.**
- **The potential exists for contaminants to migrate through groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The depth to regional groundwater is greater than 1000 ft. There are no seeps, springs, or shallow groundwater at the sites.

Question F:

Might erosion or mass wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

- **This question is only applicable to release sites located on or near the mesa edge.**
- **Consider the erodability of surficial material and the geologic processes of canyon/mesa edges.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: Most sites are not located near the main canyon edge, so mass wasting is not relevant. There is minimal evidence of erosion at the sites.

Question G:

Could airborne contaminants interact with receptors through the respiration of vapors?

- **Contaminants must be present as volatiles in the air.**
- **Consider the importance of the inhalation of vapors for burrowing animals.**
- **Foliar uptake of vapors is typically not a significant exposure pathway.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: VOCs were detected but at low concentrations.

Question H:

Could airborne contaminants interact with plants through the deposition of particulates or with animals through the inhalation of fugitive dust?

- **Contaminants must be present as particulates in the air or as dust for this exposure pathway to be complete.**
- **Exposure through the inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 3

Terrestrial Animals: 3

Provide explanation: Surface soil contamination is present.

Question I:

Could contaminants interact with plants through root uptake or rain splash from surficial soils?

- **Contaminants in bulk soil may partition into soil solution, making them available to roots.**
- **Exposure of terrestrial plants to contaminants is present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 3

Provide explanation: Surface soil contamination is present.

Question J:

Could contaminants interact with receptors through food-web transport from surficial soils?

- **The chemicals may bioaccumulate in animals.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 3

Provide explanation: COPCs are present in the surface soil.

Question K:

Could contaminants interact with receptors through the incidental ingestion of surficial soils?

- **Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil, or groom themselves clean of soil.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 3

Provide explanation: COPCs are present in the surface soil.

Question L:

Could contaminants interact with receptors through dermal contact with surficial soils?

- **Significant exposure through dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 2

Provide explanation: Low to moderate concentrations of lipophilic COPCs were detected in surface soil.

Question M:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: Some radionuclides were identified as COPCs.

<u>Question N:</u>

Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- **Contaminants may be taken up by terrestrial plants whose roots are in contact with surface waters.**
- **Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash) in an area that is only periodically inundated with water.**
- **Contaminants in sediment may partition into soil solution, making them available to roots.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 0

Provide explanation: No water or sediment was sampled.

<u>Question O:</u>

Could contaminants interact with receptors through food-web transport from water and sediment?

- **The chemicals may bioconcentrate in food items.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 0

Provide explanation: No water or sediment was sampled.

<u>Question P:</u>

Could contaminants interact with receptors through the ingestion of water and suspended sediments?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.**
- **Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 0

Provide explanation: No water or sediment was sampled.

Question Q:

Could contaminants interact with receptors through dermal contact with water and sediment?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.**
- **Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 0

Provide explanation: No water or sediment was sampled.

Question R:

Could suspended or sediment-based contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: No water or sediment was sampled.

Question S:

Could contaminants bioconcentrate in free-floating aquatic plants, attached aquatic plants, or emergent vegetation?

- **Aquatic plants are in direct contact with water.**
- **Contaminants in sediment may partition into pore water, making them available to submerged roots.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Aquatic Plants/Emergent Vegetation: 0

Provide explanation: There is no aquatic habitat at the sites.

<u>Question T:</u>

Could contaminants bioconcentrate in sedimentary or water-column organisms?

- **Aquatic receptors may actively or incidentally ingest sediment while foraging.**
- **Aquatic receptors may be directly exposed to contaminated sediments or may be exposed to contaminants through osmotic exchange, respiration, or ventilation of sediment pore waters.**
- **Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Aquatic Animals: 0

Provide explanation: There is no aquatic habitat at the sites.

<u>Question U:</u>

Could contaminants bioaccumulate in sedimentary or water-column organisms?

- **Lipophilic organic contaminants and some metals may concentrate in an organism's tissues.**
- **Ingestion of contaminated food items may result in contaminant bioaccumulation through the food web.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Aquatic Animals: 0

Provide explanation: There is no aquatic habitat at the sites.

<u>Question V:</u>

Could contaminants interact with aquatic plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **The water column acts to absorb radiation; therefore, external irradiation is typically more important for sediment-dwelling organisms.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

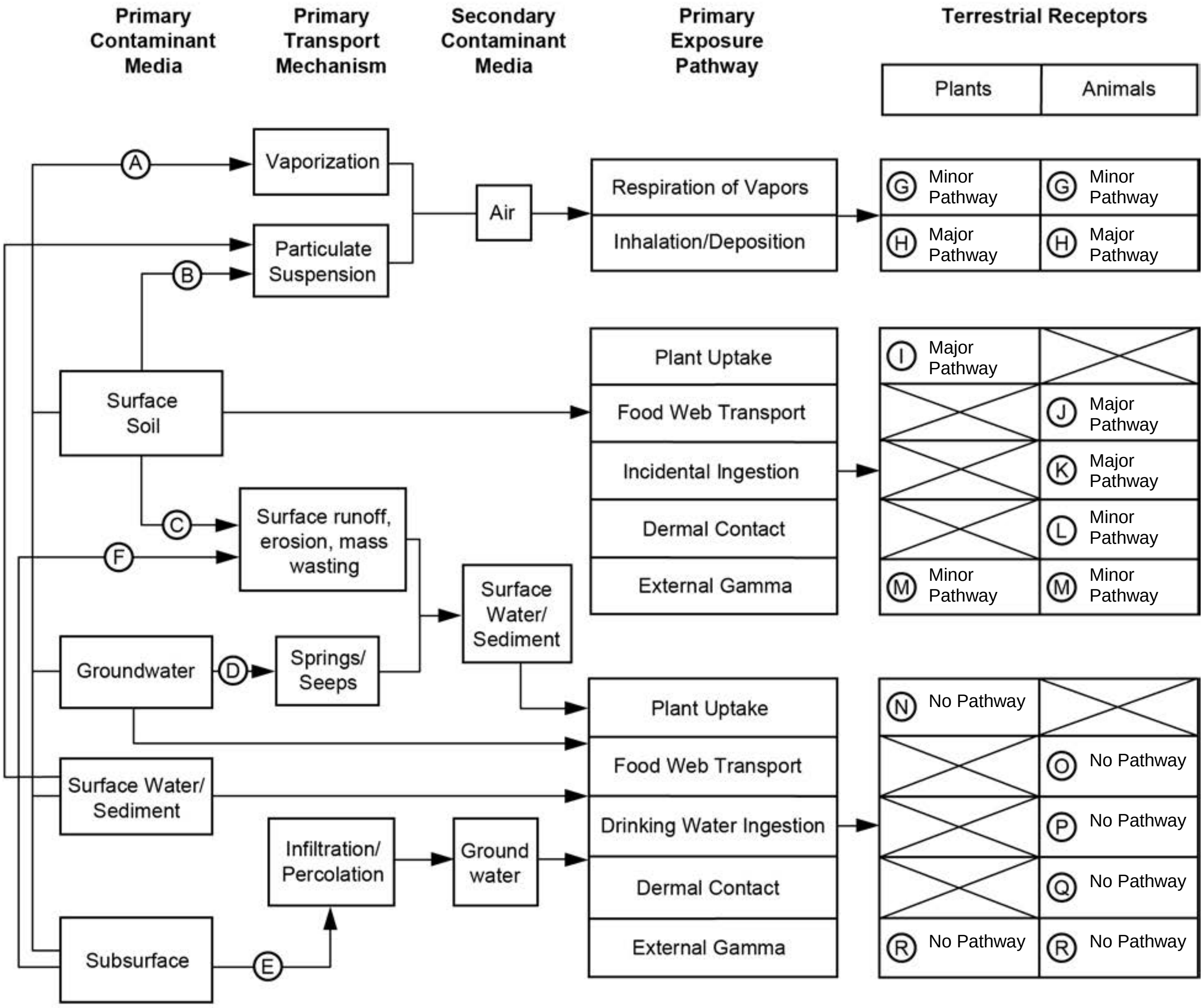
Aquatic Plants: 0

Aquatic Animals: 0

Provide explanation: There is no aquatic habitat at the sites.

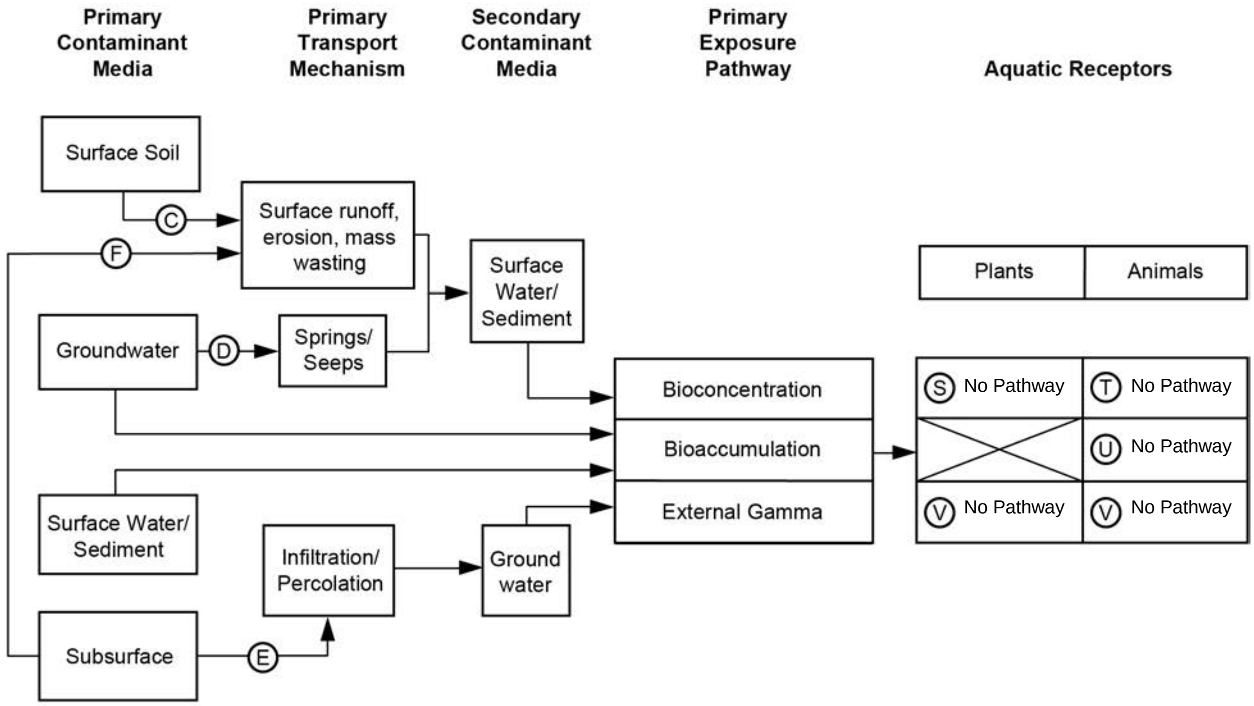
Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



Ecological Scoping Checklist
Aquatic Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



SIGNATURES AND CERTIFICATION

Checklist completed by:

Name (printed): Randall Ryti
Name (signature): Randall Ryti
Organization: Neptune and Company, Inc.
Date completed: March 31, 2016

Checklist reviewed by:

Name (printed): Richard Mirenda
Name (signature): Richard Mirenda
Organization: Los Alamos National Laboratory
Date reviewed: 7/20/16

I2-4.0 REFERENCES

The following reference list includes documents cited in this attachment. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

LANL (Los Alamos National Laboratory), January 2008. "Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1," Los Alamos National Laboratory document LA-UR-08-0449, Los Alamos, New Mexico. (LANL 2008, 102215)

LANL (Los Alamos National Laboratory), February 2011. "Phase II Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary," Los Alamos National Laboratory document LA-UR-11-0553, Los Alamos, New Mexico. (LANL 2011, 111691)

NMED (New Mexico Environment Department), September 22, 2010. "Approval with Modifications, Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 110859)

NMED (New Mexico Environment Department), June 10, 2011. "Approval, Phase II Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 203824)

Appendix J

Los Alamos National Laboratory Cultural Resource Team Assessment of Trenches Located in Area 6 West, Solid Waste Management Unit 49-004

Los Alamos
NATIONAL LABORATORY
EST. 1943
memorandum
Environmental Protection Division
Ecology and Air Quality Group

To/MS: Mark Vaneeckhout, CM-STRS, M992
From/MS: Leslie Hansen, ENV-EAQ, J978
Phone/Fax: 5-9873/5-8858
Symbol: ENV-EAQ:10-015
Date: January 19, 2010

ORIGIN OF "OPEN TRENCHES" IN TA-49, AREA 6 WEST

The LANL ENV-EAQ Cultural Resources Team has been requested by the Environmental Programs Directorate to provide an evaluation of the possible origin and nature of four trenches in Technical Area 49 (TA-49) on Frijoles Mesa. Solid Waste Management Unit (SWMU) 49-004 is located along a portion of Fire Break 4, with three of the four trenches being located a few hundred meters to the west. The fourth trench is located west of the other three trenches near the paved mesa top road. These trenches and SWMU-49-004 are described in the Area 6 West discussion in the October 2007 report *Historical Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary* (LA-UR-07-6428), and are depicted in Figure 2.3-3 of that report. For ease of discussion in this memo, the four trenches are designated A-D from west to east. We note that the somewhat isolated westernmost Trench A near the paved road could not be relocated by the Cultural Resources Team; however, two of the other three trenches (B and C) have been periodically visited since the late 1990s, including specifically on behalf of the Environmental Programs Directorate in 2009. The Cultural Resources Team observed the presumed location of the easternmost Trench D (the trench closest to SWMU-49-004), and could tell that the area had been disturbed, but the actual physical structure of the trench could not be ascertained.

As noted by the Historical Investigation Report, SWMU-49-004 is the location of a landfill dating to the period of 1959-1961 and associated with the open-pit burning of Laboratory combustible construction wastes and for burial of uncontaminated wastes. The landfill area was reopened in 1971 for disposal of materials as part of a general cleanup of TA-49, and again in 1984 for disposal of uncontaminated solid wastes. The four trenches are absent in aerial photographs taken in 1935, but are present in aerial photographs taken in 1954. Due to the apparent absence of additional aerial photographs between these two dates, a more precise date for the construction of the trenches is not possible. However, it was the opinion of authors of the Historical Investigation Report that because the trenches pre-dated the beginning of intensive Laboratory operations at TA-49 in the period of 1959-1961, they were not used for the disposal of contaminated Laboratory materials. This opinion was supported by negative findings during a radiological survey in and around the four trenches in 1995, which included single auger holes placed in the bottom of the three open trenches.

Trench B and Trench C are directly associated with visible Ancestral Pueblo masonry roomblocks sites (LA 15861 and LA 15866A, respectively). Trench B is placed immediately east of the roomblock for site LA 15861 in an area that would have dissected the major trash deposit associated with the roomblock. Trench C appears to have been placed through a series of masonry rooms associated with the two-row roomblock at site LA 15866A (Figure 1).

Laboratory archaeologist Charlie Steen excavated the remaining surface rooms at LA 15866A (Figure 2) sometime between the La Mesa Fire in 1977 and 1981 (*Pajarito Plateau Archaeological Surveys and Excavations, II*, LA-8860-NERP, dated April, 1982, pp. 34-35). Steen states (p. 34): "When TA-49 was abandoned [i.e., immediately after the 1959-61 operations], it was planned to bury scrap metal and other 'garbage' in three large trenches. Bulldozers bladed out the trenches and one of them was partially filled with trash when it was determined not to bury the scrap." In Laboratory archaeological site records Steen dated the excavation of the trenches to around 1960. Based on the previously mentioned aerial photographs it is obvious that Steen was in error regarding the date of the excavation of the trenches. It would make sense that because the trenches were already open and visible by 1959, they could have been considered as potential disposal locations for the 1959-1961 activities in TA-49. What is unclear is what Steen meant by the implication that 'garbage' or 'trash' was buried in the partially backfilled trench. Presumably he got this information from other Laboratory employees familiar with the 1959-1961 TA-49 activities. It is possible, although seemingly unlikely, that Steen confused the partially backfilled trench with the SWMU-49-004 landfill trench and the 1971 reopening of the landfill for waste disposal. We speculate based on proximity that Steen's partially backfilled trench containing the Laboratory trash is our present Trench D, although this is by no means certain.

The October 2007 Historical Investigation Report suggests that the four trenches in Area 6 West may have been related to pre-Laboratory mine-claim activities during the period of 1935 to 1943. It is, instead, the present opinion of the LANL Cultural Resources Team that at least the trenches through the two archaeological sites (Trench B in LA 15861 and Trench C in LA 15866A) were likely purposefully placed with the intent to gain information and/or artifacts (such as ceramic pots associated with burials) from the trench excavations. This is suggested by the alignment of the trenches exactly parallel to the long axis of the two associated roomblocks, and the placement of Trench B so as to cut through the middle of the LA 15861 trash midden (and potentially to look for the presence of a semi-subterranean ceremonial kiva structure which typically are located to the east of roomblocks), and the placement of Trench C so as to cut through the entire string of western rooms of the LA 15866A two-row masonry roomblock..

Trenches B and C conceivably may have been the work of a pre-Laboratory (1935-1943) local homesteader, or early Laboratory (1943-1954) employee "pot-hunting" the two sites. However, the LANL Cultural Resources Team presently believes it even more likely that the trenches were placed by Frederick Worman, the Laboratory's first archaeologist who worked at LANL between late 1950 and 1971.

In a May 1977 report (*Pajarito Plateau Archaeological Survey and Excavations*, LASL-77-4, pp. 5-6), Charlie Steen notes that in 1950, while then still employed at Adams State College in Colorado, Worman placed three sizable trenches in the large Ancestral Pueblo Late Coalition period plaza pueblo site (LA 4693) situated between Buildings 49-113 and 49-115. Because LA 4693 is only about 650 meters to the southeast of LA 15866A, it is probable that Worman was aware of the presence of LA 15866A and LA 15861. Assuming this to have been the case, Worman may have elected to place trenches at LA 15866A and LA 15861 during the period of 1950 to 1954 to better understand the range of Ancestral Pueblo habitation roomblock sites in the vicinity of LA 4693. Regrettably, as noted by Steen, Worman prepared no report on his trenches at LA 4693, which may also explain the lack of information regarding the trenches at LA 15866A and LA 15861.

If Frederick Worman was, in fact, responsible for the excavation of Trenches B and C, this may also explain the other two trenches in Area 6 West. Situated around the many Ancestral Pueblo roomblock habitation sites at TA-49 are numerous Ancestral Pueblo fieldhouse structures consisting of 1-2 masonry rooms with few associated artifacts. It is therefore possible that Trenches A and D were used by Worman to explore fieldhouse structures whose integrity and very presence has since been obliterated by the trenches. However, this does not preclude the possibility that one of these two trenches, perhaps Trench D, was later used for Laboratory 'trash' as noted by Steen.

In conclusion, the LANL Cultural Resources Team is of the opinion that at least the two trenches associated with LA 15861 and LA 15866A (Trenches B and C) are more likely to have been originally excavated by Frederick Worman, or at least knowledgeable pot-hunters, rather than by the Laboratory for waste disposal. The general open nature and physical appearance of these two trenches strongly suggests that they were never used for waste disposal. One practical test of presumed archaeological origin of these two trenches would be to place test trenches in the debris mounds at each end of Trench B and Trench C and to stratigraphically study the depositional character of these mound deposits. A rapidly excavated Laboratory waste disposal trench would likely yield debris mounds with generally homogenous deposits consisting of few well defined stratigraphic lenses, whereas a trench excavated by pot-hunters or an archaeologist should yield evidence of several distinct stratigraphic lenses representing the stripping of archaeological site deposits in somewhat controlled levels each 10-20 cm thick. Trenches A and D are more problematic and the LANL Cultural Resources Team cannot vouch for their origin or later use, although a reasonable inference is that they were initially excavated at around the same time as Trench B and Trench C.

LH:alb

Cy:
Bruce Masse, ENV-EAQ, J978
ENV-EAQ File

Figure 1. View looking south along the open trench (Trench C) associated with archaeological site LA 15866A, soon after the Cerro Grande Fire (October 2000).

Figure 2. View looking south at masonry rooms adjacent to open trench at LA 15866A (Trench C), excavated by Charlie Steen after the 1977 La Mesa Fire (October 2000).