

LA-UR-12-23970
August 2012
EP2012-0188

Investigation Report for Lower Mortandad/Cedro Canyons Aggregate Area, Revision 1

Prepared by the Environmental Programs Directorate

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August 2012

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EXECUTIVE SUMMARY

This investigation report presents the investigation activities at four solid waste management units (SWMUs) located within the Lower Mortandad/Cedro Canyons Aggregate Area at Los Alamos National Laboratory (LANL or the Laboratory). The four SWMUs are located in Technical Area 05 (TA-05).

The objectives of this investigation are to define the nature and extent of contamination and, if defined, to determine whether the sites pose a potential unacceptable risk to human health or the environment. This report presents the results of site characterization activities conducted during the 2011 investigation, as directed by the approved investigation work plan for the Lower Mortandad/Cedro Canyons Aggregate Area. Additional sampling was conducted at several new and existing locations to complete the extent of contamination determinations at the four SWMUs.

The 2011 investigation activities included collecting soil, sediment, and tuff samples from the surface to a maximum depth of 56 ft below ground surface. Data from samples collected during the 2011 investigation were evaluated along with data collected during previous investigations (if applicable) that meet current Laboratory data-quality requirements.

The sampling data presented in this report indicate the extent of contamination is defined at the four SWMUs. The human health risk-screening assessment results indicate no potential unacceptable risks or doses exist from chemicals of potential concern (COPCs) under the industrial and residential scenarios at SWMUs 05-003, 05-005(b), and 05-006(c). The total excess cancer risks are below the New Mexico Environment Department (NMED) target risk level of 1×10^{-5} , the hazard indexes (HIs) are below the NMED target HI of 1, and the total doses are below the U.S. Department of Energy target dose limit of 15 mrem/yr. SWMU 05-004 does not pose a potential unacceptable risk or dose under the industrial scenario, does not pose a potential unacceptable noncarcinogenic risk and potential unacceptable dose under the residential scenario, but poses a potential unacceptable cancer risk under the residential scenario. The cancer risk is from the presence of polycyclic aromatic hydrocarbons (PAHs) that are not site-related. After PAHs are removed from the residential carcinogenic screening evaluation, the total excess cancer risk is below the NMED target risk level of 1×10^{-5} .

An ecological risk-screening assessment was conducted for the four SWMUs at TA-05. The ecological risk-screening assessment results indicate no potential risks exist to any ecological receptors at these sites.

No further investigation or remediation activities are warranted in the Lower Mortandad/Cedro Canyons Aggregate Area. Based on the risk-screening assessment results, the Laboratory recommends corrective actions complete without controls for SWMUs 05-003, 05-004, 05-005(b), and 05-006(c).

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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 Los Alamos 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 40 mi² of the Pajarito Plateau, which consists of a series of fingerlike mesas that are separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 ft to 7800 ft above mean sea level.

The Laboratory is participating in a national effort by DOE to clean up sites and facilities formerly involved in weapons research and development. The goal of the Laboratory's effort is to ensure past operations do not threaten human health and safety and the environment in and around Los Alamos County, New Mexico. To achieve this goal, the Laboratory is currently investigating sites potentially contaminated by past Laboratory operations. These sites are designated as either solid waste management units (SWMUs) or areas of concern (AOCs).

This investigation report discusses the 2011 investigation of the Lower Mortandad/Cedro Canyons Aggregate Area at the Laboratory (Figure 1.0-1). These sites are potentially contaminated with both hazardous and radioactive components. 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 5400.5, Radiation Protection of the Public and the Environment; DOE Order 435.1, Radioactive Waste Management; and DOE Order 458.1, Administrative Change 2, Radiation Protection of the Public and the Environment. 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 the Compliance Order on Consent (the Consent Order). This investigation report describes work activities that were completed in accordance with the Consent Order.

1.1 General Site Information

The Lower Mortandad/Cedro Canyons Aggregate Area, located in Technical Area 05 (TA-05) at the Laboratory (Figure 1.1-1) consists of four SWMUs and two AOCs. Of the six sites, one AOC has been previously approved for no further action (NFA), and one AOC was included in the investigation of the Middle Mortandad/Ten Site Canyons Aggregate Area (LANL 2008, 102187). These two AOCs are not addressed in this report. The four remaining SWMUs were addressed in the approved investigation work plan (LANL 2010, 108281; NMED 2010, 108451). Historical details of previous investigations and data were provided in the historical investigation report for the Lower Mortandad/Cedro Canyons Aggregate Area (LANL 2008, 101803). This investigation report describes the investigation status and results from sampling activities conducted to date for the four SWMUs. Table 1.1-1 lists the four sites and provides a brief description, summary of previous investigations, and summary of investigation activities conducted in 2011 for each site.

1.2 Purpose of Investigation

Four SWMUs within the Lower Mortandad/Cedro Canyons Aggregate Area were addressed during the 2011 investigation. The objectives of the 2011 investigation were to (1) establish the nature and extent of contamination, (2) determine whether current site conditions pose a potential unacceptable risk to human health and the environment, and (3) assess whether any additional sampling and/or corrective actions are required.

Sampling was conducted at the four SWMUs from January to March 2011 in accordance with the approved investigation work plan (LANL 2010, 108281; NMED 2010, 108451). Additional sampling and soil removal were conducted in June 2011 as proposed by the Laboratory (2011, 203592) and approved by NMED (2011, 203618).

All analytical data collected during the 2011 investigation activities are presented and evaluated in this report in conjunction with decision-level data from previous investigations (if applicable).

1.3 Document Organization

This report is organized into nine sections, including this introduction, with multiple supporting appendixes. Section 2 provides site conditions (surface and subsurface) of the aggregate area. Section 3 provides an overview of the scope of the activities performed during the implementation of the work plan. Section 4 describes the regulatory criteria used to evaluate potential risks to human and ecological 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 2011 investigation, site contamination, evaluation of the nature and extent of contamination, and summaries of human health and ecological risk-screening assessments. Section 7 presents the conclusions of the nature and extent of contamination and risk-screening assessments. Section 8 discusses recommendations based on applicable data and risk-screening assessment results. Section 9 includes a list of references cited and the map data sources used in all figures and plates.

Appendixes include a list of acronyms and abbreviations, a metric conversion table, and definitions of data qualifiers (Appendix A); field methods (Appendix B); x-ray fluorescence (XRF) survey results (Appendix C); borehole logs (Appendix D); analytical program descriptions and summaries of data quality (Appendix E); analytical suites and results and analytical reports (Appendix F); investigation-derived waste (IDW) management (Appendix G); box plots and statistical comparisons (Appendix H); and risk-screening assessments (Appendix I).

2.0 AGGREGATE AREA SITE CONDITIONS

2.1 Surface Conditions

2.1.1 Soil

Soil on the Pajarito Plateau was initially mapped and described by Nyhan et al. (1978, 005702). The soil on the slopes between the mesa tops and canyon floors is mostly steep rock outcrops consisting of approximately 90% bedrock with patches of shallow, weakly developed colluvial soil. South-facing canyon walls generally are steep and usually have shallow soil in limited, isolated patches between rock outcrops. In contrast, the north-facing canyon walls generally have more extensive areas of shallow dark-colored soil under thicker forest vegetation. The canyon floors generally contain poorly developed, deep, well-drained soil on floodplain terraces or small alluvial fans (Nyhan et al. 1978, 005702).

The mesa-top soil where the Lower Mortandad/Cedro Canyons Aggregate Area SWMUs are located is mapped as the Hackroy-Rock outcrop complex. The Hackroy-Rock outcrop complex consists of small areas of Hackroy soil and 70% rock outcrop so intermingled that they could not be separated at the scale selected for mapping. Shallow, well-drained Hackroy soil makes up about 20% of the complex, and Nyjack soil and very shallow undeveloped soil make up about 10% of the unit. The Hackroy-Rock outcrop complex exhibits slow permeability and low available water capacity. It has a moderate to severe water erosion hazard and medium to high runoff (Nyhan et al. 1978, 005702, p. 25).

2.1.2 Surface Water

Most surface water in the Los Alamos area occurs as ephemeral, intermittent, or interrupted streams in canyons cut into the Pajarito Plateau. Springs on the flanks of the Jemez Mountains, west of the Laboratory's western boundary, supply flow to the upper reaches of Cañon de Valle and to Guaje, Los Alamos, Pajarito, and Water Canyons (Purtymun 1975, 011787; Stoker 1993, 056021). These springs discharge water perched in the Bandelier Tuff and Tschicoma Formation at rates from 2 to 135 gal./min (Abeelee et al. 1981, 006273). The volume of flow from the springs maintains natural perennial reaches of varying lengths in each of the canyons.

Mortandad Canyon has a relatively small drainage area (4.7 mi²) that originates on Laboratory property within TA-03 at an elevation of approximately 7410 ft above sea level. The canyon has a length of 10 mi and trends east-southeast across Laboratory property and Pueblo de San Ildefonso before reaching the Rio Grande in White Rock Canyon. Named tributaries include Cañada del Buey, Effluent Canyon, and Ten Site Canyon on Laboratory property and Cedro Canyon on Pueblo de San Ildefonso.

Mortandad Canyon contains a small ephemeral stream. No perennial springs or natural perennial reaches occur. Snowmelt runoff and stormwater runoff flow for a limited distance in the upper part of the canyon. Surface water flows from the National Pollutant Discharge Elimination System (NPDES) permitted outfall at the TA-50 Radioactive Liquid Waste Treatment Facility but typically extends less than 1 mi below the outfall (LANL 1997, 056835, p. 3-2).

Reach MCW-1 is located downgradient of the sites addressed in this report (Figure 1.1-1). Cedro Canyon, a tributary of Mortandad Canyon located on San Ildefonso Pueblo land, starts approximately 1.3 mi southeast of the sites.

2.1.3 Land Use

Currently, land use of that portion of the Lower Mortandad/Cedro Canyons Aggregate Area on Laboratory property is industrial. The four SWMUs addressed in this report are located in TA-05 near Mortandad Canyon, and no SWMUs or AOCs are located near Cedro Canyon. TA-05 is currently used as a security buffer zone and contains physical support facilities such as an electrical substation, a water-supply well, test wells, several archeological sites, and environmental monitoring and buffer areas. In the past, Laboratory employees used the gravel road extending along the length of Mesita del Buey for recreational activities such as walking or jogging, but the road is currently inaccessible for such use. TA-05 is not accessible to the public. The current land use is not expected to change for the reasonably foreseeable future. The portion of Lower Mortandad/Cedro Canyons Aggregate Area outside the Laboratory boundary is on San Ildefonso Pueblo land and is not accessible to the public.

2.2 Subsurface Conditions

2.2.1 Stratigraphic Units of the Bandelier Tuff

The stratigraphy of the Lower Mortandad/Cedro Canyons Aggregate Area is summarized in this section. Additional information on the geologic setting of the area and information on the Pajarito Plateau can be found in the Laboratory's hydrogeologic synthesis report (Collins et al. 2005, 092028).

The bedrock at or near the surface of the mesa top is the Quarternary Tshirege Member of the Bandelier Tuff (Qbt). There are approximately 1250 ft of volcanic and sedimentary materials between any potential contaminant-bearing units at the mesa-top surface and the regional aquifer. The following descriptions of the stratigraphic units begin with the oldest (deepest) and proceed to the youngest (topmost).

Stratigraphic units comprising the Bandelier Tuff are shown in Figure 2.2-1. The only stratigraphic unit encountered during the Lower Mortandad/Cedro Canyons Aggregate Area investigation was Qbt 3 of the Tshirege Member of the Bandelier Tuff.

2.2.1.1 Otowi Member of the Bandelier Tuff

Griggs and Hem (1964, 092516); Smith and Bailey (1966, 021584); Bailey et al. (1969, 021498); and Smith et al. (1970, 009752) described the Otowi Member. It consists of moderately consolidated (indurated) porous 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 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, crystal fragments, and fragments of perlite. The basal part of the Otowi Member includes the Guaje Pumice Bed, which is a sequence of well-stratified pumice-fall and ash-fall deposits.

The Otowi Member is absent in Lower Mortandad Canyon where it either was not deposited or was removed by erosion before the Tshirege Member was deposited (LANL 2010, 108281, p. 8).

2.2.1.2 Tephra and Volcaniclastic Sediment of the Cerro Toledo Interval

The Cerro Toledo interval is an informal name given to a sequence of volcaniclastic sediment and tephra of mixed provenance that separates the Otowi and Tshirege Members of the Bandelier Tuff (Broxton et al. 1995, 050121; Broxton and Reneau 1995, 049726; Goff 1995, 049682). Although it is located between the two members of the Bandelier Tuff, it is not considered part of that formation (Bailey et al. 1969, 021498). The unit contains primary volcanic deposits described by Smith et al. (1970, 009752) as well as reworked volcaniclastic sediment. The occurrence of the Cerro Toledo interval is widespread; however, its thickness is variable, ranging between several feet and more than 100 ft.

The predominant rock types in the Cerro Toledo interval are rhyolitic tuffaceous sediment and tephra (Heiken et al. 1986, 048638; Stix et al. 1988, 049680; Broxton et al. 1995, 050121; Goff 1995, 049682). The tuffaceous sediment is the reworked equivalent of Cerro Toledo rhyolite tephra. Oxidation and clay-rich horizons indicate at least two periods of soil development occurred within the Cerro Toledo deposits. Because the soil is rich in clay, it may act as a barrier to the movement of vadose zone moisture. Some of the deposits contain both crystal-poor and crystal-rich varieties of pumice. The pumice deposits tend to form porous and permeable horizons within the Cerro Toledo interval and locally may provide important pathways for moisture transport in the vadose zone. A subordinate lithology within the Cerro Toledo interval includes clast-supported gravel, cobble, and boulder deposits derived from the Tschicomma Formation (Broxton et al. 1995, 050121; Goff 1995, 049682; Broxton and Reneau 1996, 055429).

2.2.1.3 Tshirege Member of the Bandelier Tuff

The Tshirege Member of the Bandelier Tuff is the upper member 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 years 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. It is a cooling unit whose physical properties vary vertically and laterally. 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 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. The Tshirege Member is generally over 200 ft thick.

The Tshirege Member differs from the Otowi Member most notably in its generally greater degree of welding and compaction. Time breaks between the successive emplacement 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). The welding and crystallization variability in the Tshirege Member produce recognizable vertical variations in its properties, such as density, porosity, hardness, composition, color, and surface-weathering patterns. The subunits are mappable based on a combination of hydrologic properties and lithologic characteristics.

Broxton et al. (1995, 050121) provide extensive descriptions of the Tshirege Member cooling units. The following paragraphs describe, in ascending order, subunits of the Tshirege Member present within the Lower Mortandad/Cedro Canyons Aggregate Area.

The Tsankawi Pumice Bed forms the base of the Tshirege Member. Where exposed, it is commonly 20 to 30 in. thick. This pumice-fall deposit contains moderately well-sorted pumice lapilli (diameters reaching about 2.5 in.) in a crystal-rich matrix. Several thin ash beds are interbedded with the pumice-fall deposits.

Subunit Qbt 1g is the lowermost tuff subunit of the Tshirege Member. It consists of porous, nonwelded, and poorly sorted ash-flow tuff. This unit is poorly indurated but nonetheless forms steep cliffs because of a resistant bench near the top of the unit; the bench forms a harder protective cap over the softer underlying tuff. A thin (4–10 in.) pumice-poor surge deposit commonly occurs at the base of this unit.

Subunit Qbt 1v forms alternating cliff-like and sloping outcrops composed of porous, nonwelded, crystallized tuff. The base of this unit is a thin horizontal zone of preferential weathering that marks the abrupt transition from glassy tuff below (in Qbt 1g) to the crystallized tuff above. This feature forms a widespread marker horizon (locally termed the vapor-phase notch) throughout the Pajarito Plateau. The lower part of Qbt 1v is orange-brown, is resistant to weathering, and has distinctive columnar (vertical) joints; hence, the term “colonnade tuff” is appropriate for its description. A distinctive white band of alternating cliff- and slope-forming tuffs overlies the colonnade tuff. The tuff of Qbt 1v is commonly nonwelded (pumices and shards retain their initial equant shapes) and has an open, porous structure.

Qbt 2 forms a distinctive medium-brown vertical cliff that stands out in marked contrast to the slope-forming, lighter-colored tuff above and below. It displays the greatest degree of welding in the Tshirege Member. A series of surge beds commonly mark its base. It typically has low porosity and permeability relative to the other units of the Tshirege Member.

Qbt 3 is a nonwelded to partially welded, vapor-phase altered tuff that forms the upper cliffs. Its base consists of a purple-gray, unconsolidated, porous, and crystal-rich nonwelded tuff that forms a broad, gently sloping bench developed on top of Qbt 2. Abundant fractures extend through the upper units of the Bandelier Tuff, including the ignimbrite of Qbt 3. The origin of the fractures has not been fully determined, but the most probable cause is brittle failure of the tuff caused by cooling contraction soon after initial emplacement (Vaniman 1991, 009995.1; Wohletz 1995, 054404).

2.2.2 Hydrogeology

The hydrogeology of the Pajarito Plateau is generally separable in terms of mesas and canyons forming the plateau. Mesas are generally devoid of water, both on the surface and within the rock forming the mesa. Canyons range from wet to relatively dry with the wettest canyons containing continuous streams and perennial groundwater in the canyon-bottom alluvium. Dry canyons have only occasional stream flow and may lack alluvial groundwater. Perched-Intermediate groundwater has been found at certain locations on the plateau at depths ranging between 100 and 700 ft below ground surface (bgs). The regional aquifer is found at depths of about 600 to 1250 ft bgs (Collins et al. 2005, 092028).

The hydrogeologic conceptual site model for the Laboratory (LANL 2010, 109830) shows that, under natural conditions, relatively small volumes of water move beneath mesa tops because of low rainfall, high evaporation, and efficient water use by vegetation. Atmospheric evaporation may extend into mesas, further inhibiting downward flow.

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) perched-intermediate 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 Laboratory's annual Interim Facility-Wide Groundwater Monitoring Plan (LANL 2010, 109830) details the implementation of extensive groundwater characterization across the Pajarito Plateau within an area potentially affected by past and present Laboratory operations.

The locations of the existing wells within the vicinity of the Lower Mortandad/Cedro Canyons Aggregate Area investigation sites are shown in Figure 1.1-1.

Alluvial Groundwater

Intermittent and ephemeral stream flows in the canyons of the Pajarito Plateau have deposited alluvium that can be as thick as 100 ft. The alluvium in canyons of the Jemez Mountains is generally composed of sand, gravel, pebbles, cobbles, and boulders derived from the Tschicoma Formation and Bandelier Tuff. The alluvium in canyons of the Pajarito Plateau is finer grained, consisting of clay, silt, sand, and gravel derived from the Bandelier Tuff (Purtymun 1995, 045344).

In contrast to the underlying volcanic tuff and sediment, alluvium is relatively permeable. Ephemeral runoff in some canyons infiltrates the alluvium until downward movement is impeded by the less permeable tuff and sediment, resulting in the buildup of a shallow alluvial groundwater body. Depletion by evapotranspiration and movement into the underlying rock limit the horizontal and vertical extent of the alluvial water (Purtymun et al. 1977, 011846). The limited saturated thickness and extent of the alluvial groundwater preclude its use as a viable source of water for municipal and industrial needs. Lateral flow of the alluvial perched groundwater is in an easterly, downcanyon direction (Purtymun et al. 1977, 011846).

The downgradient extent of alluvial saturation in Mortandad Canyon is about 2300 ft below the confluence of Mortandad and Ten Site Canyons (LANL 2006, 094161, p. 60). The Lower Mortandad/Cedro Canyons Aggregate Area sites addressed in this report are located in TA-05 approximately 0.25 mi south of the confluence of Mortandad and Ten Site Canyons. Thus, alluvial groundwater is present in Ten Site Canyon to the north of the investigation sites. The unnamed canyon to the south of the investigation sites, the canyon receiving runoff from these sites, is a small tributary to Mortandad Canyon. This tributary does not join Mortandad Canyon until approximately 1 mi below the extent of alluvial saturation. Given the small drainage area of the tributary canyon and the absence of active outfalls, alluvial groundwater is not expected to the south of the investigation sites.

Perched-Intermediate Waters

Observations of perched-intermediate water are rare on the Pajarito Plateau. Perched-intermediate waters are thought to form mainly at horizons where medium properties change dramatically, such as at paleosol horizons containing clay or caliche. It is not known whether perched-intermediate water bodies are isolated or connected and to what degree they may influence travel times and pathways for contaminants in the vadose zone.

Two known locations of perched-intermediate groundwater have been identified in the vicinity of TA-05. One occurs near the confluence of Mortandad and Ten Site Canyons. At this location, a thin zone of saturation is found at a depth of approximately 520 ft at the top of the Cerros del Rio basalts. The other location is in Mortandad Canyon approximately 1150 ft east of the confluence with Ten Site Canyon. Perched water is encountered at this location in the lower part of the Cerros del Rio basalts at depths ranging from about 646 to 729 ft (LANL 2006, 094161, pp. 64–65).

Regional Groundwater

The regional aquifer is the only aquifer capable of large-scale municipal water supply in the Los Alamos area (Purtymun 1984, 006513). The surface of the regional aquifer rises westward from the Rio Grande within the Santa Fe Group into the lower part of the Puye Formation beneath the central and western part of the Pajarito Plateau. The depths to the regional aquifer below the mesa tops range between about 1200 ft bgs along the western margin of the plateau and about 600 ft bgs at the eastern margin. The location of wells and generalized water-level contours on top of the regional aquifer are described in the annual General Facility Information report (LANL 2011, 201568). The regional aquifer is typically separated from the alluvial groundwater and perched-intermediate zone groundwater by 350–620 ft of tuff, basalt, and sediment (LANL 1993, 023249).

Groundwater in the regional aquifer flows east-southeast toward the Rio Grande. The velocity of groundwater flow ranges from about 20 to 250 ft/yr (LANL 1998, 058841, pp. 2–7). Details of depths to the regional aquifer, flow directions and rates, and well locations are presented in various Laboratory documents (Purtymun 1995, 045344; LANL 1997, 055622; LANL 2000, 066802). Figure 2.2-2 shows depths to the top of the regional aquifer across the Laboratory.

Regional well R-14 is located in Ten Site Canyon, approximately one-half mi west of the investigation sites. The depth to the regional aquifer at this location is approximately 1200 ft (LANL 2003, 076062). Regional wells R-15 and R-33 are located in Mortandad Canyon to the north (Figure 1.1-1), and the depths to the regional aquifer are approximately 1200 ft (Figure 2.2-2). Supply well PM-5 is located on Mesita del Buey just west of the investigation sites, and the depth to the regional aquifer at this location is at least 1200 ft (LANL 2008, 102187, p. 38).

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 from 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 and generally decreases 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 Lower Mortandad/Cedro Canyons Aggregate Area approved investigation work plan (LANL 2010, 108281; NMED 2010, 108451). The scope of activities for the 2011 investigation included site access and premobilization activities; geodetic, XRF, and radiological surveys; surface and shallow subsurface sampling; borehole drilling, subsurface sampling, and borehole abandonment; excavation and removal activities; health and safety monitoring; and waste management activities.

All activities were conducted in accordance with the approved investigation work plan (LANL 2010, 108281; NMED 2010, 108451). Deviations from the approved investigation work plan are provided in section 3.3 and in Appendix B.

3.1 Site Access and Premobilization Activities

The area encompassing the Lower Mortandad/Cedro Canyons Aggregate Area is currently used for Laboratory operations, and some areas are used by Laboratory personnel for road and foot traffic. Before field mobilization, the issue of Laboratory worker access (e.g., traffic control plan and notifications) was

reviewed as part of the management self-assessment process. All efforts were made to provide a secure and safe work area and to reduce impacts to Laboratory personnel, cultural resources, and the environment.

3.2 Field Activities

This section describes the field activities conducted during the 2011 investigation. Additional details regarding the field methods and procedures used to perform these field activities are presented in Appendix B.

3.2.1 Geodetic Survey

Geodetic surveys were conducted during the Lower Mortandad/Cedro Canyons Aggregate Area investigation to locate surface and subsurface sampling locations. Initial geodetic surveys were performed to establish and mark the planned sampling locations in the field. Geodetic surveys were conducted in accordance with Standard Operating Procedure (SOP) 5028, Coordinating and Evaluating Geodetic Surveys, using a Trimble R8 Global Navigation Satellite System (GNSS). The surveyed coordinates for all 2011 sampling locations are presented in Table 3.2-1. All geodetic coordinates are expressed as State Plane Coordinate System 1983, New Mexico Central, U.S.

3.2.2 XRF Surveys

A survey of lead contamination at the former site of building 05-5 [SWMU 05-006(c) of Consolidated Unit 05-005(b)-00] was conducted using a field XRF instrument to identify areas of elevated metal concentrations. Lead was previously detected above the industrial soil screening level (SSL) of 800 mg/kg at the site (LANL 2010, 108281). The XRF survey was conducted using an instrument with sufficient sensitivity for lead (i.e., 100 mg/kg or less) to identify areas with lead concentrations above the industrial SSL. The instrument was operated according to the manufacturer's instructions, including collecting, preparing, and analyzing samples. Appendix C presents the XRF survey report.

3.2.3 Field Screening

Environmental samples were field screened for headspace organic vapors with a MiniRAE 2000 photoionization detector (PID) equipped with an 11.7-electron volt lamp. Calibration was performed in accordance with the manufacturer's specifications and SOP-06.33, Headspace Vapor Screening with a Photoionization Detector, and recorded in the field logbook. After collection, each sample was placed in a sealed plastic bag for approximately 5 min. Screening measurements were recorded in the field sample collection logs (SCLs). The organic vapor-screening results are presented in Table 3.2-2.

All samples collected were field screened for radioactivity before they were submitted to the Sample Management Office (SMO). A Laboratory radiation control technician (RCT) conducted radiological screening using an Eberline E-600 radiation meter with an SHP-380AB alpha/beta scintillation detector held within 1 in. of the sample. All field results for gross-alpha and gross-beta/gamma radioactivity were recorded in disintegrations per min (dpm) on the field SCL/chain-of-custody (COC) forms. The SCLs/COC forms are provided on DVD in Appendix F. The radioactivity-screening results are presented in Table 3.2-2.

3.2.4 Surface, Shallow Subsurface, and Sediment Sampling

Samples were collected according to the approved investigation work plan (LANL 2010, 108281; NMED 2010, 108451). Table 3.2-1 shows the proposed sampling locations that were listed in the approved investigation work plan, with the corresponding actual location identifiers as sampled. In addition to those proposed in the work plan, additional samples were collected in June 2011 as proposed by the Laboratory (LANL 2011, 203592) and approved by NMED (2011, 203618). The locations of the additional samples are also listed in Table 3.2-1.

Surface samples were collected using the spade-and-scoop method in accordance with SOP-06.09, Spade and Scoop Method for Collection of Soil Samples, or with a hand auger in accordance with SOP-06.10, Hand Auger and Thin-Wall Tube Sampler. Shallow-subsurface samples were collected using the hand-auger method in accordance with SOP-06.10. The samples were collected in stainless-steel bowls and transferred to sample collection bottles with a stainless-steel spoon.

Sediment samples were collected from areas of sediment accumulation that include sediment determined as representative of the historical period of Laboratory operations. The locations were selected by the field geologist based on geomorphic relationships in areas likely to have been affected by discharges from Laboratory operations. Because sediment systems are dynamic and subject to redistribution by runoff events, sediment sampling locations were adjusted appropriately and the adjusted locations were surveyed using a Trimble R8 GNSS.

All surface, shallow subsurface, and sediment samples were placed in appropriate sample containers and submitted to the analytical laboratory for the analyses specified by the approved investigation work plan. Standard quality assurance (QA)/quality control (QC) samples (field duplicates, field trip blanks, and rinsate blanks) were collected in accordance with SOP-5059, Field Quality Control Samples.

All sample collection activities were coordinated with the SMO. After the samples were collected, they remained in the controlled custody of the field team at all times until they were delivered to the SMO. Sample custody was then relinquished to the SMO for delivery to a preapproved off-site contract analytical laboratory.

3.2.5 Borehole Drilling and Subsurface Sampling

At locations where the required sampling depths could not be reached by hand augers, a drill rig with a hollow-stem auger was used to collect subsurface samples. Samples were collected using stainless-steel core barrel samplers in accordance with SOP-06.26, Core Barrel Sampling for Subsurface Earth Materials. For the 2011 investigation, three boreholes were drilled to depths ranging from 5–56 ft bgs. The samples were extracted from the core barrels, placed in stainless-steel bowls, and handled the same way as the surface and shallow-subsurface samples were handled (section 3.2.4). Samples were then delivered to the SMO where the sample custody was relinquished for delivery to a preapproved off-site contract analytical laboratory. Boreholes logs for these three boreholes are provided in Appendix D.

3.2.6 Borehole Abandonment

All boreholes were abandoned in accordance with SOP-5034, Monitoring Well and RFI Borehole Abandonment, by filling the boreholes with bentonite chips up to 2–3 ft from the ground surface. The chips were hydrated and clean soil was placed on top. All cuttings were managed as IDW, as described in Appendix G.

3.2.7 Debris Removal and Soil Excavation

Debris was removed from an area at the former site of building 05-5 [SWMU 05-006(c) of Consolidated Unit 05-005(b)-00]. The debris was believed to be associated with the destruction of former building 05-5 by burning. Because of the small volume of debris present, removal was conducted using hand tools. The debris included man-made debris, such as nails, wire, pieces of metal (including lead fragments), charred wood, and melted glass. Following removal of the debris, soil at the debris area was surveyed using a field XRF (Appendix C). Contaminated soil and tuff were then excavated to remove media that contained lead exceeding the 800 mg/kg industrial SSL. The total volume of the IDW (debris, elemental lead, and excavated media) was approximately 1.04 yd³. Management of the waste generated from the excavation and associated IDW is described in Appendix G.

Upon evaluating the analytical results at SWMU 05-006(c) after completing the sampling from January to March 2011, the Laboratory conducted additional remediation and sampling activities at this site (LANL 2011, 203592). The additional activities included excavating the surface soil at location 05-613800 (outside the debris area) to remove lead-contaminated soil and tuff, and collecting confirmation samples. The total volume of the excavated media was approximately 1.02 yd³. Management of the lead-contaminated soil and associated IDW is described in Appendix G. Although location 05-613800 is within the boundary of SWMU 05-005(b), it was originally proposed in the approved investigation work plan to be sampled to define the nature and extent of contamination at SWMU 05-006(c).

3.2.8 Equipment Decontamination

All field equipment with the potential to contact sample material (e.g., hand augers, sampling scoops, bowls, and core barrel sections) was decontaminated between sample collection and between sampling locations to prevent cross-contamination of samples and sampling equipment. Decontamination was performed in accordance with SOP-5061, Field Decontamination of Equipment. Rinsate blanks were collected on sampling equipment to check the effectiveness of decontamination. The decontamination methods used are described in Appendix B.

At sites where a drill rig was used, an RCT screened the drilling equipment for gross-alpha and -beta radioactivity in the field after each borehole was drilled. An RCT also surveyed the drill rig before it was brought on-site and before it was released back to the drilling contractor.

3.2.9 Sample Analyses

All samples were shipped by the SMO to off-site contract analytical laboratories for the requested analyses. The analyses requested were specified by the approved work plan (LANL 2010, 108281; NMED 2010, 108451). The samples were analyzed for all or a subset of the following: target analyte list (TAL) metals, nitrate, perchlorate, total cyanide, dioxin and furan congeners, explosive compounds, polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), gamma-emitting radionuclides, isotopic plutonium, and isotopic uranium.

Field duplicates of investigation samples were analyzed for the same analytical suites as the corresponding investigation samples. Equipment rinsate blanks were analyzed for the same inorganic chemical suites as the related investigation samples. Field trip blanks were analyzed only for VOCs. Analytical methods and summaries of data quality are presented in Appendix E. Analytical results and analytical reports are included on DVD in Appendix F.

3.2.10 Health and Safety Measures

All 2011 investigation activities were conducted in accordance with an approved site-specific health and safety plan and integrated work document that detailed work steps, potential hazards, hazard controls, and required training to conduct work. These health and safety measures included the use of modified Level-D personal protective equipment and field monitoring for organic vapors and for gross-alpha and -beta radioactivity using portable air monitoring systems.

3.2.11 IDW Storage and Disposal

All IDW generated during the 2011 investigation was managed in accordance with SOP-5238, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable U.S. Environmental Protection Agency (EPA) and NMED regulations, DOE orders, and Laboratory implementation requirements, policies, and procedures. The waste streams associated with the 2011 investigation included drill cuttings, contact waste, removed debris, and excavation waste. Each waste stream was containerized and managed in accordance with the approved waste characterization strategy form (WCSF). Details of IDW management are presented in Appendix G. All available waste documentation, including WCSF, waste profiles forms, and land application packages are provided in Appendix G (Attachment G-1 on CD).

3.3 Deviations

Deviations occurred while conducting field activities as defined in the approved work plan (LANL 2010, 108281; NMED 2010, 108451). The deviations did not adversely affect the completion or results of the investigation. The specific deviations are described in Appendix B, section B-9.0.

4.0 REGULATORY CRITERIA

This section describes the criteria used for evaluating potential risks and doses to human and ecological 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 Lower Mortandad/Cedro Canyons Aggregate Area sites using NMED guidance (NMED 2009, 108070). Ecological risk-screening assessments were performed using Laboratory guidance (LANL 2004, 087630).

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. The current and reasonably foreseeable future land use for a site determines the receptors and exposure scenarios used to select screening and cleanup levels.

The land use of Laboratory property within and surrounding the Lower Mortandad/Cedro Canyons Aggregate Area is currently industrial and is expected to remain industrial for the reasonably foreseeable future. The four sites under investigation in the Lower Mortandad/Cedro Canyons Aggregate Area have undergone decontamination and decommissioning (D&D), and currently no aboveground structures remain at the sites. Future construction work is not anticipated at these sites. Therefore, the construction worker scenario is not evaluated for the sites investigated. TA-05 is not accessible to Laboratory employees for recreational activities such as walking or jogging and is not accessible to the general

public. Therefore, the recreational scenario is also not evaluated for the sites investigated. Although the residential scenario is not applicable given the current and foreseeable future land use, this scenario is evaluated for comparison purposes.

4.2 Screening Levels

Human health risk-screening evaluations were conducted for all four sites investigated. The human health screening assessments (Appendix I) were performed for inorganic and organic chemicals of potential concern (COPCs) using NMED SSLs for the industrial and residential scenarios (NMED 2009, 108070). Radionuclides were assessed using the Laboratory screening action levels (SALs) (LANL 2009, 107655). When an NMED SSL was not available for a COPC, SSLs were obtained from EPA regional tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) (adjusted to a risk level of 10^{-5} for carcinogens). Surrogate SSLs were used for some COPCs for which no SSLs were available, based on structural similarity or breakdown products.

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 2.5 (LANL 2010, 110846). The ESLs are based on similar species and are derived from experimentally determined no observed adverse effect levels, 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 2.5 (LANL 2010, 110846).

4.4 Cleanup Standards

Screening levels are used as soil cleanup levels unless they are determined to be impracticable in accordance with the Consent Order, Section VIII.E, paragraph 2, or if values do not exist for current and reasonably foreseeable future land use.

The cleanup goals specified in Section VIII of the Consent Order are a target risk of 10^{-5} for carcinogens or a hazard index (HI) of 1 for noncarcinogens. For radionuclides, the target dose is 15 mrem/yr based on DOE guidance (DOE 2000, 067489). The SSLs and SALs used in the risk-screening assessments in Appendix I are based on these cleanup goals.

5.0 DATA REVIEW METHODOLOGY

The purpose of the data review is to identify COPCs for each SWMU in the Lower Mortandad/Cedro Canyons Aggregate Area, where the nature and extent of contamination have been defined.

Extent is determined for inorganic chemicals and radionuclides by spatial analysis of detections above background values (BVs) or fallout values (FVs) and by detection for organic chemicals. For inorganic chemicals and radionuclides, statistical comparisons are performed to determine if concentrations are comparable with background and to aid in defining extent. Across a site, extent is defined for inorganic chemicals and radionuclides whose concentrations decrease with depth and decrease laterally, or are not different from background. In addition, concentrations of certain naturally occurring inorganic chemicals (e.g., nitrate) that do not have an established BV likely reflect naturally occurring concentrations and not a contaminant release. Extent is defined for organic chemicals whose concentrations decrease with depth

and decrease laterally, or are detected at or below the estimated quantitation limit (EQL) for the analytical method and are considered present at “trace” concentrations.

If the nature and extent of inorganic chemicals, organic chemicals, and/or radionuclides have been defined for a site, COPC identification is performed for that site. If nature and extent are not defined for all analytes, COPCs are not identified for that site and further investigation is recommended.

5.1 Identification of COPCs

Inorganic COPCs are identified by comparing site data with BVs (LANL 1998, 059730) or are based on detection status if no BVs are available. Organic chemicals are identified as COPCs based on detection status. Radionuclides are identified as COPCs based on comparisons to BVs or FVs or are based on detection status if no BVs or FVs are available.

For inorganic chemicals, data are evaluated by sample media to facilitate the comparison with media-specific background data. Background data are generally available for 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 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.

To identify inorganic COPCs, the first step is to compare the sampling results with the BVs, if available. If sampling results are above BVs and sufficient data are available (10 or more sampling results), statistical tests are used to compare the site sample data with the background data set for the appropriate medium. If statistical tests cannot be performed because of insufficient data (less than 10 samples) or a high percentage of nondetects, the sampling results are compared with the BV and the maximum background concentration of the chemical in the appropriate medium. If sampling results are above the BV and maximum background concentration, the chemical is identified as a COPC. The same evaluation is performed using sample DLs when a constituent is not detected but has DLs above the BV. If no BV is available, detected inorganic chemicals are identified as COPCs.

Radionuclides are identified as COPCs based on comparisons to BVs for naturally occurring radionuclides or to FVs for fallout radionuclides. Isotopic thorium and isotopic uranium are naturally occurring radionuclides. Americium-241, cesium-137, plutonium-238, plutonium-239/240, strontium-90, and tritium are fallout radionuclides. FVs apply only to surface soil (0–1 ft bgs) and sediment (all depths). Fallout radionuclides detected at any concentration below 1 ft bgs in soil are identified as COPCs. Fallout radionuclides in tuff are also identified as COPCs based on detection status.

Sample media encountered during investigations at Lower Mortandad/Cedro Canyons Aggregate Area include soil (all soil horizons, designated by the media code ALLH or SOIL), fill material (media code FILL); alluvial sediment (media code SED), alluvium (media code Qal), and Bandelier Tuff (media code QBT3—the only unit of Bandelier Tuff encountered during this investigation). Because no separate BVs are available for fill material, fill samples are evaluated by comparison with soil BVs (LANL 1998, 059730).

5.2 Overview of Statistical Methods

A variety of statistical methods may be applied to each of the data sets but generally include distributional comparisons and box plots comparing site data with background data. In cases where no background data are available, fewer than 10 samples were analyzed for a specific constituent or more than 80% of the site samples and background samples were nondetects, statistical tests are not valid. In such cases, COPC identification is based on detection status, direct comparison to the BV or FV (if one is available),

and subsequent comparison with the maximum background concentration if it is greater than the BV or FV. If no BV or FV is available, the constituent is identified as a COPC if it was detected in any samples at the site.

Comparisons between site data sets and the Laboratory background data sets are performed using statistical methods. All comparisons begin with a simple comparison of site-specific data to media-specific BVs or FVs (LANL 1998, 059730). The BV/FV comparisons are followed, when appropriate, by statistical tests that evaluate potential differences between the distributions. These tests are used for testing hypotheses about data from two potentially different distributions (e.g., a test of the hypothesis that site concentrations are different from background levels).

Nonparametric tests most commonly performed include the two-sample Wilcoxon Rank Sum test (the Wilcoxon test), the Gehan test (modification of the Wilcoxon test), and the quantile test (Gehan 1965, 055611; Gilbert and Simpson 1990, 055612). The Gehan test is best suited for assessing complete shifts in distributions and accounts for nondetected concentrations at multiple DLs in a statistically robust manner. If the data have no nondetected concentrations, the Gehan test is equivalent to the Wilcoxon test. The quantile test is better suited for assessing shifts of a subset of the data. Most types of differences between distributions can be identified. Occasionally, if the differences between two distributions appear to occur far into the tails, the slippage test might be performed. 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.

Observed significance levels (p-values) are obtained from the Gehan, quantile, or slippage test. If a p-value is less than a specified probability (e.g., 0.05, a nominal significance level), then there is some reason to suspect that a difference exists between the distributions. If the p-value is greater than 0.05, no difference is indicated. The standard set of tests is run whenever the detection rate for both the site data set and the Laboratory background data set is greater than 50%. If there are fewer than 50% detections in either set, then the Gehan test is not applicable. If all sample data are nondetects, statistical tests are not performed.

Paired tests are used to test whether site data are different from background. Specifically, the Gehan test (or the Wilcoxon Rank Sum test, if all sampling results are detects) is the preferred initial test. If the results of the Gehan test indicate the site data are not different from background (i.e., $p > 0.05$), the quantile test is performed. Site data must pass (i.e., $p > 0.05$) both tests to eliminate an inorganic chemical as a COPC. If the p-value from either the Gehan (or Wilcoxon) or the quantile test is less than 0.05, the constituent is identified as a COPC for the specific medium tested.

If the Gehan test is not applicable because either the site or background data set includes more than 50% nondetects, the quantile test is performed first. If the p-value from the quantile test is > 0.05 , the slippage test is performed next. Again, the p-value from both tests must be > 0.05 to eliminate an inorganic chemical as a COPC. If the p-value from the first test is < 0.05 , indicating the site data are different from background, the second test does not need to be performed, and the inorganic chemical is identified as a COPC. Results of statistical tests are presented in Appendix H.

Box plots provide a visual representation of the data and may identify the presence of outliers or other anomalous data that might affect statistical results and interpretations. The plots allow a visual comparison between site and background concentration distributions. The plots are generally used in conjunction with the statistical tests (distributional comparisons) described above. A box plot consists of a box, a line across the box, whiskers (lines extended beyond the box and terminated with a short perpendicular line), and points outside the whiskers. The box area of the plot is the region between the 25th percentile and the 75th percentile of the data, which is the interquartile range or middle half of the

data. The horizontal line within the box represents the median (50th percentile) of the data. The whiskers give an interval of 1.5 times the interquartile range, outside of which data may be evaluated for their potential to be outliers. The concentrations of individual samples are plotted as points overlaying the box plot.

When a data set contains both detected and nondetected concentrations reported as DLs, the detected concentrations are plotted as Xs, and the nondetected concentrations are plotted as Os. The medium-specific BV is also illustrated by a dashed line in each box plot. All box plots are presented in Appendix H.

6.0 TA-05 BACKGROUND AND FIELD INVESTIGATION RESULTS

The Lower Mortandad/Cedro Canyons Aggregate Area contains four sites associated with TA-05 that are addressed in this investigation report (Table 1.1-1). Each site is described separately in sections 6.2 through 6.4, including site description and operational history, relationship to other SWMUs and AOCs, historical and 2011 investigation activities, site contamination results based on qualified data (decision-level data from the current and previous investigations), and summaries of human health and ecological risk-screening assessments.

6.1 Background of TA-05

TA-05 is located on the eastern side of the Laboratory (Figure 1.0-1) and is situated on a small finger mesa, Mesita del Buey, that extends eastward from the main mesa between Mortandad and Pajarito Canyons. The western portion of TA-05 is located within the Middle Mortandad/Ten Site Canyons Aggregate Area, and the eastern portion is located within the Lower Mortandad/Cedro Canyons Aggregate Area. That portion of TA-05 within the Lower Mortandad/Cedro Canyons Aggregate Area is bounded by TA-53 and TA-72 to the north and east, Middle Mortandad/Ten Site Canyons Aggregate Area to the north and west, and Pueblo de San Ildefonso to the south.

6.1.1 Operational History

TA-05, also known as Beta Site, was established in 1944 as an adjunct test firing site to TA-04 (Alpha Site). Firing activities were conducted at two small firing sites located within the Middle Mortandad/Ten Site portion of TA-05 and one large firing site, known as Far Point Site, within the Lower Mortandad/Cedro portion of TA-05. Far Point Site was used briefly during 1944 and 1945 for half-scale mockup tests of the Trinity device (LANL 2008, 102187, p. 3). TA-05 was used as a firing site for implosion studies until 1947. After firing activities were halted, several Laboratory groups used the site for a variety of experiments, including the study of hydrogen fires, animal radiation experiments, and beryllium combustion experiments. In late 1959, two experimental reactors known as "Little Eva" and "Godiva" were brought to TA-05 and operated briefly (Ulery 1995, 046037). Little Eva was located inside a trailer, and Godiva was located in an underground chamber (SWMU 05-003). TA-05 was taken out of service in 1959 and underwent D&D in 1985 as part of the Los Alamos Site Characterization Program (LASCP). The 1985 LASCP addressed only radioactive contamination.

6.1.2 Summary of Releases

Potential contaminant sources at TA-05 include an underground chamber that housed an experimental reactor (Godiva), past discharges from outfalls and a septic system, and residual soil contamination associated with demolition of a former building by burning.

6.1.3 Current Site Usage and Status

Currently, land use of the Lower Mortandad/Cedro Canyons Aggregate Area within the Laboratory boundary is industrial. TA-05 is currently used as a security buffer zone and contains physical support facilities such as an electrical substation, a water-supply well, test wells, several archeological sites, and environmental monitoring and buffer areas. In the past, Laboratory employees used the gravel road extending along the length of Mesita del Buey for recreational activities such as walking or jogging but the road is currently inaccessible for such use. TA-05 is not accessible to the public. The current land use is not expected to change for the reasonably foreseeable future.

6.2 SWMU 05-003, Former Calibration Chamber

6.2.1 Site Description and Operation History

SWMU 05-003 is a former underground calibration facility (structures 05-20 and 05-21) located at the west end of TA-05 near the edge of Mortandad Canyon (Figure 6.2-1). The calibration facility consisted of an aboveground shed (structure 05-20) constructed over a 6-ft-diameter, 35-ft-deep access shaft equipped with a ladder to provide facility personnel access to the calibration chamber (structure 05-21), located belowground to the west of the access shaft. The aboveground shed (structure 05-20) was a wooden building that measured 8 ft wide × 12 ft long × 8 ft high. The belowground chamber (structure 05-21) measured 10 ft square × 10 ft deep and was used to calibrate neutron detector systems for experiments at TA-49. The base of the access shaft was connected to the calibration chamber by an 8-ft-tall, 9.5-ft-long tunnel. A second 24-in.-diameter shaft extended from the center of the chamber to the surface. The shafts were separated by 15 ft (center to center). The smaller shaft was lined with a 16-in.-diameter casing and capped with concrete, with a 3-in.-diameter opening in the concrete cap. The small shaft was used to direct neutrons from the underground chamber to detectors located above the shaft. The approximate dimensions and layout of the facility have been obtained through interviews with people who worked on the project, personal logs, and site inspections (Koch 1995, 091204; Pratt 1995, 091206) as well as historical drawings.

The neutron source used in the calibration facility was a critical assembly called Godiva. This assembly used highly enriched uranium (HEU) and was operated in the underground chamber beneath the smaller shaft. Neutron detectors were placed on the ground surface above the opening in the small shaft. The Godiva assembly could be pulsed every 2 h and produced 2×10^{16} fissions per pulse. Small amounts of HEU would spall off the source with each pulse (Pratt 1995, 091206). Borated paraffin and lead bricks were used as shielding, and heavy water was used to moderate the energy and intensity of the neutrons.

The Godiva assembly was installed in the TA-05 underground chamber on November 16, 1959 (Pratt 1995, 091206). The chamber was used only for approximately 1 mo. TA-05 officially ceased operation on December 18, 1959 (Montoya 1976, 004547). The Godiva assembly was moved to TA-49 where it became operational on January 12, 1960 (Pratt 1995, 091206).

The underground calibration chamber (structure 05-21) and the corrugated metal pipe (CMP) liner for the large access shaft are still present at the site. The CMP extends approximately 2.5 ft above the ground surface. The inside of the CMP contains backfill and some vegetation is presently growing in the backfill. An 8.75-ft-wide × 12.5-ft-long concrete pad extends around the CMP. Currently, the area of the smaller shaft is covered with dirt.

6.2.2 Relationship to Other SWMUs and AOCs

Although SWMU 05-004 is located approximately 50 ft east of SWMU 05-003, these two SWMUs are not associated. No other SWMUs or AOCs are associated with SWMU 05-003.

6.2.3 Summary of Previous Investigations

During a radiation survey of TA-05 in 1973, structure 05-20 was locked and could not be entered (Martin 1973, 004544). A subsequent inspection in January 1974 noted a hole in the side of the building and the door was unlocked. Because of safety concerns, a cover was placed over the shaft (Bacastow 1974, 000756). A radiation survey of structure 05-20 was conducted in May 1976 to prepare for removing the remaining structures from TA-05. This survey showed no detectable radioactivity (Blackwell 1976, 004546). Structure 05-20 was removed sometime around 1976, and the access shaft was backfilled at that time. Although the 1992 Resource Conservation and Recovery Act facility investigation (RFI) work plan for Operable Unit 1129 indicates the lead shielding bricks had not been removed before the area was backfilled (LANL 1992, 007666, p. 3-16), a subsequent review of records and interviews with former site staff concluded the lead bricks were removed before the shaft was backfilled (Pratt 1995, 091206).

In 1995, an engineering survey was conducted at the site of the former calibration chamber (structure 05-21) to locate the 24-in.-diameter shaft that was reported to be present at the site. This shaft was found 15 ft west of the 6-ft-diameter shaft. An 8.75-ft-wide × 12.25 ft-long concrete pad is present around the 6-ft-diameter shaft and a smaller 1.5-ft-wide × 5 ft-long concrete pad is located just north of the 24-in.-diameter shaft (Koch 1995, 091204). The larger pad is the foundation that remains from former aboveground structure 05-20. The site was surveyed for potential high explosives (HE) materials in May 1995. Fragments of white material were found near the shaft but were determined to be paraffin rather than HE (Koch 1995, 048943.21).

No previous sampling has been performed at SWMU 05-003; therefore, no historical analytical data exist for this site.

6.2.4 Site Contamination

6.2.4.1 Soil and Rock Sampling

As part of the 2011 investigation, the following activities were conducted at SWMU 05-003:

- All samples were field screened for organic vapors and gross-alpha, -beta, and -gamma radioactivity. Field-screening results were recorded on the SCLs/COC forms (Appendix F) and are presented in Table 3.2-2.

Twelve samples were collected from two locations (05-613784 and 05-613785) at depth intervals of 5–6 ft, 15–16 ft, 25–26 ft, 35–36 ft, 45–46 ft, and 55–56 ft bgs. All 12 samples were analyzed for TAL metals, perchlorate, gamma-emitting radionuclides, and isotopic uranium.

The 2011 sampling locations at SWMU 05-003 are shown in Figure 6.2-1. Table 6.2-1 presents the 2011 samples collected and the analyses requested for SWMU 05-003. The geodetic coordinates of the 2011 sampling locations are presented in Table 3.2-1.

6.2.4.2 Soil and Rock Sample Field-Screening Results

No organic vapors were detected at more than 5 ppm above ambient air during PID screening of the samples during the 2011 investigation. No radiological-screening results exceeded twice the daily site background levels. Field-screening results for the 2011 samples are presented in Table 3.2-2. No changes to sampling or other activities occurred because of the field-screening results.

6.2.4.3 Soil and Rock Sample Analytical Results

Decision-level data at SWMU 05-003 consist of results from 12 Qbt 3 samples collected from two locations in 2011. The extent of contamination is defined at SWMU 05-003. Therefore, the COPCs for the site are identified below.

Inorganic Chemicals

Twelve Qbt 3 samples were analyzed for TAL metals and perchlorate. Table 6.2-2 presents the inorganic chemicals above BVs. Figure 6.2-2 shows the spatial distribution of inorganic chemicals detected above BVs at SWMU 05-003.

Antimony was not detected above the Qbt 3 BV (0.5 mg/kg) but had DLs (0.934 mg/kg to 1.06 mg/kg) above the Qbt 3 BV in nine samples. Antimony is identified as a COPC in tuff.

Chromium was detected above the Qbt 3 BV (7.14 mg/kg) in one sample (82.6 mg/kg). The Gehan and quantile tests indicated site concentrations are not different from background (Figure H-1.0-1 and Table H-1.0-1). Chromium is not identified as a COPC in tuff.

Perchlorate was not detected at SWMU 05-003. Therefore, perchlorate is not identified as a COPC.

Selenium was detected above the Qbt 3 BV (0.3 mg/kg) in one sample (0.316 mg/kg). Selenium was not detected but had DLs (0.886 mg/kg to 1.05 mg/kg) above the Qbt 3 BV in the other 11 samples at the site. Selenium is identified as a COPC in tuff.

Zinc was detected above the Qbt 3 BV (63.5 mg/kg) in one sample (66.5 mg/kg). The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-1.0-2 and Table H-1.0-1). Zinc is not identified as a COPC in tuff.

In summary, the inorganic COPCs identified at SWMU 05-003 are antimony and selenium.

Organic Chemicals

Samples were not analyzed for organic chemicals at SWMU 05-003 based on the materials used at this site (LANL 2010, 108281, pp. 13–14).

Radionuclides

Twelve Qbt 3 samples were analyzed for gamma-emitting radionuclides and isotopic uranium. Radionuclides were not detected or detected above BVs/FVs at SWMU 05-003. Therefore, no radionuclide COPCs were identified at SWMU 05-003.

6.2.4.4 Nature and Extent of Soil and Rock Contamination

Inorganic COPCs

Antimony was not detected above BV but had DLs above BV at the site. Because antimony was not detected above BV and all results reported between the BV and the maximum DL were nondetects, the lateral and vertical extent of antimony are defined.

Selenium was detected above the Qbt 3 BV (0.3 mg/kg) in one sample (0.316 mg/kg) at location 05-613784 from 15–16 ft bgs. Selenium was not detected but had DLs above BV in deeper samples at this location. Selenium was not detected but had DLs above BV in all six samples at location 05-613785. The lateral and vertical extent of selenium are defined.

Organic COPCs

Samples were not analyzed for organic chemicals at SWMU 05-003.

Radionuclide COPCs

No radionuclide COPCs were identified at SWMU 05-003.

Summary of Nature and Extent

The lateral and vertical extent of TAL metals, perchlorate, gamma-emitting radionuclides, and isotopic uranium are defined at SWMU 05-003.

6.2.5 Summary of Human Health Risk Screening

The human health risk-screening assessment for SWMU 05-003 is discussed in Appendix I, section I-4.

SWMU 05-003 is a former underground calibration chamber located 35 ft bgs. No potential exposure pathway exists, and samples were not collected between 0–1 ft bgs. A risk-screening assessment was not performed for the industrial scenario.

No carcinogens were retained as COPCs; therefore, no potential unacceptable cancer risk exists for the residential scenario. The HI is 0.04 for the residential scenario, which is below the NMED target HI of 1. No radionuclides were retained as COPCs at the site; therefore, no potential unacceptable dose exists for the residential scenario.

Based on the risk-screening assessment results, no potential unacceptable risk and dose exist for the industrial and residential scenarios at SWMU 05-003.

6.2.6 Summary of Ecological Risk Screening

Because samples were collected below 5 ft bgs and no potential exposure pathway for terrestrial receptors exists, an ecological risk-screening assessment was not performed for the ecological receptors at SWMU 05-003. No potential unacceptable risk or dose for ecological receptors is expected at the site because the contamination source was 35 ft bgs.

6.3 SWMU 05-004, Former Septic Tank

6.3.1 Site Description and Operation History

SWMU 05-004 is a former septic tank (structure 05-13), associated drainlines, and outfall that were located at the west end of TA-05 near the edge of Mortandad Canyon (Figure 6.2-1). The tank was constructed in May 1948 to serve building 05-1 (a laboratory) and was decommissioned in place in December 1959 (LANL 1992, 007666, p. 3-14). It was constructed of reinforced concrete and was 5 ft² × 7 ft deep (LANL 1990, 007511). As-built drawings show an inlet line running from building 05-1 to the septic tank and an outlet line discharging south into an unnamed tributary of Mortandad Canyon.

From 1948 to 1949, the tank received industrial waste from a laboratory (building 05-1). A 1952 memorandum states that septic tank 05-13 was no longer needed to support use of building 05-1 and the structure was being returned to Engineering Division for disposition (Vogt 1952, 004379). The types of materials used in building 05-1 are not known. During the 1985 LASCPC, building 05-1 was removed. The septic tank and associated drainlines had been removed before the 1985 LASCPC activities. The removal of the tank and piping was confirmed by excavation of the area (LANL 1990, 007511).

The outfall, a 2-ft wide by 1-ft deep trench cut into the tuff, is located at the edge of the mesa. Stormwater best management practices (BMPs), including straw wattles, are in place above and downslope of the site.

6.3.2 Relationship to Other SWMUs and AOCs

Although SWMU 05-003 is located approximately 50 ft west of SWMU 05-004, these two SWMUs are not associated. No other SWMUs or AOCs are associated with SWMU 05-004.

6.3.3 Summary of Previous Investigations

A 1959 memorandum states the tank had been monitored for radioactivity, and no radioactivity above background was found (Blackwell 1959, 000761). A site inspection conducted in January 1974 identified the septic tank as an open concrete pit with a rotted wooden cover. The wooden cover was replaced with a metal grating cover (Bacastow 1974, 000756). Notes from a radiation survey conducted at TA-05 during May 1976 describe structure 05-13 as “an acid septic tank filled with liquid” (Blackwell 1976, 004546).

The 1985 LASCPC investigation confirmed the tank and piping had been removed, and no evidence of radioactively contaminated soil was detected at that time (NUS Corporation 1990, 012571, p. 3-10). A 1988 survey detected gamma activity slightly above background. Notes taken during this survey described evidence of an outfall near the former location of structure 05-13 (LANL 1990, 007511).

A site inspection conducted in December 1994 noted the location of an approximately 2-ft-wide × 1-ft-deep outfall trench cut into the tuff. The trench, which was filled with plant debris, flowed to the south onto a natural bedrock rill/gully to the canyon (Koch 1994, 048943.21). This trench presumably contained the discharge drainline that was removed.

Phase I RFI sampling was performed in June 1995. Three surface samples (0–0.5 ft) were collected, two hand-augered holes were drilled to a depth of 3 ft, and one borehole was drilled to a depth of 15 ft. The hand-auger and surface samples were collected in the outfall trench between the septic tank location and the edge of the canyon. Three samples were collected from each hand-augered hole at depth intervals of 0–1 ft, 1–2 ft, and 2–3 ft bgs. The borehole was drilled at the former location of the septic tank. Three samples were collected from the borehole at depth intervals of 3.5–4.5 ft, 8.8–9.8 ft, and

14–15 ft bgs. All samples were submitted for laboratory analysis of isotopic plutonium and isotopic uranium. One sample from one hand-augured hole was also submitted for laboratory analysis of SVOCs, and one sample from another hand-augured hole was submitted for laboratory analysis of VOCs, gross-alpha, gross-beta, and gamma-emitting radionuclides. One sample from the 15-ft borehole was also submitted for laboratory analysis of TAL metals, and one surface sample was submitted for analysis of HE. No metals were detected above BVs or had DLs above BVs during the 1995 RFI. Benzoic acid, the only organic chemical detected, was detected in one sample at 0.61 mg/kg. Plutonium-239/240, the only radionuclide detected, was detected at 0.098 pCi/g in one subsurface sample.

A second sampling event was conducted at this site in 1998. A deeper borehole was advanced at the location of the former septic tank, and 11 samples were collected at 1-ft intervals from 14–25 ft bgs. Additional samples were collected downslope of the outfall. Surface samples (0–0.5 ft) were collected at five locations and subsurface samples (0.5–1.0 ft bgs) were collected at three of these locations. All samples were submitted for laboratory analysis of TAL metals, SVOCs, and HE. No metals were detected above BVs during the 1998 sampling. Mercury had DLs above BV for two soil samples and one sediment sample. Selenium had DLs above BV in two sediment samples. No organic chemicals were detected, and no samples were analyzed for radionuclides.

All decision-level data collected during previous investigations are presented and evaluated together with the 2011 decision-level data in section 6.3.4.3.

6.3.4 Site Contamination

6.3.4.1 Soil and Rock Sampling

As part of the 2011 investigation, the following activities were conducted at SWMU 05-004 from January to March 2011:

- All samples were field screened for organic vapors and gross-alpha, -beta, and -gamma radioactivity. Field-screening results were recorded on the SCLs/COC forms (Appendix F) and are presented in Table 3.2-2.
- Six samples were collected from locations 05-613786, 05-613787, and 05-613788 along the inlet drainline between building 05-1 and the septic tank at depth intervals of 3–4 ft and 5–6 ft bgs.
- Five samples were collected in a borehole at the former septic tank (location 05-613790 at previous location 05-02001) at depth intervals of 5–6 ft, 9–10 ft, 14–15 ft, 19–20 ft, and 24–25 ft bgs.
- Six samples were collected from locations 05-613958, 05-613959, and 05-613789 (at previous locations 05-02002, 05-02003, and 05-02005, respectively) in the outfall trench and at the outfall at depth intervals of 3–4 ft and 5–6 ft bgs.
- Fifteen samples were collected from five locations in the drainage downgradient of the outfall. Locations 05-613794, 05-613795 (at previous location 05-02089), 05-613796, and 05-613797 were sampled at depth intervals of 0–1 ft, 1–2 ft, and 2–3 ft bgs. The most downgradient location, 05-613793, was sampled at depth intervals of 0–1 ft, 4.5–5.5 ft, and 5.5–6.5 ft bgs.

All samples were analyzed for TAL metals, nitrate, perchlorate, total cyanide, explosive compounds, PCBs, SVOCs, VOCs, isotopic plutonium, and isotopic uranium.

After evaluating the analytical results from sampling conducted from January to March 2011 to define the nature and extent of contamination, the Laboratory proposed to conduct additional sampling (LANL 2011, 203592) and NMED approved the proposed sampling (NMED 2011, 203618). The following activities were conducted at SWMU 05-004 in June 2011:

- One deeper sample was collected at location 05-613788 from 9–10 ft bgs and was analyzed for lead, nitrate, and SVOCs.
- Two deeper samples were collected at location 05-613790 from 34–35 and 44–45 ft and were analyzed for 2-hexanone and uranium-235/236.

One deeper sample each was collected at locations 05-613789, 05-613958, and 05-613959 from 9–10 ft bgs and was analyzed for selenium, copper, and copper and selenium, respectively.

Historical and 2011 sampling locations at SWMU 05-004 are shown in Figure 6.2-1. Table 6.3-1 presents the historical and 2011 samples collected and the analyses requested for SWMU 05-004. The geodetic coordinates of the 2011 sampling locations are presented in Table 3.2-1.

6.3.4.2 Soil and Rock Sample Field-Screening Results

No organic vapors were detected at more than 5 ppm above ambient air during PID screening of the samples during the 2011 investigation. No radiological screening results exceeded twice the daily site background levels. Field-screening results for the 2011 samples are presented in Table 3.2-2. No changes to sampling or other activities occurred because of the field-screening results.

6.3.4.3 Soil and Rock Sample Analytical Results

Decision-level data at SWMU 05-004 consist of results from 69 samples collected from 23 locations in 1995, 1998, and 2011. The 69 samples include 12 soil/fill, 50 Qbt 3, and 7 sediment samples. The nature and extent of contamination are defined at SWMU 05-004. Therefore, the COPCs for the site are identified below.

Inorganic Chemicals

Fifty-two samples (7 soil/fill, 38 Qbt 3, and 7 sediment) were analyzed for TAL metals, and additionally, one Qbt 3 sample was analyzed for copper, one Qbt 3 sample for lead, one Qbt 3 sample for selenium, and a fourth Qbt 3 sample for copper and selenium. Thirty-two samples (27 Qbt 3 and 5 sediment) were analyzed for perchlorate and total cyanide. Thirty-three samples (28 Qbt 3 and 5 sediment) were analyzed for nitrate. Table 6.3-2 presents the inorganic chemicals above BVs. Figure 6.3-1 shows the spatial distribution of inorganic chemicals detected or detected above BVs at SWMU 05-004.

Antimony was detected at a concentration (0.505 mg/kg) equivalent to the Qbt 3 BV (0.5 mg/kg) in one sample and was not detected but had DLs (0.56 mg/kg to 1.04 mg/kg) above the Qbt 3 BV in 18 samples. Antimony is identified as a COPC in tuff. Antimony was not detected but had a DL (0.832 mg/kg) equivalent to the sediment BV (0.83 mg/kg). Antimony is not identified as a COPC in sediment.

Barium was detected above the Qbt 3 BV (46 mg/kg) in five samples, with a maximum concentration of 96.9 mg/kg. The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-2.0-1 and Table H-2.0-1). Barium is not identified as a COPC in tuff.

Cadmium was not detected above the sediment BV (0.4 mg/kg) but had DLs (0.527 mg/kg to 0.55 mg/kg) above the sediment BV in four samples. Cadmium is identified as a COPC in sediment.

Calcium was detected above the Qbt 3 BV (2200 mg/kg) in one sample (2910 mg/kg). The Wilcoxon test indicated site concentrations are different from background (Figure H-2.0-2 and Table H-2.0-1). Calcium is identified as a COPC in tuff.

Copper was detected above the Qbt 3 BV (4.66 mg/kg) in nine samples, with a maximum concentration of 13.8 mg/kg. The Gehan test indicated site concentrations are different from background (Figure H-2.0-3 and Table H-2.0-1). Copper is identified as a COPC in tuff.

Cyanide was not detected above BV at the site. Therefore, cyanide is not identified as a COPC.

Lead was detected above the Qbt 3 BV (11.2 mg/kg) in two samples, with a maximum concentration of 54.1 mg/kg. The Gehan test indicated site concentrations are different from background (Figure H-2.0-4 and Table H-2.0-1). Lead is identified as a COPC in tuff.

Mercury was not detected but had two DLs (both 0.11 mg/kg) equivalent to the soil BV (0.1 mg/kg). Mercury is not identified as a COPC in soil. Mercury was not detected but had a DL (0.11 mg/kg) that is equivalent to the sediment BV (0.1 mg/kg). Mercury is not identified as a COPC in sediment.

Nickel was detected above the Qbt 3 BV (6.58 mg/kg) in one sample (6.68 mg/kg). Because the background data set had more than 50% nondetects, the Gehan test could not be performed. The quantile and slippage tests indicated site concentrations are not different from background (Figure H-2.0-5 and Table H-2.0-1). Nickel is not identified as a COPC in tuff.

Nitrate was detected in 26 Qbt 3 and sediment samples, with a maximum concentration of 71.8 mg/kg. No background data are available for nitrate. Nitrate is identified as a COPC.

Perchlorate was detected in eight Qbt 3 and sediment samples, with a maximum concentration of 0.00346 mg/kg. No background data are available for perchlorate. Perchlorate is identified as a COPC.

Selenium was detected above the Qbt 3 BV (0.3 mg/kg) in six samples, with a maximum concentration of 0.406 mg/kg, and was not detected but had DLs (0.885 mg/kg to 1.04 mg/kg) above the Qbt 3 BV in 23 samples. Selenium is identified as a COPC in tuff. Selenium was not detected but had DLs (0.51 mg/kg to 1.1 mg/kg) above the sediment BV (0.3 mg/kg) in seven samples. Selenium is identified as a COPC in sediment.

In summary, the inorganic COPCs identified at SWMU 05-004 are antimony, cadmium, calcium, copper, lead, nitrate, perchlorate, and selenium.

Organic Chemicals

Fifty-two samples (7 soil, 38 Qbt 3, and 7 sediment) were analyzed for explosive compounds; 32 samples (27 Qbt 3 and 5 sediment) were analyzed for PCBs; 53 samples (7 soil, 39 Qbt 3, and 7 sediment) were analyzed for SVOCs; and 33 samples (28 Qbt 3 and 5 sediment) were analyzed for VOCs. Additionally, two Qbt 3 samples were analyzed for 2-hexanone. Table 6.3-3 presents the organic chemicals detected. Figure 6.3-2 shows the spatial distribution of organic chemicals detected at SWMU 05-004.

Explosive compounds and PCBs were not detected at SWMU 05-004.

Organic chemicals detected at SWMU 05-004 include acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; benzoic acid; chrysene; dibenz(a,h)anthracene; diethylphthalate; fluoranthene; fluorene; 2-hexanone;

indeno(1,2,3-cd)pyrene; 4-isopropyltoluene; methylene chloride; 2-methylnaphthalene; naphthalene; phenanthrene; pyrene; and styrene.

These organic chemicals are retained as COPCs at SWMU 05-004.

Radionuclides

One Qbt 3 sample was analyzed for gamma-emitting radionuclides. Forty-four samples (6 soil/fill, 33 Qbt 3, and 5 sediment) were analyzed for isotopic plutonium and isotopic uranium. Additionally, two Qbt 3 samples were analyzed for uranium-235/236. Table 6.3-4 presents the radionuclides detected or detected above BVs/FVs. Figure 6.3-3 shows the spatial distribution of radionuclides detected or detected above BVs/FVs at SWMU 05-004.

Plutonium-239/240 was detected in one Qbt 3 sample (0.098 pCi/g). Plutonium-239/240 is identified as a COPC in tuff.

Uranium-234 was detected above the sediment BV (2.59 pCi/g) in one sample (4.71 pCi/g). Uranium-234 is identified as a COPC in sediment.

Uranium-235/236 was detected above the Qbt 3 BV (0.09 pCi/g) in three samples, with a maximum concentration of 0.11 pCi/g. Uranium-235/236 is identified as a COPC in tuff. Uranium-235/236 was detected at a concentration of 0.206 pCi/g equivalent to the sediment BV (0.2 pCi/g) in one sample. Uranium-235/236 is not identified as a COPC in sediment.

Uranium-238 was detected above the sediment BV (2.29 pCi/g) in one sample (4.66 pCi/g). Uranium-238 is identified as a COPC in sediment.

In summary, the radionuclide COPCs identified at SWMU 05-004 are plutonium-239/240, uranium-234, uranium-235/236, and uranium-238.

6.3.4.4 Nature and Extent of Soil and Rock Contamination

Inorganic COPCs

Antimony was detected at a concentration (0.505 mg/kg) equivalent to the Qbt 3 BV (0.5 mg/kg) in one sample at location 05-613790 from 5–6 ft bgs. Concentrations of antimony decreased with depth at this location. The vertical extent of antimony is defined. Antimony was not detected above BVs, and all results reported between the BVs and the maximum DL were nondetects downgradient of location 05-613790. The lateral extent of antimony is defined.

Cadmium was not detected above BV but had DLs above BV at the site. Because cadmium was not detected above BV and all results reported between the BV and the maximum DL were nondetects, the lateral and vertical extent of cadmium are defined.

Calcium was detected above the Qbt 3 BV (2200 mg/kg) in one sample (2910 mg/kg) at location 05-613958 from 3–4 ft bgs. Concentrations of calcium decreased with depth at this location. The vertical extent of calcium is defined. Calcium was not detected above BV in the drainage downgradient of location 05-613958. The lateral extent of calcium is defined.

Copper was detected above the Qbt 3 BV (4.66 mg/kg) in nine samples at five locations. Concentrations of copper decreased with depth at locations 05-613789, 05-613793, 05-613958, and 05-613959. Copper was not detected above BV in the deepest sample from 9–10 ft bgs at location 05-613958

(RE05-11-14585, Table 6.3-1 and Appendix F). Copper was detected at a concentration of 6.75 mg/kg in the deepest sample (5–6 ft bgs) at location 05-613786. However, copper was not detected above BV in samples as deep as 25 ft bgs at location 05-613790, which is approximately 5 ft downgradient of location 05-613786. The vertical extent of copper is defined at all five locations. Concentrations of copper decreased downgradient in the drainage. The lateral extent of copper is defined.

Lead was detected above the Qbt 3 BV (11.2 mg/kg) in two samples at location 05-613788. Concentrations of lead decreased with depth at this location. Lead was not detected above BV downgradient of location 05-613788. The lateral and vertical extent of lead are defined.

Nitrate was detected in 26 Qbt 3 and sediment samples at 11 locations. The maximum concentration (71.8 mg/kg) was detected at location 05-613788 from 3–4 ft bgs. Concentrations of nitrate decreased with depth at this location. No background data for nitrate are available. Nitrate is naturally occurring, and the concentrations detected at the other 10 locations—all of which are downgradient of location 05-613788 with a highest concentration of 5.27 mg/kg—likely reflect naturally occurring levels. The lateral and vertical extent of nitrate are defined.

Perchlorate was detected in eight Qbt 3 and sediment samples at five locations. Concentrations of perchlorate decreased with depth at all five locations and overall decreased downgradient. The lateral and vertical extent of perchlorate are defined.

Selenium was detected above the Qbt 3 BV (0.3 mg/kg) in six samples at four locations. Concentrations of selenium were essentially unchanged with depth at location 05-613786, and selenium was not detected above BV in deeper samples at location 05-613790, which is approximately 5 ft downgradient of location 05-613786. Concentrations of selenium were essentially unchanged at location 05-613787. Selenium was detected above BV in two samples at locations 05-613789 and 05-613959 but was not detected above BV in the deeper samples at both locations. The vertical extent of selenium is defined at all four locations. Selenium was not detected and all results reported between the BVs, and the maximum DL were nondetects downgradient of location 05-613789. The lateral extent of selenium is defined.

Organic COPCs

Seventeen organic COPCs [acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenz(a,h)anthracene; fluoranthene; fluorene; indeno(1,2,3-cd)pyrene; 2-methylnaphthalene; naphthalene; phenanthrene; and pyrene] were detected at location 05-613788. They were either not detected in deeper samples or concentrations decreased with depth at this location. The vertical extent of these 17 organic COPCs is defined at location 05-613788. Fluoranthene was also detected in one sample at location 05-613790 from 5–6 ft bgs and was not detected in deeper samples at this location. The vertical extent of fluoranthene is defined at location 05-613790. None of the 17 organic COPCs were detected downgradient of location 05-613790. The lateral extent of these organic COPCs is defined.

Diethylphthalate was detected only in the deepest sample (0.0824 mg/kg) below the EQL from 9–10 ft bgs at location 05-613788. The lateral and vertical extent of diethylphthalate are defined.

Benzoic acid was detected in six samples at four locations. It was detected in one sample (0.61 mg/kg) at location 05-02003 from 0–1 ft bgs. This location was resampled as location 05-613959 in 2011, and benzoic acid was not detected in the 2011 samples as deep as 6 ft bgs. Concentrations of benzoic acid decreased with depth at locations 05-613796 and 05-613797. Benzoic acid was detected only in the sample (0.266 mg/kg) below the EQL from 5–6 ft bgs at location 05-613789, while the deeper sample from 9–10 ft bgs was not analyzed for SVOCs (section 6.3.4.1). The vertical extent of benzoic acid is

defined at all four locations. Benzoic acid was not detected downgradient of location 05-613796. The lateral extent of benzoic acid is defined.

Hexanone(2-) was detected in six samples at two locations. Location 05-613790 is approximately 5 ft downgradient of location 05-613786; therefore, the sampling results from these two locations are evaluated together. Hexanone(2-) was not detected in deeper samples from 34–35 ft and 44–45 ft bgs at location 05-613790 (RE05-11-14587 and RE05-11-14588, Table 6.3-1 and Appendix F). The vertical extent of 2-hexanone is defined. Hexanone(2-) was not detected downgradient of location 05-613790. The lateral extent of 2-hexanone is defined.

Isopropyltoluene(4-) was detected in one sample (0.000429 mg/kg) at location 05-613790 from 5–6 ft bgs. Isopropyltoluene(4-) was not detected in deeper samples at this location. The vertical extent of 4-isopropyltoluene is defined. Isopropyltoluene(4-) was not detected downgradient of location 05-613790. The lateral extent of 4-isopropyltoluene is defined.

Methylene chloride was detected in three samples at three locations. Methylene chloride was detected in samples from 1–2 ft and 3–4 ft bgs, respectively, at locations 05-613796 and 05-613959 but was not detected in deeper samples at both locations. Methylene chloride was detected only in the deepest sample (0.00228 mg/kg) below the EQL from 2–3 ft bgs at location 05-613797. The vertical extent of methylene chloride is defined at all three locations. Methylene chloride was not detected downgradient of location 05-613796. The lateral extent of methylene chloride is defined.

Styrene was detected in one sample (0.00035 mg/kg) at location 05-613797 from 0–1 ft bgs. Styrene was not detected in deeper samples at this location. The vertical extent of styrene is defined. Styrene was not detected downgradient of location 05-613797. The lateral extent of styrene is defined.

Radionuclide COPCs

Plutonium-239/240 was detected in one sample (0.098 pCi/g) at historical location 05-02003 from 2–3 ft bgs. This location was resampled as location 05-613959 in 2011, and plutonium-239/240 was not detected in the 2011 samples as deep as 6 ft bgs. The vertical extent of plutonium-239/240 is defined. Plutonium-239/240 was not detected or detected above FV downgradient of location 05-613959. The lateral extent of plutonium-239/240 is defined.

Uranium-234 was detected above the sediment BV (2.59 pCi/g) in one sample (4.71 pCi/g) at location 05-613796 from 0–1 ft bgs. Concentrations of uranium-234 decreased with depth at this location. The vertical extent of uranium-234 is defined. Uranium-234 was not detected above BV downgradient of location 05-613796. The lateral extent of uranium-234 is defined.

Uranium-235/236 was detected above the Qbt 3 BV (0.09 pCi/g) in three samples at locations 05-613790 and 05-613958 and was detected at a concentration (0.206 pCi/g) equivalent to the sediment BV (0.2 pCi/g) in one sample at location 05-613796. Concentrations of uranium-235/236 decreased with depth at all three locations. Uranium-235/236 was not detected above BV in the deepest sample from 44–45 ft bgs at location 05-613790 (RE05-11-14588, Table 6.3-1 and Appendix F). The vertical extent of uranium-235/236 is defined. Uranium-235/236 was not detected above BV downgradient of location 05-613796. The lateral extent of uranium-235/236 is defined.

Uranium-238 was detected above the sediment BV (2.29 pCi/g) in one sample (4.66 pCi/g) at location 05-613796 from 0–1 ft bgs. Concentrations of uranium-238 decreased with depth at this location. The vertical extent of uranium-238 is defined. Uranium-238 was not detected above BV downgradient of location 05-613796. The lateral extent of uranium-238 is defined.

Summary of Nature and Extent

The lateral and vertical extent of TAL metals, nitrate, perchlorate, total cyanide, explosive compounds, PCBs, SVOCs, VOCs, and radionuclides are defined at SWMU 05-004.

6.3.5 Summary of Human Health Risk Screening

The human health risk-screening assessment is discussed in section I-4.0 in Appendix I.

No carcinogens were retained as COPCs; therefore, there is no cancer risk for the industrial scenario. The HI is 0.02, which is below the NMED target HI of 1 (NMED 2009, 108070). The total dose for the industrial scenario is 0.1 mrem/yr, which is below the DOE target dose limit of 15 mrem/yr (DOE 2000, 067489).

The total excess cancer risk for the residential scenario is approximately 4×10^{-5} , which is above the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is approximately 0.06, which is below the NMED target HI of 1 (NMED 2009, 108070). The total dose for the residential scenario is 0.5 mrem/yr, which is below the DOE target dose limit of 15 mrem/yr (DOE 2000, 067489).

The cancer risk of 4×10^{-5} for the residential scenario is from polycyclic aromatic hydrocarbons (PAHs) detected next to former building 05-1. PAHs were not detected below the locations of the former drainlines and septic tank or in the drainage. Therefore, PAHs were not discharged from the building to the septic system. An engineering drawing (LASL 1947, 206411) indicates the access road to building 05-1 was gravel-surfaced with one coat of hot oil penetration, the most likely source of the PAHs detected next to former building 05-1. Because the PAHs are not related to SWMU 05-004, they are removed from the residential carcinogenic and noncarcinogenic screening evaluations. Consequently, the total excess cancer risk is approximately 1×10^{-10} , which is below the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is 0.05, which is below the NMED target HI of 1 (NMED 2009, 108070).

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial and residential scenarios at SWMU 05-004.

6.3.6 Summary of Ecological Risk Screening

The ecological risk-screening assessment is discussed in section I-5.0 in Appendix I. No potential ecological risk was found for any receptor following evaluations based on minimum ESLs, HI analyses, comparison with background concentrations, potential effects to populations (individuals for threatened and endangered [T&E] species), and LOAEL analyses.

6.4 Consolidated Unit 05-005(b)-00

Consolidated Unit 05-005(b)-00 consists of SWMU 05-005(b), a former outfall, and SWMU 05-006(c), an area of potential soil contamination associated with a former building (Figure 6.4-1).

6.4.1 SWMU 05-005(b), Former Outfall

6.4.1.1 Site Description and Operation History

SWMU 05-005(b) is an area of potentially contaminated soil associated with a former outfall that was located in TA-05 at the edge of Mortandad Canyon (Figure 6.4-1). The outfall served building 05-5 (a shop and darkroom) and is believed to have operated during the same period as the building, from

1944 to 1959. Building 05-5 supported TA-05 firing site activities, including shop work and processing photographs of experiments conducted at the firing sites. For a brief period in 1952, high-range radiation meters were also calibrated in the building.

No evidence of the outfall has been found at the site. A capped pipe was found at the ground surface at the former location of building 05-5 (LANL 2010, 108281, p. 17). The pipe, about 18 in. long, was removed with the debris at SWMU 05-006(c) (section 6.4.2.1). A drainage channel that collects most of the runoff from the site is present at the edge of the mesa. Stormwater BMPs, including straw wattles, are in place above and downslope of the site.

6.4.1.2 Relationship to Other SWMUs and AOCs

The outfall of SWMU 05-005(b) was associated with former building 05-5 [SWMU 05-006(c)]. SWMUs 05-005(b) and 05-006(c) comprise Consolidated Unit 05-005(b)-00.

6.4.1.3 Summary of Previous Investigations

A Phase I RFI was conducted at SWMU 05-005(b) in 1994 and 1995. Preliminary RFI activities included an interview with a former Beta Site supervisor and engineering surveys to identify sampling locations. The engineering surveys consisted of reviews of archival aerial photos and engineering drawings, site environmental surveys, and site visits and walkovers to locate the former building and site features. The location of the outfall was surveyed for potential HE contamination in May 1995, and no contamination was found (Koch 1995, 048943.21). A radiation grid survey performed on July 7, 1995, covered an area of approximately 70 ft × 120 ft and provided contiguous coverage of SWMUs 05-005(b) and 05-006(c). The radiation grid locations were spaced at 20-ft intervals. Gross-beta/-gamma radiation measurements were within background levels.

Phase I RFI sampling was performed in July 1995. Nine soil and tuff samples were collected from three locations at and below the outfall. At each location, samples were collected from depth intervals of 0–1 ft, 1–2 ft, and 2–3 ft bgs. All samples were submitted for laboratory analysis of TAL metals, isotopic uranium, and isotopic plutonium. One sample was also submitted for laboratory analysis of HE and another sample for laboratory analysis of SVOCs. Metals detected above BVs in the 1995 sampling were chromium and nickel, each detected above its BV in four tuff samples. Antimony and selenium had DLs above the tuff BVs. Bis(2-ethylhexyl)phthalate, the only organic chemical detected, was detected in one sample at 0.29 mg/kg. Plutonium-238, the only radionuclide detected or detected above BV/FV, was detected at 0.0225 pCi/g in one sample.

Decision-level data from the 1995 RFI are presented and evaluated together with the 2011 decision-level data in section 6.4.1.4.

6.4.1.4 Site Contamination

Soil and Rock Sampling

As part of the 2011 investigation, the following activities were conducted at SWMU 05-005(b) from January to March 2011:

- All samples were field screened for organic vapors and gross-alpha, -beta, and -gamma radioactivity. Field-screening results were recorded on the SCLs/COC forms (Appendix F) and are presented in Table 3.2-2.

- Six samples were collected from locations 05-613920 and 05-613801 (at previous locations 05-02042 and 05-02043, respectively) at depth intervals of 0–1 ft, 2–3 ft, and 5–6 ft bgs.
- Twelve samples were collected from locations 05-613799 (at previous location 05-02044), 05-613798, 05-613803, and 05-613802 in the drainage at depth intervals of 0–1 ft, 1–2 ft, and 2–3 ft bgs.
- Nine samples were collected from three new locations (05-613921, 05-613922, and 05-613923) in another discernable drainage identified during sampling activities. Samples were collected at depth intervals of 0–1 ft, 2–3 ft, and 5–6 ft bgs.

All samples were analyzed for TAL metals, nitrate, perchlorate, total cyanide, explosive compounds, dioxin and furan congeners, PCBs, SVOCs, VOCs, isotopic plutonium, and isotopic uranium.

After evaluating the analytical results from sampling conducted from January to March 2011 to define the nature and extent of contamination, the Laboratory proposed to conduct additional sampling (LANL 2011, 203592) and NMED approved the proposed sampling (NMED 2011, 203618). The following activities were conducted at SWMU 05-005(b) in June 2011:

- Two deeper samples were collected at location 05-613799 from 5–6 ft and 9–10 ft bgs and were analyzed for antimony.
- Four samples were collected at a new location (05-614429) farthest downgradient at depth intervals of 0–1 ft, 2–3 ft, 5–6 ft, and 9–10 ft bgs and were analyzed for perchlorate and acenaphthene.

Historical and 2011 sampling locations at SWMU 05-005(b) are shown in Figure 6.4-1. Table 6.4-1 presents the historical and 2011 samples collected and the analyses requested for SWMU 05-005(b). The geodetic coordinates of the 2011 sampling locations are presented in Table 3.2-1.

Soil and Rock Sample Field-Screening Results

No organic vapors were detected at more than 5 ppm above ambient air during PID screening of the samples during the 2011 investigation. No radiological-screening results exceeded twice the daily site background levels. Field-screening results for the 2011 samples are presented in Table 3.2-2. No changes to sampling or other activities occurred because of the field-screening results.

Soil and Rock Sample Analytical Results

Decision-level data at SWMU 05-005(b) consist of results from 42 samples collected from 13 locations in 1995 and 2011. The 42 samples include 6 soil, 5 Qal, 27 Qbt 3, and 4 sediment samples. The extent of contamination is defined at SWMU 05-005(b). Therefore, the COPCs for the site are identified below.

Inorganic Chemicals

Thirty-six samples (6 soil, 26 Qbt 3, and 4 sediment) were analyzed for TAL metals, and additionally one Qal sample and one Qbt 3 sample were analyzed for antimony. Twenty-seven samples (3 soil, 20 Qbt 3, and 4 sediment) were analyzed for nitrate and total cyanide, and 31 samples (3 soil, 4 Qal, 20 Qbt 3, and 4 sediment) were analyzed for perchlorate. Table 6.4-2 presents the results of the inorganic chemicals above BVs. Figure 6.4-2 shows the spatial distribution of inorganic chemicals detected or detected above BVs at SWMU 05-005(b).

Antimony was not detected but had DLs (0.986 mg/kg to 1.09 mg/kg) above the soil BV (0.83 mg/kg) in three soil samples. One DL exceeded the maximum soil background concentration (1 mg/kg). Antimony is identified as a COPC in soil. Antimony was detected above the Qbt 3 BV (0.5 mg/kg) in two samples, with a maximum concentration of 0.834 mg/kg. Antimony was not detected but had DLs (0.52 mg/kg to 1.05 mg/kg) above the Qbt 3 BV in 18 samples. Antimony is identified as a COPC in tuff. Antimony was not detected above the sediment BV (0.83 mg/kg) but had two DLs (1.02 mg/kg and 1.06 mg/kg) above the sediment BV. Antimony is identified as a COPC in sediment.

Barium was detected above the Qbt 3 BV (46 mg/kg) in two samples, with a maximum concentration of 68 mg/kg. The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-3.0-1 and Table H-3.0-1). Barium is not identified as a COPC in tuff.

Cadmium was not detected but had DLs (0.493 mg/kg to 0.544 mg/kg) above the soil BV (0.4 mg/kg) in three samples. These DLs are below the maximum soil background concentration (2.6 mg/kg). Cadmium is not identified as a COPC in soil. Cadmium was not detected but had DLs (0.484 mg/kg to 0.535 mg/kg) above the sediment BV (0.4 mg/kg) in four samples. Cadmium is identified as a COPC in sediment.

Calcium was detected above the Qbt 3 BV (2200 mg/kg) in one sample (3220 mg/kg). The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-3.0-2 and Table H-3.0-1). Calcium is not identified as a COPC in tuff.

Chromium was detected above the Qbt 3 BV (7.14 mg/kg) in four samples, with a maximum concentration of 45.9 mg/kg. The Gehan test indicated site concentrations are different from background (Figure H-3.0-3 and Table H-3.0-1). Chromium is identified as a COPC in tuff.

Copper was detected above the Qbt 3 BV (4.66 mg/kg) in one sample (4.72 mg/kg). The Gehan test indicated site concentrations are different from background (Figure H-3.0-4 and Table H-3.0-1). Copper is identified as a COPC in tuff.

Cyanide was not detected above BV at the site. Therefore, cyanide is not identified as a COPC.

Lead was detected above the Qbt 3 BV (11.2 mg/kg) in four samples, with a maximum concentration of 29.8 mg/kg. The Wilcoxon test indicated site concentrations are different from background (Figure H-3.0-5 and Table H-3.0-1). Lead is identified as a COPC in tuff.

Nickel was detected above the Qbt 3 BV (6.58 mg/kg) in four samples, with a maximum concentration of 23.7 mg/kg. The quantile test indicated site concentrations are not different from background, but the slippage test indicated site concentrations are different from background (Figure H-3.0-6 and Table H-3.0-1). Nickel is identified as a COPC in tuff.

Nitrate was detected in 17 soil, Qbt 3, and sediment samples, with a maximum concentration of 2.73 mg/kg. No background data are available for nitrate. Nitrate is naturally occurring, and the concentrations detected likely reflect naturally occurring levels. Nitrate is not identified as a COPC.

Perchlorate was detected in six Qbt 3 and sediment samples, with a maximum concentration of 0.00107 mg/kg. No background data are available for perchlorate. Perchlorate is identified as a COPC.

Selenium was not detected but had DLs (0.43 mg/kg to 1.06 mg/kg) above the Qbt 3 BV (0.3 mg/kg) in 26 samples. Selenium is identified as a COPC in tuff. Selenium was not detected but had DLs (1.04 mg/kg to 1.07 mg/kg) above the sediment BV (0.3 mg/kg) in four samples. Selenium is identified as a COPC in sediment.

Silver was not detected but had a DL (1.11 mg/kg) above the Qbt 3 BV (1 mg/kg) in one sample. The DL is below the maximum Qbt 3 background concentration (1.9 mg/kg). Silver is not identified as a COPC in tuff.

In summary, the inorganic COPCs identified at SWMU 05-005(b) are antimony, cadmium, chromium, copper, lead, nickel, perchlorate, and selenium.

Organic Chemicals

Twenty-eight samples (3 soil, 21 Qbt 3, and 4 sediment) were analyzed for explosive compounds and SVOCs, and 27 samples (3 soil, 20 Qbt 3, and 4 sediment) were analyzed for dioxin and furan congeners, PCBs, and VOCs. Additionally, four Qal samples were analyzed for acenaphthene. Table 6.4-3 presents the organic chemicals detected. Plate 1 shows the spatial distribution of organic chemicals detected at SWMU 05-005(b).

Explosive compounds and PCBs were not detected at SWMU 05-005(b).

Organic chemicals detected at SWMU 05-005(b) include acenaphthene; benzoic acid; bis(2-ethylhexyl)phthalate; di-n-butylphthalate; fluoranthene; 1,2,3,4,6,7,8-heptachlorodibenzodioxin; 1,2,3,4,6,7,8-heptachlorodibenzofuran; 4-isopropyltoluene; 1,2,3,4,6,7,8,9-octachlorodibenzodioxin; 1,2,3,4,6,7,8,9-octachlorodibenzofuran; 2,3,4,7,8-pentachlorodibenzofuran; and toluene.

These organic chemicals are retained as COPCs at SWMU 05-005(b).

Radionuclides

Thirty-six samples (6 soil, 26 Qbt 3, and 4 sediment) were analyzed for isotopic plutonium and isotopic uranium. Table 6.4-4 presents the radionuclides detected or detected above BVs/FVs. Figure 6.4-3 shows the spatial distribution of radionuclides detected or detected above BVs/FVs at SWMU 05-005(b).

Plutonium-238 was detected in one Qbt 3 sample (0.0225 pCi/g). Plutonium-238 is identified as a COPC in tuff.

Plutonium-239/240 was detected in one Qbt 3 sample (0.0281 pCi/g). Plutonium-239/240 is identified as COPC in tuff.

Uranium-235/236 was detected above the Qbt 3 BV (0.09 pCi/g) in one sample (0.103 pCi/g). Uranium-235/236 is identified as a COPC in tuff.

In summary, the radionuclide COPCs identified at SWMU 05-005(b) are plutonium-238, plutonium-239/240, and uranium-235/236.

Nature and Extent of Soil and Rock Contamination

Inorganic COPCs

Antimony was detected above the Qbt 3 BV (0.5 mg/kg) in two samples at locations 05-613799 and 05-613921. Antimony was not detected but had DLs above BV in deeper samples at both locations. The vertical extent of antimony is defined. Antimony was not detected above BVs and all results reported between the BVs, and the maximum DL were nondetects downgradient of location 05-613799. The lateral extent of antimony is defined.

Cadmium and selenium were not detected but had DLs above BVs. Because they were not detected above BVs and all results reported between the BVs and the maximum DL were nondetects, the lateral and vertical extent of cadmium and selenium are defined.

Chromium was detected above the Qbt 3 BV (7.14 mg/kg) in four samples at two historical locations 05-02042 and 05-02043 (depths ranging from 0–3 ft bgs), which were resampled in 2011 as locations 05-613920 and 05-613801, respectively. Chromium was not detected above BV in the 2011 samples (depths ranging from 0–6 ft bgs). The lateral and vertical extent of chromium are defined.

Copper was detected above the Qbt 3 BV (4.66 mg/kg) in one sample (4.72 mg/kg) at location 05-613803 from 2–3 ft bgs. This concentration is below the maximum Qbt 3 background concentration (6.2 mg/kg). Copper was not detected above BV at location 05-613802, downgradient of location 05-613803. The lateral and vertical extent of copper are defined.

Lead was detected above the Qbt 3 BV (11.2 mg/kg) in four samples at locations 05-613801, 05-613920, 05-613921, and 05-613922. Concentrations of lead decreased with depth at all four locations. The vertical extent of lead is defined. Lead was not detected above BV downgradient of location 05-613922. The lateral extent of lead is defined.

Nickel was detected above the Qbt 3 BV (6.58 mg/kg) in four samples at two historical locations 05-02042 and 05-02043 (depths ranging from 0–3 ft bgs), which were resampled in 2011 as locations 05-613920 and 05-613801, respectively. Nickel was not detected above BV in the 2011 samples (depths ranging from 0–6 ft bgs). The lateral and vertical extent of nickel are defined.

Nitrate was detected in 17 soil, Qbt 3, and sediment samples at eight locations. Nitrate is naturally occurring, and the concentrations detected likely reflect naturally occurring levels. The lateral and vertical extent of nitrate are defined.

Perchlorate was detected in six Qbt 3 and sediment samples at four locations. Concentrations of perchlorate decreased with depth at all four locations. The vertical extent of perchlorate is defined. Perchlorate was not detected in samples (depths ranging from 0–10 ft bgs) at location 05-614429 (RE05-11-14596 through RE05-11-14599, Table 6.4-1 and Appendix F). The lateral extent of perchlorate is defined.

Organic COPCs

Acenaphthene was detected in one sample (0.0444 mg/kg) at location 05-613802 from 1–2 ft bgs. Acenaphthene was not detected in deeper samples at this location. The vertical extent of acenaphthene is defined. Acenaphthene was not detected in samples (depths ranging from 0–10 ft bgs) at location 05-614429 (RE05-11-14596, RE05-11-14598, and RE05-11-14599, Table 6.4-1 and Appendix F). The lateral extent of acenaphthene is defined.

Benzoic acid was detected in one sample (0.538 mg/kg) below the EQL at location 05-613803 from 0–1 ft bgs. Benzoic acid was not detected in deeper samples at this location. The vertical extent of benzoic acid is defined. Benzoic acid was not detected at location 05-613802, downgradient of location 05-613803. The lateral extent of benzoic acid is defined.

Bis(2-ethylhexyl)phthalate was detected in one sample (0.29 mg/kg) at historical location 05-02043 from 1–2 ft bgs. This location was resampled as location 05-613801 in 2011, and bis(2-ethylhexyl)phthalate was not detected in the 2011 samples (depths ranging from 0–6 ft bgs). The lateral and vertical extent of bis(2-ethylhexyl)phthalate are defined.

Di-n-butylphthalate was detected in one sample (0.0774 mg/kg) below the EQL at location 05-613921 from 0–1 ft bgs. Di-n-butylphthalate was not detected in deeper samples at this location. The vertical extent of di-n-butylphthalate is defined. Di-n-butylphthalate was not detected downgradient of location 05-613921. The lateral extent of di-n-butylphthalate is defined.

Fluoranthene was detected in one sample (0.0116 mg/kg) below the EQL at location 05-613922 from 0–1 ft bgs. Fluoranthene was not detected in deeper samples at this location. The vertical extent of fluoranthene is defined. Fluoranthene was not detected downgradient of location 05-613922. The lateral extent of fluoranthene is defined.

Dioxin and furan congeners were detected at eight locations. Dioxin and furan congeners were either not detected in deeper samples or their concentrations decreased with depth. Dioxin and furan congeners were not detected at the farthest downgradient location 05-613802. The lateral and vertical extent of dioxin and furan congeners are defined.

Isopropyltoluene(4-) was detected in one sample (0.000748 mg/kg) below the EQL at location 05-613798 from 0–1 ft bgs. Isopropyltoluene(4-) was not detected in deeper samples at this location. The vertical extent of 4-isopropyltoluene is defined. Isopropyltoluene(4-) was not detected downgradient of location 05-613798. The lateral extent of 4-isopropyltoluene is defined.

Toluene was detected in one sample (0.000326 mg/kg) below the EQL at location 05-613802 from 0–1 ft bgs. The lateral and vertical extent of toluene are defined.

Radionuclide COPCs

Plutonium-238 was detected in one sample (0.0225 pCi/g) at historical location 05-02042 from 0–1 ft bgs. This location was resampled as location 05-613920 in 2011, and plutonium-238 was not detected in the 2011 samples (depths ranging from 0–6 ft bgs). Plutonium-238 was not detected or detected above FV downgradient of location 05-613920. The lateral and vertical extent of plutonium-238 are defined.

Plutonium-239/240 was detected in one Qbt 3 sample (0.0281 pCi/g) at location 05-613921 from 0–1 ft bgs. Concentrations of plutonium-239/240 decreased with depth at this location. The vertical extent of plutonium-239/240 is defined. Plutonium-239/240 was not detected or detected above FV downgradient of location 05-613921. The lateral extent of plutonium-239/240 is defined.

Uranium-235/236 was detected above the Qbt 3 BV (0.09 pCi/g) in one sample (0.103 pCi/g) at location 05-613801 from 0–1 ft bgs. Concentrations of uranium-235/236 decreased with depth at this location. The vertical extent of uranium-235/236 is defined. Uranium-235/236 was not detected above BV downgradient of location 05-613801. The lateral extent of uranium-235/236 is defined.

Summary of Nature and Extent

The lateral and vertical extent of TAL metals, nitrate, perchlorate, total cyanide, dioxin and furan congeners, explosive compounds, PCBs, SVOCs, VOCs, and radionuclides are defined at SWMU 05-005(b).

6.4.1.5 Summary of Human Health Risk Screening

The human health risk-screening assessment is discussed in section I-4.0 in Appendix I.

The total excess cancer risk for the industrial scenario is 1×10^{-8} , which is below the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is 0.023, which is below the NMED target HI of 1 (NMED 2009, 108070). The total dose for the industrial scenario is 0.02 mrem/yr, which is below the DOE target dose limit of 15 mrem/yr (DOE 2000, 067489).

The total excess cancer risk for the residential scenario is 6×10^{-8} , which is below the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is 0.074, which is below the NMED target HI of 1 (NMED 2009, 108070). The total dose for the residential scenario is 0.1 mrem/yr, which is below the DOE target dose limit of 15 mrem/yr (DOE 2000, 067489).

Based on the risk-screening assessment results, no potential unacceptable risks and doses exist for the industrial and residential scenarios at SWMU 05-005(b).

6.4.1.6 Summary of Ecological Risk Screening

The ecological risk-screening assessment is discussed in section I-5.0 in Appendix I. No potential ecological risk was found for any receptor following evaluations based on minimum ESLs, HI analyses, comparison with background concentrations, potential effects to populations (individuals for T&E species), and LOAEL analyses.

6.4.2 SWMU 05-006(c), Area of Potential Soil Contamination

6.4.2.1 Site Description and Operation History

SWMU 05-006(c) is an area of potentially contaminated soil associated with the location of former building 05-5, a shop and darkroom (Figure 6.4-1). The shop was 16 ft², and the darkroom was 6 ft wide × 9 ft long (LANL 1990, 007511). The building was operational from about 1944 to 1959. The structure was originally used to support firing-site activities, including processing photographs of experiments conducted at the TA-05 firing sites. In 1952, J Division temporarily used the building to calibrate high-range radiation meters (LANL 1992, 007666, p. 3-12). A 1959 memorandum indicates this structure was contaminated with HE (Penland 1959, 000806), as does a 1959 list generated by the Laboratory's H-3 Group. Potential soil contamination associated with SWMU 05-006(c) was reported to also include uranium. Building 05-5 was destroyed by intentional burning on March 5, 1960 (Wingfield 1960, 029398).

During the 2011 investigation activities, a small amount of burned debris (charred wood, melted glass, and metal) was removed from the former location of building 05-5. An 18-in.-long capped pipe was also removed. Stormwater BMPs, including a soil berm with straw wattles, are in place south of the site.

6.4.2.2 Relationship to Other SWMUs and AOCs

The outfall of SWMU 05-005(b) was associated with former building 05-5 [SWMU 05-006(c)]. SWMUs 05-005(b) and 05-006(c) comprise Consolidated Unit 05-005(b)-00.

6.4.2.3 Summary of Previous Investigations

Cleanup of the site of the former building was included in the 1985 LASCP. Surface debris, including wood, copper wire, scrap metal, and other building debris, was removed. No radioactive contamination was detected (NUS Corporation 1990, 012571). A mound of burned debris, including charred wood and melted glass, was noted to be present at the site during an inspection in September 1994 (Koch 1994, 048943.13).

A Phase I RFI was conducted at SWMU 05-006(c) in 1994 and 1995. Preliminary RFI activities included an interview with a former Beta Site supervisor and engineering surveys to identify sampling locations. The engineering surveys consisted of reviews of archival aerial photographs and engineering drawings, site environmental surveys, site visits and walkovers to locate the former buildings, and the staking of sampling locations. A radiation grid survey performed on July 7, 1995, covered an area of approximately 70 ft × 120 ft and provided contiguous coverage of SWMUs 05-005(b) and 05-006(c). The radiation grid locations were spaced at 20-ft intervals. Gross-beta/gamma radiation measurements were within background levels.

Phase I RFI sampling was performed in July 1995. Thirteen soil and tuff samples were collected from seven locations. (Two samples from two locations were excavated in 2011; therefore, they are not listed in Table 6.4-5 [see section 6.4.2.4].) To characterize potential contamination from chemical disposal, nine soil and tuff samples were collected from three locations around three sides of the former building in areas where chemicals may have been poured on the ground. At each location, samples were collected from depth intervals of 0–1 ft, 1–2 ft, and 2–3 ft bgs. All samples were submitted for laboratory analysis of TAL metals, isotopic uranium, and isotopic plutonium. One sample was also submitted for analysis of gross-alpha and gross-beta radioactivity and gamma-emitting radionuclides. Four additional samples were collected to characterize potential contamination associated with the debris remaining from the demolition of the building. A surface (0–0.5 ft) sample was collected at each of four locations at and downslope of the debris pile. All samples were submitted for laboratory analysis of TAL metals. Two of these four surface samples were excavated in 2011 (section 6.4.2.4). No samples collected in 1995 were analyzed for organic chemicals.

Metals detected above BV in the 1995 sampling were antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, nickel, selenium, silver, and zinc (results before the 2011 excavation are presented in LANL 2010, 108281, Table 4.0-3). Antimony, cadmium, and silver each were detected above their BVs for one soil sample. Arsenic was detected slightly above the BV in one soil sample and slightly above the BV in one tuff sample. Barium was detected above the BV in one tuff sample, and calcium was detected above the BV in one tuff sample. Chromium was detected above the BV in six tuff samples. Copper was detected above the BV in three soil samples. Iron and selenium were each detected slightly above the BVs in one soil sample. Lead was detected above the BV in four soil samples and one tuff sample. Nickel was detected above the BV for two soil samples and five tuff samples. Zinc was detected above the BV in three soil samples. Mercury had DLs above the soil BV in one sample.

Samples were not analyzed for organic chemicals, and no radionuclides were detected or detected above BVs or FVs.

Decision-level data from the 1995 RFI are presented and evaluated together with the 2011 decision-level data in section 6.4.2.4.

6.4.2.4 Site Contamination

Soil and Rock Sampling

As part of the 2011 investigation, the following activities were conducted at SWMU 05-006(c) from January to March 2011:

- All samples were field screened for organic vapors and gross-alpha, -beta, and -gamma radioactivity. Field-screening results were recorded on the SCLs/COC forms (Appendix F) and are presented in Table 3.2-2.
- Originally 24 samples were collected from eight locations (05-613800, 05-613804, 05-613805, 05-613806, 05-613807, 05-613808, 05-613809, and 05-613929) within and around the footprint at depth intervals of 0–1 ft, 2–3 ft, and 5–6 ft bgs. Locations 05-613805, 05-613804, 05-613807, 05-613806, 05-613800, and 05-613808 were at previous locations 05-02039, 05-02040, 05-02041, 05-02070, 05-02071, and 05-02072, respectively.
- An XRF survey conducted at SWMU 05-006(c) identified locations with elevated concentrations of lead. All remaining debris and all soil containing lead above the industrial SSL (800 mg/kg) were removed. The depth of the excavation ranged from 0.5–1 ft bgs within the remediated area (Figure 6.4-1). During the excavation, locations 05-02072 (0–0.5 ft) and 05-613808 (0–1 ft) were removed (excavated samples 0405-95-0300 and RE05-11-3427, respectively, Appendix F). Because only a surface sample was collected at location 05-02072 in 1995 and the location was subsequently excavated in 2011, Figure 6.4-1 shows this location only as location 05-613808. Four confirmation samples were collected at four locations (05-613925 through 05-613928) from 0–1 ft bgs at the bottom of excavation. Only surface samples were collected because other locations with multiple depths are within the immediate vicinity of these four locations.

All samples were analyzed for TAL metals, nitrate, perchlorate, total cyanide, explosive compounds, dioxin and furan congeners, PCBs, SVOCs, VOCs, isotopic plutonium, and isotopic uranium.

After evaluating the analytical results from sampling conducted from January to March 2011 to define the nature and extent of contamination, the Laboratory proposed to conduct additional sampling (LANL 2011, 203592) and NMED approved the proposed sampling (NMED 2011, 203618). The following activities were conducted at SWMU 05-006(c) in June 2011:

- One deeper sample each was collected at locations 05-613807 and 05-613929 from 9–10 ft bgs and analyzed for toluene and silver, respectively.
- Location 05-613800 was excavated to remove additional lead contamination. The excavation depth ranged from 1–2 ft bgs within the 6-ft x 6-ft remediated area (Figure 6.4-1). Location 05-613800 is collocated with historical location 05-02071. Location 05-02071, although located within the boundary of SWMU 05-005(b), was originally planned and sampled west of SWMU 05-006(c). During the excavation, locations 05-02071 (0–0.5 ft) and 05-613800 (0–1 ft) were removed (excavated samples 0405-95-0299 and RE05-11-3393, respectively, Appendix F). Two deeper samples (2–3 ft and 5–6 ft bgs) at location 05-613800 remain and serve to define vertical extent. Because only a surface sample was collected at location 05-02071 in 1995 and the location was subsequently excavated in 2011, Figure 6.4-1 shows this location only as location 05-613800.

Confirmation samples for excavation at location 05-613800 were collected from three step-out locations 3 ft to the north, east, and south of location 05-613800 (locations 05-614430, 05-614431, and 05-614432,

respectively) at depth intervals of 0–1 ft, 2–3 ft, and 5–6 ft bgs. No confirmation sample was collected to the west because of the close proximity to the other sampled locations at SWMU 05-006(c). Confirmation samples were analyzed only for lead.

Historical and 2011 sampling locations at SWMU 05-006(c) are shown in Figure 6.4-1. Table 6.4-5 presents the historical and 2011 samples collected and the analyses requested for SWMU 05-006(c). The geodetic coordinates of the 2011 sampling locations are presented in Table 3.2-1.

Soil and Rock Sample Field-Screening Results

No organic vapors were detected at more than 5 ppm above ambient air during PID screening of the samples during the 2011 investigation. No radiological screening results exceeded twice the daily site background levels. Field-screening results for the 2011 samples are presented in Table 3.2-2. No changes to sampling or other activities occurred because of the field-screening results.

Soil and Rock Sample Analytical Results

Decision-level data at SWMU 05-006(c) consist of results from 48 samples collected from 20 locations in 1995 and 2011. The 48 samples include 5 soil and 43 Qbt 3 samples. The extent of contamination is defined at SWMU 05-006(c). Therefore, the COPCs for the site are identified below.

Inorganic Chemicals

Thirty-seven samples (5 soil and 32 Qbt 3) were analyzed for TAL metals; in addition, nine Qbt 3 samples were analyzed only for lead, and one Qbt 3 sample was analyzed only for silver. Twenty-six Qbt 3 samples were analyzed for nitrate, perchlorate, and total cyanide. Table 6.4-6 presents the inorganic chemicals above BVs. Figure 6.4-4 shows the spatial distribution of inorganic chemicals detected or detected above BVs SWMU 05-006(c).

Aluminum was detected above the Qbt 3 BV (7340 mg/kg) in one sample (9190 mg/kg). The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-4.0-1 and Table H-4.0-1). Aluminum is not identified as a COPC in tuff.

Antimony was detected above the soil BV (0.83 mg/kg) and the maximum soil background concentration (1 mg/kg) in one sample (2.3 mg/kg) and was not detected but had a DL (0.85 mg/kg) above the soil BV in one sample. Antimony is identified as a COPC in soil. Antimony was detected above the Qbt 3 BV (0.5 mg/kg) in five samples, with a maximum concentration of 2.13 mg/kg, and was not detected but had DLs (0.55 mg/kg to 1.2 mg/kg) above the Qbt 3 BV in 14 samples. Antimony is identified as a COPC in tuff.

Arsenic was detected above the Qbt 3 BV (2.79 mg/kg) in one sample (3.2 mg/kg). The Gehan and quantile tests indicated site concentrations are not different from background (Figure H-4.0-2 and Table H-4.0-1). Arsenic is not identified as a COPC in tuff.

Barium was detected above the Qbt 3 BV (46 mg/kg) in three samples, with a maximum concentration of 87.9 mg/kg. The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-4.0-3 and Table H-4.0-1). Barium is not identified as a COPC in tuff.

Calcium was detected above the Qbt 3 BV (2200 mg/kg) in three samples, with a maximum concentration of 6710 mg/kg. The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-4.0-4 and Table H-4.0-1). Calcium is not identified as a COPC in tuff.

Chromium was detected above the Qbt 3 BV (7.14 mg/kg) in six samples, with a maximum concentration of 187 mg/kg. The Gehan test indicated site concentrations are different from background (Figure H-4.0-5 and Table H-4.0-1). Chromium is identified as a COPC in tuff.

Copper was detected above the soil BV (14.7 mg/kg) and the maximum soil background concentration (16 mg/kg) in one sample (126 mg/kg). Copper is identified as a COPC in soil. Copper was detected above the Qbt 3 BV (4.66 mg/kg) in 10 samples, with a maximum concentration of 317 mg/kg. The Gehan test indicated site concentrations are different from background (Figure H-4.0-6 and Table H-4.0-1). Copper is identified as a COPC in tuff.

Cyanide was not detected at SWMU 05-006(c). Therefore, cyanide is not identified as a COPC.

Iron was detected above the soil BV (21,500 mg/kg) in one sample (25,100 mg/kg). This concentration is below the maximum soil background concentration (36,000 mg/kg). Iron is not identified as a COPC in soil. Iron was detected above the Qbt 3 BV (14,500 mg/kg) in one sample (18,600 mg/kg). The Wilcoxon and quantile tests indicated site concentrations in Qbt 3 tuff are not different from background (Figure H-4.0-7 and Table H-4.0-1). Iron is not identified as a COPC in tuff.

Lead was detected above the soil BV (22.3 mg/kg) and the maximum soil background concentration (28 mg/kg) in two samples, with a maximum concentration of 42.9 mg/kg. Lead is identified as a COPC in soil. Lead was detected above the Qbt 3 BV (11.2 mg/kg) in 26 samples, with a maximum concentration of 337 mg/kg. The Gehan test indicated site concentrations are different from background (Figure H-4.0-8 and Table H-4.0-1). Lead is identified as a COPC in tuff.

Magnesium was detected above the Qbt 3 BV (1690 mg/kg) in one sample (1710 mg/kg). The Wilcoxon and quantile tests indicated site concentrations are not different from background (Figure H-4.0-9 and Table H-4.0-1). Magnesium is not identified as a COPC in tuff.

Nickel was detected above the soil BV (15.4 mg/kg) in one sample (28.2 mg/kg). This concentration is below the maximum soil background concentration (29 mg/kg). Nickel is not identified as a COPC in soil. Nickel was detected above the Qbt 3 BV (6.58 mg/kg) in five samples, with a maximum concentration of 89.4 mg/kg. The quantile test indicated site concentrations are not different from background, but the slippage test indicated site concentrations are different from background (Figure H-4.0-10 and Table H-4.0-1). Nickel is identified as a COPC in tuff.

Nitrate was detected in 11 Qbt 3 samples, with a maximum concentration of 1.63 mg/kg. No background data are available for nitrate. Nitrate is naturally occurring, and the concentrations detected likely reflect naturally occurring levels. Nitrate is not identified as a COPC in tuff.

Perchlorate was not detected at SWMU 05-006(c). Therefore, perchlorate is not identified as a COPC.

Selenium was detected above the Qbt 3 BV (0.3 mg/kg) in four samples, with a maximum concentration of 0.394 mg/kg, and was not detected but had DLs (0.43 mg/kg to 1.09 mg/kg) above the Qbt 3 BV in 28 samples. Selenium is identified as a COPC in tuff.

Silver was detected above Qbt 3 BV (1 mg/kg) and the maximum Qbt 3 background concentration (1.9 mg/kg) in one sample (2.22 mg/kg). Silver is identified as a COPC in tuff.

Zinc was detected above the soil BV (48.8 mg/kg) in one sample (58.4 mg/kg). This concentration is below the maximum soil background concentration (75.5 mg/kg). Zinc is not identified as a COPC in soil.

In summary, the inorganic COPCs identified at SWMU 05-006(c) are antimony, chromium, copper, lead, nickel, selenium, and silver.

Organic Chemicals

Twenty-six Qbt 3 samples were analyzed for dioxin and furan congeners, explosive compounds, PCBs, SVOCs, and VOCs. Additionally, one Qbt 3 sample was analyzed for toluene only. Table 6.4-7 presents the organic chemicals detected. Plate 2 shows the spatial distribution of organic chemicals detected at SWMU 05-006(c).

Explosive compounds and SVOCs were not detected at SWMU 05-006(c).

Organic chemicals detected at SWMU 05-006(c) include acetone; Aroclor-1260; 1,2,3,4,6,7,8-heptachlorodibenzodioxin; 1,2,3,4,6,7,8-heptachlorodibenzofuran; 1,2,3,6,7,8-hexachlorodibenzodioxin; 4-isopropyltoluene; methylene chloride; 1,2,3,4,6,7,8,9-octachlorodibenzodioxin; 1,2,3,4,6,7,8,9-octachlorodibenzofuran; 2,3,7,8-tetrachlorodibenzofuran; toluene; 1,2,4-trimethylbenzene. These organic chemicals are retained as COPCs at SWMU 05-006(c).

Radionuclides

One soil sample was analyzed for gamma-emitting radionuclides, and 35 samples (3 soil and 32 Qbt 3) were analyzed for isotopic plutonium and isotopic uranium. Table 6.4-8 presents the radionuclides detected or detected above BVs/FVs. Figure 6.4-3 shows the spatial distribution of radionuclides detected or detected above BVs/FVs.

Uranium-235/236 was detected above the Qbt 3 BV (0.09 pCi/g) in three samples, with a maximum concentration of 0.103 pCi/g. Uranium-235/236 is identified as a COPC in tuff.

The radionuclide COPC identified at SWMU 05-006(c) is uranium-235/236.

Nature and Extent of Soil and Rock Contamination

Inorganic COPCs

Antimony was detected above the soil BV (0.83 mg/kg) in one sample at historical location 05-02070 and was detected above the Qbt 3 BV (0.5 mg/kg) in five samples at four locations. Historical location 05-02070 was resampled as location 05-613806 in 2011. Concentrations of antimony decreased with depth at locations 05-613804, 05-613806, and 05-613929. Only surface samples (0–1 ft bgs) were collected at locations 05-613926 and 05-613928. However, antimony was not detected above BV at location 05-613808 (approximately 4 ft from location 05-613926), and its concentrations decreased with depth at location 05-613929 (approximately 3 ft from location 05-613928). Therefore, the vertical extent of antimony is defined at all five locations. Antimony was not detected above the BV, and all results reported between the BV and the maximum DL were nondetects at perimeter locations 05-613800, 05-613806, 05-613807, and 05-613809. The lateral extent of antimony is defined.

Chromium was detected above the Qbt 3 BV (7.14 mg/kg) in six samples at three historical locations 05-02039, 05-02040, and 05-02041 (depths ranging from 0–3 ft bgs), which were resampled in 2011 as locations 05-613805, 05-613804, and 05-613807 (depths ranging from 0–6 ft bgs), respectively. Chromium was not detected above BV in the 2011 samples at these three locations. The lateral and vertical extent of chromium are defined.

Copper was detected above the soil BV (14.7 mg/kg) in one sample (0–0.5 ft bgs) at historical location 05-02070. This historical location was resampled as location 05-613806 (depths ranging 0–6 ft bgs) in 2011, and copper was not detected above BV at location 05-613806. Copper was detected above the Qbt 3 BV (4.66 mg/kg) in 10 samples at eight locations. Concentrations of copper decreased with depth at five of the eight locations. At location 05-613808, a surface sample (0–1 ft bgs) was collected before the debris was removed at SWMU 05-006(c); this location was subsequently removed during the excavation (section 6.4.2.4). Decision-level data from this surface sample (RE05-11-3427, excavated sample, Appendix F) showed copper at a concentration of 49 mg/kg. Copper was detected at concentrations of 7.94 mg/kg and 9.18 mg/kg from 2–3 ft and 5–6 ft bgs, respectively. Overall, concentrations of copper decreased with depth at location 05-613808. At locations 05-613926 and 05-613928, where only surface samples (0–1 ft bgs) were collected, concentrations of copper decreased with depth at locations 05-613808 (approximately 4 ft from location 05-613926) and 05-613929 (approximately 3 ft from 05-613928), respectively. Therefore, the vertical extent of copper is defined at all eight locations. Concentrations of copper decreased laterally in all four directions. The lateral extent of copper is defined.

Lead was detected above the soil BV (22.3 mg/kg) in two samples at historical locations 05-02040 and 05-02070 and was detected above the Qbt 3 BV (11.2 mg/kg) in 26 samples at 14 locations, including at historical location 05-02040. Historical locations 05-02040 and 05-02070 were resampled as locations 05-613804 and 05-613806 in 2011, respectively. Concentrations of lead decreased with depth at location 05-613804, and it was not detected above BV at location 05-613806. Concentrations of lead also decreased with depth at five other locations. Only surface samples (0–1 ft bgs) were collected at locations 05-613925, 05-613926, and 05-613928, and the concentrations of lead decreased with depth at locations 05-613804 (approximately 4 ft from location 05-613925), 05-613808 (approximately 4 ft from location 05-613926), and 05-613929 (approximately 3 ft from 05-613928), respectively. The vertical extent of lead is defined. Location 05-613800 was excavated to remove lead contamination, with confirmation samples collected from three step-out locations 05-614430, 05-614431, and 05-614432 (section 6.4.2.4). The preexcavated concentration of lead was 26,500 mg/kg from 0–1 ft bgs at location 05-613800 (RE05-11-3393, excavated sample, Appendix F). Lead was detected at concentrations of 26.4 mg/kg and 60.1 mg/kg from 2–3 ft and 5–6 ft bgs, respectively. Overall, lead concentrations decreased with depth at this location from 0–1 ft to 5–6 ft bgs, and the remaining concentrations are approximately an order of magnitude below the residential SSL (400 mg/kg). Lead concentrations decreased laterally in all four directions at the excavation. Lead concentrations also decreased with depth at step-out locations 05-614430 and 05-614432. Lead concentrations increased slightly with depth at step-out location 05-614431 but showed essentially no change with depth from 2–3 ft to 5–6 ft. The lead concentrations at depth at this location are slightly above the maximum Qbt 2,3,4 background concentration (15.5 mg/kg) and are comparable with the lead concentrations detected at the other step-out locations (locations 05-614430 and 05-614432). All lead concentrations within and around the excavated area are an order of magnitude or more below the residential SSL (400 mg/kg). Therefore, further sampling for extent is not warranted.

Nickel was detected above the soil BV (15.4 mg/kg) in one sample at historical location 05-02070, which was resampled in 2011 as location 05-613806. Nickel was detected above the Qbt 3 BV (6.58 mg/kg) in five samples at three historical locations 05-02039, 05-02040, and 05-02041, which were resampled in 2011 as locations 05-613805, 05-613804, and 05-613807, respectively. Nickel was not detected above BV in the 2011 samples at these four locations. The lateral and vertical extent of nickel are defined.

Selenium was detected above the Qbt 3 BV (0.3 mg/kg) in four samples at three locations. Concentrations of selenium decreased with depth at locations 05-613800 and 05-613929. Only a surface sample (0–1 ft bgs) was collected at location 05-613928, but its concentrations decreased with depth at location 05-613929 (approximately 3 ft from 05-613928). The vertical extent of selenium is defined at all

three locations. Selenium was not detected above BVs and all results reported between the BVs and the maximum DL were nondetects at all other locations at the site. The lateral extent of selenium is defined.

Silver was detected above Qbt 3 BV (1 mg/kg) in one sample from 5–6 ft bgs at location 05-613929. Silver was not detected above BV in the deepest sample from 9–10 ft bgs at location 05-613929 (RE05-11-14605, Table 6.4-5 and Appendix F). Concentrations of silver decreased with depth at location 05-613929. The vertical extent of silver is defined. Silver was not detected above BV at any other locations at the site. The lateral extent of silver is defined.

Organic COPCs

Acetone was detected in two samples below the EQLs at two locations. The lateral and vertical extent of acetone are defined.

Aroclor-1260 was detected in three samples below the EQLs at two locations. The lateral and vertical extent of Aroclor-1260 are defined.

Dioxin and furan congeners were detected at 12 locations. Concentrations of all dioxin and furan congeners decreased with depth at all locations, except locations 05-613925, 05-613926, 05-613927, and 05-613928 where only surface samples collected. The concentrations detected at these four locations are less than the EQLs, except for total heptachlorodibenzodioxins; 1,2,3,4,6,7,8,9-octachlorodibenzodioxin; and total tetrachlorodibenzofurans at location 05-613928. However, concentrations of these congeners decreased with depth at location 05-613929 (approximately 3 ft from 05-613928). The concentrations of dioxin and furan congeners also decreased laterally in all four directions at the site. The lateral and vertical extent of dioxin and furan congeners are defined.

Isopropyltoluene(4-) was detected in six samples at five locations. Concentrations of 4-isopropyltoluene decreased with depth at 05-613808 and 05-613929. Only surface samples (0–1 ft bgs) were collected at locations 05-613925, 05-613927, and 05-613928, but 4-isopropyltoluene was not detected at locations 05-613804 (approximately 4 ft from location 05-613925), and its concentrations decreased with depth at locations 05-613808 and 05-613929 (approximately 5 ft from location 05-613927 and 3 ft from location 05-613928, respectively). Therefore, the vertical extent of 4-isopropyltoluene is defined at all five locations. Isopropyltoluene(4-) was not detected at perimeter locations 05-613800, 05-613806, 05-613807, and 05-613809. The lateral extent of 4-isopropyltoluene is defined.

Methylene chloride was detected in 11 samples below the EQLs at seven locations. The lateral and vertical extent of methylene chloride are defined.

Toluene was detected in nine samples at four locations. Concentrations of toluene are below the EQLs at locations 05-613804, 05-613805, and 05-613806. Toluene was not detected in the deepest sample from 9–10 ft bgs at location 05-613807 (RE05-11-14604, Table 6.4-5 and Appendix F). The vertical extent of toluene is defined at all four locations. Toluene was not detected at perimeter locations 05-613800 and 05-613809, was detected at concentrations below the EQLs at location 05-613806, and was not detected to the south at location 05-613920 (Table 6.4-3). The lateral extent of toluene is defined.

Trimethylbenzene(1,2,4-) was detected in one sample (0.000461 mg/kg) below the EQL at location 05-613805 from 0–1 ft bgs. The lateral and vertical extent of 1,2,4-trimethylbenzene are defined.

Radionuclide COPCs

Uranium-235/236 was detected above the Qbt 3 BV (0.09 pCi/g) in three samples at three locations. Concentrations of uranium-235/236 decreased with depth at location 05-613805. Only a surface sample (0–1 ft bgs) was collected at location 05-613927, but uranium-235/236 was not detected above BV at location 05-613929, which is approximately 3 ft from location 05-613927. Uranium-235/236 was detected above the Qbt 3 BV only in the deepest sample (0.0903 pCi/g) at location 05-613800; however, this concentration is equivalent to the BV. Uranium-235/236 was not detected above BV at the other three perimeter locations 05-613806, 05-613807, and 05-613809. The lateral and vertical extent of uranium-235/236 are defined.

Summary of Nature and Extent

The lateral and vertical extent of TAL metals, nitrate, perchlorate, total cyanide, dioxin and furan congeners, explosive compounds, PCBs, SVOCs, VOCs, and radionuclides are defined at SWMU 05-006(c).

6.4.2.5 Summary of Human Health Risk Screening

The human health risk-screening assessment is discussed in section I-4.0 in Appendix I.

The total excess cancer risk for the industrial scenario is 1×10^{-8} , which is below the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is 0.2, which is below the NMED target HI of 1 (NMED 2009, 108070). The total dose for the industrial scenario is 0.02 mrem/yr, which is below the DOE target dose limit of 15 mrem/yr (DOE 2000, 067489).

The total excess cancer risk for the residential scenario is approximately 85×10^{-8} , which is below the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is 0.34, which is below the NMED target HI of 1 (NMED 2009, 108070). The total dose for the residential scenario is 0.04 mrem/yr, which is below the DOE target dose limit of 15 mrem/yr (DOE 2000, 067489).

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial and residential scenarios at SWMU 05-006(c).

6.4.2.6 Summary of Ecological Risk Screening

The ecological risk-screening assessment is discussed in section I-5.0 in Appendix I. No potential ecological risk was found for any receptor following evaluations based on minimum ESLs, HI analyses, comparison with background concentrations, potential effects to populations (individuals for T&E species), and LOAEL analyses.

7.0 CONCLUSIONS

7.1 Nature and Extent of Contamination

The nature and extent of contamination from inorganic, organic, and/or radionuclide COPCs have been defined at SWMUs 05-003, 05-004, 05-005(b), and 05-006(c).

7.2 Summary of Risk-Screening Assessments

Risk-screening assessments were conducted for SWMUs 05-003, 05-004, 05-005(b), and 05-006(c) under the industrial and residential scenarios and for ecological receptors.

7.2.1 Human Health Risk-Screening Assessments

The human health risk-screening assessments are presented in section I-4.0 in Appendix I.

The human health risk-screening assessments indicated no potential unacceptable risks or doses exist for the industrial and residential scenarios at SWMUs 05-003, 05-005(b) and 05-006(c).

The human health risk-screening assessments indicated no potential unacceptable risks or doses exist for the industrial scenario, and no potential unacceptable noncarcinogenic risk and no potential unacceptable dose exist for the residential scenario at SWMU 05-004. However, a potential unacceptable cancer risk exists for the residential scenario at SWMU 05-004. The cancer risk is because of the presence of PAHs that are not site-related (section 6.3.5). After removing the PAHs from the residential carcinogenic screening evaluation, the total excess cancer risk is below the NMED target risk level of 1×10^{-5} .

7.2.2 Ecological Risk-Screening Assessments

The ecological risk-screening assessments are presented in section I-5.0 in Appendix I.

No potential ecological risk exists at SWMU 05-003 because there is no potential exposure pathway for ecological receptors at SWMU 05-003.

No potential ecological risks exist for ecological receptors at SWMUs 05-004, 05-005(b), and 05-006(c) based on minimum ESL comparisons, HI analyses, comparisons to background concentrations, potential effects to populations (individuals for T&E species), and LOAEL analysis.

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 on 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 scenario—industrial—results in corrective action complete with controls; that is, some type of institutional controls must be in place to ensure the land use remains consistent with site cleanup levels. The current and reasonably foreseeable future land use for sites in the Lower Mortandad/Cedro Canyons Aggregate Area is industrial.

8.1 Recommendations for Corrective Actions Complete

The extent of contamination has been defined for all four sites, SWMUs 05-003, 05-004, 05-005(b), and 05-006(c), within the Lower Mortandad/Cedro Canyons Aggregate Area (Table 8.1-1). Therefore, no further investigation or remediation activities are warranted in this aggregate area.

SWMUs 05-003, 05-004, 05-005(b), and 05-006(c) do not pose a potential unacceptable risk or dose under the industrial and residential scenarios and do not pose potential ecological risk to any receptor at the site. The Laboratory recommends corrective actions complete without controls for SWMUs 05-003, 05-004, 05-005(b), and 05-006(c).

9.0 REFERENCES AND MAP DATA SOURCES

9.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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9.2 Map Data Sources

Sampling location- er_location_ids_pnt; Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2010-0035; 21 January 2010.

SWMU or AOC: er_prs_all_reg; Potential Release Sites; Los Alamos National Laboratory, Waste and Environmental Services Division, Environmental Data and Analysis Group, EP2009-0633; 1:2,500 Scale Data; 25 January 2010.

Structure or Building: ksl_structures_ply; Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Former structures: frmr_structures_ply; Former Structures of the Los Alamos Site; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2008-0441; 1:2,500 Scale Data; 08 August 2008.

Fence: ksl_fences_arc; 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.

Paved road: ksl_paved_rds_arc; 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 road: ksl_dirt_rds_arc; Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Storm drain: ksl_stormdrn_arc; Storm Drain Line Distribution System; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Contours: lanl_contour1991_;Hypsography, 2, 10, 20, 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

Communication: ksl_comm_arc; Communication Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 08 August 2002; as published 28 May 2009.

Electric: ksl_electric_arc; Primary Electric Grid; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Gas: ksl_gas_arc; Primary Gas Distribution Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Sewer: ksl_sewer_arc; Sewer Line System; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Water: ksl_water_arc; Water Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Technical area boundary: plan_tecareas_ply; Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 04 December 2008.

(inset)LANL Boundary: plan_ownerclip_reg;Ownership Boundaries Around LANL Area; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; 19 September 2007; as published 04 December 2008.

(Inset)ROADS: lac_streets_arc; Streets; County of Los Alamos, Information Services; as published 16 May 2006.

Landscape: ksl_landscape_arc;Primary Landscape Features; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Berms: ksl_berm_arc; Primary Berm Features; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 12 September 2002; as published 29 November 2010.

Inactive Outfall:wqh_inact_outfalls_pnt; WQH Inactive Outfalls; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; Edition 2002.01; 01 September 2003.

NPDES Outfalls:wqh_npdes_outfalls_pnt; WQH NPDES Outfalls; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; Edition 2002.01; 01 September 2003.

Outfalls:er_outfalls_pnt; Outfalls; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; Unknown publication date.

Monitoring wells:Environmental Surveillance at Los Alamos During 2006, Groundwater monitoring; LANL Report LA-14341-ENV, September 2007.

Supply Wells:Locations of Monitoring and Supply Wells at Los Alamos National Laboratory, Table A-2, 2009 General Facility Information; LANL Report LA-UR-09-1341; March 2009.

Alluvial Groundwater Saturation; wqh_allv_grndwtr_sat_arc; ENV Water Quality & Hydrology Group; 07 December 2004.

Well Locations of the Environmental Restoration Project Database; er_wells_erdb_pnt: Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2003-0390; 03 June 2003.

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

Aggregate Area:er_agg_areas_ply:Aggregate Areas; Los Alamos National Laboratory, ENV Environmental Remediation & Surveillance Program, ER2005-0496; 1:2,500 Scale Data; 22 September 2005.

Canyon Reaches:er_reaches_ply:Canyon Reaches; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2002-0592; 1:24,000 Scale Data; Unknown publication date.

