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Investigation Report for Technical Area 57 Aggregate Area (Fenton Hill), Revision 1

Prepared by the Environmental Programs Directorate

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EXECUTIVE SUMMARY

This investigation report presents the investigation activities at two areas of concern (AOCs) in the Technical Area 57 (TA-57) Aggregate Area, located at Fenton Hill, which lies on the western side of the Jemez Mountains, approximately 12 mi west of Los Alamos National Laboratory (LANL or the Laboratory). Two AOCs within the TA-57 Aggregate Area were addressed during the 2014 investigation because these sites are potentially contaminated with hazardous chemicals and/or radionuclides, and final assessments of site contamination, associated risks, and recommendations for additional corrective actions were incomplete.

The objectives of this investigation were to define the nature and extent of contamination associated with AOCs 57-006 and 57-007 and to obtain data to support decisions regarding the need to remediate or remove contamination at these sites. This report presents the results of site characterization activities conducted during the 2014 investigation, as directed by the approved investigation work plan for the TA-57 Aggregate Area.

The 2014 investigation activities included surface and subsurface characterization sampling at AOCs 57-006 and 57-007. Analysis of sampling data identified two locations of arsenic-contaminated soil above the residential soil screening level at AOC 57-007. Soil removal was completed at two locations, and additional step-out characterization samples were collected to define extent.

Based on the evaluation of the data, the extent of contamination has been defined or no further sampling for extent is warranted at AOCs 57-006 and 57-007. After soil removal, human health and ecological risk assessments were performed for both AOCs, and no potential unacceptable risks exist for any receptors.

Based on the evaluation of the sampling data and risk assessments, the Laboratory recommends corrective action complete without controls for both sites.

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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 36 mi^2 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 (amsl).

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 efforts is to ensure past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, the Laboratory 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 addresses AOCs 57-006 and 57-007 within the Technical Area 57 (TA-57) Aggregate Area. These sites are potentially contaminated with hazardous constituents and radionuclides. The New Mexico Environment Department (NMED), pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 458.1, Administrative Change 3, Radiation Protection of the Public and the Environment, and DOE Order 435.1, Radioactive Waste Management. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

Corrective actions for hazardous constituents at the Laboratory are subject to the March 2005 Compliance Order on Consent (the Consent Order). This investigation report describes work activities completed in accordance with the Consent Order and the approved TA-57 Aggregate Area investigation work plan (LANL 2012, 214550; NMED 2012, 520936).

1.1 General Site Information

The TA-57 Aggregate Area is located at Fenton Hill, which lies on the western side of the Jemez Mountains, approximately 12 mi west of the Laboratory, at an elevation of approximately 8700 ft amsl (Figure 1.1-1). The TA-57 Aggregate Area is located on property owned by the U.S. Forest Service and has been used by DOE pursuant to agreements with the Forest Service. Laboratory operations have been conducted in the aggregate area since 1974. The TA-57 Aggregate Area consists of 10 AOCs, 8 of which have previously been approved for no further action (NFA) or closed under another regulatory program. Three AOCs were approved for NFA by the U.S. Environmental Protection Agency (EPA). The 5 AOCs used to manage geothermal exploration wastes were not subject to regulation under the Resource Conservation and Recovery Act (RCRA). These sites were closed under a discharge plan issued by the New Mexico Oil Conservation Division (NMOCD). Following termination of the discharge plan by NMOCD, no additional corrective actions are required for NMOCD-regulated sites and activities. As indicated in the approval with modifications for the investigation work plan for TA-57 Aggregate Area (LANL 2012, 214550; NMED 2012, 520936), supporting documentation related to past investigations and corrective actions at the closed sites is provided in this report (on CD in Appendix H).

The remaining two AOCs were addressed in the approved TA-57 Aggregate Area investigation work plan (LANL 2012, 214550; NMED 2012, 520936). This investigation report describes the investigation status and results from sampling activities conducted at the two sites. Table 1.1-1 lists the sites included in the investigation report with a brief description and summary of the investigation activities conducted in 2014 for each site.

1.2 Purpose of the Investigation

Two AOCs within the TA-57 Aggregate Area were addressed during the 2014 investigation because these sites are potentially contaminated with hazardous chemicals and/or radionuclides, and final assessments of site contamination, associated risks, and recommendations for additional corrective actions are incomplete. The objectives of the 2014 investigation were to (1) define the nature and extent of contamination associated with historical waste management activities at AOCs 57-006 and 57-007, and (2) obtain data to support decisions regarding the need to remediate or remove contamination at these sites.

The process for evaluating the data collected during the 2014 TA-57 Aggregate Area investigation is as follows:

- Initially identify chemicals of potential concern (COPCs) to focus efforts on the constituents of most concern.
- Screen COPCs against soil screening levels (SSLs) and screening action levels (SALs) during determination of extent to focus efforts on characterizing contamination potentially posing a risk/dose and requiring corrective action.
- Perform risk/dose screening level evaluations on all sites to incorporate risk/dose reduction into recommendations for further actions.

All analytical data collected during the 2014 investigation activities are presented and evaluated in this report.

1.3 Document Organization

This report is organized into nine sections, including this introduction, with multiple supporting appendixes. Section 2 provides details on the aggregate area site conditions (surface and subsurface). 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 risk to ecological and human receptors. Section 5 describes the data review methods. Section 6 presents an overview of the operational history of the sites, historical releases, summaries of previous investigations, results of the field activities performed, site contamination, and evaluation of the nature and extent of contamination. Section 7 presents the conclusions of the nature and extent evaluations and risk-screening assessments. Section 8 discusses recommendations based on the nature and extent discussions and the risk-screening assessments. Section 9 includes a list of references cited and the map data sources used in all figures.

The appendixes include acronyms, a metric conversion table, and definitions of the data qualifiers used in this report (Appendix A); field methods (Appendix B); investigation-derived waste (IDW) management (Appendix C); analytical program descriptions and summaries of data quality (Appendix D); analytical suites and results and analytical reports (Appendix E on CD); box plots and statistical comparisons (Appendix F); risk-screening assessments (Appendix G); and NFA documentation for other sites from NMOCD (Appendix H).

2.0 AGGREGATE AREA SITE CONDITIONS

2.1 Surface Conditions

2.1.1 Soil

No site-specific soil surveys have been performed at TA-57. Undisturbed soil at TA-57 is probably typical of the soil described by Nyhan et al. (1978, 005702) for the plateau tops and edges in the Los Alamos area (LANL 1994, 034757, p. 3-17). The parent material is the Bandelier Tuff, and the processes-forming soil are expected to be very similar to the processes-forming soils in the Los Alamos area. For most of TA-57, no undisturbed soil remains because of site development activities. Much of the TA-57 site has been filled and regraded. The depth to bedrock noted during previous investigations at TA-57 ranged from 3.5–16 ft.

A thin veneer of physically weathered bedrock colluvium is the only surficial material left in the few undisturbed areas of TA-57. The residual material is thicker on the top of the plateau and thins along the edges to bedrock outcrops on the steep portions of the canyon walls. Some fine-grained to coarser material was observed in the two small alluvial channels draining the site to the southeast and northwest; however, these channels have been considerably altered by activities related to site construction and operations.

2.1.2 Surface Water

The major surface water drainage near TA-57 is the Jemez River and its tributaries. The East Fork of the Jemez River drains the Valle Grande. Base flow is from discharge of groundwater to the stream from the near-surface water table in the Valle Grande and from the relatively large amount of precipitation that occurs in the high mountains around the Valles Caldera. San Antonio Creek drains the Valle Toledo to the north of the Valle Grande as well as an area along the west side of the Valles Caldera and is a tributary to the Jemez River at the confluence with the East Fork of the Jemez River. Several thermal springs discharge into the creek. Base flow in San Antonio Creek is from the discharge of groundwater from the near-surface water table in Valle Toledo and from precipitation. At the confluence of the East Fork of the Jemez River and San Antonio Creek, approximately 10 mi south of TA-57, the combined streams become the Jemez River.

The Rio Guadalupe drains the area west of TA-57 and includes the tributaries Rio de las Vacas and Rio Cebolla. The Rio de las Vacas drains an area west of the Valles Caldera. Base flow to the Rio Cebolla is from groundwater discharge from the shallow alluvial aquifers along numerous tributaries and from springs on the canyon walls.

The TA-57 site slopes gently south so the major part of the run-off is into Lake Fork Creek, a tributary to the Rio Cebolla below Fenton Lake. The land immediately northwest of TA-57 drains into an unnamed tributary that joins the Rio Cebolla at Fenton Lake. The land immediately northeast of TA-57 drains toward San Antonio Creek but is diverted by a low divide into Lake Fork Creek (Figure 2.1-1).

2.1.3 Land Use

Currently, land use at TA-57 is industrial. The TA-57 site is fenced and locked and is accessible only to authorized workers. A portion of the area immediately adjacent to TA-57 is used by the U.S. Forest Service as a seasonal support area for firefighters. The area around TA-57 is within the Santa Fe National Forest and is used recreationally. Current land uses are not expected to change in the foreseeable future.

2.2 Subsurface Conditions

2.2.1 Stratigraphic Units

This section summarizes the stratigraphy of the bedrock beneath the TA-57 Aggregate Area. The stratigraphy includes, in descending order, the Bandelier Tuff, the Paliza Canyon Formation, the Abiquiu Tuff, the Abo Formation, the Madera limestone, the Sandia Formation, and Precambrian granite (LANL 1994, 034757, pp. 3-12–3-14).

2.2.1.1 Bandelier Tuff

The Bandelier Tuff is a nonwelded to densely welded rhyolite tuff that ranges from light to dark gray. It is composed of quartz and sanadine crystals, lithic fragments of latite and rhyolite, and fragments of glass shards and rare mafic minerals in a fine-grained ash matrix. This tuff layer thins to the west and southwest away from its source at the Valles Caldera (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941). The Bandelier Tuff is approximately 350 ft thick under the TA-57 Aggregate Area (Purtymun et al. 1974, 005483).

2.2.1.2 Paliza Canyon Formation

The Paliza Canyon Formation underlies the Bandelier Tuff and is composed of andesite and basaltic andesite breccias interbedded with sand and gravels and is approximately 50 ft thick under the site (Purtymun et al. 1974, 005483).

2.2.1.3 Abiquiu Tuff

The Abiquiu Tuff underlies the Paliza Canyon Formation and is a light gray, friable tuffaceous sandstone and is approximately 50 ft thick under the TA-57 site (Purtymun et al. 1974, 005483).

2.2.1.4 Abo Formation

The Permian redbeds of the Abo Formation underlie the Abiquiu Tuff. The lithologies are typically arkosic siltstone, sandstone, and shale with small inclusions of calcareous gray clay. Particles include granules of quartz and feldspar and pieces of igneous rock. The thickness is highly variable because of erosion before Cenozoic volcanism (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941).

2.2.1.5 Magdalena Group

The Magdalena group consists of Madera limestone over the Sandia Formation. The Madera limestone is an arkosic limestone containing both gray and red arkosic shale overlying a dark gray limestone with insets of gray shale and beds of sandstone. The Sandia Formation has an upper clastic member of sandstone, shale, and limestone. The lower part is a discontinuous dark gray siliceous limestone (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941).

2.2.1.6 Precambrian Granite

The Precambrian granite is a coarse basement rock beneath the Sandia Formation and consists or large microcline crystals, quartz-feldspar lenticular gneiss, schists, amphibolites, and pegmatites. Veins include quartz and hornblendite. Minerals include quartz and microcline, oligoclase-andesine, hornblende, biotite, epidote, sphene, apatite, zircon, and magnetite (Rea 1977, 005713; Kaufman and Siciliano 1979, 005941).

2.2.2 Hydrogeology

2.2.2.1 Groundwater

Groundwater in the area of TA-57 occurs as (1) water in saturated alluvium, (2) perched aquifers, and (3) the regional aquifer.

Saturated Alluvium

Burns Swale, a dry tributary of Lake Fork Canyon at the south side of TA-57, has a 2.0–6.0-ft depth of alluvium in its upper reaches and more than a 40-ft depth of alluvium at the confluence with Lake Fork Canyon (Figure 2.1-1). In May 1979, water was encountered in four holes bored in the alluvium. Later that year, these holes were dry (Kaufman and Siciliano 1979, 005941). After a release of water into Burns Swale in September 1979, the two holes closest to the site again contained water. Releases to Burns Swale were observed to infiltrate the alluvium and then either moved downstream along the alluvium/Cenozoic volcanic bedrock interface or infiltrated the underlying bedrock.

Perched Aquifers

The water supply for TA-57 is furnished by a well completed in a perched aquifer at a depth of about 450 ft below ground surface (bgs). The aquifer is in the Abiquiu Tuff and is perched on the clays and siltstones of the Abo Formation. The aquifer is of limited extent, terminating to the east along the canyon cut by San Antonio Creek. Water movement in the aquifer is to the southwest, where a part is discharged through springs and seeps in the lower part of Lake Fork Canyon and along the Rio Cebolla.

Other perched aquifers were identified beneath the site as part of an evaluation of alternate water supplies. Four saturated zones were identified in the Abo Formation at depths of 780–800 ft, 970–995 ft, 1005–1015 ft, and 1100–1120 ft bgs. These zones were described as fine-grained sandstones underlain by shales. Six perched zones were also identified in the Madera limestone.

Regional Aquifer

The regional aquifer is at the base of the Madera formation. Many of the hot springs in the region appear at outcrops of this horizon. These are generally hot mineral springs. The regional aquifer is encountered at a depth of 1750 ft bgs below TA-57. All the aquifers above this depth are perched. Within the regional aquifer, a permeable horizon was found in the depth interval 1770–1800 ft bgs. It consisted of 30 ft of arkosic sandstone or granite wash. Geophysical log data indicate the zone is “only fair” as an aquifer (LANL 1994, 034757). Water in the granitic basement is primarily contained in fracture porosity.

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 vadose zone underlying TA-57 is in thin surficial soil deposits and in the underlying volcanic tuff. Flow and transport in the vadose zone will be mainly downward to the perched water at the base of the volcanic tuff. 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.

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

The various units of the Bandelier Tuff tend to have relatively high porosities. Porosity ranges between 30% and 60% by volume, generally decreasing for more highly welded tuff. Permeability varies for each cooling unit of the Bandelier Tuff. The moisture content of tuff beneath the mesa tops 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 field activities performed during the implementation of the TA-57 Aggregate Area approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). The field investigation results and observations are presented in detail in section 6 and in the appendixes. The scope of activities for the 2014 investigation included site access and premobilization activities; geodetic and field-screening surveys; surface and subsurface sampling; soil removal; site restoration; health and safety monitoring; and waste management activities.

When possible, all field activities were conducted following the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). The applicable field methods are summarized below and are discussed in Appendix B. Any deviations from the approved investigation work plan are noted in section 6 and are described in detail in Appendix B.

3.1 Site Access and Premobilization Activities

The area encompassing TA-57 is behind a locked fence and is currently used to operate a fully automated observatory in support of the Thinking Telescopes project overseen by the Laboratory’s Intelligence and Space Research Division. A portion of the area immediately adjacent to TA-57 is used by the U.S. Forest Service as a seasonal support area for firefighters. Before field mobilization, the issue of Laboratory worker access (e.g., health and safety documents, 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 any site operations, cultural resources, and the environment.

3.2 Field Activities

The following subsections describe the field activities conducted during the 2014 investigation, including geodetic surveys, field screening, surface and subsurface sampling, and soil removal. 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 TA-57 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 in accordance with the most current version of Standard Operating Procedure (SOP) 5028, Coordinating and Evaluating Geodetic Surveys, using a Trimble 5700 differential global positioning system. The surveyed coordinates for all sampling locations at sites included in this report 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 Field Screening

Environmental samples were analyzed for organic vapors with a MiniRAE 2000 photoionization detector equipped with an 11.7 electronvolt lamp before they were submitted to the Sample Management Office (SMO). Calibration was performed in accordance with the manufacturer's specifications and the most current version of SOP-06.33, Headspace Vapor Screening with a Photoionization Detector, and recorded on the corresponding sample collection logs (SCLs), chain-of-custody (COC) forms, and the field logbook. The SCLs and COC forms are provided on CD in Appendix E. The organic vapor screening results for the sites are presented Table 3.2-2.

All samples collected were field-screened for radioactivity before they were submitted to the SMO. A Laboratory radiological control technician 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. The SCLs and COC forms are provided on CD in Appendix E. The radiological screening results for the sites are presented in Table 3.2-2.

3.2.3 Surface and Subsurface Soil Investigation

Samples were collected according to the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). Table 3.2-3 lists the proposed sampling locations for the sites crosswalked with actual location identifiers. 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. The samples were collected in stainless-steel bowls and transferred to sample collection bottles with a stainless-steel spoon.

All surface and shallow subsurface samples were placed in appropriate sample containers and submitted to the laboratory for the analyses specified by the approved work plan. Samples for volatile organic compound (VOC) analysis were collected immediately to minimize the loss of subsurface VOCs during the sample collection process. Standard quality assurance (QA)/quality control (QC) samples (field duplicates, field trip blanks, and rinsate blanks) were also 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 of samples to a preapproved off-site analytical laboratory (SCLs and COC forms are included on CD in Appendix E).

3.2.4 Soil Removal

Analytical data collected from AOC 57-007 identified levels of arsenic above the residential SSL in surface samples (0.0–1.0 ft bgs) at locations 57-4011 and 57-4020. Specifically, arsenic was detected at concentrations of 13.8 mg/kg and 18.6 mg/kg at locations 57-4011 and 57-4020, respectively. The Laboratory conducted soil removal of the arsenic-contaminated soil using hand tools. A 2-ft radius was removed around locations 57-4011 and 57-4020 to a depth of 2.0 ft and 2.5 ft bgs, respectively. Confirmation samples were not necessary because samples collected at depth at both locations defined the extent of soil removal.

The remediated areas were backfilled to original grade using clean fill, reseeded using an approved native seed mix, and raked. Straw wattles were placed on the downslope side of each area to prevent run off.

3.2.5 Equipment Decontamination

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

3.2.6 Chemical and Radiological Sample Analyses

All investigation samples were shipped by the SMO to off-site contract analytical laboratories for the requested analyses. The analyses requested were as specified by the approved work plan (LANL 2012, 214550; NMED 2012, 520936). The samples were analyzed for the following; target analyte list (TAL) metals, total cyanide, nitrate, perchlorate, VOCs, semivolatile organic compounds (SVOCs), and isotopic uranium. Four samples were analyzed for arsenic only.

3.2.7 Health and Safety Measures

All 2014 investigation activities were conducted in accordance with an integrated work document that detailed work steps, potential hazards, hazard controls, and required training to conduct work. These health and safety measures included using Level-D personal protective equipment.

3.2.8 IDW Storage and Disposal

All IDW generated during the TA-57 Aggregate Area field investigations was managed in accordance with SOP-10021, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable EPA and NMED regulations, DOE orders, and Laboratory implementation requirements, policies, and/or procedures. IDW was also managed in accordance with the approved waste characterization strategy form (WCSF). Details of IDW management for the TA-57 Aggregate Area investigation are presented in Appendix C.

The waste streams associated with the investigation included arsenic-contaminated soil, contact waste, and solid waste. Each waste stream was containerized and placed in an accumulation area appropriate for the regulatory classification of the waste, in accordance with the approved WSCF.

3.3 Deviations

Deviations occurred while conducting field activities as defined in the approved work plan (LANL 2012, 214550; NMED 2012, 520936). The deviations did not adversely affect the completion or results of the investigation. Specific deviations are described in Appendix B, section B-9.0.

4.0 REGULATORY CRITERIA

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

Human health risk-screening evaluations were conducted for the TA-57 Aggregate Area using NMED guidance (NMED 2014, 600115). Ecological risk-screening assessments were performed using Laboratory guidance (LANL 2012, 226715).

4.1 Current and Future Land Use

The specific screening levels used in the risk evaluation and corrective action decision process at a site depend on the current and reasonably foreseeable future land use(s). The current and reasonably foreseeable future land use(s) for a site determines the receptors and exposure scenarios used to select screening and cleanup levels. The land use within and surrounding the TA-57 Aggregate Area is currently industrial and is expected to remain industrial for the reasonably foreseeable future. The residential scenario is evaluated for comparison purposes per the Consent Order and is the decision scenario for sites that do not require future controls.

4.2 Screening Levels

Human health and ecological risk-screening evaluations were conducted for the COPCs detected in solid media at the sites within the TA-57 Aggregate Area. The human health risk-screening assessments (Appendix G) were performed on inorganic and organic COPCs using NMED SSLs for the industrial and residential scenarios (NMED 2014, 600115). 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). Radionuclides were assessed using the Laboratory SALs for the same scenarios (LANL 2014, 600064).

Total chromium now has NMED SSLs (NMED 2014, 600115). Because the toxicity of chromium strongly depends on its oxidation state, NMED and EPA have SSLs for trivalent chromium and hexavalent chromium. For screening purposes, the NMED SSLs for total chromium are used for comparison unless there is a known or suspected source of hexavalent chromium at the site. Total chromium screening levels are appropriate for low-level releases to soil from sources not associated with hexavalent chromium. However, NMED and EPA recommends collecting valence-specific data for chromium when it is likely to be an important contaminant at a site and when hexavalent chromium may exist (NMED 2014, 600115; http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm). Otherwise, total chromium data are used.

Based on the site operational history and email correspondence with an individual who worked in the on-site chemistry trailer (former structure 57-23), no sources of hexavalent chromium are associated with AOCs 57-006 and 57-007 (Haagenstad 2015, 600266). The chemistry trailer was used until 1989 and was removed from the site in 1994. Two potential oxidizing agents were used at the site that could have potentially converted trivalent chromium to hexavalent chromium: nitric acid (<1% solution) was used to preserve water samples, and dilute potassium permanganate was also used occasionally in very small quantities. However, even if some of the chromium had been oxidized to the hexavalent form in the presence of these oxidants, site conditions for decades following the operational activity at the site strongly favor stability of chromium in the trivalent form. The soil pH is circumneutral, which tends to stabilize chromium as trivalent chromium and form insoluble chromium hydroxide. The redox conditions of the soil from the organic matter concentrated in the vegetation and plant litter enhance and maintain the stability of trivalent chromium and prevent oxidation to hexavalent chromium. Furthermore, iron and manganese are present at background concentrations, and the iron concentrations are greater than the manganese concentrations, which favors reducing conditions for chromium and the formation of trivalent chromium. Based on these lines of evidence, chromium is present in the environment in the stable trivalent form. Total chromium results for these AOCs are screened for potential risk using the NMED total chromium SSLs, and no additional sampling and analysis for hexavalent chromium are warranted. The sampling and analysis approach was presented in in the investigation work plan and approved by NMED (LANL 2012, 214550; NMED 2012, 520936).

4.3 Ecological Screening Levels

The ecological risk-screening assessments (Appendix G) were conducted using ecological screening levels (ESLs) obtained from the ECORISK Database, Version 3.2 (LANL 2014, 262559). 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 3.2 (LANL 2014, 262559).

4.4 Cleanup Standards

As specified in the Consent Order, SSLs for inorganic and organic chemicals (NMED 2014, 600115) are used as soil cleanup levels unless they are determined to be impracticable or values do not exist for the current and reasonably foreseeable future land uses. SALs are used as soil cleanup levels for radionuclides (LANL 2014, 600064). Screening assessments compare COPC concentrations for each site with industrial and residential SSLs and SALs.

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 25 mrem/yr as authorized by DOE Order 458.1. The SSLs/SALs used for the risk-screening assessments in Appendix G are based on these cleanup goals.

5.0 DATA REVIEW METHODOLOGY

The purpose of the data review is to define the nature and extent of contaminant releases for AOCs 57-006 and 57-007 in the TA-57 Aggregate Area. The nature of a contaminant release refers to the specific contaminants that are present, the affected media, and associated concentrations. The nature of contamination is defined through identification of COPCs, as discussed in section 5.1. The extent of contamination refers to the spatial distribution of COPCs, with an emphasis on the distribution of COPCs potentially posing a risk or requiring corrective action. The process for determining the extent of contamination and for concluding no further sampling for extent is warranted is discussed in section 5.2.

5.1 Identification of COPCs

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

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

5.1.1 Inorganic Chemical and Radionuclide Background Comparisons

The COPCs are identified for inorganic chemicals and radionuclides following EP-SOP-10071, Background Comparisons for Inorganic Chemicals, and EP-SOP-10073, Background Comparisons for Radionuclides. Inorganic COPCs are identified by comparing site data with BVs and maximum concentrations in a background data set and using statistical comparisons, as applicable (LANL 1998, 059730). Radionuclides are identified as COPCs based on background comparisons and statistical methods if BVs or FVs are available or based on detection status if BVs or FVs have not been established.

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

For inorganic chemicals, data are evaluated by sample media to facilitate the comparison with media-specific background data. To identify inorganic COPCs, the first step is to compare the sampling result with BVs. If sampling results are above the BV and sufficient data are available (eight or more sampling results and five or more detections), statistical tests are used to compare the site sampling data with the background data set for the appropriate media. If statistical tests cannot be performed because of insufficient data or a high percentage of nondetections, the sampling results are compared with the BV for the appropriate media. If at least one sampling result is above the BV, the inorganic chemical is identified as a COPC unless lines of evidence can be presented to establish the inorganic chemical is not a COPC. Such lines of evidence include, but are not limited to, comparison to the maximum background concentration, number of detects below or above the BV(s), number of nondetects in the data set, and site history. The same evaluation is performed using DLs when an inorganic chemical is not detected but has a DL above the BV. If no BV is available, detected inorganic chemicals are identified as COPCs.

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

Naturally occurring radionuclides detected at activities above their respective BVs are identified as COPCs. These radionuclides background have no data sets. If there is no associated BV or FV and the radionuclide is detected, it is retained as a COPC.

The FVs for the fallout radionuclides apply to the top 0.0–1.0 ft of soil and fill and to sediment regardless of depth. If a fallout radionuclide is detected in soil or fill samples collected below 1.0 ft or in tuff samples, the radionuclide is identified as a COPC. For soil and fill samples from 1.0 ft bgs or less, if the activity of a fallout radionuclide is greater than the FV, comparisons of the top 0.0–1.0-ft sampling data are made with the fallout data set and the radionuclide is eliminated as a COPC if activities are similar to fallout activities. Sediment results are evaluated in the same manner, although all data are included, not only the data from 0.0–1.0 ft bgs.

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

5.1.2 Statistical Methods Overview

A variety of statistical methods may be applied to each of the data sets. The use of any of these methods depends on how appropriate the method is for the available set.

5.1.2.1 Distributional Comparisons

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

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

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

However, the test cannot be performed if nondetections occur in the top chosen quantile. The threshold percentage can be adjusted to accommodate the detection rate of an analyte or to analyze differences further into the distribution tails. The quantile test is more powerful than the Gehan test for detecting differences when only a small percentage of the site concentrations are elevated.

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

For all statistical tests, a p-value greater than 0.05 was the criterion for accepting the null hypothesis that site sampling results are not different from background (Appendix F).

5.1.2.2 Graphical Presentation

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

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

5.2 Extent of Contamination

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

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

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

The primary focus for defining the extent of contamination is characterizing contamination that potentially poses a potential unacceptable risk and may require additional corrective actions. As such, comparison with SSLs/SALs is used as an additional step following a determination of whether extent is defined by decreasing concentrations with depth and distance and whether concentrations are below EQLs or DLs. The initial SSL/SAL comparison is conducted using the residential SSL/SAL (regardless of whether the current and reasonably foreseeable future land use is residential) because this value is typically the most protective. If the current and reasonably foreseeable future land use is not residential, the relevant SSL/SAL may also be compared if the residential SSL/SAL is exceeded or otherwise similar to COPC concentrations. For the AOCs in the TA-57 Aggregate Area, the current and reasonably foreseeable future land use is industrial (section 4.1).

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

Several inorganic chemicals (calcium, magnesium, potassium, and sodium) may be COPCs but do not have SSLs. These constituents are essential nutrients and their maximum concentrations are compared with NMED’s essential nutrient screening levels (NMED 2014, 600115). If the maximum concentration is less than the screening level, no additional sampling for extent is warranted.

6.0 TA-57 BACKGROUND AND FIELD-INVESTIGATION RESULTS

Two AOCs located in TA-57 are addressed in this investigation report (Table 1.1-1). Each site is described separately in sections 6.2 and 6.3, including the site description and operational history, relationship to other SWMUs and AOCs, previous investigations, site contamination results based on decision-level data from the current and previous investigations, and summaries of human health and ecological risk screening assessments.

6.1 Background of TA-57

6.1.1 Operational History

TA-57 was established at the Fenton Hill site in 1974 to support the Laboratory's Hot Dry Rock (HDR) program. HDR was an experimental geothermal energy program designed to test the feasibility of extracting heat from deep geologic units near the Valles Caldera. The first location selected for HDR was in Barley Canyon north of the current TA-57 site. After one test well had been drilled, this location was abandoned because of poor winter access and topographic limitations. Operations were moved to the current TA-57 location, which offered a large flat area with easier access. Operations at TA-57 began in 1974.

The HDR energy recovery concept was based on drilling two deep (i.e., 10,000–15,000 ft) wells into the low-permeability, hot-crystalline rock beneath TA-57. Hydraulic fracturing was then used to create a permeable fractured zone between the two wells. During operations, pressurized water was injected into one well and extracted from the other after it flowed through the fractured zone and became heated. Heat exchangers on the surface were used to extract heat from the water, which was then reinjected.

The first geothermal well drilled at TA-57 was well GT-2, which was started in 1974 and completed in 1975. Upon completion of hydraulic fracturing of well GT-2, drilling began on well EE-1, which was to be the extraction well used with GT-2. After completion of fracturing and additional drilling, testing of the two-well system began in 1978. Work on a larger Phase II system began in 1979 with the drilling of well EE-2, the injection well for the Phase II system. Well EE-2 was completed in 1980, and drilling began on extraction well EE-3, which was completed in 1981. Testing of the Phase II system began in 1985 and continued until 1992, when operations were reduced substantially because of funding limitations.

When the extraction wells were drilled, drilling muds were discharged to mud pits and settling ponds near the drill sites. Drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of geothermal energy are solid wastes that are specifically excluded from regulation as hazardous wastes under RCRA [40 Code of Federal Regulations 261.4(b)(5)]. These waste management sites were regulated by NMOCD and were closed in accordance with NMOCD requirements (NMOCD 2003, 101265).

After the HDR project ended, the 5-million-gal. pond originally constructed for the HDR program was converted to a gamma-ray observatory for a project known as Milagro. To construct the observatory, liquid was removed from the pond, the interior of the pond was cleaned, over 700 photomultiplier tubes were placed in the pond, and the pond was refilled with treated water and covered. This water was obtained from an on-site supply well and off-site sources and treated with ion-exchange, granular activated carbon, and ultraviolet light. The Milagro observatory began operating in 1996, and it was decommissioned in June 2008.

TA-57 is currently used to operate a fully automated observatory in support of the Thinking Telescopes project overseen by the Laboratory's Intelligence and Space Research Division. This project combines automated telescope observation, feature extraction from image data, change and anomaly detection, and automated response. An automated measurement program continuously scans the sky to detect optical transients.

6.1.2 Summary of Releases

Releases at the TA-57 Aggregate Area sites may have occurred as a result of normal site operations or spills/leaks. Potential contaminant sources include a waste storage drum (AOC 57-006) and a leach field (AOC 57-007).

6.1.3 Current Site Usage and Status

The fenced area at TA-57 is industrial. A portion of the area immediately adjacent to TA-57 is used by the U.S. Forest Service as a seasonal support area for firefighters.

6.2 AOC 57-006, Former Waste Storage Drum

6.2.1 Site Description and Operational History

AOC 57-006 is the former location of a plastic-lined 55-gal. drum that was buried in the ground at TA-57 beneath a trailer (structure 57-23) that served as an analytical chemistry laboratory (Figure 6.2-1). The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer was used to dispose of wastewater associated with chemical analyses. The sink drained to a leach field (AOC 57-007) near the trailer. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to the polyethylene drum. When the drum was full, its contents were transported to the Laboratory for disposal. In 1994, the drum was removed as part of a voluntary corrective action (VCA). The chemistry trailer was removed from the site in March 1994.

The site of the former waste drum is currently vegetated with grasses. The ground surface where the trailer was located is level and then slopes to the southeast toward a drainage swale.

6.2.2 Relationship to Other SWMUs and AOCs

AOC 57-006 is located southwest and upgradient of AOC 57-007.

6.2.3 Summary of Previous Investigations

A VCA was conducted in 1994 to remove the waste collection drum (LANL 1995, 054336). The contents of the drum had previously been removed in January 1994 (LANL 1995, 054336, p. 1). Sampling of the contents indicated elevated levels of lead and mercury as well as various organic solvents, and the waste was classified as hazardous (LANL 1995, 054336, p. 1). During the VCA, the 55-gal. drum was removed. No evidence of leakage was observed during the removal. After the drum was removed, a sample was collected from the bottom of the excavation at a depth of 0.0–0.5 ft below the bottom of the excavation and submitted for laboratory analysis of TAL metals, total cyanide, total uranium, and VOCs. Data from the 1994 VCA are screening-level data and are summarized below. Section 2.1.3 of the historical investigation report (HIR) (LANL 2012, 214549) presents a more detailed discussion of the screening-level results.

Lead and mercury were each detected above BVs in one sample. Organic chemicals were not detected.

6.2.4 Site Contamination

6.2.4.1 Soil, Rock and Sediment Sampling

Based on previous investigation results, further characterization using decision-level data was required to assess the potential contamination at AOC 57-006. As a result, the following activities were completed as part of the 2014 investigation:

- All investigation samples were field-screened for organic vapors and gross-alpha, -beta, and -gamma radiation. Field-screening results were recorded on the SCLs (Appendix E).

- Twelve samples were collected from four locations. Three samples were collected at the previously sampled location of the former waste storage drum (location 57-4022), and three samples each were collected at three step-out locations. At each location, samples were collected from 3.0–4.0 ft (approximately 0.0–1.0 ft below the bottom of the former drum location), 5.0−6.0 ft bgs, and 8.0–9.0 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.

The 2014 sampling locations at AOC 57-006 are shown in Figure 6.2-1. Table 6.2-1 presents the samples collected and analysis requested for AOC 57-006. The geodetic coordinates of sampling locations are presented in Table 3.2-1.

6.2.4.2 Soil, Rock, and Sediment Field-Screening Results

During headspace screening for organic vapors at AOC 57-006, no organic vapors were detected. No radiological screening results exceeded twice the daily background levels. Field-screening results are presented in Table 3.2-2. There were no changes to sampling or other activities because of field-screening results.

6.2.4.3 Soil, Rock, and Sediment Analytical Results

Decision-level data at AOC 57-006 consist of 12 samples (7 fill and 5 tuff) collected from 4 locations.

Inorganic Chemicals

Twelve samples (seven fill and five tuff) were analyzed for TAL metals, total cyanide, nitrate, and perchlorate. Table 6.2-2 presents the inorganic chemicals above BVs and detected inorganic chemicals with no BVs. Figure 6.2-2 shows the spatial distribution of inorganic chemicals detected or detected above BVs.

Antimony was not detected above the soil and Qbt 2,3,4 BVs (0.83 mg/kg and 0.5 mg/kg) but had DLs (0.946 mg/kg to 1.12 mg/kg) above BVs in all 12 samples. The DLs were also above the maximum soil or Qbt 2,3,4 background concentrations (1 mg/kg and 0.4 mg/kg) in 10 samples. Antimony is retained as a COPC.

Barium was detected above the Qbt 2,3,4 BV (46 mg/kg) in four samples with a maximum concentration of 136 mg/kg. Barium is retained as a COPC.

Cadmium was not detected above the soil and Qbt 2,3,4 BVs (0.4 mg/kg and 1.63 mg/kg) but had DLs (0.477 mg/kg to 0.56 mg/kg) above the soil BV in 7 samples. The DLs were only 0.077 mg/kg to 0.16 mg/kg above the soil BV and were approximately 2 mg/kg to 2.1 mg/kg below the maximum soil background concentration (2.6 mg/kg). Cadmium was not detected in the 7 soil samples and was not detected above BVs in the 12 samples (detected in 1 tuff sample below the Qbt 2,3,4 BV). The single detected concentration of cadmium (0.14 mg/kg) was well below both BVs and indicates that cadmium, when present, is background. Cadmium is not a COPC.

Chromium was detected above the soil and Qbt 2,3,4 BVs (19.3 mg/kg and 7.14 mg/kg) in one fill sample and three tuff samples with a maximum concentration of 113 mg/kg. Chromium is retained as a COPC.

Copper was detected above the Qbt 2,3,4 BV (4.66 mg/kg) in two samples with a maximum concentration of 26 mg/kg. Copper is retained as a COPC.

Lead was detected above the Qbt 2,3,4 BV (11.2 mg/kg) in four samples with a maximum concentration of 14.5 mg/kg. The concentrations were only 0.6 mg/kg to 3.3 mg/kg above the Qbt 2,3,4 BV and were approximately 1 mg/kg to 3.7 mg/kg below the maximum Qbt 2,3,4 background concentration (15.5 mg/kg). Lead was detected below the soil and Qbt 2,3,4 BVs in the other eight samples and at similar concentrations in soil and tuff samples with concentrations ranging from 9.05 mg/kg to 14.5 mg/kg (a difference of 5.45 mg/kg). Lead is not a COPC.

Manganese was detected above the Qbt 2,3,4 BV (482 mg/kg) in 1 sample at a concentration of 536 mg/kg. The concentration was 54 mg/kg above the Qbt 2,3,4 BV and approximately 216 mg/kg below the maximum Qbt 2,3,4 background concentration (752 mg/kg). Manganese was detected below the soil and Qbt 2,3,4 BVs in the other 11 samples and at similar concentrations in soil and tuff samples with concentrations ranging from 326 mg/kg to 552 mg/kg (the maximum concentration was detected in a fill sample below the soil BV). Manganese is not a COPC.

Nitrate was detected in 12 samples with a maximum concentration of 8.03 mg/kg. Nitrate is naturally occurring, and the concentrations reflect naturally occurring levels of nitrate. Nitrate is not a COPC.

Selenium was detected above the Qbt 2,3,4 BV (0.3 mg/kg) in two samples with a maximum concentration of 0.358 mg/kg and had DLs (0.944 mg/kg to 1.06 mg/kg) above the BV in three samples. Selenium is retained as a COPC.

Zinc was detected above the soil and Qbt 2,3,4 BVs (48.8 mg/kg and 63.5 mg/kg) in five fill samples and two tuff samples with a maximum concentration of 75.1 mg/kg. Zinc is retained as a COPC.

Organic Chemicals

Twelve samples (seven fill and five tuff) were analyzed for SVOCs and VOCs. Table 6.2-3 summarizes the analytical results for detected organic chemicals. Figure 6.2-3 shows the spatial distribution of detected organic chemicals.

The organic chemicals detected at AOC 57-006 include bis(2-ethylhexyl)phthalate, methylene chloride, and trichloroethene. All detected organic chemicals are retained as COPCs.

Radionuclides

Twelve samples (seven fill and five tuff) were analyzed for isotopic uranium. Table 6.2-4 summarizes radionuclides detected above BVs. Figure 6.2-4 shows the spatial distribution of detected radionuclides.

Uranium-235/236 was detected above the Qbt 2,3,4 BV (0.09 mg/kg) in 1 sample at an activity of 0.0956 pCi/g. The activity was only 0.0056 pCi/g above the BV, and uranium-235/236 was not detected or was detected below the soil or Qbt 2,3,4 BVs in the other 11 samples (detected in 4 samples below the BVs). The Qbt 2,3,4 BV for uranium-235/236 is calculated using the total uranium measured in rock and the isotopic abundance and activity of uranium-234, uranium-235/236, and uranium-238. As presented in Table 5.3-4 of the Laboratory's background report (LANL 1998, 059730), the maximum activity of total uranium in Qbt 2,3,4 is about 23% greater (7.123 pCi/g versus 5.79 pCi/g) than the BV based on 26 background samples. A calculated maximum uranium-235/236 activity for Qbt 2,3,4 background is 0.11 pCi/g. This activity is 0.014 pCi/g above the maximum site activity and indicates the uranium-235/236 activities are naturally occurring. The other uranium isotopes (uranium-234 and uranium-238) are not different from background, also indicating naturally occurring activities of uranium-235/236. Uranium-235/236 is not a COPC.

6.2.2.4 Nature and Extent of Contamination

The nature and extent of inorganic, organic, and radionuclide COPCs at AOC 57-006 are discussed below.

Inorganic Chemicals

Inorganic COPCs at AOC 57-006 are antimony, barium, chromium, copper, selenium, and zinc.

Antimony was not detected above the soil and Qbt 2,3,4 BVs but had DLs (0.946 mg/kg to 1.12 mg/kg) above BVs in all 12 samples. Because antimony was not detected in any sample and the residential SSL is approximately 28 times the maximum DL, further sampling for extent of antimony is not warranted.

Barium was detected above the Qbt 2,3,4 BV in four samples with a maximum concentration of 136 mg/kg. Concentrations decreased with depth at location 57-4023. The concentrations at locations 57-4022, 57-4024, and 57-4025 increased with depth, and concentrations increased laterally from location 57-4022. The residential and industrial SSLs were approximately 115 times and 1875 times the maximum concentration. Further sampling for extent of barium is not warranted.

Chromium was detected above the soil and Qbt 2,3,4 BVs in one fill sample and three tuff samples with a maximum concentration of 113 mg/kg. Concentrations decreased with depth at location 57-4024. The concentrations at locations 57-4022, 57-4023, and 57-4025 increased with depth and increased laterally from location 57-4022. As discussed in section 4.2, no source of hexavalent chromium was present at this site, and site conditions would not have produced hexavalent chromium. Therefore, the results were compared with trivalent chromium SSLs for extent purposes. The trivalent chromium residential and industrial SSLs were approximately 1035 times and 15,044 times the maximum concentration, respectively. Further sampling for extent of chromium is not warranted.

Copper was detected above the Qbt 2,3,4 BV in two samples with a maximum concentration of 26 mg/kg. Concentrations at location 57-4022 did not change substantially with depth (2.2 mg/kg) and increased with depth at location 57-4025. Concentrations increased laterally to the north from location 57-4022 to location 57-4025. The residential and industrial SSLs were approximately 120 times and 1996 times the maximum concentration, respectively. Further sampling for extent of copper is not warranted.

Selenium was detected above the Qbt 2,3,4 BV in two samples at concentrations of 0.347 mg/kg and 0.358 mg/kg and had DLs (0.944 mg/kg to 1.06 mg/kg) above the BV in three samples. The detected concentrations at locations 57-4022 and 57-4025 were in the deepest samples but only 0.047 mg/kg and 0.058 mg/kg above the BV. Selenium was not detected at locations 57-4023 and 57-4024. The residential SSL was approximately 1092 times the detected concentrations and approximately 368 times the maximum DL. Further sampling for extent of selenium is not warranted.

Zinc was detected above the soil and Qbt 2,3,4 BVs in five fill samples and two tuff samples with a maximum concentration of 75.1 mg/kg. Concentrations decreased with depth at locations 57-4024 and 57-4022. The concentrations at locations 57-4023 and 57-4025 increased slightly with depth (12.9 mg/kg and 24.7 mg/kg) and increased slightly laterally (12.3 mg/kg or less at depth) from location 57-4022. However, the concentrations were reported at similar ranges at each location across the site (44.5 mg/kg to 75.1 mg/kg) and were below the maximum soil background concentration (75.5 mg/kg) and below or slightly above (9.5 mg/kg or less) the maximum Qbt 2,3,4 background concentration (65.6 mg/kg). The residential and industrial SSLs were approximately 313 times and 5180 times the maximum concentration, respectively. Further sampling for extent of zinc is not warranted.

Organic Chemicals

Organic COPCs at 57-006 include bis(2-ethylhexyl)phthalate, methylene chloride, and trichloroethene.

Bis(2-ethylhexyl)phthalate was detected in one sample at a concentration of 0.269 mg/kg. The concentration was below the EQL and decreased laterally from location 57-4022. The residential SSL was approximately 1412 times the concentration. Further sampling for extent of bis(2-ethylhexyl)phthalate is not warranted.

Methylene chloride was detected in two samples with a maximum concentration of 0.0028 mg/kg. Concentrations decreased with depth and were below the EQLs. Concentrations decreased or did not change substantially laterally (0.00032 mg/kg). The residential SSL was approximately 146,071 times the maximum concentration. The vertical extent of methylene chloride is defined, and further sampling for lateral extent is not warranted.

Trichloroethene was detected in two samples with a maximum concentration of 0.000726 mg/kg. The concentrations did not change substantially with depth and were below the EQLs. Concentrations increased laterally from location 57-4022. The residential SSL was approximately 9325 times the maximum concentration. The vertical extent of trichloroethene is defined, and further sampling for lateral extent is not warranted.

Radionuclides

No radionuclide COPCs were identified at AOC 57-006.

6.2.5 Summary of Human Health Risk Screening

Industrial Scenario

Samples were not collected from the 0.0–1.0-ft depth interval; therefore, the industrial scenario was not evaluated for AOC 57-006.

Residential Scenario

The total excess cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5}. The HI for the residential scenario is 0.05, which is less than the NMED target HI of 1.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial and residential scenarios at AOC 57-006.

6.2.6 Summary of Ecological Risk Screening

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, and LOAEL analyses, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, and red fox exist at AOC 57-006.

6.3 AOC 57-007, Leach Field

6.3.1 Site Description and Operational History

AOC 57-007 is a leach field at TA-57 that served a former trailer (structure 57-23) that was used as an analytical chemistry laboratory (Figure 6.2-1). The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer drained to the leach field and was used to dispose of wastewater associated with chemical analyses. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to a polyethylene-lined 55-gal. drum (AOC 57-006). The chemistry trailer was removed from the site in March 1994.

The RCRA facility investigation (RFI) work plan for Operable Unit 1154 (LANL 1994, 034757) described the leach field's location as approximately 20 ft southeast of the trailer at 8.0–10.0 ft bgs. During the 1994 Phase I RFI at this site, the leach field was discovered to be northeast of the trailer and at a depth of 1.0–2.0 ft bgs. The site of the leach field is currently vegetated with grasses, shrubs, and small trees. The ground surface slopes to the southeast toward a drainage swale. An elevated electrical conduit rack runs across the site roughly parallel to the road.

6.3.2 Relationship to Other SWMUs and AOCs

AOC 57-007 is located northeast and downgradient of AOC 57-006.

6.3.3 Summary of Previous Investigations

During the 1994 Phase I RFI conducted at AOC 57-007, the drainline from the trailer to the leach field was found to be in place, uncovered, and used to locate the leach field (LANL 1996, 053801). One sample was collected where the drainline discharged to the leach field from a depth 0.0–1.0 ft below the bottom of the drainline. The sample was submitted for laboratory analysis of TAL metals, total cyanide, total uranium, and SVOCs. Data from the 1994 RFI are screening-level data and are summarized below. Section 2.2.3 of the HIR presents a more detailed discussion of the screening-level results (LANL 2012, 214549).

Mercury, uranium, and zinc were each detected above the soil BVs in the one sample. Organic chemicals were not detected.

6.3.4 Site Contamination

6.3.4.1 Soil, Rock, and Sediment Sampling

Based on previous investigation results, further characterization using decision-level data was required to assess the potential contamination at AOC 57-007. As a result, the following activities were completed as part of the 2014 investigation:

- All investigation samples were field-screened for organic vapors and gross-alpha, -beta, and -gamma radiation. Field screening results were recorded in the SCLs (Appendix E).

- Nine samples were collected where the drainline exited the former trailer (location 57-4011), beneath the midpoint of the drainline (location 57-4013), and near the previously sampled location where the drainline entered the leach field (location 57-4012) (see discussion of deviations in Appendix B). At each location, samples were collected from three depth intervals: the interval encompassing the former drainline; the interval 0.0–1.0 ft below the drainline/1 ft above tuff; and approximately 2.0–3.0 ft into tuff. These intervals deviate slightly from those proposed in investigation work plan because two of the intervals specified in the work plan were the same (see discussion of deviations in Appendix B). At location 57-4011, samples were collected from 0.0–1.0 ft, 1.0–2.0 ft, and 3.0–4.0 ft bgs. At location 57-4012, samples were collected from 0.0–1.0 ft, 1.25–2.25 ft, and 4.25–5.25 ft bgs. At location 57-4013, samples were collected from 0.0–1.0 ft, 1.0–2.0 ft, and 4.0–5.0 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Six samples were collected from two locations within the leach field. At location 57-4014 samples were collected from 1.0–2.0 ft, 2.0–3.0 ft, and 4.0–5.0 ft bgs. At location 57-4015 samples were collected from 1.5–2.5 ft, 2.5–3.5 ft, and 4.5–5.5 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Nine samples were collected from three step-out locations around the leach field. At location 57-4016, samples were collected from 2.5–3.5 ft, 3.0–4.0 ft, and 6.0–7.0 ft bgs. At location 57-4017, samples were collected from 1.0–2.0 ft, 2.5–3.5 ft, and 4.0–5.0 ft bgs. At location 57-4018, samples were collected from 2.5–3.5 ft, 4.4–5.4 ft, and 7.4–8.4 ft bgs. Samples were also collected from 0.0–1.0 ft bgs at each location (see deviations in Appendix B). All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Nine samples were collected from three locations in the drainage downgradient of the leach field to define lateral extent of contamination. At location 57-4019, samples were collected from 0.0–1.0 ft, 1.5–2.5 ft, and 4.5–5.5 ft bgs. At location 57-4020, samples were collected from 0.0–1.0 ft, 2.5–3.5 ft, and 5.5–6.5 ft bgs. At location 57-4021, samples were collected from 0.0–1.0 ft, 4.5–5.5 ft, and 6.5–7.5 ft bgs. All samples were analyzed at off-site fixed laboratories for TAL metals, total cyanide, nitrate, perchlorate, VOCs, SVOCs, and isotopic uranium.
- Soil removal occurred at locations 57-4011 and 57-4020 to remove elevated arsenic concentrations in the 0.0−1.0-ft depth interval. Excavations were to 2.0 ft bgs at location 57-4011 and to 2.5 ft bgs at location 57-4020 (three samples were eliminated from the data set because of this activity). No additional samples were collected because sampling data from the bottom of the excavations were available.
- Four samples were collected from 2 locations (57-4026 and 57-4027) southwest of location 57-4011. At location 57-4026, samples were collected from 3.5–4.5 ft and 6.5–7.5 ft bgs. At location 57-4027, samples were collected from 2.0–3.0 ft and 5.0–6.0 ft bgs. Samples were analyzed at an off-site fixed laboratory for arsenic only.

The 2014 sampling locations at AOC 57-007 are shown in Figure 6.2-1. Table 6.3-1 presents the samples collected and analysis requested for AOC 57-007. The geodetic coordinates of sampling locations are presented in Table 3.2-1.

6.3.4.2 Soil, Rock, and Sediment Field-Screening Results

During headspace screening for organic vapors at AOC 57-007, no organic vapors were detected. No radiological screening results exceeded twice the daily background levels. Field-screening results are presented in Table 3.2-2. There were no changes to sampling or other activities because of field-screening results.

6.3.4.3 Soil, Rock, and Sediment Analytical Results

Decision-level data at AOC 57-007 consist of 37 samples (21 soil/fill and 16 tuff) collected from 13 locations.

Inorganic Chemicals

Thirty-three samples (19 soil/fill and 14 tuff) were analyzed for TAL metals, total cyanide, nitrate, and perchlorate. Four samples (2 soil and 2 tuff) were analyzed for arsenic only. Table 6.3-2 presents the inorganic chemicals above BVs and detected inorganic chemicals with no BVs. Figure 6.3-1 shows the spatial distribution of inorganic chemicals detected or detected above BVs.

Aluminum was detected above the soil and Qbt 2,3,4 BVs (29,200 mg/kg and 7340 mg/kg) in one soil and one tuff sample with a maximum concentration of 29,600 mg/kg. The Gehan and quantile tests indicated site concentrations of aluminum in soil are not statistically different from background (Figure F-1 and Table F-1). The quantile and slippage tests indicated site concentrations of aluminum in tuff are not statistically different from background (Figure F-1 and Table F-2). Aluminum is not a COPC.

Antimony was not detected above the soil and Qbt 2,3,4 BVs (0.83 mg/kg and 0.5 mg/kg) but had DLs (0.875 mg/kg to 1.15 mg/kg) above BVs in 14 soil samples and 12 tuff samples (78% of samples). The DLs were also above the maximum soil and Qbt 2,3,4 background concentrations (1 mg/kg and 0.4 mg/kg, respectively). Antimony is retained as a COPC.

Arsenic was detected above the Qbt 2,3,4 BV (2.79 mg/kg) in one sample at a concentration of 5.12 mg/kg. The Gehan and quantile tests indicated site concentrations of arsenic in tuff are statistically different from background (Table F-2 and Figure F-2). Arsenic is retained as a COPC.

Barium was detected above the soil and Qbt 2,3,4 BVs (295 mg/kg and 46 mg/kg) in one soil sample and eight tuff samples with a maximum concentration of 384 mg/kg. The Gehan and quantile tests indicated the site concentrations of barium in soil are not statistically different from background (Figure F-3 and Table F-1). The Gehan and quantile tests indicated site concentrations of barium in tuff are statistically different from background (Figure F-3 and Table F-2). Barium is retained as a COPC.

Beryllium was detected above the soil BV (1.83 mg/kg) in one soil sample at a concentration of 2.29 mg/kg. The Gehan and quantile tests indicated the site concentrations of beryllium in soil are not statistically different from background (Figure F-4 and Table F-1). Beryllium is not a COPC.

Cadmium was detected above the soil BV (0.4 mg/kg) in 1 sample at a concentration of 0.574 mg/kg and had DLs (0.479 mg/kg to 0.575 mg/mg) above the soil BV in 17 samples (the DLs for all samples, whether soil or tuff, were similar, ranging from 0.438 mg/kg to 0.575 mg/kg). The detected concentration above BV was only 0.174 mg/kg and the DLs were only 0.079 mg/kg to 0.175 mg/kg above the soil BV. The detected concentration and DLs were approximately 2 mg/kg to 2.1 mg/kg below the maximum soil background concentration (2.6 mg/kg). Cadmium was not detected in 27 samples, was detected below the soil BV in 1 sample, and was detected below the Qbt 2,3,4 BV (1.63 mg/kg) in 4 samples (concentrations were also below the soil BV). The detected concentrations of cadmium are well below both BVs and indicate that cadmium, when present, is background. Cadmium is not a COPC.

Chromium was detected above the Qbt 2,3,4 BV (7.14 mg/kg) in eight samples with a maximum concentration of 68.3 mg/kg. The Gehan and quantile tests indicated the site concentrations of chromium in tuff are statistically different from background (Table F-2 and Figure F-5). Chromium is retained as a COPC.

Copper was detected above the soil and Qbt 2,3,4 BVs (14.7 mg/kg and 4.66 mg/kg) in one soil sample and two tuff samples with a maximum concentration of 65.1 mg/kg. The Gehan and slippage tests indicated site concentrations of copper in soil are not statistically different from background (Figure F-6 and Table F-1).The Gehan and quantile tests indicated the site concentrations of copper in tuff are statistically different from background (Figures F-6 and Table F-2). Copper is retained as a COPC.

Cyanide was detected above the soil BV (0.5 mg/kg) in one soil sample at a concentration of 0.73 mg/kg. Cyanide is retained as a COPC.

Lead was detected above the soil and Qbt 2,3,4 BVs (22.3 mg/kg and 11.2 mg/kg) in one soil sample and seven tuff samples with a maximum concentration of 33.6 mg/kg. The Gehan and quantile tests indicated site concentrations of lead in soil are not statistically different from background (Figure F-7 and Table F-1). The Gehan and quantile tests indicated the site concentrations of lead in tuff are statistically different from background (Figure F-7 and Table F-2). Lead is retained as a COPC.

Mercury was detected above the soil and Qbt 2,3,4 BV (0.1 mg/kg) in two soil samples and two tuff samples with a maximum concentration of 20.6 mg/kg. Mercury is retained as a COPC.

Nitrate was detected in four soil samples and two tuff samples with a maximum concentration of 1.16 mg/kg. Nitrate is naturally occurring and the concentrations reflect naturally occurring levels of nitrate. Nitrate is not a COPC.

Perchlorate was detected in six soil samples and two tuff samples with a maximum concentration of 0.00159 mg/kg. Perchlorate is retained as a COPC.

Selenium was not detected above the Qbt 2,3,4 BV (0.3 mg/kg) but had DLs (0.917 mg/kg to 1.08 mg/kg) above the BV in 14 samples. Selenium is retained as a COPC.

Silver was detected above the soil BV (1 mg/kg) in two soil samples with a maximum concentration of 15.2 mg/kg. Silver is retained as a COPC.

Zinc was detected above the soil and Qbt 2,3,4 BVs (48.8 mg/kg and 63.5 mg/kg) in five soil samples and six tuff samples with a maximum concentration of 113 mg/kg. The Gehan and quantile tests indicated site concentrations of zinc in soil are statistically different from background (Figure F-8 and Table F-1). The Gehan and quantile tests indicated site concentrations of zinc in tuff are statistically different from background (Figure F-8 and Table F-2). Zinc is retained as a COPC.

Organic Chemicals

Thirty-three samples (19 soil/fill and 14 tuff) were analyzed for SVOCs and VOCs. Table 6.3-3 summarizes the analytical results for detected organic chemicals. Figure 6.3-2 shows the spatial distribution of detected organic chemicals.

The organic chemicals detected at AOC 57-007 include benzoic acid; bis(2-ethylhexyl)phthalate; butylbenzylphthalate; 1,4-dichlorobenzene; fluoranthene; methylene chloride; phenanthrene; and trichloroethene. All detected organic chemicals are retained as COPCs.

Radionuclides

Thirty-three samples (19 soil/fill and 14 tuff) were analyzed for isotopic uranium. Table 6.3-4 summarizes radionuclides detected or detected above BVs/FVs. Figure 6.3-3 shows the spatial distribution of detected radionuclides.

Uranium-235/236 was detected above the Qbt 2,3,4 BV (0.09 pCi/g) in 4 samples with a maximum activity of 0.115 pCi/g. The differences in activities between the site activities and the BV are 0.0056 pCi/g to 0.025 pCi/g, and the frequency of detected activities above BVs is only 4 of 33 samples. The Qbt 2,3,4 BV for uranium-235/236 is calculated using the total uranium measured in rock and the isotopic abundance and activity of uranium-234, uranium-235/236, and uranium-238. As presented in Table 5.3-4 of the Laboratory's background report (LANL 1998, 059730), the maximum activity of total uranium in Qbt 2,3,4 is about 23% greater than the BV (7.123 pCi/g versus 5.79 pCi/g) based on 26 background samples. A calculated maximum uranium-235/236 activity for Qbt 2,3,4 background is 0.11 pCi/g. This activity is similar to the maximum site activity and indicates the uranium-235/236 activities are naturally occurring. The other uranium isotopes (uranium-234 and uranium-238) are not different from background, also indicating naturally occurring activities of uranium-235/236. Uranium-235/236 is not a COPC.

6.3.4.4 Nature and Extent of Contamination

The nature and extent of inorganic, organic, and radionuclide COPCs at AOC 57-007 are discussed below.

Inorganic Chemicals

Inorganic COPCs at AOC 57-007 are antimony, arsenic, barium, chromium, copper, cyanide, lead, mercury, perchlorate, selenium, silver, and zinc.

Antimony was not detected above the soil and Qbt 2,3,4 BVs but had DLs (0.875 mg/kg to 1.15 mg/kg) above BVs in 14 soil samples and 12 tuff samples. The residential SSL was approximately 27 times the maximum DL. Further sampling for extent of antimony is not warranted.

Arsenic was detected above the Qbt 2,3,4 BV in one sample at a concentration of 5.12 mg/kg. The concentration at location 57-4026 increased slightly with depth (approximately 3.3 mg/kg), but the concentration at depth (5.12 mg/kg) is similar to the maximum Qbt 2,3,4 background concentration (5 mg/kg). The industrial SSL was approximately 4.2 times the detected concentration. Further sampling for extent of arsenic is not warranted.

Barium was detected above the soil and Qbt 2,3,4 in one soil sample and eight tuff samples with a maximum concentration of 384 mg/kg. Concentrations decreased with depth at all locations and decreased downgradient. The lateral and vertical extent of barium are defined.

Chromium was detected above the Qbt 2,3,4 BV in eight samples with a maximum concentration of 68.3 mg/kg. Chromium concentrations decreased downgradient. Chromium concentrations decreased with depth at locations 57-4014 and 57-4015. Concentrations increased with depth at locations 57-4012, 57-4013, 57-4016, 57-4017, and 57-4018. As discussed in section 4.2, no source of hexavalent chromium is present at this site, and site conditions would not have produced hexavalent chromium. Therefore, the results were compared with trivalent chromium SSLs for extent purposes. The trivalent chromium residential SSL was approximately 1713 times the maximum concentration. The lateral extent of chromium is defined, and further sampling for vertical extent is not warranted.

Copper was detected above the soil and Qbt 2,3,4 BVs in one soil sample and two tuff samples with a maximum concentration of 65.1 mg/kg. Concentrations decreased with depth at locations 57-4014, and 57-4015 and decreased downgradient. The lateral and vertical extent of copper are defined.

Cyanide was detected above the soil BV in one sample at a concentration of 0.73 mg/kg. Concentrations decreased with depth and decreased downgradient. The lateral and vertical extent of cyanide are defined.

Lead was detected above the soil and Qbt 2,3,4 BVs in one soil sample and seven tuff samples with a maximum concentration of 33.6 mg/kg. Lead concentrations decreased with depth at locations 57-4011 and 57-4020 (Appendix E, Excavated Samples Table) as well as at location 57-4015 and did not change substantially with depth (0.1 mg/kg to 3.6 mg/kg) at locations 57-4014, 57-4017, 57-4019, and 57-4021. The concentrations at depth at these four locations were less than or equivalent to the maximum Qbt 2,3,4 background concentration (15.5 mg/kg) and the residential and industrial SSLs were approximately 26 times and 52 times the maximum concentration at these locations. Concentrations decreased downgradient. The lateral extent of lead is defined, and further sampling for vertical extent is not warranted.

Mercury was detected above the soil and Qbt 2,3,4 BVs in two soil samples and two tuff samples with a maximum concentration of 20.6 mg/kg. Concentrations decreased with depth at locations 57-4014 and 57-4015 and decreased downgradient. The lateral and vertical extent of mercury are defined.

Perchlorate was detected in six soil samples and two tuff samples with a maximum concentration of 0.00159 mg/kg. Concentrations were below the estimated DLs and decreased with depth at locations 57-4011 (Appendix E, Excavated Samples Table), 57-4012, 57-4013, 57-4015, 57-4018, and 57-4020 and did not change substantially with depth (0.000954 mg/kg) at location 57-4016. Concentrations decreased downgradient. The lateral and vertical extent of perchlorate are defined.

Selenium was not detected above the Qbt 2,3,4 BV but had DLs (0.917 mg/kg to 1.08 mg/kg) above the BV in 14 samples. Because selenium was not detected in any samples and the residential SSL was approximately 362 times the maximum DL, further sampling for extent of selenium is not warranted.

Silver was detected above the soil BV in two samples with a maximum concentration of 15.2 mg/kg. Concentrations decreased with depth and decreased downgradient. The lateral and vertical extent of silver are defined.

Zinc was detected above the soil and Qbt 2,3,4 BVs in five soil samples and six tuff samples with a maximum concentration of 113 mg/kg. Concentrations decreased with depth at locations 57-4012, 57-4015, 57-4018, and 57-4021 and decreased downgradient. Concentrations increased slightly with depth (approximately 14 mg/kg to 24 mg/kg) at locations 57-4013, 57-4014, and 57-4017 with the deepest concentrations at locations 57-4013 and 57-4017 below or equivalent to the maximum Qbt 2,3,4 background concentration (65.6 mg/kg). The residential SSL was approximately 320 times the maximum concentration at these three locations. The lateral extent of zinc is defined, and further sampling for vertical extent is not warranted.

Organic Chemicals

Organic COPCs at AOC 57-007 include benzoic acid; bis(2-ethylhexyl)phthalate; butylbenzylphthalate; 1,4-dichlorobenzene; fluoranthene; methylene chloride; phenanthrene; and trichloroethene.

Benzoic acid was detected in three samples with a maximum concentration of 2.83 mg/kg. Concentrations decreased with depth and decreased downgradient. The lateral and vertical extent of benzoic acid are defined.

Bis(2-ethylhexyl)phthalate and butylbenzylphthalate were detected in one sample at concentrations of 0.13 mg/kg and 0.339 mg/kg, respectively. Concentrations were below the EQLs, decreased with depth, and decreased downgradient. The lateral and vertical extent of bis(2-ethylhexyl)phthalate and butylbenzylphthalate are defined.

Dichlorobenzene[1,4-] and methylene chloride were detected in three and two samples, respectively, with maximum concentrations of 0.00043 mg/kg and 0.00299 mg/kg. Concentrations were below the EQLs, decreased with depth, and decreased downgradient. The lateral and vertical extent of 1,4-dichlorobenzene and methylene chloride are defined.

Fluoranthene and phenanthrene were detected in one or two samples with maximum concentrations of 0.0145 mg/kg and 0.0134 mg/kg, respectively. Concentrations were below the EQLs, decreased with depth at all locations, and decreased downgradient. The lateral and vertical extent of fluoranthene and phenanthrene are defined.

Trichloroethene was detected in two samples with a maximum concentration of 0.00294 mg/kg. Concentrations decreased with depth or did not change substantially downgradient (0.00186 mg/kg). The residential SSL was approximately 2303 times the maximum concentration. The vertical extent of trichloroethene is defined, and further sampling for lateral extent is not warranted.

Radionuclides

No radionuclide COPCs were identified at AOC 57-007.

6.3.5 Summary of Human Health Risk Screening

Industrial Scenario

Carcinogenic COPCs were not identified in the 0.0–1.0-ft depth interval. The HI for the industrial scenario is 0.001, which is less than the NMED target HI of 1.

Residential Scenario

The total excess cancer risk for the residential scenario is 7×10^{-6}, which is less than the NMED target risk level of 1×10^{-5}. The HI for the residential scenario is 0.3, which is less than the NMED target HI of 1.

Based on the risk-screening assessment results, no potential unacceptable risks or doses exist for the industrial and residential scenarios at AOC 57-007.

6.3.6 Summary of Ecological Risk Screening

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, LOAEL analyses, and chemicals of potential ecological concern (COPECs) without ESLs, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, and red fox exist at AOC 57-007.

7.0 CONCLUSIONS

7.1 Nature and Extent of Contamination

Based on the evaluation of the data, the nature and extent of contamination have been defined and/or no further sampling for extent is warranted for the sites investigated.

7.1.1 TA-57 Aggregate Area

The nature and extent of contamination have been defined, and/or no further sampling for extent is warranted for the following sites in TA-57:

- AOC 57-006, Former Waste Storage Drum
- AOC 57-007, Leach Field

7.2 Summary of Risk-Screening Assessments

AOCs 57-006 and 57-007 were evaluated for potential risk by human health and ecological risk-screening assessments.

7.2.1 Human Health Risk-Screening Assessments

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

The industrial scenario was not evaluated AOC 57-006 because samples were not collected from the 0.0–1.0-ft depth interval. The human health risk-screening assessments found no unacceptable risks under the industrial scenario at AOC 57-007 and found no unacceptable risks under the residential scenario at both AOCs. The total excess cancer risks were less than the NMED target risk level of 1×10^{-5} and the HIs were less than the NMED target HI of 1.

7.2.2 Ecological Risk-Screening Assessment

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

Ecological risks were evaluated for both sites based on comparisons to minimum ESLs, HI analyses, potential effects to populations, and LOAEL analyses. These lines of evidence and the analysis of COPECs with no ESLs support the conclusion that no potential ecological risk exists at these sites.

8.0 RECOMMENDATIONS

The determination of site status is based on the results of the risk-screening assessments and the nature and extent evaluation. Depending upon the decision scenario used, the sites are recommended as corrective actions complete either with or without controls or for additional action. The residential scenario is the only scenario under which corrective action complete without controls is applicable; that is, no additional corrective actions or conditions are necessary. The other decision scenarios (industrial, construction worker, and recreational) result in corrective action complete with controls; that is, some type of institutional controls must be in place to ensure land use remains consistent with site cleanup levels. The current and reasonably foreseeable future land use for the TA-57 Aggregate Area is industrial.

8.1 Additional Field Characterization Activities

Additional sampling to define the nature and extent of contamination is not warranted for AOCs 57-006 and 57-007.

8.2 Recommendations for Corrective Actions Complete

AOCs 57-006 and 57-007 do not pose a potential unacceptable risk or dose under the industrial and residential scenarios and have no potential ecological risks to any receptor, and the nature and extent of contamination are defined and/or no further sampling for extent is warranted. At these sites, the Laboratory recommends no further investigation or remediation activities, and both sites are appropriate for corrective actions complete without controls.

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 or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the ESH 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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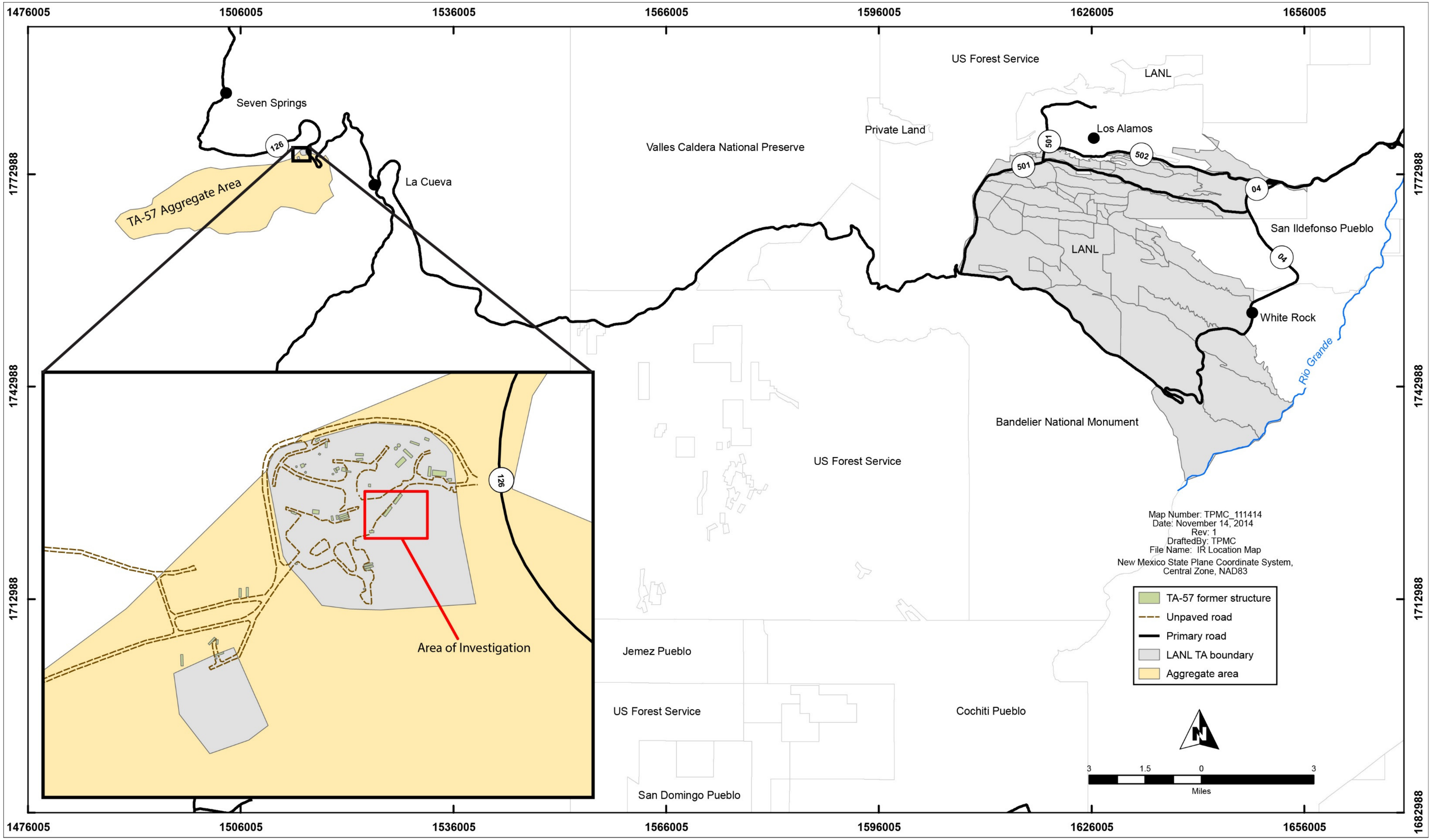
9.2 Map Data Sources

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

Legend Item	Data Source
LANL Technical Areas	Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 04 December 2008.
Paved roads	Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Dirt roads	Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Drainages	WQH Drainage Arcs; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; 1:24,000 Scale Data; 03 June 2003.
LANL AOC boundaries	Areas of Concern; Los Alamos National Laboratory, Waste and Environmental Services Division, Environmental Data and Analysis Group, EP2009-0137; 1:2,500 Scale Data; 25 January 2010.
LANL structures	Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL fence lines	Security and Industrial Fences and Gates; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL communications lines	Communication Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 08 August 2002; as published 28 May 2009.
LANL electric lines	Primary Electric Grid; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL gas lines	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.
LANL sewer lines	Sewer Line System; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
LANL water lines	Water Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.
Contours	Hypsography, 2, 10, 20, and 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.



Map Number: TPMC_111414
Date: November 14, 2014
Rev: 1
DraftedBy: TPMC
File Name: IR Location Map
New Mexico State Plane Coordinate System,
Central Zone, NAD83

Figure 1.1-1 Location of TA-57 Aggregate Area with respect to the Laboratory and surrounding area

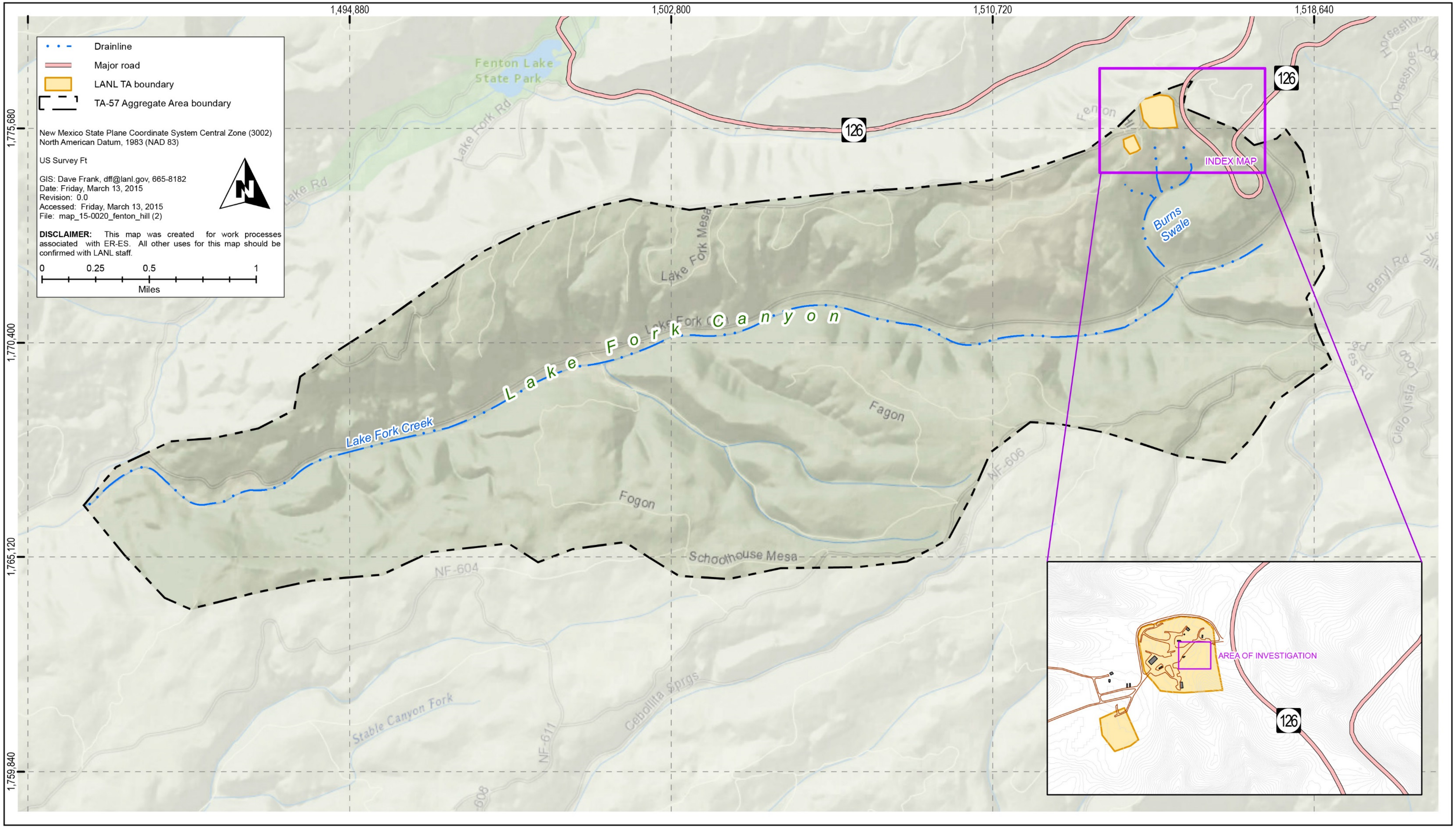
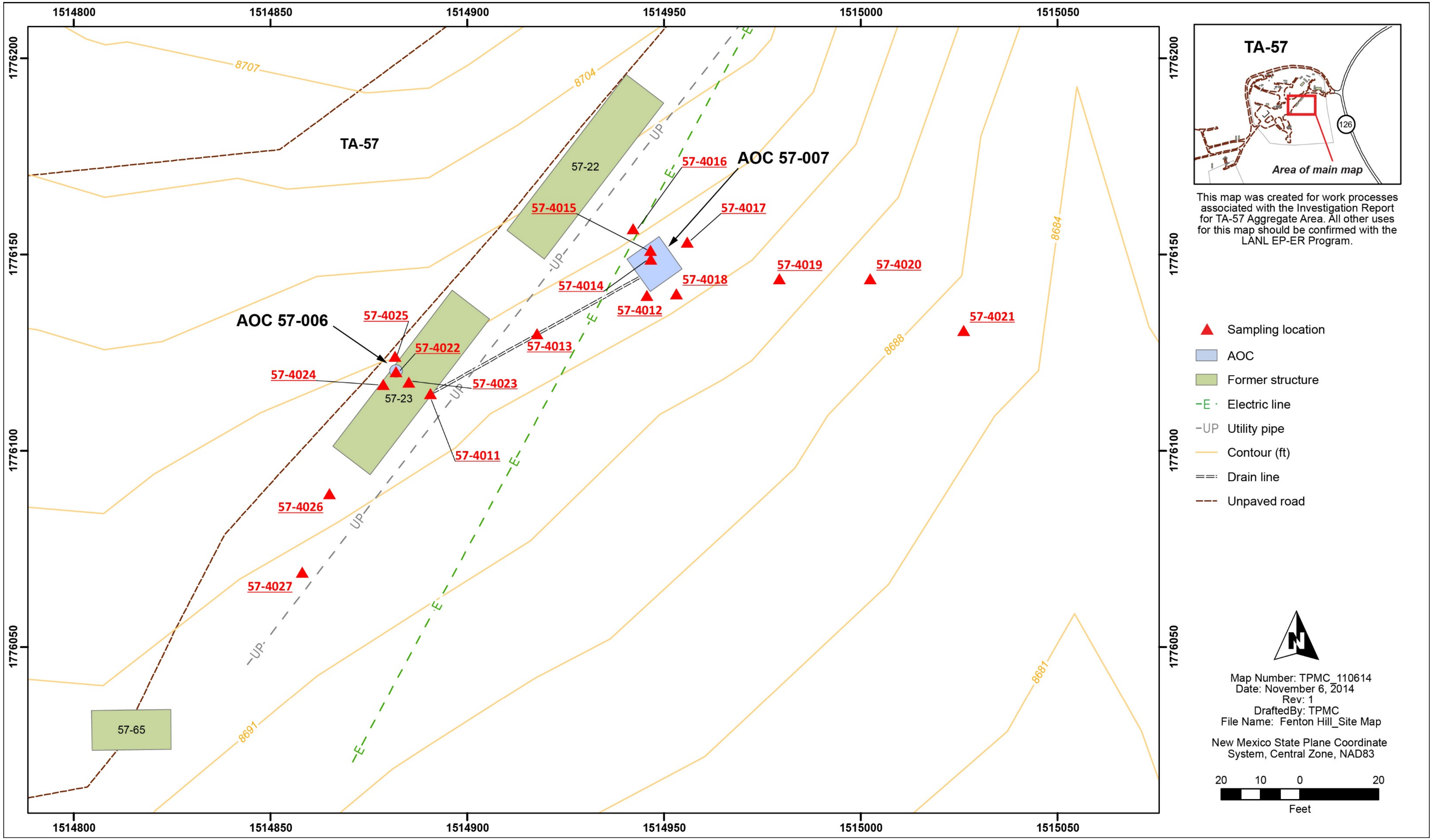


Figure 2.1-1 Geologic and surface water features in the vicinity of the TA-57 Aggregate Area

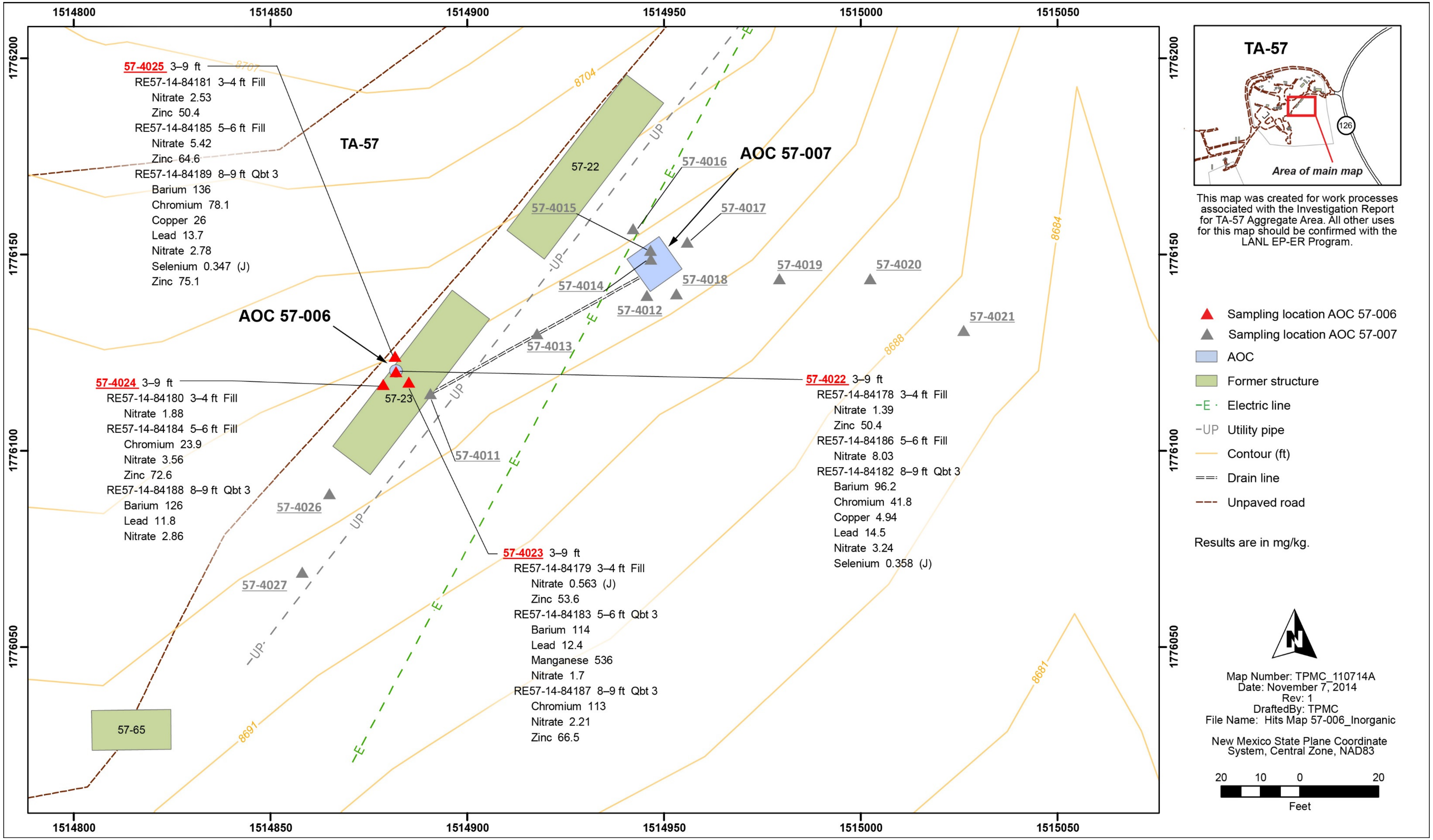


This map was created for work processes associated with the Investigation Report for TA-57 Aggregate Area. All other uses for this map should be confirmed with the LANL EP-ER Program.

Map Number: TPMC_110614
Date: November 6, 2014
Rev: 1
DraftedBy: TPMC
File Name: Fenton Hill_Site Map

New Mexico State Plane Coordinate System, Central Zone, NAD83

Figure 6.2-1 Site map of AOCs 57-006 and 57-007 with sample locations



57-4025 3–9 ft
RE57-14-84181 3–4 ft Fill
Nitrate 2.53
Zinc 50.4
RE57-14-84185 5–6 ft Fill
Nitrate 5.42
Zinc 64.6
RE57-14-84189 8–9 ft Qbt 3
Barium 136
Chromium 78.1
Copper 26
Lead 13.7
Nitrate 2.78
Selenium 0.347 (J)
Zinc 75.1

57-4024 3–9 ft
RE57-14-84180 3–4 ft Fill
Nitrate 1.88
RE57-14-84184 5–6 ft Fill
Chromium 23.9
Nitrate 3.56
Zinc 72.6
RE57-14-84188 8–9 ft Qbt 3
Barium 126
Lead 11.8
Nitrate 2.86

57-4022 3–9 ft
RE57-14-84178 3–4 ft Fill
Nitrate 1.39
Zinc 50.4
RE57-14-84186 5–6 ft Fill
Nitrate 8.03
RE57-14-84182 8–9 ft Qbt 3
Barium 96.2
Chromium 41.8
Copper 4.94
Lead 14.5
Nitrate 3.24
Selenium 0.358 (J)

57-4023 3–9 ft
RE57-14-84179 3–4 ft Fill
Nitrate 0.563 (J)
Zinc 53.6
RE57-14-84183 5–6 ft Qbt 3
Barium 114
Lead 12.4
Manganese 536
Nitrate 1.7
RE57-14-84187 8–9 ft Qbt 3
Chromium 113
Nitrate 2.21
Zinc 66.5

This map was created for work processes associated with the Investigation Report for TA-57 Aggregate Area. All other uses for this map should be confirmed with the LANL EP-ER Program.

Results are in mg/kg.

Map Number: TPMC_110714A
Date: November 7, 2014
Rev: 1
DraftedBy: TPMC
File Name: Hits Map 57-006_Inorganic

New Mexico State Plane Coordinate System, Central Zone, NAD83

Figure 6.2-2 Inorganic chemicals detected or detected above BVs at AOC 57-006

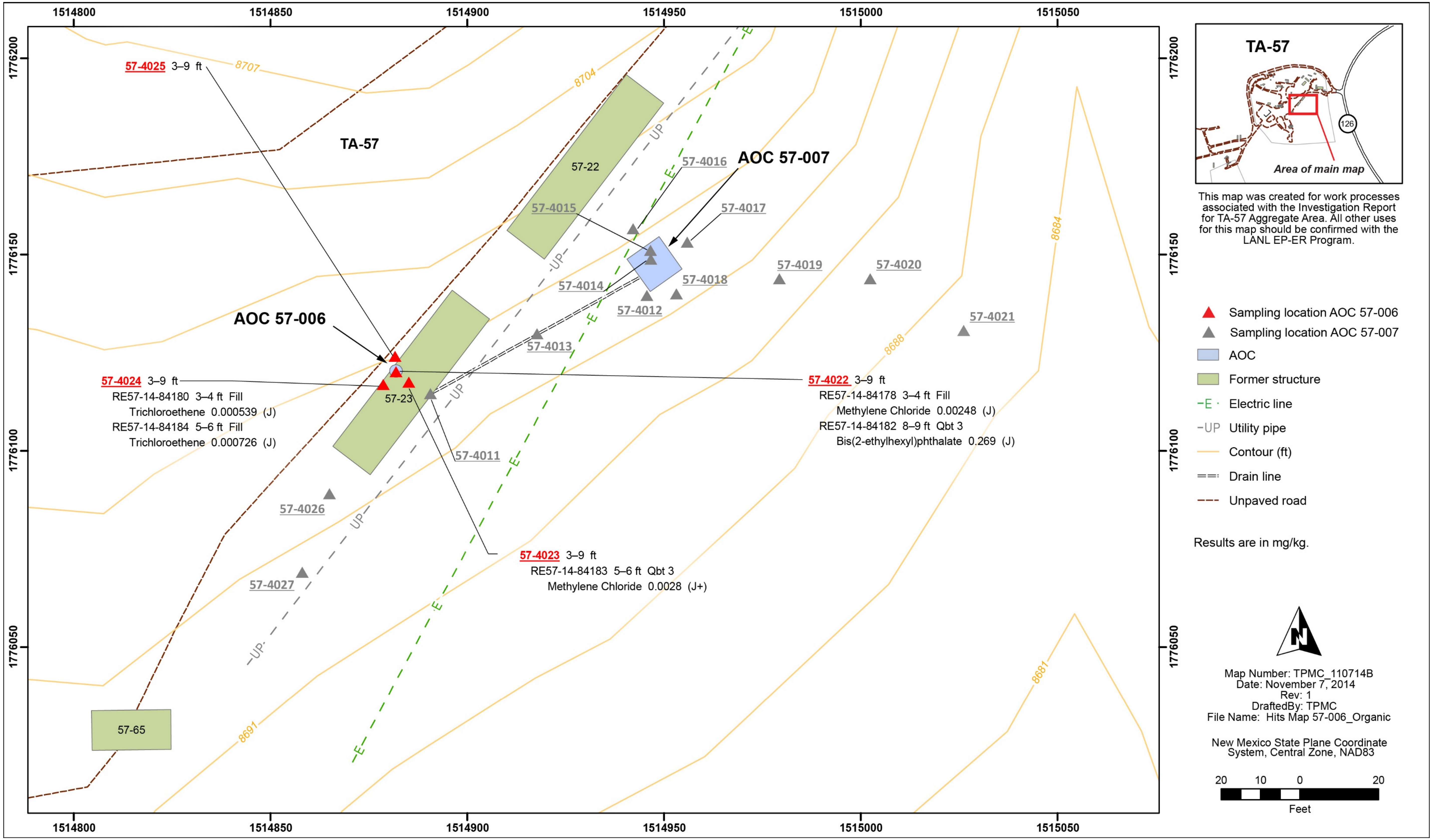


Figure 6.2-3 Organic chemicals detected at AOC 57-006

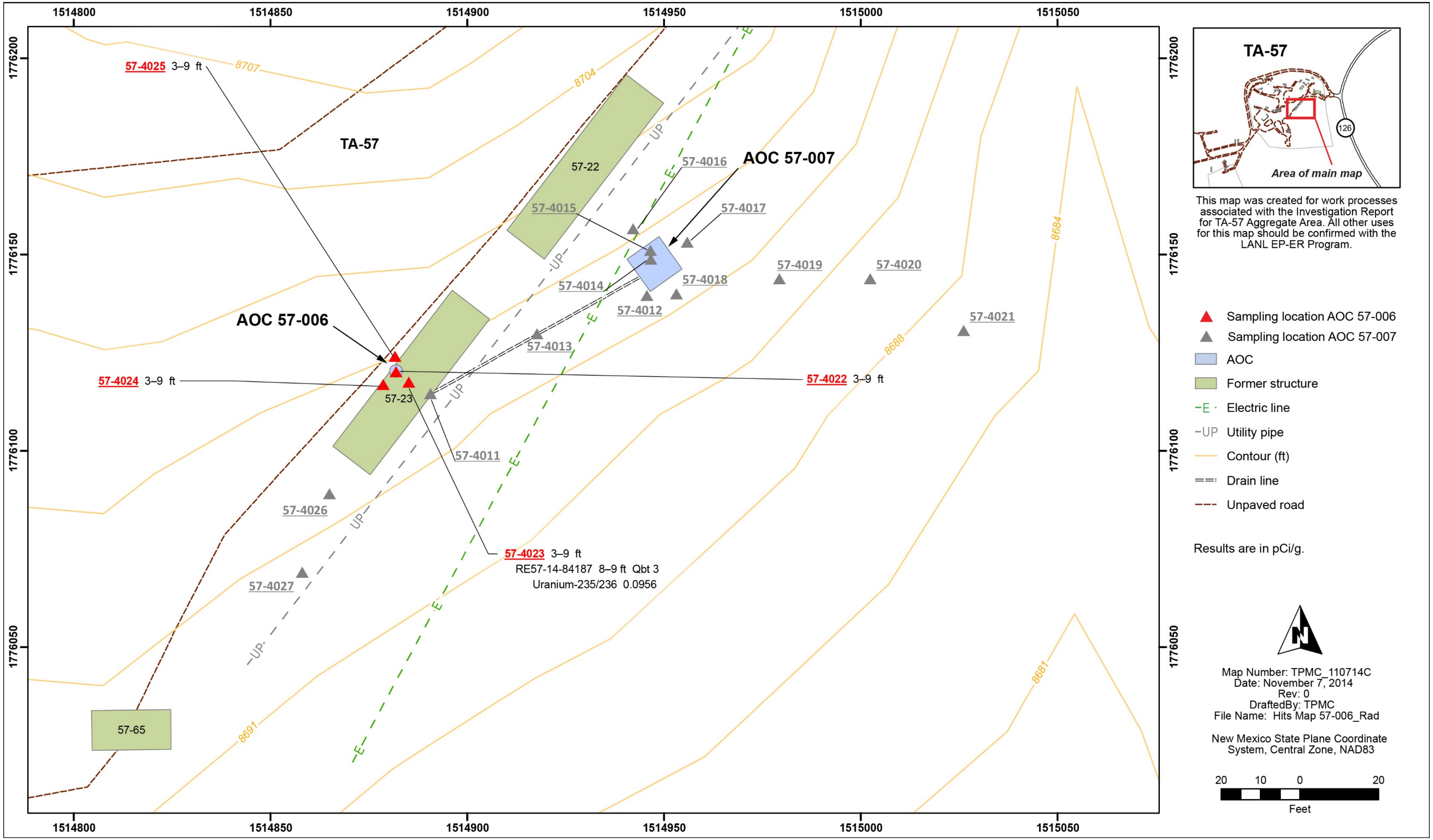


Figure 6.2-4 Radionuclides detected above BVs at AOC 57-006

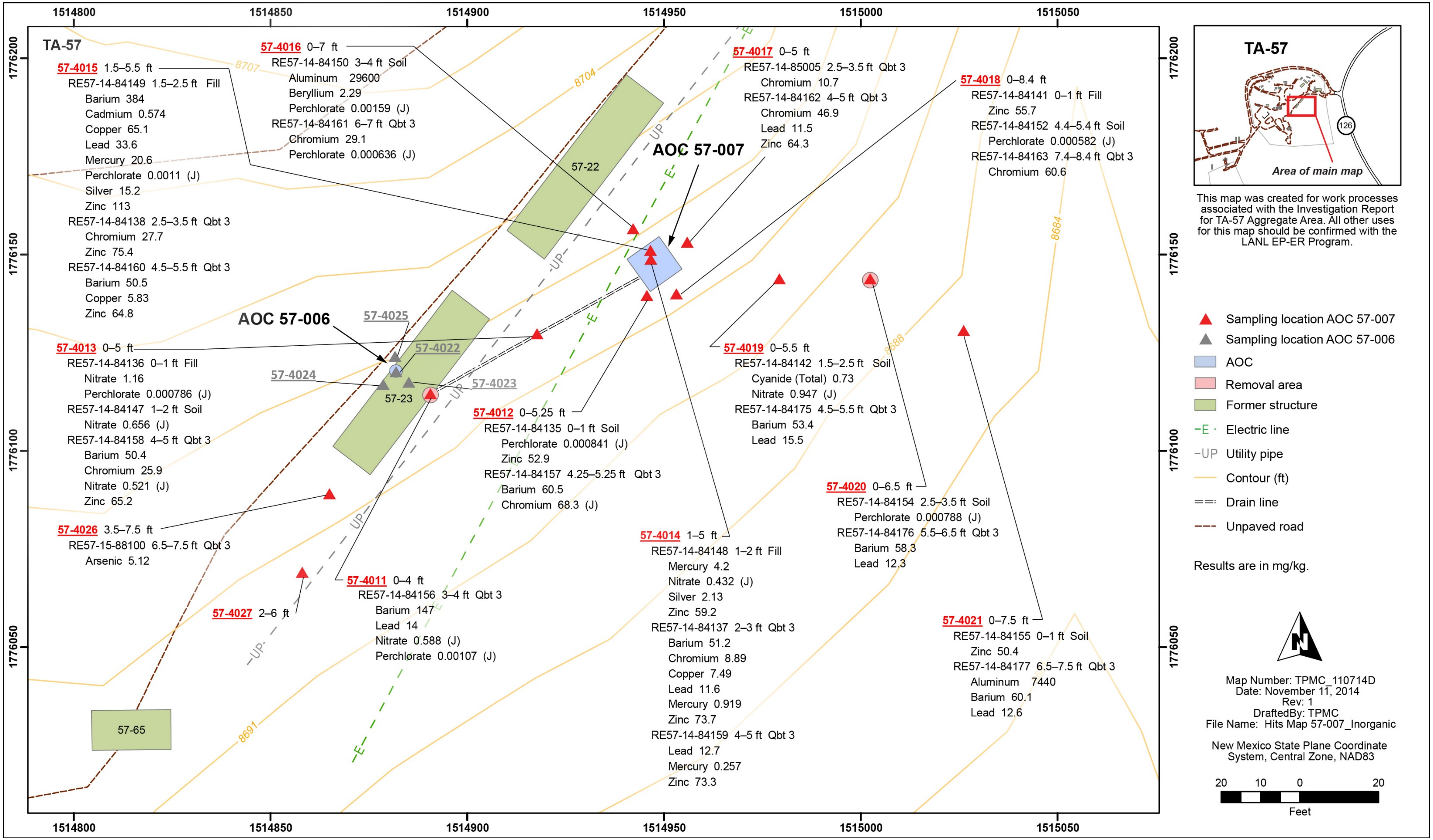


Figure 6.3-1 Inorganic chemicals detected or detected above BVs at AOC 57-007

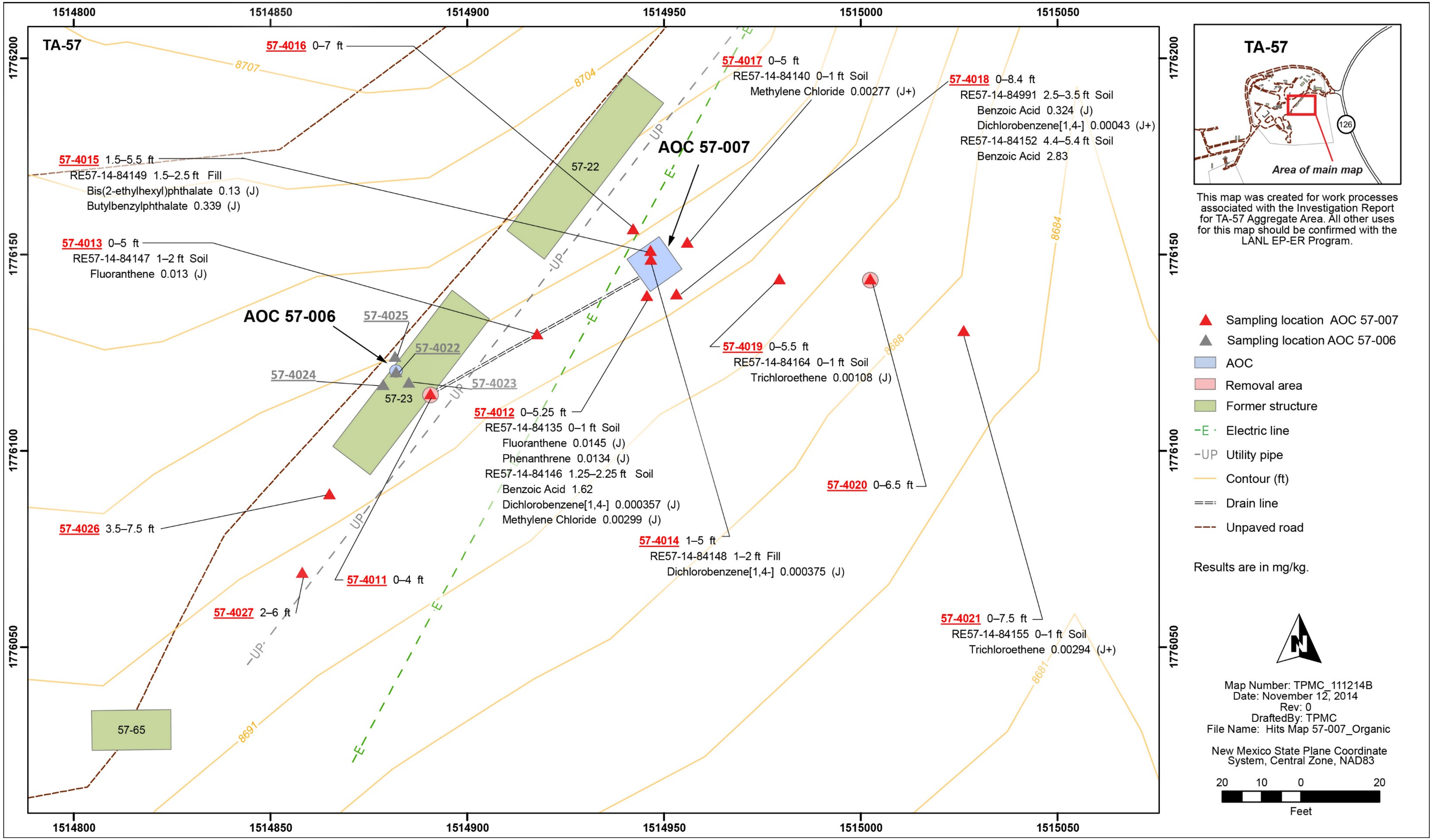


Figure 6.3-2 Organic chemicals detected at AOC 57-007

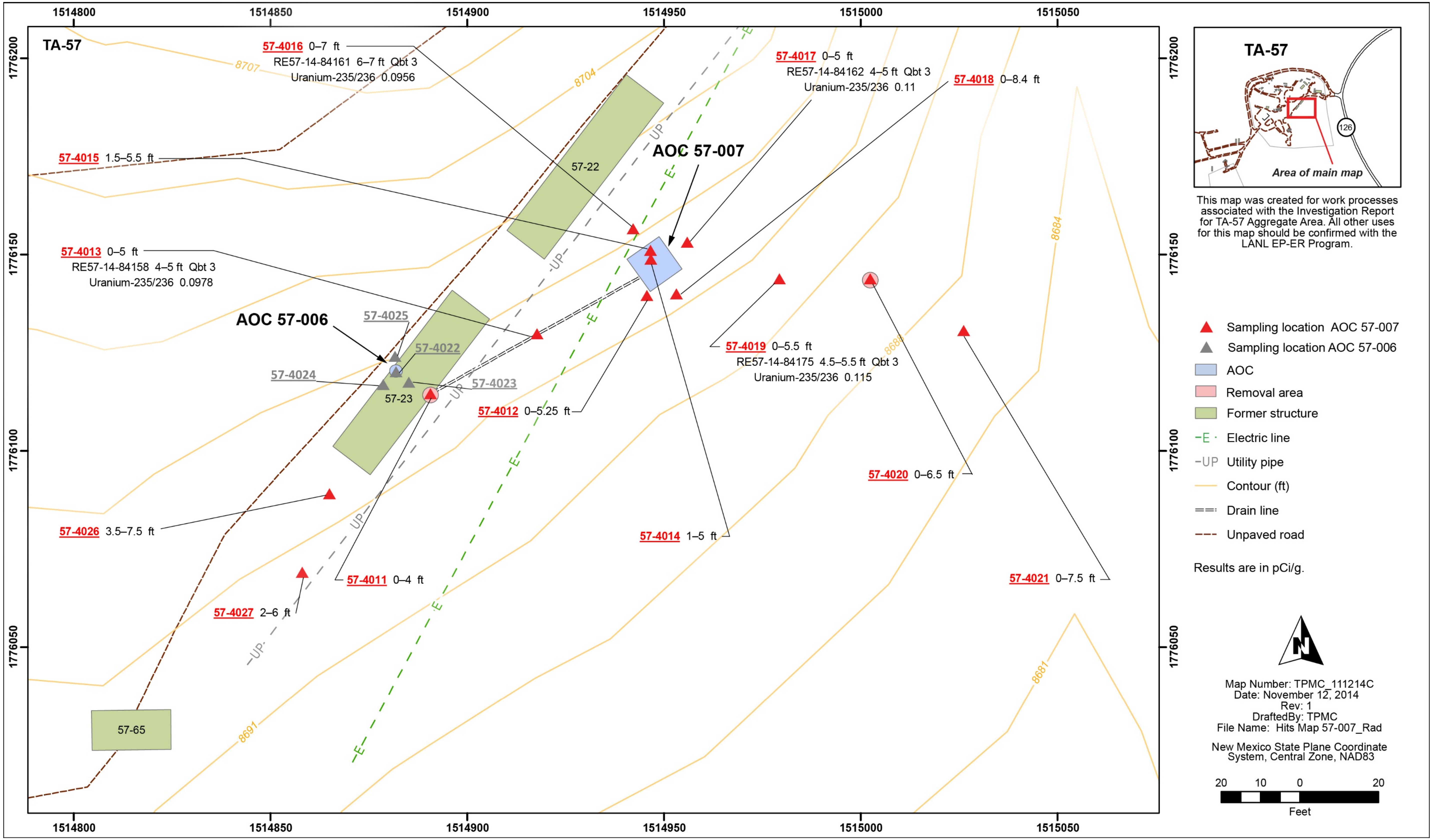


Figure 6.3-3 Radionuclides detected above BVs at AOC 57-007

Table 1.1-1
Sites Included in the TA-57 Aggregate Area Investigation

Site	Brief Description	2014 Investigation	Current Status
AOC 57-006	Former waste storage drum	Sampled	Investigation report (section 6.2)
AOC 57-007	Leach field	Sampled and remediated	Investigation report (section 6.3)

Table 3.2-1
Surveyed Coordinates for Locations Sampled in 2014

Site	Location ID	Easting (ft)	Northing (ft)
AOC 57-006	57-4022	1514881.914	1776120.145
AOC 57-006	57-4023	1514885.169	1776117.454
AOC 57-006	57-4024	1514878.659	1776116.846
AOC 57-006	57-4025	1514881.654	1776124.095
AOC 57-007	57-4011	1514890.694	1776114.563
AOC 57-007	57-4012	1514942.934	1776143.626
AOC 57-007	57-4013	1514917.726	1776129.772
AOC 57-007	57-4014	1514946.632	1776148.834
AOC 57-007	57-4015	1514949.132	1776145.918
AOC 57-007	57-4016	1514942.153	1776156.543
AOC 57-007	57-4017	1514955.903	1776153.157
AOC 57-007	57-4018	1514953.142	1776139.980
AOC 57-007	57-4019	1514979.288	1776143.782
AOC 57-007	57-4020	1515002.413	1776143.834
AOC 57-007	57-4021	1515026.163	1776130.605
AOC 57-007	57-4026	1514853.653	1776083.717
AOC 57-007	57-4027	1514846.753	1776063.727

Table 3.2-2
Field-Screening Results for Samples Collected in 2014

Site	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha[a] (dpm[b])	Beta/Gamma[a] (dpm)
AOC 57-006	57-4022	3.0–4.0	RE57-14-84178	0.0	19	1466
AOC 57-006	57-4022	5.0–6.0	RE57-14-84186	0.0	29	1468
AOC 57-006	57-4022	8.0–9.0	RE57-14-84182	0.1	44	1603
AOC 57-006	57-4023	3.0–4.0	RE57-14-84179	0.0	4	1603
AOC 57-006	57-4023	5.0–6.0	RE57-14-84183	0.0	19	1736
AOC 57-006	57-4023	8.0–9.0	RE57-14-84187	0.0	19	1600
AOC 57-006	57-4024	3.0–4.0	RE57-14-84180	0.0	29	1509
AOC 57-006	57-4024	5.0–6.0	RE57-14-84184	0.0	14	1588
AOC 57-006	57-4024	8.0–9.0	RE57-14-84188	0.0	19	1651
AOC 57-006	57-4025	3.0–4.0	RE57-14-84181	0.0	4	1591
AOC 57-006	57-4025	5.0–6.0	RE57-14-84185	0.0	39	1500
AOC 57-006	57-4025	8.0–9.0	RE57-14-84189	0.0	24	1524
AOC 57-007	57-4011	0.0–1.0	RE57-14-84134	0.0	15	1566
AOC 57-007	57-4011	1.0–2.0	RE57-14-84145	0.0	44	1657
AOC 57-007	57-4011	3.0–4.0	RE57-14-84156	0.0	9	1415
AOC 57-007	57-4012	0.0–1.0	RE57-14-84135	0.0	9	1554
AOC 57-007	57-4012	1.25–2.25	RE57-14-84146	0.0	9	1569
AOC 57-007	57-4012	4.25–5.25	RE57-14-84157	0.0	44	1506
AOC 57-007	57-4013	0.0–1.0	RE57-14-84136	0.0	19	1563
AOC 57-007	57-4013	1.0–2.0	RE57-14-84147	0.0	24	1524
AOC 57-007	57-4013	4.0–5.0	RE57-14-84158	0.0	24	1506
AOC 57-007	57-4014	2.0–3.0	RE57-14-84137	0.0	24	1572
AOC 57-007	57-4014	1.0–2.0	RE57-14-84148	0.0	34	1481
AOC 57-007	57-4014	4.0–5.0	RE57-14-84158	0.0	19	1648
AOC 57-007	57-4015	1.5–2.5	RE57-14-84149	0.0	9	1469
AOC 57-007	57-4015	2.5–3.5	RE57-14-84120	0.0	34	1606
AOC 57-007	57-4015	4.5–5.5	RE57-14-84160	0.0	19	1433
AOC 57-007	57-4016	0.0–1.0	RE57-14-84139	0.0	29	1606
AOC 57-007	57-4016	2.5–3.5	RE57-14-84990	0.0	0	39
AOC 57-007	57-4016	3.0–4.0	RE57-14-84150	0.0	34	1600
AOC 57-007	57-4016	6.0–7.0	RE57-14-84161	0.0	39	1509
AOC 57-007	57-4017	0.0–1.0	RE57-14-84140	0.0	14	1563
AOC 57-007	57-4017	1.0–2.0	RE57-14-84151	0.0	13	1530
AOC 57-007	57-4017	2.5–3.5	RE57-14-85005	0.0	0	3
AOC 57-007	57-4017	4.0–5.0	RE57-14-84162	0.0	14	1706
AOC 57-007	57-4018	0.0–1.0	RE57-14-84141	0.0	9	1563
AOC 57-007	57-4018	2.5–3.5	RE57-14-84991	0.0	0	6

Table 3.2-2 (continued)

Site	Location ID	Depth (ft)	Sample ID	PID (ppm)	Alpha[a] (dpm[b])	Beta/Gamma[a] (dpm)
AOC 57-007	57-4018	4.4–5.4	RE57-14-84152	0.0	34	1630
AOC 57-007	57-4018	7.4–8.4	RE57-14-84163	0.0	24	1642
AOC 57-007	57-4019	0.0–1.0	RE57-14-84164	0.0	9	1581
AOC 57-007	57-4019	1.5–2.5	RE57-14-84142	0.0	34	1597
AOC 57-007	57-4019	4.5–5.5	RE57-14-84175	0.0	29	1548
AOC 57-007	57-4020	0.0–1.0	RE57-14-84165	0.0	19	1500
AOC 57-007	57-4020	2.5–3.5	RE57-14-84154	0.0	35	1542
AOC 57-007	57-4020	5.5–6.5	RE57-14-84176	0.0	14	1615
AOC 57-007	57-4021	0.0–1.0	RE57-14-84155	0.0	34	1751
AOC 57-007	57-4021	4.5–5.5	RE57-14-84144	0.0	9	1500
AOC 57-007	57-4021	6.5–7.5	RE57-14-84177	0.0	14	1785
AOC 57-007	57-4026	3.5–4.5	RE57-14-88102	0.0	37	1956
AOC 57-007	57-4026	5.5–6.5	RE57-14-88100	0.0	9	2510
AOC 57-007	57-4027	2.0–3.0	RE57-14-88101	0.0	221	1846
AOC 57-007	57-4027	4.0–5.0	RE57-14-88103	0.1	210	1929

[a] Result reported represents site background level.

[b] dpm = Disintegrations per minute.

Table 3.2-3
Crosswalk of Proposed and Sampled Locations

Site	Proposed Location	Location ID
AOC 57-006	6-1	57-4022
AOC 57-006	6-2	57-4023
AOC 57-006	6-3	57-4024
AOC 57-006	6-4	57-4025
AOC 57-007	7-1	57-4011
AOC 57-007	7-2	57-4012
AOC 57-007	7-3	57-4013
AOC 57-007	7-4	57-4014
AOC 57-007	7-5	57-4015
AOC 57-007	7-6	57-4016
AOC 57-007	7-7	57-4017
AOC 57-007	7-8	57-4018
AOC 57-007	7-9	57-4019
AOC 57-007	7-10	57-4020
AOC 57-007	7-11	57-4021
AOC 57-007	57-1	57-4026
AOC 57-007	57-2	57-4027

Table 6.2-1
Samples Collected and Analyses Requested at AOC 57-006

Sample ID	Location ID	Depth (ft)	Media	TAL Metals	Cyanide (Total)	Perchlorate	Nitrate	VOCs	SVOCs	Isotopic Uranium
RE57-14-84178	57-4022	3.0–4.0	Fill	2014-3701*	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84186	57-4022	5.0–6.0	Fill	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84182	57-4022	8.0–9.0	Qbt3	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84179	57-4023	3.0–4.0	Fill	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84183	57-4023	5.0–6.0	Qbt3	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84187	57-4023	8.0–9.0	Qbt3	2014-3719	2014-3719	2014-3719	2014-3719	2014-3719	2014-3719	2014-3719
RE57-14-84180	57-4024	3.0–4.0	Fill	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84184	57-4024	5.0–6.0	Fill	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84188	57-4024	8.0–9.0	Qbt3	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84181	57-4025	3.0–4.0	Fill	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84185	57-4025	5.0–6.0	Fill	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701
RE57-14-84189	57-4025	8.0–9.0	Qbt3	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701	2014-3701

*Request number.

Table 6.2-2
Inorganic Chemicals above BVs at AOC 57-006

Sample ID	Location ID	Depth (ft)	Media	Antimony	Barium	Cadmium	Chromium	Copper	Lead	Manganese	Nitrate	Selenium	Zinc
Qbt 2,3,4 BV[a]				**0.5**	**46**	**1.63**	**7.14**	**4.66**	**11.2**	**482**	**na[b]**	**0.3**	**63.5**
Soil BV[a]				**0.83**	**295**	**0.4**	**19.3**	**14.7**	**22.3**	**671**	**na**	**1.52**	**48.8**
Industrial SSL[c]				**519**	**255000**	**1110**	**505[d]**	**51900**	**800**	**160000**	**2080000**	**6490**	**389000**
Residential SSL[c]				**31.3**	**15600**	**70.5**	**96.6[d]**	**3130**	**400**	**10500**	**125000**	**391**	**23500**
RE57-14-84178	57-4022	3.0–4.0	Fill	1.06 (U)	—[e]	0.528 (U)	—	—	—	—	1.39	—	50.4
RE57-14-84186	57-4022	5.0–6.0	Fill	1.12 (U)	—	0.56 (U)	—	—	—	—	8.03	—	—
RE57-14-84182	57-4022	8.0–9.0	Qbt3	1.06 (U)	96.2	—	41.8	4.94	14.5	—	3.24	0.358 (J)	—
RE57-14-84179	57-4023	3.0–4.0	Fill	1.09 (U)	—	0.546 (U)	—	—	—	—	0.563 (J)	—	53.6
RE57-14-84183	57-4023	5.0–6.0	Qbt3	1.05 (U)	114	—	—	—	12.4	536	1.7	0.966 (U)	—
RE57-14-84187	57-4023	8.0–9.0	Qbt3	1.02 (U)	—	—	113	—	—	—	2.21	1.06 (U)	66.5
RE57-14-84180	57-4024	3.0–4.0	Fill	1.09 (U)	—	0.545 (U)	—	—	—	—	1.88	—	—
RE57-14-84184	57-4024	5.0–6.0	Fill	0.953 (U)	—	0.477 (U)	23.9	—	—	—	3.56	—	72.6
RE57-14-84188	57-4024	8.0–9.0	Qbt3	1.05 (U)	126	—	—	—	11.8	—	2.86	0.944 (U)	—
RE57-14-84181	57-4025	3.0–4.0	Fill	1.1 (U)	—	0.551 (U)	—	—	—	—	2.53	—	50.4
RE57-14-84185	57-4025	5.0–6.0	Fill	0.961 (U)	—	0.48 (U)	—	—	—	—	5.42	—	64.6
RE57-14-84189	57-4025	8.0–9.0	Qbt3	0.946 (U)	136	—	78.1	26	13.7	—	2.78	0.347 (J)	75.1

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

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

[b] na = Not available.

[c] SSLs from NMED (2014, 600115).

[d] SSL for total chromium.

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

Table 6.2-3
Organic Chemicals Detected at AOC 57-006

Sample ID	Location ID	Depth (ft)	Media	Bis(2-ethylhexyl)phthalate	Methylene Chloride	Trichloroethene
Industrial SSL[a]				**1830**	**5130**	**36.5**
Residential SSL[a]				**380**	**409**	**6.77**
RE57-14-84178	57-4022	3.0–4.0	Fill	—[b]	0.00248 (J)	—
RE57-14-84182	57-4022	8.0–9.0	Qbt3	0.269 (J)	—	—
RE57-14-84183	57-4023	5.0–6.0	Qbt3	—	0.0028 (J+)	—
RE57-14-84180	57-4024	3.0–4.0	Fill	—	—	0.000539 (J)
RE57-14-84184	57-4024	5.0–6.0	Fill	—	—	0.000726 (J)

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

[a] SSLs from NMED (2014, 600115).

[b] — = Not detected.

Table 6.2-4
Radionuclides Detected above BVs at AOC 57-006

Sample ID	Location ID	Depth (ft)	Media	Uranium-235/236
Qbt2, 3, 4 BV[a]				**0.09**
Industrial SAL[b]				**150**
Residential SAL[b]				**39**
RE57-14-84187	57-4023	8.0–9.0	Qbt3	0.0956

Notes: All activities are in pCi/g.

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

[b] SALs from LANL (2014, 600064).

Table 6.3-1
Samples Collected and Analyses Requested at AOC 57-007

Sample ID	Location ID	Depth (ft)	Media	TAL Metals	Cyanide (Total)	Perchlorate	Nitrate	VOCs	SVOCs	Isotopic Uranium
RE57-14-84134	57-4011	0.0–1.0	Fill	2014-3718[a]	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84145	57-4011	1.0–2.0	Soil	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84156	57-4011	3.0–4.0	Qbt3	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84135	57-4012	0.0–1.0	Soil	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84146	57-4012	1.25–2.25	Soil	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84157	57-4012	4.25–5.25	Qbt3	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84136	57-4013	0.0–1.0	Fill	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84147	57-4013	1.0–2.0	Soil	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84158	57-4013	4.0–5.0	Qbt3	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84148	57-4014	1.0–2.0	Fill	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84137	57-4014	2.0–3.0	Qbt3	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718	2014-3718
RE57-14-84159	57-4014	4.0–5.0	Qbt3	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84149	57-4015	1.5–2.5	Fill	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84138	57-4015	2.5–3.5	Qbt3	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84160	57-4015	4.5–5.5	Qbt3	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84139	57-4016	0.0–1.0	Soil	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84990	57-4016	2.5–3.5	Soil	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910
RE57-14-84150	57-4016	3.0–4.0	Soil	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84161	57-4016	6.0–7.0	Qbt3	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84140	57-4017	0.0–1.0	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84151	57-4017	1.0–2.0	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-85005	57-4017	2.5–3.5	Qbt3	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910
RE57-14-84162	57-4017	4.0–5.0	Qbt3	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84141	57-4018	0.0–1.0	Fill	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84991	57-4018	2.5–3.5	Soil	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910	2014-3910

Table 6.3-1 (continued)

Sample ID	Location ID	Depth (ft)	Media	TAL Metals	Cyanide (Total)	Perchlorate	Nitrate	VOCs	SVOCs	Isotopic Uranium
RE57-14-84152	57-4018	4.4–5.4	Soil	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751	2014-3751
RE57-14-84163	57-4018	7.4–8.4	Qbt3	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84164	57-4019	0.0–1.0	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84142	57-4019	1.5–2.5	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84175	57-4019	4.5–5.5	Qbt3	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84165	57-4020	0.0–1.0	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84154	57-4020	2.5–3.5	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84176	57-4020	5.5–6.5	Qbt3	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84155	57-4021	0.0–1.0	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84144	57-4021	4.5–5.5	Soil	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-84177	57-4021	6.5–7.5	Qbt3	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795	2014-3795
RE57-14-88102	57-4026	3.5–4.5	Soil	2015-82[b]	—[c]	—	—	—	—	—
RE57-14-88100	57-4026	6.5–7.5	Qbt3	2015-82[b]	—	—	—	—	—	—
RE57-14-88101	57-4027	2–3	Soil	2015-88[b]	—	—	—	—	—	—
RE57-14-88103	57-4027	5–6	Qbt3	2018-88[b]	—	—	—	—	—	—

Note: Shaded samples were excavated to remove elevated arsenic concentrations (Appendix E).

[a] Request number.

[b] Samples analyzed for arsenic only.

[c] — = Analyses not requested.

Table 6.3-2
Inorganic Chemicals above BVs at AOC 57-007

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Cyanide (Total)	Lead	Mercury	Nitrate	Perchlorate	Selenium	Silver	Zinc
Qbt2, 3, 4 BV[a]				**7340**	**0.5**	**2.79**	**46**	**1.21**	**1.63**	**7.14**	**4.66**	**0.5**	**11.2**	**0.1**	**na**[b]	**na**	**0.3**	**1**	**63.5**
Soil BV[a]				**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**19.3**	**14.7**	**0.5**	**22.3**	**0.1**	**na**	**na**	**1.52**	**1**	**48.8**
Industrial SSL[c]				**1290000**	**519**	**21.5**	**255000**	**2580**	**1110**	**505**[d]	**51900**	**63.3**	**800**	**389**	**2080000**	**908**	**6490**	**6490**	**389000**
Residential SSL[c]				**78000**	**31.3**	**4.25**	**15600**	**156**	**70.5**	**96.6**[d]	**3130**	**11.2**	**400**	**23.5**	**125000**	**54.8**	**391**	**391**	**23500**
RE57-14-84156	57-4011	3–4	Qbt3	—[e]	1 (U)	—	147	—	—	—	—	—	14	—	0.588 (J)	0.00107 (J)	1.05 (U)	—	—
RE57-14-84135	57-4012	0–1	Soil	—	1.06 (U)	—	—	—	0.528 (U)	—	—	—	—	—	—	0.000841 (J)	—	—	52.9
RE57-14-84146	57-4012	1.25–2.25	Soil	—	0.986 (U)	—	—	—	0.493 (U)	—	—	—	—	—	—	—	—	—	—
RE57-14-84157	57-4012	4.25–5.25	Qbt3	—	1.06 (U)	—	60.5	—	—	68.3 (J)	—	—	—	—	—	—	1.04 (U)	—	—
RE57-14-84136	57-4013	0–1	Fill	—	1.01 (U)	—	—	—	0.505 (U)	—	—	—	—	—	1.16	0.000786 (J)	—	—	—
RE57-14-84147	57-4013	1–2	Soil	—	1.02 (U)	—	—	—	0.509 (U)	—	—	—	—	—	0.656 (J)	—	—	—	—
RE57-14-84158	57-4013	4–5	Qbt3	—	0.99 (U)	—	50.4	—	—	25.9	—	—	—	—	0.521 (J)	—	0.984 (U)	—	65.2
RE57-14-84148	57-4014	1–2	Fill	—	1.04 (U)	—	—	—	0.518 (U)	—	—	—	—	4.2	0.432 (J)	—	—	2.13	59.2
RE57-14-84137	57-4014	2–3	Qbt3	—	0.992 (U)	—	51.2	—	—	8.89	7.49	—	11.6	0.919	—	—	0.97 (U)	—	73.7
RE57-14-84159	57-4014	4–5	Qbt3	—	1.03 (U)	—	—	—	—	—	—	—	12.7	0.257	—	—	1.05 (U)	—	73.3
RE57-14-84149	57-4015	1.5–2.5	Fill	—	1.05 (U)	—	384	—	0.574	—	65.1	—	33.6	20.6	—	0.0011 (J)	—	15.2	113
RE57-14-84138	57-4015	2.5–3.5	Qbt3	—	—	—	—	—	—	27.7	—	—	—	—	—	—	0.984 (U)	—	75.4
RE57-14-84160	57-4015	4.5–5.5	Qbt3	—	0.991 (U)	—	50.5	—	—	—	5.83	—	—	—	—	—	0.981 (U)	—	64.8
RE57-14-84139	57-4016	0–1	Soil	—	1 (U)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RE57-14-84990	57-4016	2.5–3.5	Soil	—	1.03 (U)	—	—	—	0.516 (U)	—	—	—	—	—	—	—	—	—	—
RE57-14-84150	57-4016	3–4	Soil	29600	1.15 (U)	—	—	2.29	0.575 (U)	—	—	—	—	—	—	0.00159 (J)	—	—	—
RE57-14-84161	57-4016	6–7	Qbt3	—	0.94 (U)	—	—	—	—	29.1	—	—	—	—	—	0.000636 (J)	1.03 (U)	—	—
RE57-14-84140	57-4017	0–1	Soil	—	—	—	—	—	0.524 (U)	—	—	—	—	—	—	—	—	—	—
RE57-14-84151	57-4017	1–2	Soil	—	—	—	—	—	0.479 (U)	—	—	—	—	—	—	—	—	—	—
RE57-14-85005	57-4017	2.5–3.5	Qbt3	—	0.875 (U)	—	—	—	—	10.7	—	—	—	—	—	—	0.917 (U)	—	—
RE57-14-84162	57-4017	4–5	Qbt3	—	0.986 (U)	—	—	—	—	46.9	—	—	11.5	—	—	—	0.984 (U)	—	64.3
RE57-14-84141	57-4018	0–1	Fill	—	1.04 (U)	—	—	—	0.521 (U)	—	—	—	—	—	—	—	—	—	55.7
RE57-14-84991	57-4018	2.5–3.5	Soil	—	0.961 (U)	—	—	—	0.481 (U)	—	—	—	—	—	—	—	—	—	—
RE57-14-84152	57-4018	4.4–5.4	Soil	—	1.01 (U)	—	—	—	0.507 (U)	—	—	—	—	—	—	0.000582 (J)	—	—	—
RE57-14-84163	57-4018	7.4–8.4	Qbt3	—	0.978 (U)	—	—	—	—	60.6	—	—	—	—	—	—	1.01 (U)	—	—
RE57-14-84164	57-4019	0–1	Soil	—	1.05 (U)	—	—	—	0.524 (U)	—	—	—	—	—	—	—	—	—	—
RE57-14-84142	57-4019	1.5–2.5	Soil	—	—	—	—	—	0.505 (U)	—	—	0.73	—	—	0.947 (J)	—	—	—	—
RE57-14-84175	57-4019	4.5–5.5	Qbt3	—	1.11 (U)	—	53.4	—	—	—	—	—	15.5	—	—	—	1.06 (U)	—	—
RE57-14-84154	57-4020	2.5–3.5	Soil	—	—	—	—	—	0.56 (U)	—	—	—	—	—	—	0.000788 (J)	—	—	—
RE57-14-84176	57-4020	5.5–6.5	Qbt3	—	—	—	58.3	—	—	—	—	—	12.3	—	—	—	1.08 (U)	—	—
RE57-14-84155	57-4021	0–1	Soil	—	—	—	—	—	0.538 (U)	—	—	—	—	—	—	—	—	—	50.4
RE57-14-84144	57-4021	4.5–5.5	Soil	—	0.997 (U)	—	—	—	0.499 (U)	—	—	—	—	—	—	—	—	—	—

Table 6.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Cyanide (Total)	Lead	Mercury	Nitrate	Perchlorate	Selenium	Silver	Zinc
Qbt2, 3, 4 BV[a]				**7340**	**0.5**	**2.79**	**46**	**1.21**	**1.63**	**7.14**	**4.66**	**0.5**	**11.2**	**0.1**	**na[b]**	**na**	**0.3**	**1**	**63.5**
Soil BV[a]				**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**19.3**	**14.7**	**0.5**	**22.3**	**0.1**	**na**	**na**	**1.52**	**1**	**48.8**
Industrial SSL[c]				**1290000**	**519**	**21.5**	**255000**	**2580**	**1110**	**505[d]**	**51900**	**63.3**	**800**	**389**	**2080000**	**908**	**6490**	**6490**	**389000**
Residential SSL[c]				**78000**	**31.3**	**4.25**	**15600**	**156**	**70.5**	**96.6[d]**	**3130**	**11.2**	**400**	**23.5**	**125000**	**54.8**	**391**	**391**	**23500**
RE57-14-84177	57-4021	6.5–7.5	Qbt3	7440	1.05 (U)	—	60.1	—	—	—	—	—	12.6	—	—	—	1.01 (U)	—	—
RE57-15-88100	57-4026	6.5–7.5	Qbt3	NA[f]	NA	5.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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

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

[b] na = Not available.

[c] SSLs from NMED (2014, 600115).

[d] SSL for total chromium.

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

[f] NA = Not analyzed.

Table 6.3-3
Organic Chemicals Detected at AOC 57-007

Sample ID	Location ID	Depth (ft)	Media	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	Dichlorobenzene[1,4-]	Fluoranthene	Methylene Chloride	Phenanthrene	Trichloroethene
Industrial SSL[a]				**3300000[b]**	**1830**	**12000[b]**	**159**	**33700**	**5130**	**25300**	**36.5**
Residential SSL[a]				**250000[b]**	**380**	**2800[b]**	**32.8**	**2320**	**409**	**1740**	**6.77**
RE57-14-84135	57-4012	0.0–1.0	Soil	—[c]	—	—	—	0.0145 (J)	—	0.0134 (J)	—
RE57-14-84146	57-4012	1.25–2.25	Soil	1.62	—	—	0.000357 (J)	—	0.00299 (J)	—	—
RE57-14-84147	57-4013	1.0–2.0	Soil	—	—	—	—	0.013 (J)	—	—	—
RE57-14-84148	57-4014	1.0–2.0	Fill	—	—	—	0.000375 (J)	—	—	—	—
RE57-14-84149	57-4015	1.5–2.5	Fill	—	0.13 (J)	0.339 (J)	—	—	—	—	—
RE57-14-84140	57-4017	0.0–1.0	Soil	—	—	—	—	—	0.00277 (J+)	—	—
RE57-14-84991	57-4018	2.5–3.5	Soil	0.324 (J)	—	—	0.00043 (J+)	—	—	—	—
RE57-14-84152	57-4018	4.4–5.4	Soil	2.83	—	—	—	—	—	—	—
RE57-14-84164	57-4019	0.0–1.0	Soil	—	—	—	—	—	—	—	0.00108 (J)
RE57-14-84155	57-4021	0.0–1.0	Soil	—	—	—	—	—	—	—	0.00294 (J+)

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

[a] SSLs from NMED (2014, 600115) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[c] — = Not detected.

Table 6.3-4
Radionuclides Detected above BVs at AOC 57-007

Sample ID	Location ID	Depth (ft)	Media	Uranium-235/236
Qbt2, 3, 4 BV[a]				**0.09**
Industrial SAL[b]				**150**
Residential SAL[b]				**39**
RE57-14-84158	57-4013	4.0–5.0	Qbt3	0.0978
RE57-14-84161	57-4016	6.0–7.0	Qbt3	0.0956
RE57-14-84162	57-4017	4.0–5.0	Qbt3	0.11
RE57-14-84175	57-4019	4.5–5.5	Qbt3	0.115

Notes: All activities are in pCi/g.

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

[b] SALs from LANL (2014, 600064).

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

%R	percent recovery
AK	acceptable knowledge
amls	above mean sea level
AOC	area of concern
bgs	below ground surface
BMP	best management practice
BV	background value
CCV	continuing calibration verification
COC	chain of custody
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DAF	dilution attenuation factor
DGPS	differential global positioning system
DL	detection limit
DOE	Department of Energy (U.S.)
dpm	disintegrations per minute
Eh	oxidation-reduction potential
EPA	Environmental Protection Agency (U.S.)
EPC	exposure point concentration
EQL	estimated quantitation limit
ESH	Environment, Safety, and Health (Directorate)
ESL	ecological screening level
FV	fallout value
HDR	Hot Dry Rock (former Laboratory program)
HI	hazard index
HIR	historical investigation report
HQ	hazard quotient
HR	home range
ICS	interference check sample
ICV	initial calibration verification
I.D.	inside diameter
ID	identification

IDW	investigation-derived waste
IS	internal standard
JMS	Jemez Mountain salamander
K_d	soil-water partition coefficient
K_{oc}	organic carbon-water partition coefficient
K_{ow}	octanol-water partition coefficient
LAL	lower acceptance limit
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MDC	minimum detectable concentration
MDL	method detection limit
MS	matrix spike
MSW	municipal solid waste
NFA	no further action
NMED	New Mexico Environment Department
NMOCD	New Mexico Oil Conservation Division
NOAEL	no observed adverse effect level
PAH	polycyclic aromatic hydrocarbon
PAUF	population area use factor
PCS	petroleum-contaminated soil
PID	photoionization detector
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RfD	reference dose
RFI	RCRA facility investigation
RPD	relative percent difference
SAL	screening action level
SCL	sample collection log
SF	slope factor
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
SSL	soil screening level

SVOC	semivolatile organic compound
SWMU	solid waste management unit
T&E	threatened and endangered
TA	technical area
TAL	target analyte list
TRV	toxicity reference value
UAL	upper acceptance limit
UCL	upper confidence limit
USFS	U.S. Forest Service
UTL	upper tolerance limit
VCA	voluntary corrective action
VOC	volatile organic compound
WCSF	waste characterization strategy form

A-2.0 METRIC CONVERSION TABLE

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

A-3.0 DATA QUALIFIER DEFINITIONS

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

Appendix B

Field Methods

B-1.0 INTRODUCTION

This appendix summarizes the field methods implemented during the 2014 investigation at Technical Area 57 (TA-57) Aggregate Area, located at Fenton Hill, which lies on the western side of the Jemez Mountains, approximately 12 mi west of Los Alamos National Laboratory (LANL or the Laboratory). Table B-1.0-1 provides a summary of field investigation methods and the following sections provide more detailed descriptions of these methods. All activities were conducted in accordance with approved subcontractor procedures technically equivalent to Laboratory standard operating procedures (SOPs) listed in Table B-1.0-2 and available at http://www.lanl.gov/community-environment/environmental-stewardship/plans-procedures.php.

B-2.0 EXPLORATORY DRILLING CHARACTERIZATION

No exploratory drilling characterization was conducted during the 2014 investigation.

B-3.0 FIELD-SCREENING METHODS

This section summarizes the field-screening methods used during the investigation activities. Field screening for organic vapors and radioactivity was performed on every sample submitted to the Sample Management Office (SMO).

B-3.1 Field Screening for Organic Vapors

Field screening for organic vapors was conducted for all samples using an IonScience PhoCheck+ photoionization detector (PID) equipped with an 11.7-electronvolt lamp. Screening was performed in accordance with the manufacturer's specifications and SOP-06.33, Headspace Vapor Screening with a Photoionization Detector. Screening measurements were recorded on the sample collection logs (SCLs) and chain-of-custody (COC) forms, provided on CD in Appendix E. The screening results are presented in Table 3.2-2 of the investigation report.

B-3.2 Field Screening for Radioactivity

All samples collected were field screened for radioactivity, targeting alpha and beta/gamma emitters. A Laboratory radiological 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. The Eberline E-600 with attachment SHP-380AB consists of a dual phosphor plate covered by two Mylar windows housed in a light-excluding metal body. The phosphor plate is a plastic scintillator used to detect beta and gamma emissions and is thinly coated with zinc sulfide to detect alpha emissions. The operational range varies from trace emissions to 1 million disintegrations per minute. Screening measurements were recorded on the SCLs and COC forms and are provided on CD in Appendix E. The screening results are presented in Table 3.2-2 of the investigation report.

B-4.0 FIELD INSTRUMENT CALIBRATION

Instrument calibration and/or function check was completed daily. Several environmental factors affected the instruments' integrity, including air temperature, atmospheric pressure, wind speed, and humidity. Calibration of the PID was conducted by the site environmental safety and health representative.

Calibration of the Eberline E-600 was conducted by the RCT. All calibrations were performed according to the manufacturer's specifications and requirements

B-4.1 IonScience PhoCheck+PID Instrument Calibration

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

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

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

All daily calibration procedures for the IonScience PhoCheck+ met the manufacturer's specifications for standard reference gas calibration.

B-4.2 Eberline E-600 Instrument Calibration

The Eberline E-600 was calibrated daily by the RCT before local background levels for radioactivity were measured. The instrument was calibrated using plutonium-239 and chloride-36 sources for alpha and beta emissions, respectively. The following five checks were performed as part of the calibration procedures:

- calibration date
- physical damage
- battery
- response to a source of radioactivity
- background

All calibrations performed for the Eberline E-600 met the manufacturer's specifications and the applicable radiation detection instrument manual.

B-5.0 SURFACE AND SUBSURFACE SAMPLING

This section summarizes the methods used for collecting surface and subsurface samples, including soil, fill, and tuff, according to the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936).

B-5.1 Surface Sampling Methods

Surface samples were collected using either the hand-auger or spade-and-scoop methods in accordance with approved subcontractor procedures technically equivalent to SOP-06.10, Hand Auger and Thin-Wall Tube Sampler, or SOP-06.09, Spade and Scoop Method for the Collection of Soil Samples. A hand auger or spade and scoop were used to collect material in approximately 6-in. increments. Samples for volatile organic compound (VOC) analysis were collected immediately to minimize the loss of subsurface VOCs during the sample collection process. Containers for VOC samples were filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap. Table B-1.0-1 provides additional details on the collection of samples for VOC analysis. The description provided is specific to the sampling method rather than to the media. The remaining sample material was placed in a stainless-steel bowl with a stainless-steel scoop, after which it was transferred to sterile sample collection jars. Samples were preserved using coolers with blue ice to maintain the required temperature in accordance with an approved subcontractor procedure technically equivalent to SOP-5056, Sample Containers and Preservation.

Samples were appropriately labeled, sealed with custody seals, and documented before they were transported to the SMO. Samples were managed in accordance with an approved subcontractor procedure technically equivalent to SOP-5057, Handling, Packaging, and Transporting Field Samples, and WES-EDA-QP-219, Sample Control and Field Documentation.

Sample collection tools were decontaminated (see section B-5.7) immediately before and after each sample was collected in accordance with a subcontractor procedure technically equivalent to SOP-5061, Field Decontamination of Equipment.

B-5.2 Subsurface Tuff Sampling Methods

Subsurface samples were collected in accordance with an approved subcontractor procedure technically equivalent to SOP-06.10, Hand Auger and Thin-Wall Tube Sampler.

Subsurface samples were collected using the hand auger method. Samples for VOC analysis were collected immediately to minimize the loss of subsurface VOCs during the sample collection process. Containers for VOC samples were filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap. Table B-1.0-1 provides additional details on collection of samples for VOC analysis. The description provided is specific to the sampling method rather than to the media. The remaining sample material was placed in a stainless-steel bowl with a stainless-steel scoop, after which it was transferred to sterile sample collection jars or bags. Samples were preserved using coolers to maintain the required temperature and chemical preservative, such as nitric acid, in accordance with an approved subcontractor procedure technically equivalent to SOP-5056, Sample Containers and Preservation.

Samples were appropriately labeled, sealed with custody seals, and documented before they were transported to the SMO. Samples were managed in accordance with an approved subcontractor procedure technically equivalent to SOP-5057, Handling, Packaging, and Transporting Field Samples, and WES-EDA-QP-219, Sample Control and Field Documentation.

Sample collection tools were decontaminated (see section B-5.7) immediately before each sample was collected in accordance with a subcontractor procedure technically equivalent to SOP-5061, Field Decontamination of Equipment.

B-5.3 Quality Control Samples

Quality control (QC) samples were collected in accordance with an approved subcontractor procedure technically equivalent to SOP-5059, Field Quality Control Samples. QC samples included field duplicates, field rinsate blanks, and field trip blanks. Field duplicate samples were collected from the same material as an investigation sample and submitted for the same analyses. Field duplicate samples were collected at a frequency of at least 1 duplicate sample for every 10 samples.

Field rinsate blanks were collected to evaluate field decontamination procedures. Rinsate blanks were collected by rinsing sampling equipment (i.e., hand auger buckets, sampling bowls and spoons), after decontamination, with deionized water. The rinsate water was collected in a sample container and submitted to the SMO. Field rinsate blank samples were analyzed for inorganic chemicals (metals) and were collected from sampling equipment at a frequency of at least 1 rinsate sample for every 10 solid samples.

Field trip blanks were provided by SMO at a frequency of 1 per day at the time samples were collected for VOC analysis. Trip blanks consisted of containers of certified clean sand and kept with the other sample containers during the sampling process and during transportation to the SMO and the off-site analytical laboratory.

B-5.4 Sample Documentation and Handling

Field personnel completed an SCL and COC form for each sample. Sample containers were sealed with signed custody seals and placed in coolers at approximately 4°C. Samples were handled in accordance with approved subcontractor procedures technically equivalent to SOP-5057, Handling, Packaging, and Transporting Field Samples, and SOP-5056, Sample Containers and Preservation. Swipe samples were collected from the exterior of sample containers and analyzed by the RCT before the sample containers were removed from the site. Samples were transported to the SMO for processing and shipment to off-site contract analytical laboratories. The SMO personnel reviewed and approved the SCLs and COC forms and accepted custody of the samples.

B-5.5 Decontamination of Sampling Equipment

The hand augers and all other sampling equipment that came (or could have come) in contact with sample material were decontaminated immediately before and after each sample was collected. Decontamination included wiping the equipment with Fantastik and paper towels. Decontamination activities were performed in accordance with an approved subcontractor procedure technically equivalent to SOP-5061, Field Decontamination of Equipment.

B-5.6 Site Demobilization and Restoration

All field equipment was demobilized from the site on October 16, 2014. All excavated areas (see section B-6.0, Soil Removal) were reseeded with an approved native grass mix and best management practices (BMPs) were installed to prevent runoff.

B-6.0 SOIL REMOVAL

Arsenic-contaminated soil with concentrations above the residential arsenic soil screening level was removed using hand tools, including shovels and picks. A 2-ft radius was removed around locations 57-4011 and 57-4020 to depths of 2.0 ft below ground surface (bgs) and 2.5 ft bgs, respectively.

Confirmation samples were not necessary because samples collected at depth at both locations defined the depth of the soil removal. The excavated material was placed in three 55-gal. drums and characterized for waste disposal by direct sampling of the containerized soil. The excavations were backfilled with clean fill material, reseeded using an approved native seed mix, and BMPs were installed to prevent runoff. The excavated soil was managed as investigation-derived waste (IDW), as described in Appendix C.

B-7.0 GEODETIC SURVEYING

Geodetic surveys of all sample locations were performed using a Trimble RTK 5700 differential global positioning system (DGPS) referenced from published and monumented external Laboratory survey control points in the vicinity. All sampling locations were surveyed in accordance with an approved subcontractor procedure technically equivalent to SOP-5028, Coordinating and Evaluating Geodetic Surveys. Horizontal accuracy of the monumented control points is within 0.1 ft. The DGPS instrument referenced from Laboratory control points is accurate within 0.2 ft. The surveyed coordinates are presented in Table 3.2-1 of the investigation report.

B-8.0 INVESTIGATION-DERIVED WASTE STORAGE AND DISPOSAL

All IDW generated during the field investigation was managed in accordance with SOP-10021, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy orders, and Laboratory implementation requirements. IDW was also managed in accordance with the approved waste characterization strategy form and the IDW management appendix of the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). Details of IDW management for the TA-57 Aggregate Area investigation are presented in Appendix C.

B-9.0 DEVIATIONS FROM THE WORK PLAN

Several proposed sampling locations identified in the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936) were moved as a result of site conditions encountered during implementation of the field activities at Area of Concern (AOC) 57-007. These locations were moved because they were positioned atop, or next to, underground utilities. When locations were moved, the new locations were sited as close as possible to the planned locations. Additional deviations to the approved work plan scope are discussed below:

- The investigation work plan stated hollow-stem augers would be used to collect subsurface samples where hand-augering was impractical because of the depth of the material being sampled. All samples were collected using hand-auger and spade-and-scoop methods.
- The investigation work plan proposed collecting samples from three intervals below the drainline at AOC 57-007: 0.0–1.0 ft below the drainline; 1 ft above tuff; and 2.0–3.0 ft into tuff. Because the bottom of the drainline was determined to be 1 ft bgs and the top of tuff 2 ft bgs, the first two intervals were both 1.0–2.0 ft bgs. Rather than sample only two depths (1.0–2.0 ft bgs and 4.0–5.0 ft bgs), the interval 0.0–1.0 ft bgs was also sampled to encompass the depth where the former drainline was located.
- Location 57-4012 was moved 5 ft downslope/downgradient of marked utility lines.

- Location 57-4015 was moved 6 ft northwest of marked utility and remained within the leach field.
- The investigation work plan proposed collecting samples at 0.0−1.0 below the leach field. However, the leach field was not present at locations 57-4016, 57-4017, and 57-4018 and samples were collected from 0.0−1.0 ft bgs. To be consistent with the sampling depth intervals where the leach field was present, additional samples were collected from 2.5−3.5 ft bgs at locations 57-4016, 57-4017, and 57-4018. This depth interval was selected because it was equivalent to 0.0−1.0 ft below the visible leach field at sampling location 57-4015.
- The investigation work plan proposed collecting samples at locations 7-10 and 7-11; however, to avoid disturbance to undeveloped core habitat for the Jemez Mountain salamander, these two locations were moved to new locations 57-4019 and 57-4021, respectively. These locations are shown in the map presented in Attachment G-4 of this report.
- At location 57-4021, a sample was inadvertently collected from 1.0−2.0 ft into tuff instead of 2.0−3.0 ft into tuff.
- Arsenic-contaminated soil was removed at locations 57-4011 and 57-4020 within AOC 57-007. A 2-ft radius was removed around locations 57-4011 and 57-4020 to a depth of 2.0 ft and 2.5 ft bgs, respectively.
- Additional samples were collected at AOC 57-007. Four samples were collected from locations 57-4026 and 57-4027 situated southwest and downgradient of location 57-4011. At each location, samples were collected from 1.0 ft above tuff, and 2.0−3.0 ft into tuff to define the lateral extent of arsenic.

B-10.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the ESH 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.

LANL (Los Alamos National Laboratory), April 2012. "Investigation Work Plan for Technical Area 57 Aggregate Area (Fenton Hill)," Los Alamos National Laboratory document LA-UR-12-20545, Los Alamos, New Mexico. (LANL 2012, 214550)

NMED (New Mexico Environment Department), July 11, 2012. "Approval with Modifications, Investigation Work Plan for Technical Area 57 Aggregate Area (Fenton Hill)," New Mexico Environment Department letter to P. Maggiore (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2012, 520936)

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

Method	Summary
Spade and Scoop Collection of Soil Samples	This method is typically used to collect shallow (i.e., approximately 0.0–1.0 ft.) soil samples. The spade-and-scoop method involves digging a hole to the desired depth, as prescribed in the work plan, and collecting a discrete grab sample. The sample is typically placed in a clean stainless-steel bowl for transfer into various sample containers.
Hand Auger Sampling	This method is typically used for sampling soil at depths of less than 10.0–15.0 ft but may in some cases be used to collect samples of weathered or nonwelded tuff. The method involves hand-turning a stainless-steel bucket auger (typically 3–4 in. inside diameter), creating a vertical hole that can be advanced to the desired sampling depth. When the desired depth was reached during the investigation, the auger was decontaminated before the hole was advanced through the sampling depth. The sample material was transferred from the auger bucket to a stainless-steel sampling bowl before the various required sample containers were filled.
Headspace Vapor Screening	Individual soil, rock, or sediment samples were field-screened for organic vapors by placing a portion of the sample in a plastic sample bag or in a glass container with a foil-sealed cover. The container was sealed and gently shaken and allowed to equilibrate for 5 min. The sample was then screened by inserting a PID probe into the container and measuring and recording any detected vapors.
Handling, Packaging, and Shipping of Samples	Field team members sealed and labeled samples before packing them to ensure the sample containers and the containers used for transport were free of external contamination. Field team members packaged all samples to minimize the possibility of breakage during transport. After all environmental samples were collected, packaged, and preserved, a field team member transported them to the SMO. The SMO arranged to ship the samples to analytical laboratories.
Sample Control and Field Documentation	The collection, screening, and transport of samples were documented on standard forms generated by the SMO. These included SCLs, COC forms, and sample container labels. SCLs were completed at the time of sample collection, and the logs were signed by the sampler and a reviewer who verified the logs for completeness and accuracy. Corresponding labels were initialed and applied to each sample container, and custody seals were placed around each sample container. COC forms were completed and signed to verify that the samples were not left unattended.
Field Quality Control Samples	Field QC samples were collected as follows: *Field Duplicates*: At a frequency 10%; collected at the same time as a regular sample and submitted for the same analyses. *Rinsate Blank*: At a frequency of 10%; collected by rinsing sampling equipment with deionized water that was collected in a sample container and submitted for laboratory analysis. *Trip Blanks*: Required for all field events that include the collection of samples for VOC analysis. Trip blanks containers of certified clean sand were opened and kept with the other sample containers during the sampling process.
Field Decontamination of Remediation and Sampling Equipment	Dry decontamination was used to minimize the generation of liquid waste. Dry decontamination included the use of a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by use of a commercial cleaning agent (nonacid, waxless cleaners) and paper wipes.

Table B-1.0-1 (continued)

Method	Summary
Containers and Preservation of Samples	Specific requirements/processes for sample containers, preservation techniques, and holding times are based on EPA guidance for environmental sampling, preservation, and quality assurance. Specific requirements for each sample were printed on the SCL provided by the SMO (size and type of container [e.g., glass, amber glass, and polyethylene]). All samples were preserved by placing them with ice in insulated containers to maintain a temperature of 4°C.
Coordinating and Evaluating Geodetic Surveys	Geodetic surveys focused on obtaining survey data of acceptable quality to use during project investigations. Geodetic surveys were conducted with a Trimble 5700 DGPS. The survey data conformed to Laboratory Information Architecture project standards IA-CB02, GIS Horizontal Spatial Reference System, and IA-D802, Geospatial Positioning Accuracy Standard for A/E/C/ and Facility Management. All coordinates were expressed as State Plain Coordinate System 83, NM Central, U.S. feet. All elevation data were reported relative to the National Geodetic Vertical Datum of 1983.
Management of Environmental Restoration Project Waste, Waste Characterization	IDW is managed, characterized, and stored in accordance with an approved waste characterization strategy form that documents site history, field activities, and characterization approach for each waste stream managed. Waste characterization complied with on- or off-site waste acceptance criteria. All stored IDW was marked with appropriate signage and labels and contained within an area of contamination. A waste storage area was established before waste was generated. Waste storage areas were located in controlled areas of the Laboratory to prevent unauthorized personnel from inadvertently adding or managing wastes. Each container of waste generated was individually labeled with waste classification, item identification number, and radioactivity (if applicable), immediately following containerization. All waste was segregated by classification and compatibility to prevent cross-contamination. Management of IDW is described in Appendix C.

Table B-1.0-2
SOPs Used for Investigation Activities Conducted at TA-57 Aggregate Area

P101-17, R1, Excavation/Fill/Soil Disturbance Permit Process
P101-18, R2, Procedure for Pause/Stop Work
P315, R3, Conduct of Operations Manual
P409, R4, Waste Management
SOP-5181, R1, Notebook and Logbook Documentation for Environmental Directorate Technical and Field Activities
SOP-06.09, Spade and Scoop Method for the Collection of Soil Samples
SOP-06.10, Hand Auger and Thin-Wall Tube Sampler
SOP-06.33, Headspace Vapor Screening with a Photo Ionization Detector
SOP-5028, Coordinating and Evaluating Geodetic Surveys
SOP-5056, Sample Containers and Preservation
SOP-5057, Handling, Packaging, and Transporting Field Samples
WES-EDA-QP-219, Sample Control and Field Documentation
SOP-5059, Field Quality Control Samples
SOP-5061, Field Decontamination of Equipment
EP-DIR-SOP-10021, R0, Characterization and Management of Environmental Program Waste

Note: Procedures used were approved subcontractor procedures technically equivalent to the procedures listed in the table.

Appendix C

Investigation-Derived Waste Management

C-1.0 INTRODUCTION

This appendix contains the waste management records for the investigation-derived waste (IDW) generated during the implementation of the investigation work plan for Technical Area 57 (TA-57) Aggregate Area, located at Fenton Hill, which lies on the western side of the Jemez Mountains, approximately 12 mi west of Los Alamos National Laboratory (LANL or the Laboratory).

All IDW generated during the field investigation was managed in accordance with Standard Operating Procedure (SOP) 10021, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of applicable U.S. Environmental Protection Agency and New Mexico Environment Department regulations, U.S. Department of Energy orders, and Laboratory policies and procedures.

Consistent with Laboratory procedures, a waste characterization strategy form (WCSF) was prepared to address characterization approaches, on-site management, and final disposition options for wastes. Analytical data and information on wastes generated during previous investigations and/or acceptable knowledge (AK) were used to complete the WCSF. The WCSF is included in this appendix as Attachment C-1 (on CD).

The selection of waste containers was based on appropriate U.S. Department of Transportation requirements, waste types, and estimated volumes of IDW to be generated. Immediately following containerization, each waste container was individually labeled with a unique identification number and with information regarding waste classification, contents, and radioactivity, if applicable.

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

Investigation activities were conducted in a manner that minimized the generation of waste. Waste minimization was accomplished by implementing the most recent version of the "Los Alamos National Laboratory Hazardous Waste Minimization Report."

C-2.0 WASTE STREAMS

The IDW streams generated and managed during the investigation at the TA-57 Aggregate Area are described below and are summarized in Table C-2.0-1. The waste stream numbers correspond with those identified in the WCSF.

- WCSF Waste Stream #1: Contact waste consisted of solid waste generated during soil removal and sampling activities that came in contact with contaminated environmental media and equipment. This waste included, but was not limited to, personal protective equipment (e.g., gloves); plastic sheeting (e.g., tarps, liners); plastic and glass sample bottles; disposable sampling supplies (e.g., filters, tubing, plastic bags); and dry decontamination wastes, such as paper items. These wastes were containerized at the point of generation and were characterized based on AK of the waste materials, the methods of generation, and analytical data for the media with which they came into contact. Approximately 0.25 yd^3 of contact waste was generated and disposed of as industrial waste at Waste Management of New Mexico in Rio Rancho, NM.

- WCSF Waste Stream #2: Petroleum-contaminated soil (PCS) was not generated during the TA-57 Aggregate Area investigation.
- WCSF Waste Stream #3: Municipal solid waste (MSW) consisted of noncontact trash, including paper, cardboard, wood, plastic, food, and beverage containers. Approximately 0.5 yd^3 of waste was generated and was determined to be nonhazardous, nonradioactive MSW. It was stored in plastic-lined trash cans and disposed of at the Los Alamos County landfill.

- WCSF Waste Stream #4: Soil consisted of soil contaminated with arsenic above risk-based residential soil screening levels. Approximately 1.5 yd^3 of soil was generated during this investigation and stored in 55-gal. drums. A hand auger was used in accordance with SOP-06.10, Hand Auger and Thin-Wall Tube Sampler, to collect a composite sample from the three drums. The soil was disposed of as industrial waste at Waste Management of New Mexico in Rio Rancho, NM.

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

Waste Stream	Waste Type	Volume	Characterization Method	On-Site Management	Disposition
Contact Waste	Industrial	0.25 yd^3	AK and analytical results of site characterization	55-gal. drum	Waste Management of New Mexico
PCS	New Mexico Special Waste	n/a*	AK	n/a	n/a
Municipal Solid	MSW	0.5 yd^3	AK	Plastic bags	Los Alamos County landfill
Arsenic-contaminated soil	Industrial	1.5 yd^3	Direct sampling and use of analytical results	55-gal. drum	Waste Management of New Mexico

*n/a = Not applicable.

Attachment C-1

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

Appendix D

Analytical Program

D-1.0 INTRODUCTION

This appendix discusses the analytical methods and data-quality review for samples collected during the 2014 investigation at Technical Area 57 (TA-57) Aggregate Area, located at Fenton Hill, which lies on the western side of the Jemez Mountains, approximately 12 mi west of Los Alamos National Laboratory (LANL or the Laboratory). Additionally, this appendix summarizes the effects of data-quality issues on the acceptability of the analytical data.

Quality assurance (QA), quality control (QC), and data validation procedures were implemented in accordance with the Quality Assurance Project Plan Requirements for Sampling and Analysis (LANL 1996, 054609) and the Laboratory's statement of work (SOW) for analytical laboratories (LANL 2008, 109962). The results of the QA/QC procedures were used to estimate the accuracy, bias, and precision of the analytical measurements. Samples for QC include method blanks, matrix spike samples (MS), laboratory control samples (LCS), internal standards (IS), initial calibration verifications (ICV), continuing calibration verifications (CCV), surrogate monitoring compounds, and tracer compounds.

The type and frequency of laboratory QC analyses are described in the SOW for analytical laboratories (LANL 2008, 109962). Other QC factors, such as sample preservation and holding time, were also assessed in accordance with the requirements outlined in Standard Operating Procedure (SOP) 5056, Sample Containers and Preservation.

The following SOPs, available at http://www.lanl.gov/community-environment/environmental-stewardship/plans-procedures.php, were used for data validation:

- SOP-5161, Routine Validation of Volatile Organic Compound (VOC) Analytical Data
- SOP-5162, Routine Validation of Semivolatile Organic Compound (SVOC) Analytical Data
- SOP-5165, Routine Validation of Metals Analytical Data
- SOP-5166, Routine Validation of Gamma Spectroscopy Data, Chemical Separation Alpha Spectrometry, Gas Proportional Counting, and Liquid Scintillation Analytical Data
- SOP-5191, Routine Validation of LC/MS/MS Perchlorate Analytical Data

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

D-2.0 INORGANIC CHEMICAL ANALYSES

A total of 52 samples (plus 5 field duplicates) collected within the TA-57 Aggregate Area were analyzed for inorganic chemicals. All 52 samples (plus 5 field duplicates) were analyzed for target analyte list (TAL) metals with 4 samples analyzed for arsenic only; 48 samples (plus 5 field duplicates) were analyzed for nitrate, perchlorate, and total cyanide. The analytical methods used for inorganic chemicals are listed in Table D-1.0-1.

Tables within the investigation report summarize the samples collected and the analyses requested for each site. All inorganic chemical results are provided on CD in Appendix E.

D-3.1 Inorganic Chemical QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. To assess the accuracy and precision of inorganic chemical analyses, LCS, preparation blanks, MS samples, laboratory duplicate samples, interference check samples (ICS), and serial dilution samples were analyzed as part of the investigation. Each of these QA/QC sample types is defined in the analytical services SOW (LANL 2008, 109962) and is described briefly below.

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

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

MS samples assess the accuracy of inorganic chemical analyses. These samples are designed to provide information about the effect of the sample matrix on the sample preparation procedures and analytical technique. The MS %R should fall within the control limits of 75%–125% for all spiked analytes.

Laboratory duplicate samples assess the precision of inorganic chemical analyses. The relative percent difference (RPD) between the sample and laboratory duplicate should be within ±35%.

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

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

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

D-3.2 Data-Quality Results for Inorganic Chemicals

The majority of the analytical results for inorganic chemical analyses did not require data validation qualifiers to be applied as a result of QC issues. Some of the analytical results were qualified as not detected (U) because the associated sample concentration was less than or equal to the MDL. This data qualification is related to detection status only, not to data-quality issues.

D-3.2.1 COC

SCL/COC forms were maintained properly for all samples analyzed for inorganic chemicals (Appendix E).

D-3.2.2 Sample Documentation

All samples analyzed for inorganic chemicals were properly documented on SCL/COC forms in the field (Appendix E).

D-3.2.3 Sample Dilution

Some samples were diluted for inorganic chemical analyses. No qualifiers were applied to any inorganic chemical sample results as a result of sample dilution factors.

D-3.2.4 Sample Preservation

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

D-3.2.5 Holding Time

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

D-3.2.6 ICV and CCV

ICV and CCV criteria were met for all samples analyzed for inorganic chemicals.

D-3.2.7 ICS and/or Serial Dilution Analyses

ICS and serial dilution criteria were met for all samples analyzed for inorganic chemicals.

D-3.2.8 Laboratory Duplicate Samples

A total of 11 TAL metals results were qualified as estimated (J) because the sample and the duplicate sample results were greater than or equal to 5 times the reporting limit and the duplicate RPD was greater than 35%.

D-3.2.9 Preparation Blanks

Preparation blank criteria were met for all samples analyzed for inorganic chemicals.

D-3.2.10 MS Sample Recoveries

MS sample criteria were met for all samples analyzed for inorganic chemicals.

D-3.2.11 Laboratory Control Sample Recoveries

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

D-3.2.12 Detection Limits

A total of 65 TAL metals results, 17 mercury results, 7 nitrate results, 11 perchlorate results, and 3 total cyanide results were qualified as estimated (J) because the sampling result was reported as detected between the estimated detection limit and the MDL.

D-3.2.13 Rejected Results

No data were rejected and data are usable for their intended purpose. The results of other qualified data did not affect the usability of the sampling results.

D-4.0 ORGANIC CHEMICAL ANALYSES

A total of 48 samples (plus 5 field duplicates) collected within the TA-57 Aggregate Area were analyzed for organic chemicals. All 48 samples (plus 5 field duplicates) were analyzed for volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). The analytical methods used for organic chemicals are listed in Table D-1.0-1.

Tables within the investigation report summarize the samples collected and the analyses requested for each site. All organic chemical results are provided on CD in Appendix E.

D-4.1 Organic Chemical QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. To assess the accuracy and precision of organic chemical analyses, calibration verifications, LCS, method blanks, MS samples, surrogate monitoring compounds, and ISs were analyzed as part of the investigation. Each of these QA/QC sample types is defined in the analytical services SOW (LANL 2008, 109962) and described briefly below.

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

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

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

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

Surrogate monitoring compounds (surrogates) are organic compounds that are similar in composition and behavior to the target analytes but are not normally found in environmental samples. Surrogates are added to every sample (field sample and QA/QC samples) to evaluate the efficiency with which analytes are recovered during extraction and analysis. The %R of the surrogates must fall within specified ranges or the sample may be rejected or assigned a qualifier.

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

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

D-4.2 Data-Quality Results for Organic Chemicals

The majority of the analytical results were qualified as not detected (U) because the associated sample concentration was less than or equal to the MDL. This data qualification is related to detection status only, not to data-quality issues.

D-4.2.1 Maintenance of COC

SCL/COC forms were maintained properly for all samples analyzed for organic chemicals (Appendix E).

D-4.2.2 Sample Documentation

All samples analyzed for organic chemicals were properly documented on the SCL in the field (Appendix E).

D-4.2.3 Sample Preservation

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

D-4.2.4 Holding Time

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

D-4.2.5 ICV and CCV

ICV and CCV criteria were met for all samples analyzed for organic chemicals.

D-4.2.6 Surrogate Monitoring Compound Recoveries

Two SVOC results and seven VOC results were qualified as estimated and biased high (J+) because the surrogate %R value is greater than the UAL.

D-4.2.7 IS Response

IS response criteria were met for all samples analyzed for organic chemicals.

D-4.2.8 Method Blank

Method blank criteria were met for all samples analyzed for organic chemicals.

D-4.2.9 MS Samples

MS sample criteria were met for all samples analyzed for organic chemicals.

D-4.2.10 Laboratory Duplicate Samples

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

D-4.2.11 LCS Recoveries

Twelve SVOC results were qualified as estimated not detected (UJ) because a low recovery (%R < LAL) was observed for these analytes in the associated LCS.

D-4.2.12 Quantitation and Method Detection Limits

Fourteen SVOC results and seven VOC results were qualified as estimated (J) because the sample result was reported as detected between the practical quantitation limit and the MDL.

D-4.2.13 Rejected Data

No data were rejected and data are usable for their intended purpose. The results of other qualified data did not affect the usability of the sampling results.

D-5.0 RADIONUCLIDE ANALYSES

A total of 48 samples (plus 5 field duplicates) collected within the TA-57 Aggregate Area were analyzed for radionuclides. All 48 samples (plus 5 field duplicates) were analyzed for isotopic uranium. The analytical methods used for radionuclide analyses are listed in Table D-1.0-1.

Tables in the investigation report summarize samples collected and the analyses requested for each site. All radionuclide results are provided on CD (Appendix E).

D-5.1 Radionuclide QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. To assess the accuracy and precision of the radionuclide analyses, LCS, method blanks, MS samples, laboratory duplicate samples, and tracer compounds were analyzed as part of the analyses. Each of these QA/QC sample types is defined in the analytical services SOW (LANL 2008, 109962) and is described briefly in the paragraphs below.

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

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

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

Tracer compounds (tracers) are radioisotopes added to a sample for the purposes of monitoring loss of the target analyte. The tracer is assumed to behave in the same manner as the target analyte. Tracer recoveries should fall between the analyte-specific LAL and UAL.

Laboratory duplicate samples assess the precision of radionuclide analyses. All RPDs between the sample and laboratory duplicate should be ±35%.

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

D-5.2 Data-Quality Results for Radionuclides

The majority of the analytical results for radionuclide analyses did not require data validation qualifiers to be applied as a result of QC issues. Some sample results were qualified as not detected (U) because the associated sample concentration was less than or equal to the MDC. This data qualification is related to detection status only, not to data-quality issues.

D-5.2.1 COC

SCL/COC forms were maintained properly for all samples analyzed for radionuclides (Appendix E).

D-5.2.2 Sample Documentation

All samples analyzed for radionuclides were properly documented on the SCL in the field (Appendix E).

D-5.2.3 Sample Dilution

Samples were not diluted for radionuclide analyses; therefore, no qualifiers were applied to any radionuclide sample results because of dilutions.

D-5.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for radionuclides.

D-5.2.5 Holding Time

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

D-5.2.6 Method Blanks

Method blank criteria were met for all samples analyzed for radionuclides.

D-5.2.7 MS Samples

MS sample criteria were met for all samples analyzed for radionuclides.

D-5.2.8 Tracer Compound Recoveries

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

D-5.2.9 Laboratory Control Sample Recoveries

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

D-5.2.10 Laboratory Duplicate Samples Recoveries

One isotopic uranium result was qualified as estimated (J) because the associated duplicate sample has a duplicate error ratio or relative error ratio greater than the analytical laboratory’s acceptance limits.

D-5.2.11 Rejected Data

No data were rejected and data are usable for their intended purpose. The results of other qualified data did not affect the usability of the sampling results.

D-6.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate’s Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory’s Electronic Document Management System and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the ESH 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.

EPA (U.S. Environmental Protection Agency), February 1994. “USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,” EPA-540/R-94/013, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1994, 048639)

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LANL (Los Alamos National Laboratory), March 1996. “Quality Assurance Project Plan Requirements for Sampling and Analysis,” Los Alamos National Laboratory document LA-UR-96-441, Los Alamos, New Mexico. (LANL 1996, 054609)

LANL (Los Alamos National Laboratory), June 30, 2008. “Exhibit 'D' Scope of Work and Technical Specifications, Analytical Laboratory Services for General Inorganic, Organic, Radiochemical, Asbestos, Low-Level Tritium, Particle Analysis, Bioassay, Dissolved Organic Carbon Fractionation, and PCB Congeners,” Los Alamos National Laboratory document RFP No. 63639-RFP-08, Los Alamos, New Mexico. (LANL 2008, 109962)

Table D-1.0-1
Inorganic Chemical, Organic Chemical, and Radionuclide Analytical Methods for Samples Collected from the TA-57 Aggregate Area

Analytical Method	Analytical Description	Analytical Suite
EPA 300.0	Ion chromatography	Nitrate
EPA SW-846: 6010/6010C	Inductively coupled plasma emission spectroscopy—atomic emission spectroscopy	Aluminum, antimony, barium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, potassium, silver, sodium, vanadium, and zinc (TAL metals)
EPA SW-846:6020	Inductively coupled plasma mass spectrometry	Arsenic, beryllium, nickel, selenium, and thallium
EPA SW-846: 9012A	Automated colorimetric/off-line distillation	Total cyanide
EPA SW-846:6850	Liquid chromatography–mass spectrometry/mass spectrometry	Perchlorate
EPA SW-846:7471A	Cold vapor atomic absorption spectroscopy	Mercury
EPA SW-846: 8260 and 8260B	Gas chromatography–mass spectrometry (GC/MS)	VOCs
EPA SW-846: 8270 and 8270C	GC/MS	SVOCs
HASL Method 300	Chemical separation alpha spectrometry	Isotopic uranium

Appendix E

Analytical Suites and Results and Analytical Reports
(on CD included with this document)

Appendix F

Box Plots and Statistical Results

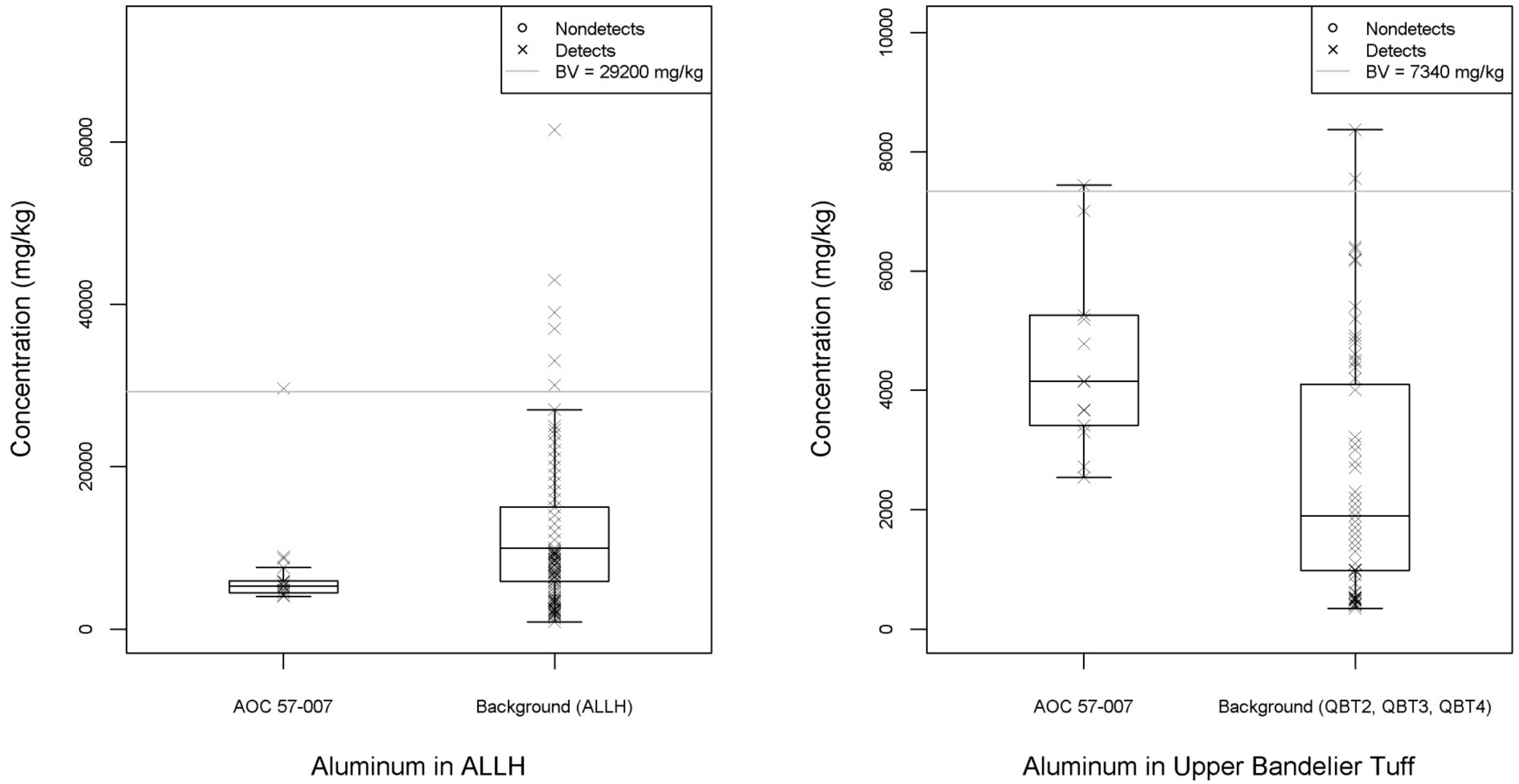

Figure F-1 **Box plots for aluminum in soil and tuff at AOC 57-007**

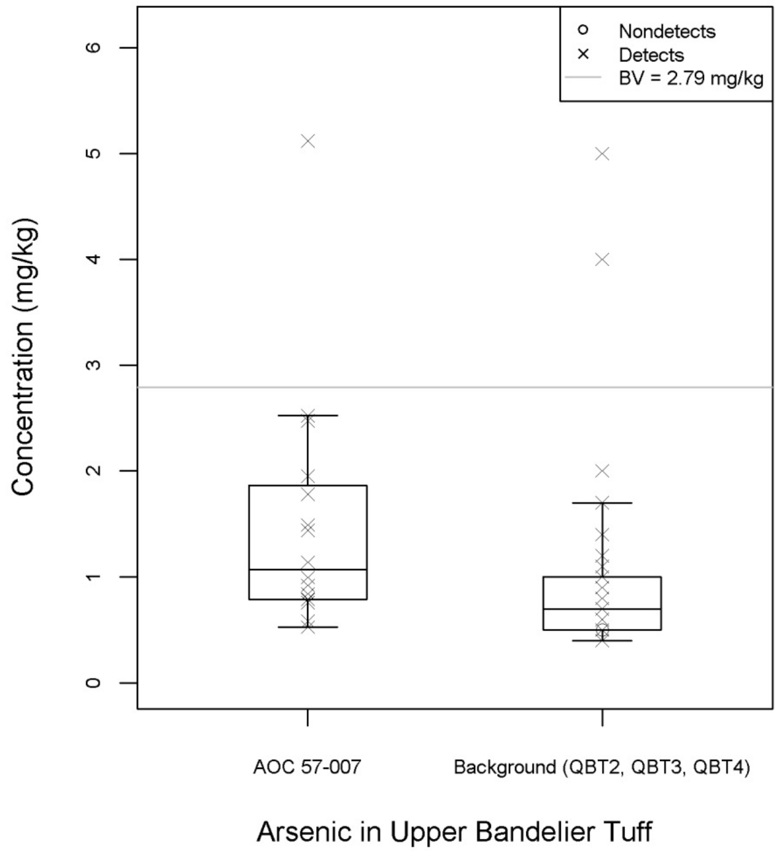

Figure F-2 Box plot for arsenic in tuff at AOC 57-007

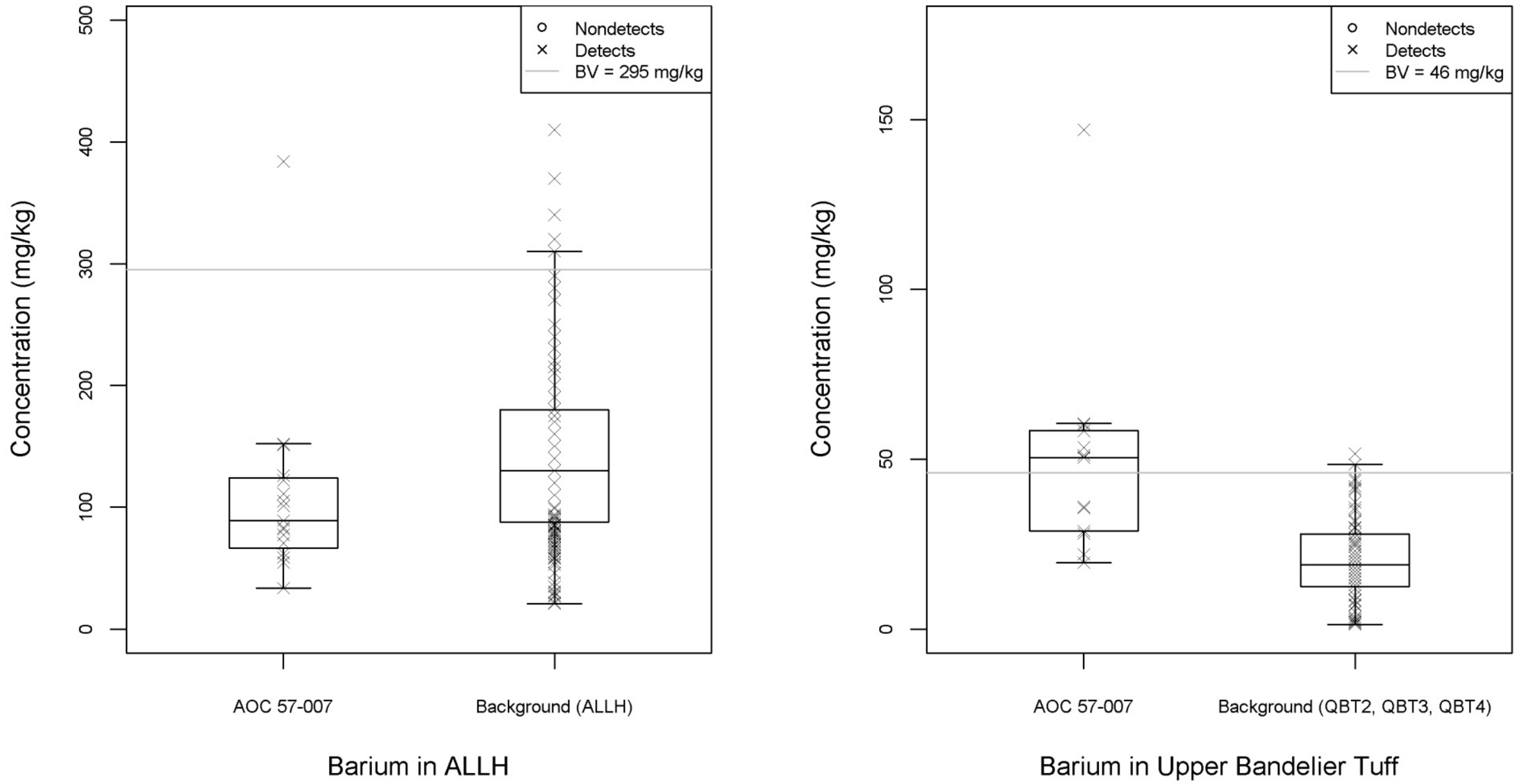

Figure F-3 Box plots for barium in soil and tuff at AOC 57-007

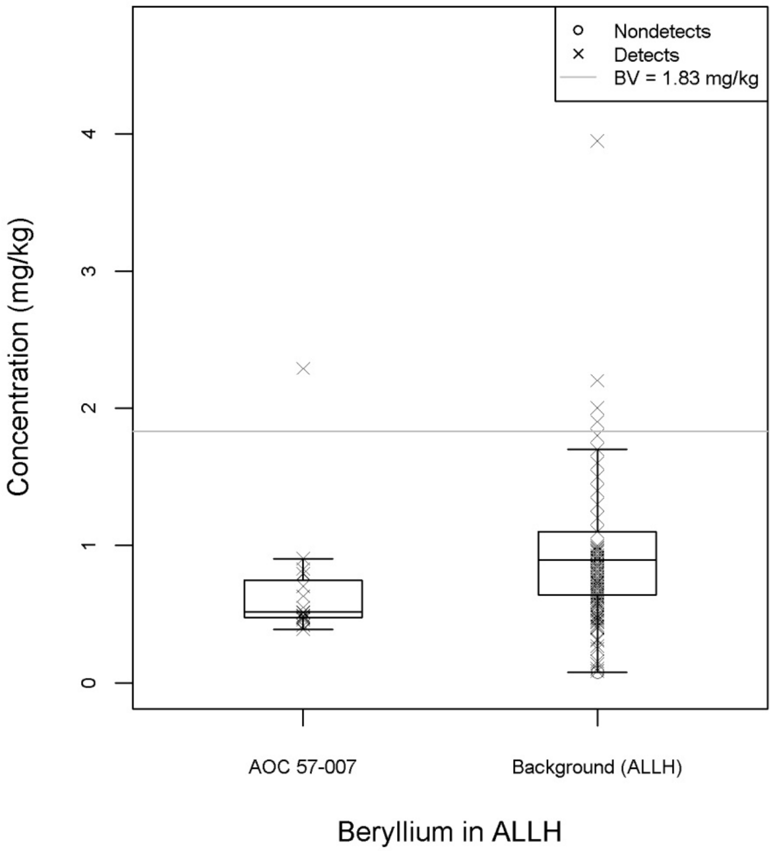

Figure F-4 **Box plot for beryllium in soil at AOC 57-007**

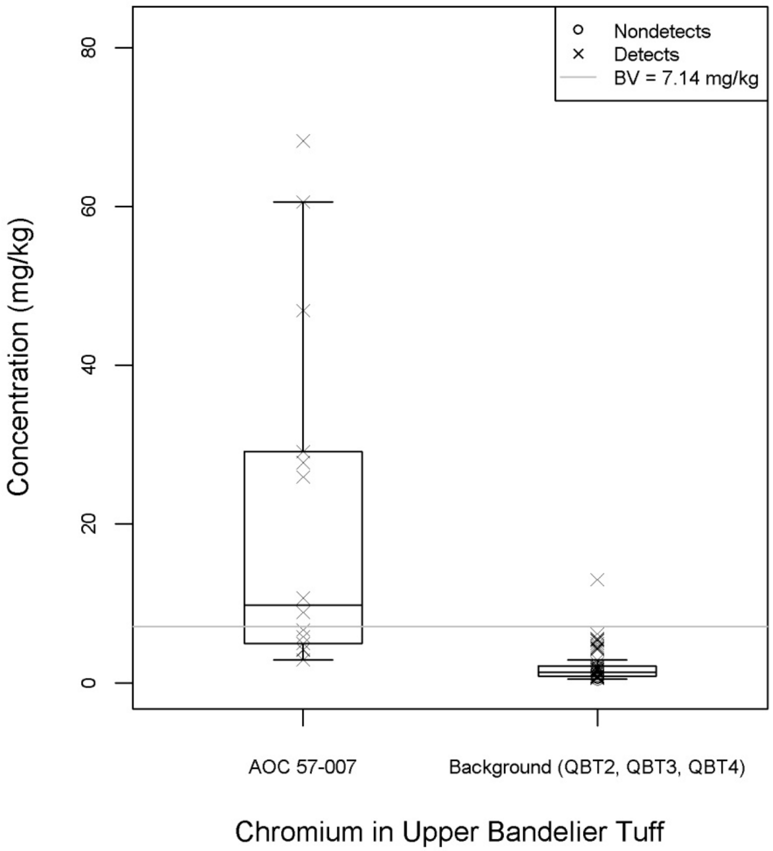

Figure F-5 Box plot for chromium in tuff at AOC 57-007

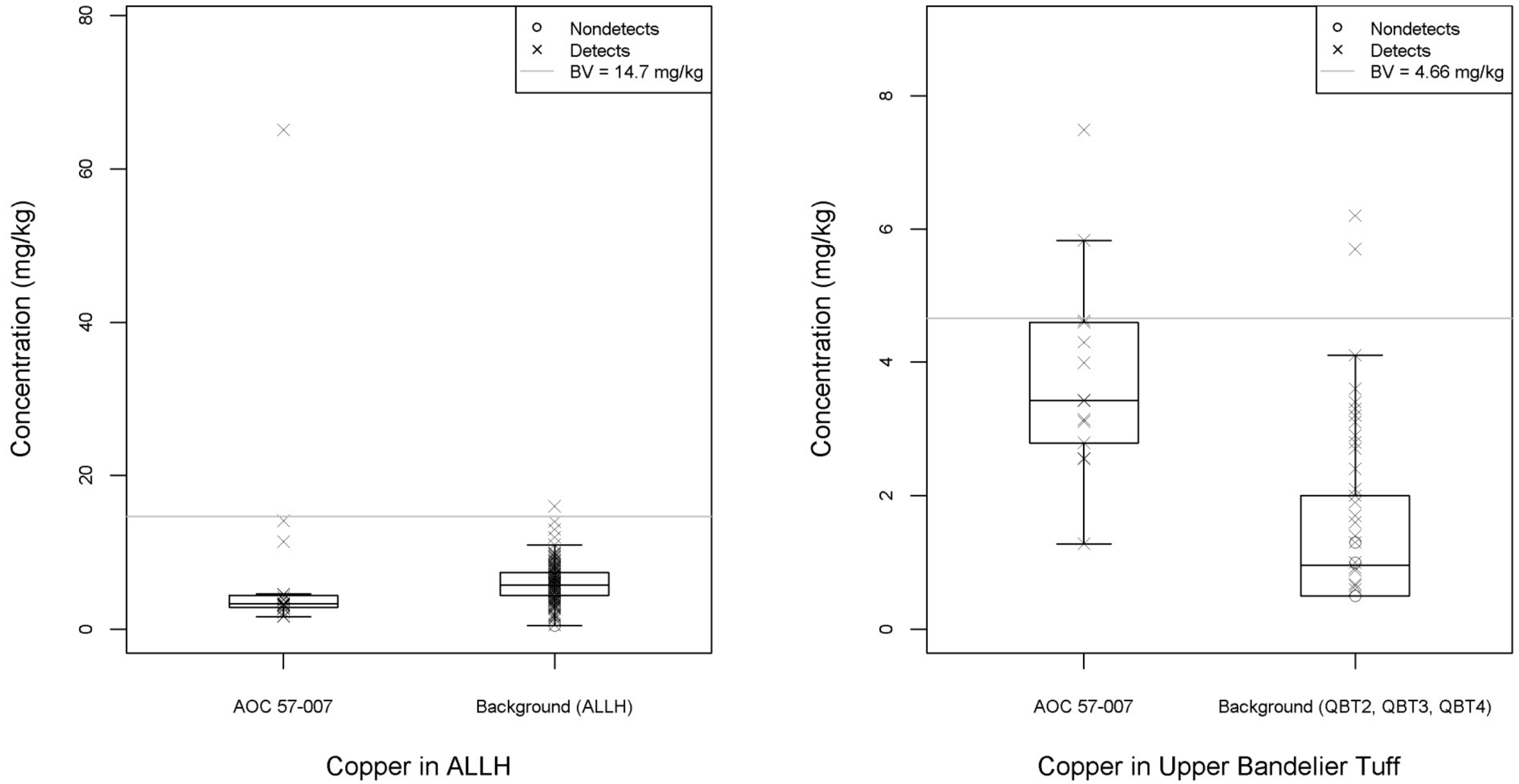

Figure F-6 **Box plots for copper in soil and tuff at AOC 57-007**

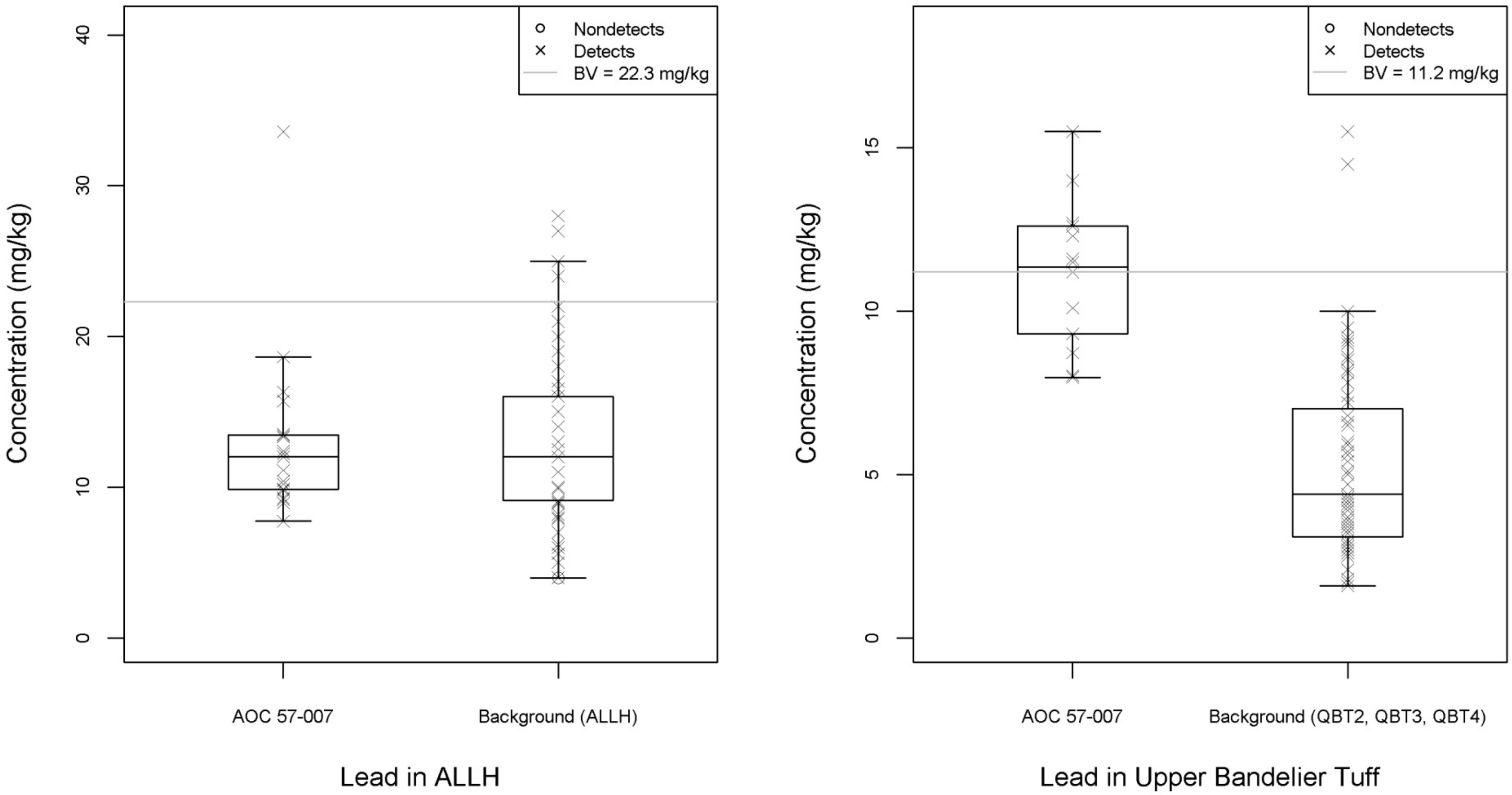

Figure F-7 Box plots for lead in soil and tuff at AOC 57-007

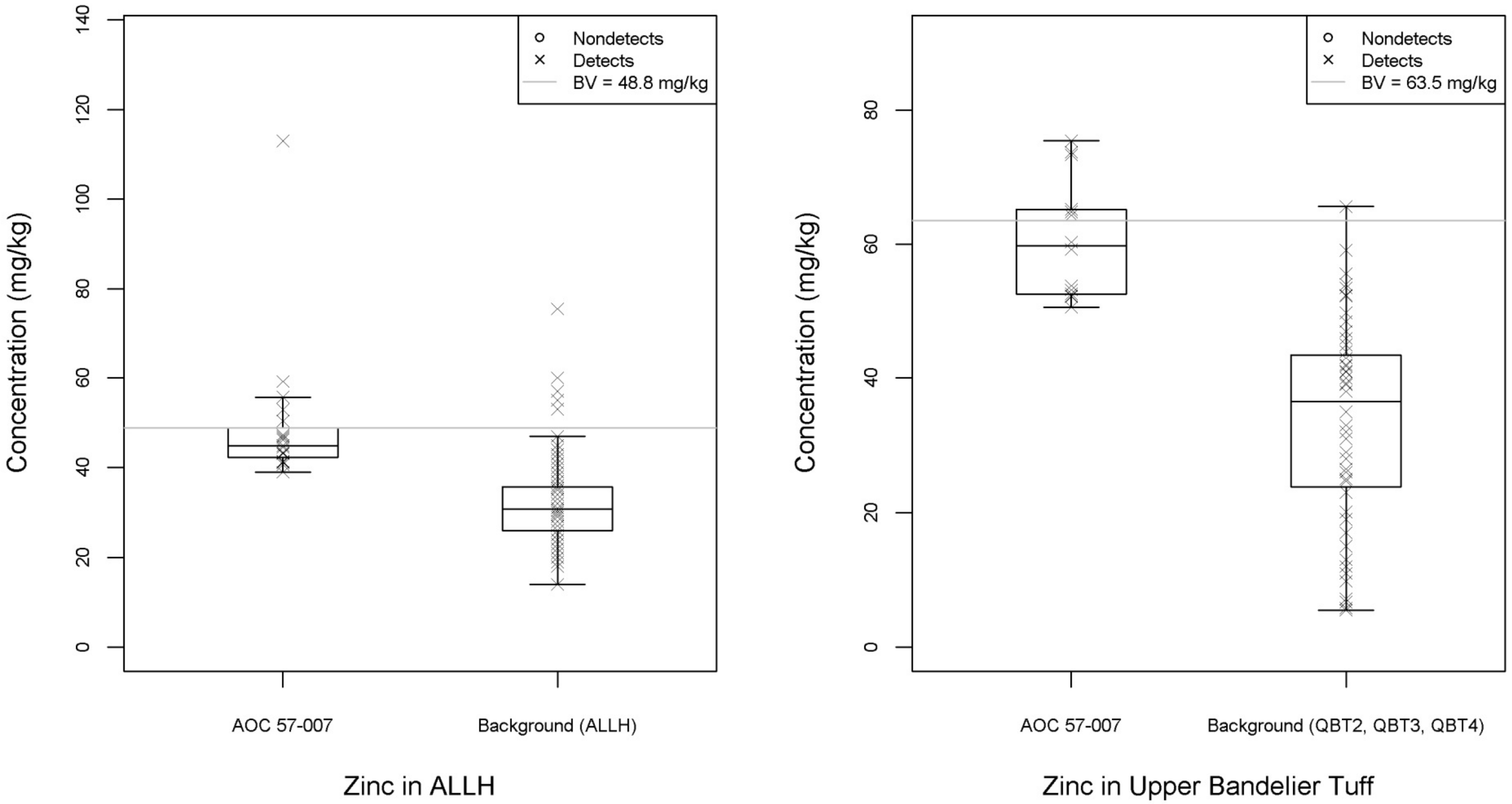

Figure F-8 Box plot for zinc in soil and tuff at AOC 57-007

Table F-1
Results of Statistical Tests for Inorganic Chemicals in Soil at AOC 57-007

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-value	Retain as COPC?
Aluminum	0.99828	1	n/a*	No
Barium	0.99503	0.61676	n/a	No
Beryllium	0.99975	0.6147	n/a	No
Copper	0.99957	0.04668	0.09845	No
Lead	0.64765	0.61676	n/a	No
Zinc	0	0	n/a	Yes

*n/a = Not applicable.

Table F-2
Results of Statistical Tests for Inorganic Chemicals in Tuff at AOC 57-007

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage p-value	Retain as COPC?
Aluminum	0.00028	0.13382	1	No
Arsenic	0.00279	0.01862	n/a*	Yes
Barium	0	9.00E-05	n/a	Yes
Chromium	0	0	n/a	Yes
Copper	0	8.00E-05	n/a	Yes
Lead	0	0	n/a	Yes
Zinc	0	0	n/a	Yes

*n/a = Not applicable.

Appendix G

Risk Assessments

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Attachments

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G-1.0 INTRODUCTION

This appendix presents the results of the human health and ecological risk-screening assessments conducted in support of the environmental characterization of two sites within the Technical Area 57 (TA-57) Aggregate Area. The areas of concern (AOCs) are located at TA-57, which is west of the main portion of Los Alamos National Laboratory (LANL or the Laboratory) (Figure 1.1-1 of the investigation report). The evaluation of potential risks at the two AOCs is based on decision-level data from the 2014 investigations.

G-2.0 BACKGROUND

Brief descriptions of the AOCs assessed for potential risks are presented below.

G-2.1 Site Descriptions and Operational History

TA-57 was established in 1974 to support the Laboratory's Hot Dry Rock (HDR) program. HDR was an experimental geothermal energy program designed to test the feasibility of extracting heat from deep geologic units near the Valles Caldera. The first location chosen for HDR was in Barley Canyon north of the current TA-57 site. After one test well had been drilled, this location was abandoned because of poor winter access and topographic limitations. Operations were moved to the current TA-57 location, which offered a large flat area with easier access. Operations at the TA-57 site began in 1974.

G-2.1.1 AOC 57-006

AOC 57-006 is the former location of a plastic-lined 55-gal. drum that was buried in the ground at TA-57 beneath a trailer (structure 57-23) that served as an analytical chemistry laboratory. The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer was used to dispose of wastewater associated with chemical analyses. The sink drained to a leach field (AOC 57-007) near the trailer. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to the polyethylene drum. When the drum was full, its contents were transported to the Laboratory for disposal. In 1994, the drum was removed as part of a voluntary corrective action (VCA). The chemistry trailer was removed from the site in March 1994.

G-2.1.2 AOC 57-007

AOC 57-007 is a leach field at TA-57 that served a former trailer (structure 57-23) used as an analytical chemistry laboratory. The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer drained to the leach field and was used to dispose of wastewater associated with chemical analyses. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to a polyethylene-lined 55-gal. drum (AOC 57-006). The chemistry trailer was removed from the site in March 1994.

G-2.2 Investigation Sampling

The data sets used to identify chemicals of potential concern (COPCs) and evaluate potential risks to human health and the environment for the sites consist of all validated data compiled from the 2014 investigations. Only data determined to be decision-level following the data-quality assessment (Appendix D) are included in the data sets evaluated in this appendix.

G-2.3 Determination of COPCs

Section 5 of the investigation report summarizes the COPC selection process. COPCs were retained only if they were detected above background (inorganic chemicals and radionuclides), had detection limits greater than background values (BVs) (inorganic chemicals), and were detected (organic chemicals and inorganic chemicals with no BVs). The industrial scenario utilizes data from samples collected from 0.0–1.0 ft below ground surface (bgs). The ecological risk screening utilizes data from samples collected from 0.0–5.0 ft bgs. The residential scenario utilizes data from samples collected from 0.0–10.0 ft bgs. However, sampling depths often overlapped because of multiple investigations; therefore, all samples with a starting depth less than the lower bound of the interval for each scenario were included in the risk-screening assessments for a given scenario.

Tables G-2.3-1 to G-2.3-5 summarize the COPCs evaluated for potential risk for the sites. Some of the COPCs identified by the data review may not be evaluated for potential risk under one or more scenarios because they were not COPCs within the specified depth intervals associated with a given scenario.

G-3.0 CONCEPTUAL SITE MODEL

The primary mechanisms of release are related to historical contaminant sources described in detail in the historical investigation report for the TA-57 Aggregate Area (LANL 2012, 214549) and summarized in section 2.3 of the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). Releases at the sites may have occurred as a result of subsurface leaks or effluent discharges. Previous sampling results indicated contamination from inorganic chemicals (LANL 2012, 214549).

G-3.1 Receptors and Exposure Pathways

The primary exposure pathway for human receptors is surface soil and subsurface soil/tuff that may be brought to the surface through intrusive activities. Migration of contamination to groundwater through the vadose zone is unlikely given the depth to groundwater (greater than 1000 ft bgs). Human receptors (industrial worker and resident) may be exposed through direct contact with soil or suspended particulates by ingestion, inhalation, dermal contact, and external irradiation pathways. Direct contact exposure pathways from subsurface contamination to human receptors are complete for the resident. The beef ingestion pathway is not complete because the sites are less than 2 acres in size. In addition, the area encompassing TA-57 is behind a locked fence, thereby prohibiting access by cattle. The exposure pathways for subsurface soil are the same as those for surface soil. Sources, exposure pathways, and receptors are shown in the conceptual site model (CSM) (Figure G-3.1-1).

The sites in the TA-57 Aggregate Area are industrial areas on U.S. Forest Service land used by the U.S. Department of Energy (DOE) pursuant to agreements with the Forest Service. The AOCs provide potential habitat and exposure pathways are complete to surface soil and tuff for ecological receptors. Weathering of tuff is the only viable natural process that may result in the exposure of receptors to COPCs in tuff. However, because of the slow rate of weathering expected for tuff, exposure to COPCs in tuff is negligible, although it is included in the assessments. Exposure pathways to subsurface contamination below 5.0 ft are not complete unless contaminated soil or tuff were excavated and brought to the surface. The potential pathways are root uptake by plants, inhalation of vapors (burrowing animals only), inhalation of dust, dermal contact, incidental ingestion of soil, external irradiation, and food web transport. Pathways from subsurface releases may be complete for plants. Surface water exposure was not evaluated because of the lack of surface water features. Sources, exposure pathways, and receptors are presented in the CSM (Figure G-3.1-1).

G-3.2 Environmental Fate and Transport

The evaluation of environmental fate addresses the chemical processes affecting the persistence of chemicals in the environment and the evaluation of transport addresses the physical processes affecting mobility along a migration pathway. Migration into soil and tuff depends on precipitation or snowmelt, soil moisture content, depth of soil, soil hydraulic properties, and properties of the COPCs. Migration into and through tuff also depends on the unsaturated flow properties of the tuff and the presence of joints and fractures.

The most important factor with respect to the potential for COPCs to migrate to groundwater is the presence of saturated conditions. Downward migration in the vadose zone is also limited by a lack of hydrostatic pressure as well as the lack of a source for the continued release of contamination. Without sufficient moisture and a source, little or no potential migration of materials through the vadose zone to groundwater occurs.

Contamination at depth is addressed in the discussion of nature and extent in the investigation report. Results from the deepest samples collected at most sites showed either no detected concentrations of COPCs or low- to trace-level concentrations of only a few inorganic, radionuclide, and/or organic COPCs in tuff. The limited extent of contamination is related to the absence of the key factors that facilitate migration, as discussed above. Given how long the contamination has been present in the subsurface, the physical and chemicals properties of the COPCs, and the lack of saturated conditions, the potential for contaminant migration to groundwater is very low.

The New Mexico Environment Department (NMED) guidance (NMED 2014, 600115) contains screening levels that consider the potential for contaminants in soil to result in groundwater contamination. These screening levels consider equilibrium partitioning of contaminants among solid, aqueous, and vapor phases and account for dilution and attenuation in groundwater through the use of dilution attenuation factors (DAFs). These DAF soil screening levels (SSLs) may be used to identify chemical concentrations in soil that have the potential to contaminate groundwater (EPA 1996, 059902). Screening contaminant concentrations in soil against these DAF SSLs does not, however, provide an indication of the potential for contaminants to migrate to groundwater. The assumptions used in the development of these DAF SSLs include an assumption of uniform contaminant concentrations from the contaminant source to the water table (i.e., it is assumed migration to groundwater has already occurred). Furthermore, this assumption is inappropriate for the sites where sampling has shown that contamination is vertically bounded near the surface and the distance from the surface to the water table is large. For these reasons, screening of contaminant concentrations in soil against the DAF SSLs was not performed.

The relevant release and transport processes of the COPCs are a function of chemical-specific properties that include the relationship between the physical form of the constituents and the nature of the constituent transport processes in the environment. Specific properties include the degree of saturation and the potential for ion exchange (barium and other inorganic chemicals) or sorption and the potential for natural bioremediation. The transport of volatile organic compounds (VOCs) occurs primarily in the vapor phase by diffusion or advection in subsurface air.

Current potential transport mechanisms that may lead to exposure include:

- dissolution and/or particulate transport of surface contaminants during precipitation and runoff events,
- airborne transport of contaminated surface soil,
- continued dissolution and advective/dispersive transport of chemical contaminants contained in subsurface soil and tuff as a result of past operations,
- disturbance of contaminants in shallow soil and subsurface tuff by Laboratory operations, and
- disturbance and uptake of contaminants in shallow soil by plants and animals.

Contaminant distributions at the sites indicate that after the initial deposition of contaminants from operational activities and historical remediation efforts, elevated levels of COPCs tend to remain concentrated in the vicinity of the original release points. The primary potential release and transport mechanisms identified for the AOCs include direct discharge; precipitation, sorption, and mechanical transport; dissolution and advective transport in water; and volatilization, diffusion, and dispersion. Less significant transport mechanisms include wind entrainment and, given the asphalt pavement covering most sites, dispersal of surface soil and uptake of contaminants from soil and water by biota.

Gas or vapor-phase contaminants such as VOCs are likely to volatilize to the atmosphere from near-surface soil and sediment and/or migrate by diffusion through air-filled pores in the vadose zone. Migration of vapor-phase contaminants from tuff into ambient air may occur by diffusion or advection driven by barometric pressure changes.

G-3.2.1 Inorganic Chemicals

In general, and particularly in a semiarid climate, inorganic chemicals are not highly soluble or mobile in the environment, although there are exceptions. The physical and chemical factors that determine the distribution of inorganic COPCs within the soil and tuff are the soil-water partition coefficient (K_d) of the inorganic chemicals, the pH of the soil, soil characteristics (such as sand or clay content), and the redox potential (Eh). The interaction of these factors is complex, but the K_d values provide a general assessment of the potential for migration through the subsurface; chemicals with higher K_d values are less likely to be mobile than those with lower ones. Chemicals with K_d values greater than 40 are very unlikely to migrate through soil towards the water table (Kincaid et al. 1998, 093270). Table G-3.2-1 presents the K_d values and water solubility for the inorganic COPCs at the AOCs. Based on this criterion, the following COPCs have a low potential to mobilize and migrate through soil and the vadose zone: antimony, barium, chromium, lead, mercury, and zinc. The K_d values for arsenic, cyanide, perchlorate, selenium, and silver are less than 40 and may indicate a greater potential to mobilize and migrate through soil and the vadose zone beneath the sites.

It is important to note that other factors besides the K_d values (e.g., speciation in soil, oxidation-reduction potential, pH, and soil mineralogy) also play significant roles in the likelihood that inorganic chemicals will migrate. The COPCs with K_d values less than 40 are discussed further below. Information about the fate and transport properties of inorganic chemicals was obtained from individual chemical profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR 1997, 056531, and http://www.atsdr.cdc.gov/toxpro2).

Arsenic may undergo a variety of reactions, including oxidation-reduction reactions, ligand exchange, precipitation, and biotransformation. Arsenic forms insoluble complexes with iron, aluminum, and magnesium oxides found in soil and in this form, arsenic is relatively immobile. However, under low pH and reducing conditions, arsenic can become soluble and may potentially leach into groundwater or result in runoff of arsenic into surface waters. Arsenic is expected to have low mobility under the environmental conditions (neutral to alkaline soil pH and oxidizing near-surface conditions) present at the sites.

Copper movement in soil is determined by physical and chemical interactions with the soil components. Most copper deposited in soil will be strongly adsorbed and remains in the upper few centimeters of soil. Copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron, and manganese oxides. In most temperate soil, pH, organic matter, and ionic strength of the soil solutions are the key factors affecting adsorption. Soil in the area is alkaline to neutral, so the leaching of copper is not a concern at this site. Copper binds to soil much more strongly than other divalent cations, and the distribution of copper in the soil solution is less affected by pH than other metals. Copper is expected to be bound to the soil and move in the system by way of transport of soil particles by water as opposed to movement as dissolved species.

Cyanide tends to adsorb onto various natural media, including clay and sediment; however, sorption is insignificant relative to the potential for cyanide to volatilize and/or biodegrade. At soil surfaces, volatilization of hydrogen cyanide is a significant mechanism for cyanide loss. Cyanide at low concentrations in subsurface soil is likely to biodegrade under both aerobic and anaerobic conditions. Cyanide is present at the site in trace to low levels and is not expected to be mobile.

Perchlorate is somewhat soluble in water and may migrate with water molecules in saturated soil. As noted above, the subsurface material beneath the sites has low moisture content, which inhibits the mobility of nitrate and perchlorate as well as most other inorganic chemicals.

Selenium is not often found in the environment in its elemental form but is usually combined with sulfide minerals or with silver, copper, lead, and nickel minerals. In soil, pH and Eh are determining factors in the transport and partitioning of selenium. In soil with a pH of greater than 7.5, selenates, which have high solubility and a low tendency to adsorb onto soil particles, are the major selenium species and are very mobile.

Natural processes, such as the weathering of rock and the erosion of soil release silver to air and water. Silver sorbs onto soil and sediment and tends to form complexes with inorganic chemicals and humic substances in soil. Organic matter complexes with silver and reduces its mobility. Silver compounds tend to leach from well-drained soil so that it may potentially migrate into the subsurface. Site conditions are neutral to slightly alkaline and silver is not expected to be mobile.

G-3.2.2 Organic Chemicals

Table G-3.2-2 presents the physical and chemical properties (organic carbon-water partition coefficient [K_{oc}], logarithm to the base 10 octanol-water partition coefficient [log K_{ow}], water solubility, and vapor pressure) of the organic COPCs identified for the sites. The physical and chemical properties of organic chemicals are important when evaluating their fate and transport. The following discussion about the physiochemical properties of organic COPCs is presented to illustrate some aspects of the fate and transport tendencies of the COPCs. The information is summarized from Ney (1995, 058210).

Water solubility is perhaps the most important chemical characteristic used to assess mobility of organic chemicals. The higher the water solubility of a chemical, the more likely it is to be mobile and the less likely it is to accumulate, bioaccumulate, volatilize, or persist in the environment. A highly soluble chemical (water solubility greater than 1000 mg/L) is prone to biodegradation and metabolism that may detoxify the parent chemical. Benzoic acid, methylene chloride, and trichloroethene have water solubilities greater than 1000 mg/L.

The lower the water solubility of a chemical, especially below 10 mg/L, the more likely it will be immobilized by adsorption. Chemicals with lower water solubilities are likely to accumulate or bioaccumulate and persist in the environment, to be slightly prone to biodegradation, and may be metabolized in plants and animals. The COPCs identified as having water solubilities less than 10 mg/L include bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and the polycyclic aromatic hydrocarbons (PAHs).

Vapor pressure is a chemical characteristic used to evaluate the tendency of organic chemicals to volatize. Chemicals with vapor pressure greater than 0.01 mmHg are likely to volatilize and, therefore, concentrations at the site are reduced over time; vapors of these chemicals are more likely to travel toward the atmosphere and not migrate towards groundwater. Dichlorobenzene[1,4-], methylene chloride, and trichloroethene have vapor pressures greater than 0.01 mmHg.

Chemicals with vapor pressures less than 0.000001 mmHg are less likely to volatilize and, therefore, tend to remain immobile. Bis(2-ethylhexyl)phthalate has a vapor pressure less than 0.000001 mmHg.

The K_{ow} is an indicator of a chemical's potential to bioaccumulate or bioconcentrate in the fatty tissues of living organisms. The unitless K_{ow} value is an indicator of water solubility, mobility, sorption and bioaccumulation. The higher the K_{ow} above 1000, the greater the affinity the chemical has for bioaccumulation/bioconcentration in the food chain, the greater the potential for sorption in the soil, and the lower the mobility (Ney 1995, 058210). The PAHs, phthalates, and 1,4-dichlorobenzene have a K_{ow} greater than 1000. A K_{ow} of less than 500 indicates high water solubility, mobility, little to no affinity for bioaccumulation, and degradability by microbes, plants, and animals. Benzoic acid, methylene chloride, and trichloroethene have a K_{ow} much less than 500.

The K_{oc} measures the tendency of a chemical to adsorb to organic carbon in soil. K_{oc} values above 500 cm^3/g indicate a strong tendency to adsorb to soil, leading to low mobility (NMED 2014, 600115). Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and the PAHs have K_{oc} values above 500 cm^3/g, indicating a very low potential to migrate toward groundwater. The organic COPCs with K_{oc} values less than 500 cm^3/g include benzoic acid, 1,4-dichlorobenzene, methylene chloride, and trichloroethene.

G-3.3 Exposure Point Concentration Calculations

The exposure point concentrations (EPCs) represent upper bound concentrations of COPCs. For comparison to risk-screening levels, the upper confidence limit (UCL) of the arithmetic mean was calculated when possible and used as the EPC. The UCLs were calculated using all available decision-level data within the depth range of interest. If an appropriate UCL of the mean could not be calculated or if the UCL exceeded the maximum concentration, the maximum detected concentration of the COPC was used as the EPC (maximum detection limits were used as the EPCs for some inorganic COPCs). The summary statistics, including the EPC for each COPC for the human health and the ecological risk-screening assessments and the distribution used for the calculation, are presented in Tables G-2.3-1 to G-2.3-5.

Calculation of UCLs of the mean concentrations was done using the EPA ProUCL 5.0.00 software (EPA 2013, 251074), which is based on EPA guidance (EPA 2002, 085640). The ProUCL program calculates 95%, 97.5%, and 99% UCLs and recommends a distribution and UCL. The 95% UCL for the recommended calculation method was used as the EPC. The ProUCL software performs distributional tests on the data set for each COPC and calculates the most appropriate UCL based on the distribution of the data set. Environmental data may have a normal, lognormal, or gamma distribution but are often nonparametric (no definable shape to the distribution). The ProUCL documentation strongly recommends against using the maximum detected concentration for the EPC. The maximum detected concentration was used to represent the EPC for COPCs only when there were too few detects to calculate a UCL. Input and output data files for ProUCL calculations are provided on CD as Attachment G-1.

G-4.0 HUMAN HEALTH RISK SCREENING ASSESSMENT RESULTS

The human health risk-screening assessments were conducted for each of the sites included in this report. All sites were screened for the residential scenarios using data from 0.0–10.0 ft bgs. Sites were also screened for the industrial scenario using data from 0.0–1.0 ft bgs, where available. The human health risk-screening assessments compare either the 95% UCL of the mean concentration, the maximum detected concentration, or the maximum detection limit of each COPC with SSLs for chemicals.

G-4.1 Human Health SSLs

Human health risk-screening assessments for chemicals were conducted using SSLs for the industrial and residential scenarios obtained from NMED guidance (NMED 2014, 600115). The NMED SSLs are based on a target noncarcinogenic hazard quotient (HQ) of 1 and a target cancer risk of 1×10^{-5} (NMED 2014, 600115). If SSLs were not available from NMED guidance, values from the EPA regional screening tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) were used. The EPA SSLs for carcinogens were multiplied by 10 to adjust from a 10^{-6} cancer risk level to the NMED target cancer risk level of 10^{-5}. Exposure parameters used to calculate the industrial and residential SSLs are presented in Table G-4.1-1.

G-4.2 Results of Human Health Screening Evaluation

The EPC of each COPC in soil was compared with the SSLs for the industrial and residential scenarios. For carcinogenic chemicals, the EPCs were divided by the SSL and multiplied by 1×10^{-5}. The sum of the carcinogenic risks was compared with the NMED target cancer risk level of 1×10^{-5}. For noncarcinogenic chemicals, an HQ was generated for each COPC by dividing the EPC by the SSL. The HQs were summed to generate a hazard index (HI). The HI was compared with the NMED target HI of 1. The results are presented in Tables G-4.2-1 to G-4.2-5 and are described below for each AOC evaluated.

G-4.2.1 AOC 57-006

The samples at AOC 57-006 were collected from depths greater than 0.0−1.0 ft bgs; therefore, no complete exposure pathways exist for the industrial scenario.

The results of the risk-screening assessment for the residential scenario are presented in Tables G-4.2-1 and G-4.2-2. The total excess cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2014, 600115). The residential HI is 0.05, which is less than the NMED target HI of 1 (NMED 2014, 600115).

G-4.2.2 AOC 57-007

The results of the risk-screening assessment for the industrial scenario are presented in Table G-4.2-3. No carcinogen COPCs were identified in the 0.0−1.0 ft bgs depth interval. The industrial HI is 0.001, which is less than the NMED target HI of 1 (NMED 2014, 600115).

The results of the risk-screening assessment for the residential scenario are presented in Tables G-4.2-4 and G-4.2-5. The total excess cancer risk for the residential scenario is 7×10^{-6}, which is less than the

NMED target risk level of 1 × 10^{-5} (NMED 2014, 600115). The residential HI is 0.3, which is less than the NMED target HI of 1 (NMED 2014, 600115).

G-4.3 Vapor-Intrusion Pathway

NMED guidance (NMED 2014, 600115) requires an evaluation of the vapor-intrusion pathway. The evaluation can be qualitative for a potentially complete pathway if the following criteria are met:

- VOCs are minimally detected,
- concentrations are below NMED's vapor-intrusion screening levels for soil-gas and/or groundwater,
- there is no suspected source(s) for VOCs, and
- concentrations are decreasing with depth (for soil).

Because only bulk soil data are available for the two AOCs, the vapor-intrusion screening levels are not applicable for the evaluation. Residential soil screening values were calculated using the Johnson and Ettinger model (http://www.epa.gov/swerrims/riskassessment/airmodel/johnson_ettinger.htm) for subsurface vapor intrusion into buildings (EPA 2002, 094114). The advanced soil model was used to calculate risk-based soil concentrations for VOCs. The maximum detected concentration of each VOC COPC was compared with the risk-based concentration generated by the model for each site. The model inputs and risk-based concentrations generated are provided in Attachment G-2 on CD. HQs and HIs were calculated for noncarcinogenic COPCs and total excess cancer risks for carcinogenic COPCs. The NMED target risk level of 1 × 10^{-5} and NMED target HI of 1 were applied.

The vapor-intrusion pathway was qualitatively evaluated as part of the residential scenario for each AOC.

G-4.3.1 AOC 57-006

There is no source for VOCs at AOC 57-006. The waste collection drum was removed as part of a VCA in 1994 (LANL 1995, 054336). Therefore, the potential source of the VOCs was removed approximately 20 yr ago. In addition, no buildings are currently on or near the site, and the Laboratory, DOE, or the Forest Service has no plans to put another trailer, structure, or building of any kind at this site.

VOCs were minimally detected at this AOC. Methylene chloride and trichloroethene were each detected in two samples at concentrations below the estimated quantitation limits (EQLs). In addition, concentrations decreased with depth at all locations. The screening of the bulk soil data using the Johnson and Ettinger model, as presented below, indicates the soil has not been impacted. The vapor-intrusion pathway is therefore potentially complete based on NMED guidance (NMED 2014, 600115) and no additional evaluation is necessary.

The results of the residential vapor-intrusion screening assessments are presented in Table G-4.3-1. The HI is approximately 0.004, which is less than the NMED target HI of 1 (NMED 2014, 600115). These results do not change the HI and cancer risk calculated as a result of exposure to soil, as presented in section G-4.2.

G-4.3.2 AOC 57-007

There is no source for VOCs at AOC 57-007. The chemistry trailer was used until 1989 and was removed from the site in March 1994. In addition, no buildings are currently on or near the site, and the Laboratory, DOE, or the Forest Service has no plans to put another trailer, structure, or building of any kind at this site.

VOCs were minimally detected at this AOC. Dichlorobenzene[1,4-] was detected in three samples, and methylene chloride and trichloroethene were each detected in two samples. Concentrations were below or slightly above the EQLs and decreased with depth at all locations. The screening of the bulk soil data using the Johnson and Ettinger model, as presented below, indicates the soil has not been impacted. The vapor-intrusion pathway is therefore potentially complete based on NMED guidance (NMED 2014, 600115) and no additional evaluation is necessary.

The results of the residential vapor-intrusion screening assessments are presented in Tables G-4.3-2 and G-4.3-3. The total excess cancer risk is approximately 2×10^{-8}, which is less than the NMED target cancer risk level of 1×10^{-5} (NMED 2014, 600115). The HI is approximately 0.004, which is less than the NMED target HI of 1 (NMED 2014, 600115). These results do not change the HI and cancer risk calculated as a result of exposure to soil, as presented in section G-4.2.

G-4.4 Uncertainty Analysis

The human health risk-screening evaluations are subject to varying degrees and types of uncertainty. Aspects of data evaluation and COPC identification, exposure evaluation, toxicity evaluation, and the additive approach all contribute to uncertainties in the risk-evaluation process.

G-4.4.1 Data-Evaluation and COPC-Identification Process

A primary uncertainty associated with the COPC-identification process is the possibility that a chemical may be inappropriately identified as a COPC when it is actually not a COPC or that a chemical may not be identified as a COPC when it actually should be identified as a COPC. All detected organic chemicals were retained for analysis. Inorganic chemicals were appropriately identified as COPCs because those either detected or with detection limits above background were retained for further analysis. However, background concentrations may not be representative of certain subunits of the Bandelier Tuff (e.g., fractured, clay-rich material) because such samples are not included in the background dataset.

Other uncertainties may include errors in sampling, laboratory analysis, and data analysis. However, because concentrations used in the risk-screening evaluations include those detected below EQLs and nondetects above BVs, data evaluation uncertainties are expected to have little effect on the risk-screening results.

G-4.4.2 Exposure Evaluation

The current and reasonably foreseeable future land use is industrial. To the degree actual activity patterns are not represented by those activities assumed by the industrial scenario, uncertainties are introduced in the assessment, and the evaluation presented in this assessment overestimates potential risk. An individual may be subject to exposures in a different manner than the exposure assumptions used to derive the industrial SSLs. For the sites evaluated, individuals might not be on-site at present or in the future for that frequency and duration. The industrial assumptions for the SSLs are that the potentially exposed individual is outside on-site for 8 h/d, 225 d/yr, and 25 yr (NMED 2014, 600115). The residential SSLs are based on exposure of 24 h/d, 350 d/yr, and 30 yr (NMED 2014, 600115). As a result, the industrial and residential scenarios evaluated at these sites likely overestimate the exposure and risk.

A number of assumptions are made relative to exposure pathways, including input parameters, completeness of a given pathway, the contaminated media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with default values (NMED 2014, 600115). When several upper-bound values (as are found in NMED 2014, 600115) are combined to estimate exposure for any one pathway, the resulting risk estimate can exceed the 99th percentile and, therefore, can exceed the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and result in exposure in the same manner as if they were in soil overestimates the potential exposure and risk to receptors.

Uncertainty is introduced in the concentration aggregation of data for estimating the EPCs at a site. Risk from a single location or area with relatively high COPC concentrations may be underestimated by using a representative site-wide value. The use of a UCL is intended to provide a protective upper-bound (i.e., conservative) COPC concentration and is assumed to be representative of the average exposure to a COPC across the entire site. Potential risk and exposure from a single location or area with relatively high COPC concentrations may be overestimated if a representative site-wide value is used. The use of the maximum detected concentration for the EPC overestimates the exposure to contamination because receptors are not consistently exposed to the maximum detected concentration across the site. In addition, the maximum detection limit was used as the EPC for some inorganic COPCs with elevated detection limits above BVs.

G-4.4.3 Toxicity Evaluation

The primary uncertainty associated with the SSLs is related to the derivation of toxicity values used in their calculation. Toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SSLs used in this risk-screening evaluation (NMED 2014, 600115). Uncertainties were identified in four areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) interindividual variability in the human population, (3) the derivation of RfDs and SFs, and (4) the chemical form of the COPC. No surrogates were used to establish toxicity values in the risk assessments.

Extrapolation from Animals to Humans. The SFs and RfDs are often determined by extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. Differences in body weight, surface area, and pharmacokinetic relationships between animals and humans are taken into account to address these uncertainties in the dose-response relationship. However, conservatism is usually incorporated in each of these steps, resulting in the overestimation of potential risk.

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

Derivation of RfDs and SFs. The RfDs and SFs for different chemicals are derived from experiments conducted by different laboratories that may have different accuracy and precision that could lead to an over- or underestimation of the risk. The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. For carcinogens, the weight of evidence classification indicates the likelihood that a contaminant is a human carcinogen. Toxicity values with high uncertainties may change as new information is evaluated.

Chemical Form of the COPC. COPCs may be bound to the environment matrix and not available for absorption into the human body. However, it is assumed that the COPCs are bioavailable. This assumption can lead to an overestimation of the total risk.

G-4.4.4 Additive Approach

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

G-4.5 Interpretation of Human Health Risk Screening Results

G-4.5.1 AOC 57-006

Industrial Scenario

Samples were not collected from 0.0−1.0 ft bgs. Therefore, the industrial scenario was not evaluated.

Residential Scenario

The total excess cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5}. The residential HI is 0.05, which is less than the NMED target HI of 1.

G-4.5.2 AOC 57-007

Industrial Scenario

No carcinogen COPCs were identified in the depth interval of 0.0−1.0 ft bgs. The HI for the industrial scenario is 0.001, which is less than the NMED target HI of 1.

Residential Scenario

The total excess cancer risk for the residential scenario is 7×10^{-6}, which is less than the NMED target risk level of 1×10^{-5}. The residential HI is 0.3, which is less than the NMED target HI of 1.

G-5.0 ECOLOGICAL RISK-SCREENING EVALUATIONS

G-5.1 Introduction

The approach for conducting ecological evaluations is described in the “Screening Level Ecological Risk Assessment Methods, Revision 3” (LANL 2012, 226715). The evaluation consists of four parts: a scoping evaluation, a screening evaluation, an uncertainty analysis, and an interpretation of the results.

G-5.2 Scoping Evaluation

The scoping evaluation establishes the breadth and focus of the screening evaluation. The ecological scoping checklist (Attachment G-3) is a useful tool for organizing existing ecological information. The information was used to determine whether ecological receptors might be affected, identify the types of receptors that might be present, and develop the ecological conceptual site model for the sites (Attachment G-3). Most of the area on the mesa top is developed and typically provides minimal potential habitat for ecological receptors. The quality of the habitat varies and, in some cases, includes native grasses, forbs, and trees that can be suitable habitat for ecological receptors.

The scoping evaluation indicated that terrestrial receptors were appropriate for evaluating the concentrations of COPCs in soil and tuff. Exposure is assessed across a site to a depth of 0.0–5.0 ft bgs. Aquatic receptors were not evaluated because no aquatic communities and no aquatic habitat or perennial source of water exist at any of the sites. The depth of the regional aquifer (greater than 1000 ft bgs) and the semiarid climate limit transport to groundwater. The potential exposure pathways for terrestrial receptors in soil and tuff are root uptake, inhalation, soil ingestion, dermal contact, and food web transport (Attachment G-3). The weathering of tuff is the only viable natural process that may result in the exposure of receptors to contaminants in tuff. Because of the slow rate of weathering expected for tuff, exposure in tuff is negligible, although it is included in the assessment. Plant exposure in tuff is largely limited to fractures near the surface, which does not produce sufficient biomass to support an herbivore population. Consequently, the contaminants in tuff are unavailable to receptors.

The potential risk was evaluated in the risk-screening assessments for the following ecological receptors representing several trophic levels:

- a plant
- soil dwelling invertebrates (represented by the earthworm)
- the deer mouse (mammalian omnivore)
- the montane shrew (mammalian insectivore)
- desert cottontail (mammalian herbivore)
- red fox (mammalian carnivore)
- American robin (avian insectivore, avian omnivore, and avian herbivore)
- American kestrel (avian insectivore and avian carnivore)

The rationale for using these receptors is presented in “Screening Level Ecological Risk Evaluation Methods, Revision 3” (LANL 2012, 226715). The Mexican spotted owl does not nest or forage in the Fenton Hill area. The Jemez Mountain salamander (JMS) is the only threatened and endangered [T&E] species known to occur in the Fenton Hill area (Attachment G-4). The entire footprint of TA-57 is comprised of either developed or undeveloped core habitat for the JMS as defined by the Laboratory’s Habitat Management Plan (ENV Division Resources Management Team 2014, 600084). The previously disturbed footprint at TA-57 is developed core habitat and the undeveloped tree covered areas are undeveloped core habitat. Both AOCs 57-006 and 57-007 and their sampling locations are within developed core habitat for JMS.

Surveys for the JMS at TA-57 have been conducted by Federal- and State-permitted Laboratory biologists in 2012, 2013, and 2014 during the monsoon season, and no JMSs were observed. Historical surveys were completed at the site on June 23, 1985, and no JMSs were found. The nearest JMS observation to TA-57 is 0.75 mi north-northeast in designated critical habitat on the east side of the highway. In a 2-mi radius of TA-57, all of the positive observations of JMS occurred on undeveloped tree-covered slopes. The TA-57 complex is situated on a flat, open mesa top with very little change in elevation. The likelihood of JMS occurring on the sites is very low, and occurrence of a JMS in the developed core habitat areas would essentially be zero (Attachment G-4).

G-5.3 Assessment Endpoints

An assessment endpoint is an explicit expression of the environmental value to be protected. These endpoints are ecologically relevant and help sustain the natural structure, function, and biodiversity of an ecosystem or its components (EPA 1998, 062809). In a screening-level evaluation, assessment endpoints are any adverse effects on ecological receptors, where receptors are populations and communities (EPA 1997, 059370). The purpose of the ecological screening evaluation is to protect populations and communities of biota rather than individual organisms, except for listed or candidate T&E species or treaty-protected species (EPA 1999, 070086) because populations of protected species tend to be small and the loss of an individual adversely affects the species as a whole (EPA 1997, 059370).

In accordance with this guidance, the Laboratory developed generic assessment endpoints (LANL 1999, 064137) to ensure that values at all levels of ecological organization are considered in the ecological screening process. These general assessment endpoints can be measured using impacts on reproduction, growth, and survival to represent categories of effects that may adversely impact populations. In addition, specific receptor species were chosen to represent each functional group. The receptor species were chosen because of their presence at the site, their sensitivity to the COPCs, and their potential for exposure to those COPCs. These categories of effects and the chosen receptor species were used to select the types of effects seen in toxicity studies considered in the development of the toxicity reference values (TRVs). Toxicity studies used in the development of TRVs included only studies in which the adverse effect evaluated affected reproduction, survival, and/or growth.

The selection of receptors and assessment endpoints is designed to be protective of both the representative species used as screening receptors and the other species within their feeding guilds and the overall food web for the terrestrial and aquatic ecosystems. Focusing the assessment endpoints on the general characteristics of species that affect populations (rather than the biochemical and behavioral changes that may affect only the studied species) also ensures the applicability to the ecosystem of concern.

G-5.4 Ecological Risk Screening Evaluation

The ecological screening evaluation identifies chemicals of potential ecological concern (COPECs) and is based on the comparison of EPCs (95% UCLs, maximum detected concentrations, or maximum detection limits) to ecological screening levels (ESLs). The EPCs used in the assessments for the sites are presented in Tables G-2.3-1 through Table G-2.3-5.

The ESLs were obtained from the ECORISK Database, Version 3.2 (LANL 2014, 262559) and are presented in Table G-5.4-1. The ESLs are based on similar species and are derived from experimentally determined NOAELs, lowest observed adverse effect levels (LOAELs), or doses determined lethal to 50% of the test population. Information relevant to the calculation of ESLs, including concentration equations, dose equations, bioconcentration factors, transfer factors, and TRVs, are presented in the ECORISK Database, Version 3.2 (LANL 2014, 262559).

The analysis begins with a comparison of the minimum ESL for a given COPC to the EPC. The HQ is defined as the ratio of the EPC to the concentration that has been determined to be acceptable to a given ecological receptor (i.e., the ESL). The higher the contaminant levels relative to the ESLs, the higher the potential risk to receptors; conversely, the higher the ESLs relative to the contaminant levels, the lower the potential risk to receptors. HQs greater than 0.3 are used to identify COPECs requiring additional evaluation (LANL 2012, 226715). Individual HQs for a receptor are summed to derive an HI; COPCs without ESLs are retained as COPECs and evaluated further in the uncertainty section. An HI greater than 1 indicates further assessment may be needed to ensure exposure to multiple COPECs at a site will not lead to potential adverse impacts to a given receptor population. The HQ and HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential of overlooking possible COPECs at the site.

G-5.4.1 AOC 57-006

The results of the minimum ESL comparisons are presented in Table G-5.4-2. Antimony and zinc are retained as COPECs because the HQs were greater than 0.3.

The HQs and HIs for each COPEC and receptor combination are presented in Table G-5.4-3. The HI analysis indicates that the robin (insectivore) and shrew have HIs equivalent to 1 (the shrew HI was 0.97). The COPECs and receptors are discussed in the uncertainty section.

G-5.4.2 AOC 57-007

The results of the minimum ESL comparisons are presented in Table G-5.4-4. Barium, chromium, copper, cyanide, lead, mercury, selenium, silver, zinc, benzoic acid, and bis(2-ethylhexyl)phthalate are retained as COPECs because the HQs were greater than 0.3.

Perchlorate does not have ESLs, is retained as a COPEC, and is discussed in the uncertainty section.

The HQs and HIs for each COPEC and receptor combination are presented in Table G-5.4-5. The HI analysis indicates that the kestel (both feeding guilds), robin (all feeding guilds), cottontail, shrew, deer mouse, earthworm, and plant have HIs greater than 1. The COPECs and receptors are discussed in the uncertainty section.

G-5.5 Uncertainty Analysis

The uncertainty analysis describes the key sources of uncertainty related to the screening evaluations. This analysis can result in either adding or removing chemicals from the list of COPECs for sites. The following narrative contains a qualitative uncertainty analysis of the issues relevant to evaluating the potential ecological risk at the sites.

G-5.5.1 Chemical Form

The assumptions used in the ESL derivations were conservative and not necessarily representative of actual conditions. These assumptions include maximum chemical bioavailability, maximum receptor ingestion rates, minimum bodyweight, and additive effects of multiple COPECs. Most of these factors tend to result in conservative estimates of the ESLs, which may lead to an overestimation of the potential risk. The assumption of additive effects for multiple COPECs may result in an over- or underestimation of the potential risk to receptors.

The chemical form of the individual COPCs was not determined as part of the investigation, largely a limitation on analytical quantitation of individual chemical species. Toxicological data are typically based on the most toxic and bioavailable chemical species not likely found in the environment. The inorganic, organic, and radionuclide COPECs are generally not 100% bioavailable to receptors in the natural environment because of the adsorption of chemical constituents to matrix surfaces (e.g., soil) or rapid oxidation or reduction changes that render harmful chemical forms unavailable to biotic processes. The ESLs were calculated to ensure a conservative indication of potential risk (LANL 2012, 226715), and the values were biased toward overestimating the potential risk to receptors.

G-5.5.2 Exposure Assumptions

The EPCs used in the calculations of HQs were the 95% UCL, the maximum detected concentration, or the maximum detection limit to a depth of 5.0 ft, thereby conservatively estimating the exposure to each COPC. As a result, the exposure of individuals within a population was evaluated using this specific concentration, which was assumed constant throughout the exposure area. The sampling also focused on areas of known contamination, and receptors were assumed to ingest 100% of their food and spend 100% of their time at the site. The assumptions made regarding exposure for terrestrial receptors results in an overestimation of the potential exposure and risk because COPECs varied across the site and were infrequently detected.

G-5.5.3 Toxicity Values

The HQs were calculated using ESLs, which are based on NOAELs as threshold effect levels; actual risk for a given COPEC/receptor combination occurs at a higher level, somewhere between the NOAEL-based threshold and the threshold based on the LOAEL. The use of NOAELs leads to an overestimation of potential risk to ecological receptors. ESLs are based on laboratory studies requiring extrapolation to wildlife receptors. Laboratory studies are typically based on “artificial” and maintained populations with genetically similar individuals and are limited to single chemical exposures in isolated and controlled conditions using a single exposure pathway. Wild species are concomitantly exposed to a variety of chemical and environmental stressors, potentially rendering them more susceptible to chemical stress. On the other hand, wild populations are likely more genetically diverse than laboratory populations, making wild populations, as a whole, less sensitive to chemical exposure than laboratory populations. The uncertainties associated with the ESLs may result in an under- or overestimation of potential risk.

G-5.5.4 Population Area Use Factors

EPA guidance is to manage the ecological risk to populations rather than to individuals, with the exception of T&E species (EPA 1999, 070086). One approach to address the potential effects on populations at sites is to estimate the spatial extent of the area inhabited by the local population that overlaps with the contaminated area. The population area for a receptor is based on the individual receptor home range (HR) and its dispersal distance. Bowman et al. (2002, 073475) estimate that the median dispersal distance for mammals is 7 times the linear dimension of the HR (i.e., the square root of the HR area). If only the dispersal distances for the mammals with HRs within the range of the screening receptors are used (Bowman et al. 2002, 073475), the median dispersal distance becomes 3.6 times the square root of the HR (R^2=0.91). If it is assumed that the receptors can disperse the same distance in any direction, the population area is circular and the dispersal distance is the radius of the circle. Therefore, the population area can be derived by $\pi(3.6\sqrt{\text{HR}})^2$ or approximately 40HR.

AOC 57-006

The area of AOC 57-006 is approximately 0.001 ha. The population area use factors (PAUFs) are estimated by dividing the site area by the population area of each receptor population (Table G-5.5-1). The HQs and HIs are recalculated using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for AOC 57-006 are less than 1 for all receptors. The plant had an unadjusted HI of 0.4 and the earthworm had an unadjusted HI of 0.5 (Table G-5.5-2).

AOC 57-007

The area of AOC 57-007 is approximately 0.03 ha. The PAUFs are estimated by dividing the site area by the population area of each receptor population (Table G-5.5-3). The HQs and HIs are recalculated using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for AOC 57-007 are less than 1 for all receptors. The plant had an unadjusted HI of 4 and the earthworm had an unadjusted HI of 82 (Table G-5.5-4).

G-5.5.5 LOAEL Analysis

AOC 57-007 has HIs greater than 1 for one or more receptors. To address the HIs and reduce the associated uncertainty, analyses were conducted using ESLs calculated based on a LOAEL rather than a NOAEL. The LOAEL-based ESLs were calculated based on toxicity information in the ECORISK Database, Release 3.2 (LANL 2014, 262559) and are presented in Table G-5.4-5. The analyses address some of the uncertainties and conservativeness of the ESLs used in the initial screening assessments. HI analyses and adjusted HI analyses were conducted using the LOAEL-based ESLs.

G-5.5.6 Site Discussions

AOC 57-007

The HI for AOC 57-007 is greater than 1 for the plant, with barium, selenium, and zinc being the primary COPECs. The HI analysis using LOAEL-based ESLs resulted in an HI of 0.9 for the plant (Table G-5.5-6).

The HI for AOC 57-007 is greater than 1 for the earthworm, with barium, mercury, and zinc being the primary COPECs. The HI analysis using LOAEL-based ESLs resulted in an HI of approximately 8 for the earthworm primarily from mercury (Table G-5.5-6). The mercury EPC for the 0.0–5.0 ft interval is 4.04 mg/kg. However, only four samples at two locations have mercury concentrations greater than the BV of 0.1 mg/kg. The locations are within the leach field and are in close proximity (less than 5 ft apart). In addition, two of the four samples in which mercury concentrations were above the BV were collected from Qbt3, which is a less bioavailable matrix compared with soil. The EPC without the two largest concentrations from soil (20.6 mg/kg and 4.2 mg/kg) is 0.21 mg/kg, which is less than the LOAEL-based-ESL and results in an HQ of 0.4. Thus, most of the site poses no potential risk to the earthworm, and the HI does not indicate potential risk to the soil invertebrate population beyond the small area and limited depth of the elevated mercury concentrations. In addition, field observations made during the site visit found no indication of adverse effects from COPECs on the terrestrial community (Attachment G-3). Field observations indicated the area in and around the site has moderate-to-high vegetative cover, which is evidence of recolonzation of these sites after their active use as industrial sites. Therefore, the HI does not indicate potential risk to the plants or soil invertebrates.

G-5.5.7 Chemicals without ESLs

One COPEC does not have ESLs for any receptor in version 3.2 of the ECORISK Database (LANL 2014, 262559). In an effort to address this uncertainty and to provide a quantitative assessment of potential ecological risk, several online toxicity databases searches were conducted to determine if any relevant toxicity information is available. The online searches of the following databases were conducted: EPA Ecotox Database, EPA Office of Pesticide Programs Aquatic Life Benchmarks, U.S. Army Corps of Engineers/EPA Environmental Residue-Effects, California Cal/Ecotox Database, Pesticide Action Network Pesticide Database, U.S. Army Wildlife Toxicity Assessment Program, U.S. Department of Agriculture Integrated Pesticide Management Database, American Bird Conservancy Pesticide Toxicity Database, and Oak Ridge National Laboratory Risk Assessment Information System. Some COPECs without ESLs do not have chemical-specific toxicity data or surrogate chemicals to be used in the screening assessments and cannot be assessed quantitatively for potential ecological risk. The COPEC in question was not detected at one site and infrequently detected at the other site.

Toxicity data are not available for perchlorate. For perchlorate, no surrogate or other toxicity information is available.

Perchlorate was not detected at AOC 57-006 and was detected in seven samples at AOC 57-007 from 0.0−5.0 ft with concentrations ranging from 0.000582 mg/kg to 0.00159 mg/kg. The NMED residential SSL for perchlorate is 54.8 mg/kg, indicating that potential toxicity is low. Because of the potential low toxicity and infrequent detection of perchlorate, it is eliminated as a COPEC.

G-5.6 Interpretation of Ecological Risk Screening Results

G-5.6.1 Receptor Lines of Evidence

Based on the ecological risk-screening assessments, several COPECs (including COPECs without an ESL) were identified for the sites. Receptors were evaluated using several lines of evidence: minimum ESL comparisons, HI analyses, potential effects to populations, and LOAEL analyses.

Plant

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the plant, were less than 0.3.
- The HI was less than 1 for the plant at AOC 57-006, and the HI was greater than 1 for the plant at AOC 57-007.
- The HI analysis using the LOAEL-based ESL resulted in an HI less than 1 for AOC 57-007.
- Field observations made during the site visit found no indication of adverse effects on the plant community from COPECs. In addition, these sites have moderate-to-high vegetative cover, which is evidence of recolonization of these sites since their active use as industrial sites.

These lines of evidence support the conclusion that no potential ecological risk to the plants exists at theTA-57 Aggregate Area sites.

Earthworm (Invertebrate)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the earthworm, were less than 0.3.
- The HI was less than 1 for the earthworm at AOC 57-006, and the HI was greater than 1 for the earthworm at AOC 57-007.
- The HI analysis using the LOAEL-based ESL resulted in an HI greater than 1 for AOC 57-007.
- As discussed in section G-5.5.6, the potential risks to the earthworm are overestimated and/or are not representative of the site.

These lines of evidence support the conclusion that no potential ecological risk to the earthworm (soil invertebrate population) exists at the TA-57 Aggregate Area sites.

Montane Shrew (Insectivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the shrew, were less than 0.3.
- The HI was less than 1 for the shrew at AOC 57-006, and the HI was greater than 1 for the shrew at AOC 57-007.
- The HI for AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the shrew's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the montane shrew exists at the TA-57 Aggregate Area sites.

Deer Mouse (Omnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the deer mouse, were less than 0.3.
- The HI was less than 1 for the deer mouse at AOC 57-006, and the HI was greater than 1 for the deer mouse at AOC 57-007.
- The HI for AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the deer mouse's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the deer mouse exists at the TA-57 Aggregate Area sites.

Desert Cottontail (Herbivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the cottontail, were less than 0.3.
- The HI was less than 1 for the cottontail at AOC 57-006, and the HI was greater than 1 for the cottontail at AOC 57-007.
- The HI for AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the cottontail's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the cottontail exists at the TA-57 Aggregate Area sites.

Red Fox (Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the fox, were less than 0.3.
- The HIs were less than 1 for the red fox at both sites.

These lines of evidence support the conclusion that no potential ecological risk to the fox exists at the TA-57 Aggregate Area sites.

Robin (All Feeding Guilds)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the robin, were less than 0.3.
- The HI was less than 1 for the robin (herbivore and omnivore) and equivalent to 1 for the robin (insectivore) at AOC 57-006, and the HIs were greater than 1 for the robin (all feeding guilds) at AOC 57-007.
- The HIs were adjusted by the PAUF, which is the ratio of the site area to the robin's population area. The adjusted HIs were less than 1 at both sites.

These lines of evidence support the conclusion that no potential ecological risk to the robin (all feeding guilds) exists at the TA-57 Aggregate Area sites.

Kestrel (Intermediate Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (intermediate carnivore), were less than 0.3.
- The HI was less than 1 for the kestrel (intermediate carnivore) at AOC 57-006, and the HI was greater than 1 for the kestrel (intermediate carnivore) at AOC 57-007.
- The HI at AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the kestrel's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the kestrel (intermediate carnivore) exists at the TA-57 Aggregate Area sites.

Kestrel (Top Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (top carnivore), were less than 0.3.
- The HI was less than 1 for the kestrel (top carnivore) at AOC 57-006, and the HI was greater than 1 for the kestrel (top carnivore) at AOC 57-007.
- The HI at AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the kestrel's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risks to the kestrel (top carnivore) exist at the TA-57 Aggregate Area sites.

G-5.6.2 COPECs with No ESLs

The COPEC without ESLs was eliminated based on comparisons to human health SSLs and the frequency of detection.

G-5.6.3 Summary

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, LOAEL analyses, and COPECs without ESLs no potential ecological risks to the ecological receptors exist at the TA-57 Aggregate Area sites.

G-6.0 CONCLUSIONS

G-6.1 Human Health Risk

AOC 57-006 was not evaluated for the industrial scenario because no samples were collected from the 0.0–1.0-ft depth interval. For AOC 57-007, no carcinogen COPCs were identified in the 0.0–1.0-ft depth interval and the industrial HI was less than 1. Therefore, the exposure and risk are not issues for a Laboratory worker. For the residential scenario, both sites had total excess cancer risks less than the 1×10^{-5} target risk level and had HIs less than 1.

G-6.2 Ecological Risk

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, LOAEL analyses, and COPECs without ESLs, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, and red fox exist for the TA-57 Aggregate Area sites.

G-7.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate’s Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory’s Electronic Document Management System and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the ESH 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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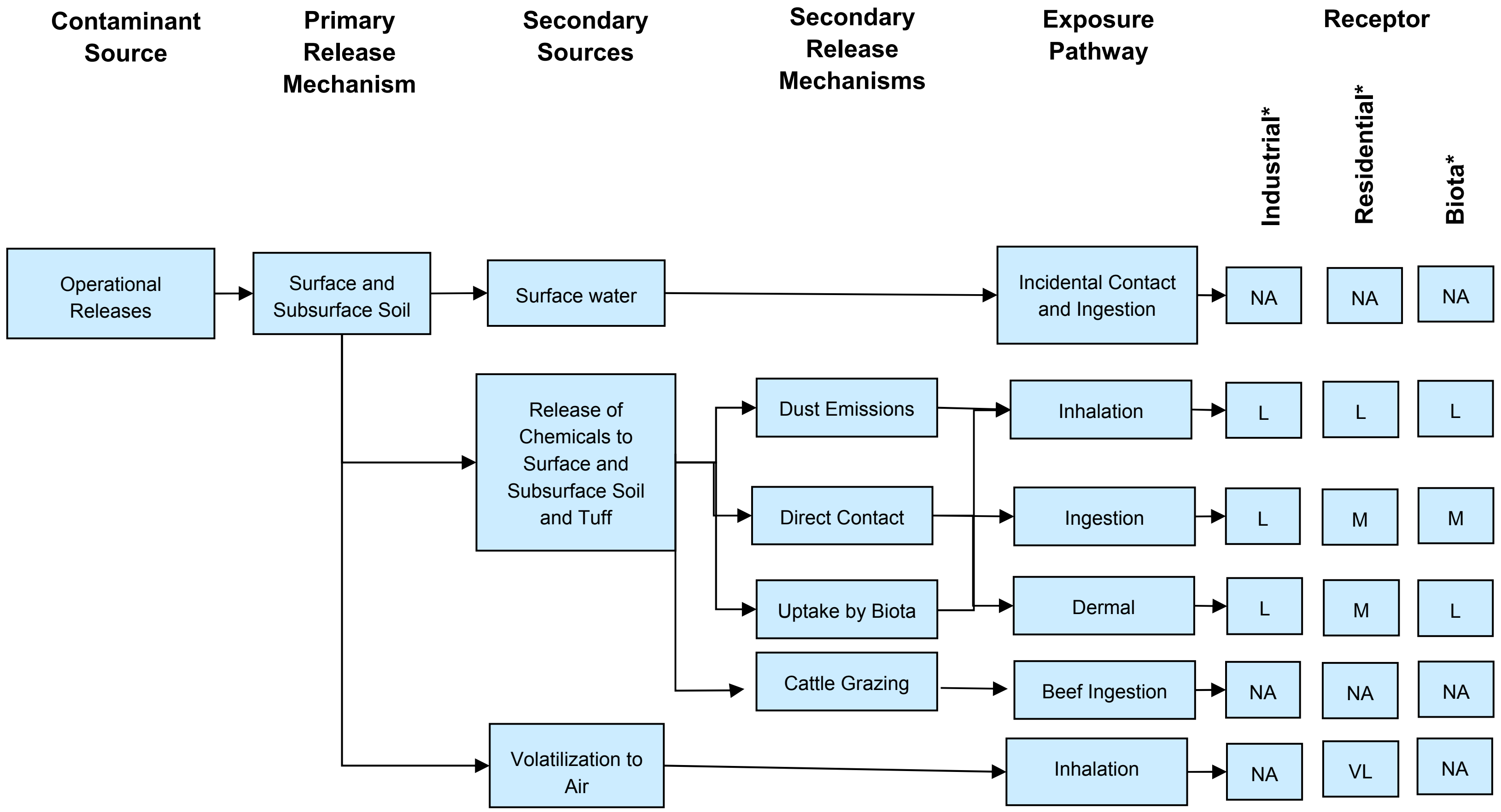


* VL = Very low, L = low, and M = moderate. Designations indicate the pathway is a potentially complete pathway and is evaluated in the risk assessments.
NA = Not applicable and indicates the pathway is incomplete and is not evaluated in the risk assessments.

Figure G-3.1-1 Conceptual site model for the TA-57 Aggregate Area AOCs

Table G-2.3-1
EPCs at AOC 57-006 for the Residential Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	12	0	0.946(U)	1.12(U)	n/a*	1.12(U)	Maximum detection limit
Barium	12	12	42.6	136	Normal	99.9	95% Student's-t
Chromium	12	12	3.37	113	Gamma	58.6	95% Adjusted Gamma
Copper	12	12	2.22	26	Nonparametric	13.5	95% Chebyshev (Mean, Sd)
Selenium	12	2	0.347	1.11(U)	n/a	0.358	Maximum detected concentration
Zinc	12	12	44.5	75.1	Normal	64	95% Student's-t
Organic Chemicals (mg/kg)							
Bis(2-ethylhexyl)phthalate	12	1	0.269	0.384(U)	n/a	0.269	Maximum detected concentration
Methylene Chloride	12	2	0.00248	0.00576(U)	n/a	0.0028	Maximum detected concentration
Trichloroethene	12	2	0.000539	0.00115(U)	n/a	0.000726	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table G-2.3-2
EPCs at AOC 57-006 for Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	4	0	1.06(U)	1.1(U)	n/a*	1.1(U)	Maximum detection limit
Zinc	4	4	45.5	53.6	n/a	53.6	Maximum detected concentration
Organic Chemicals (mg/kg)							
Methylene Chloride	4	1	0.00248	0.00565(U)	n/a	0.00248	Maximum detected concentration
Trichloroethene	4	1	0.000539	0.00113(U)	n/a	0.000539	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table G-2.3-3
EPCs at AOC 57-007 for the Industrial Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	7	2	0.361	1.06(U)	n/a*	0.488	Maximum detected concentration
Perchlorate	7	2	0.000786	0.00225(U)	n/a	0.000841	Maximum detected concentration
Zinc	7	7	41.1	55.7	n/a	55.7	Maximum detected concentration
Organic Chemicals (mg/kg)							
Fluoranthene	7	1	0.0145	0.0373(U)	n/a	0.0145	Maximum detected concentration
Methylene Chloride	7	1	0.00277	0.00561(U)	n/a	0.00277	Maximum detected concentration
Phenanthrene	7	1	0.0134	0.0373(U)	n/a	0.0134	Maximum detected concentration
Trichloroethene	7	2	0.00105(U)	0.00294	n/a	0.00294	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table G-2.3-4
EPCs at AOC 57-007 for the Residential Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	33	7	0.361	1.15(U)	Normal	0.474	95% KM (t)
Arsenic	37	37	0.527	5.12	Gamma	1.95	95% Adjusted Gamma
Barium	33	33	19.6	384	Gamma	102	95% Adjusted Gamma
Chromium	33	33	2.92	68.3	Nonparametric	25.4	95% Chebyshev (Mean, Sd)
Copper	33	33	1.28	65.1	Nonparametric	14.2	95% Chebyshev (Mean, Sd)
Cyanide (Total)	33	4	0.085	0.73	n/a*	0.73	Maximum detected concentration
Lead	33	33	7.74	33.6	Gamma	13.5	95% Adjusted Gamma
Mercury	33	33	0.00703	20.6	Nonparametric	3.56	95% Chebyshev (Mean, Sd)
Perchlorate	33	8	0.000582	0.00225(U)	Normal	0.00112	95% KM (t)
Selenium	33	0	0.917(U)	1.11(U)	n/a	1.11	Maximum detection limit
Silver	33	16	0.105	15.2	Nonparametric	1.62	95% KM (BCA)
Zinc	33	33	39	113	Gamma	58.6	95% Adjusted Gamma
Organic Chemicals (mg/kg)							
Benzoic Acid	33	3	0.324	2.83	n/a	2.83	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	33	1	0.13	0.385(U)	n/a	0.13	Maximum detected concentration
Butylbenzylphthalate	33	1	0.339	0.385(U)	n/a	0.339	Maximum detected concentration
Dichlorobenzene[1,4-]	33	3	0.000357	0.00116(U)	n/a	0.00043	Maximum detected concentration
Fluoranthene	33	2	0.013	0.0385(U)	n/a	0.0145	Maximum detected concentration
Methylene Chloride	33	2	0.00277	0.00578(U)	n/a	0.00299	Maximum detected concentration
Phenanthrene	33	1	0.0134	0.0385(U)	n/a	0.0134	Maximum detected concentration
Trichloroethene	33	2	0.00103(U)	0.00294	n/a	0.00294	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table G-2.3-5
EPCs at AOC 57-007 for Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	29	6	0.361	1.15(U)	Normal	0.475	95% KM (t)
Arsenic	31	31	0.527	3.85	Normal	1.80	95% Student's-t
Barium	29	29	19.6	384	Normal	109.6	95% Student's-t
Chromium	29	29	2.92	68.3	Nonparametric	23.1	95% Chebyshev (Mean, Sd)
Copper	29	29	1.28	65.1	Nonparametric	15.7	95% Chebyshev (Mean, Sd)
Cyanide (Total)	29	4	0.085	0.73	n/a*	0.73	Maximum detected concentration
Lead	29	29	7.74	33.6	Gamma	13.8	95% Adjusted Gamma
Mercury	29	29	0.00703	20.6	Nonparametric	4.04	95% Chebyshev (Mean, Sd)
Selenium	29	0	0.917(U)	1.11(U)	n/a	1.11(U)	Maximum detection limit
Silver	29	16	0.105	15.2	Nonparametric	3.08	95% KM Chebyshev
Zinc	29	29	39	113	Normal	59.5	95% Student's-t
Organic Chemicals (mg/kg)							
Benzoic Acid	29	3	0.324	2.83	n/a	2.83	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	29	1	0.13	0.385(U)	n/a	0.13	Maximum detected concentration
Butylbenzylphthalate	29	1	0.339	0.385(U)	n/a	0.339	Maximum detected concentration
Dichlorobenzene[1,4-]	29	3	0.000357	0.00116(U)	n/a	0.00043	Maximum detected concentration
Fluoranthene	29	2	0.013	0.0385(U)	n/a	0.0145	Maximum detected concentration
Methylene Chloride	29	2	0.00277	0.00578(U)	n/a	0.00299	Maximum detected concentration
Phenanthrene	29	1	0.0134	0.0385(U)	n/a	0.0134	Maximum detected concentration
Trichloroethene	29	2	0.00103(U)	0.00294	n/a	0.00294	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

*n/a = Not applicable.

Table G-3.2-1
Physical and Chemical Properties of Inorganic COPCs for the TA-57 Aggregate Area

COPC	K_d[a] (cm^3/g)	Water Solubility[a,b] (g/L)
Antimony	45	Insoluble
Arsenic	29	Insoluble
Barium	41	Insoluble
Chromium	850	Insoluble
Copper	35	Insoluble
Cyanide (Total)	9.9	na[c]
Lead	900	Insoluble
Mercury	52	Insoluble
Perchlorate	na	2.45E+05
Selenium	5	Insoluble
Silver	8.3	Insoluble
Zinc	62	Insoluble

[a] Information from http://rais.ornl.gov/cgi-bin/tox/TOX_select?select=nrad.

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] na = Not available.

Table G-3.2-2
Physical and Chemical Properties of Organic COPCs for the TA-57 Aggregate Area

COPC	Water Solubility[a] (mg/L)	Organic Carbon Coefficient K_{oc}[a] (L/kg)	Log Octanol-Water Partition Coefficient K_{ow}[a]	Vapor Pressure[a] (mm Hg at 25°C)
Benzoic acid	3.40E+03[b]	1.45E+01	1.87E+00[b]	7.00E-04[b]
Bis(2-ethylhexyl)phthalate	2.70E-01[b]	1.65E+05	7.60E+00[b]	1.42E-07[b]
Butylbenzylphthalate	2.69E+00	9.36E+03	4.73E+00	8.25E-06
Dichlorobenzene[1,4-]	8.13E+01	3.75E+02	3.44E+00	1.74E+00
Fluoranthene	2.60E-01[c]	5.55E+04[c]	5.16E+00	9.22E-06
Methylene chloride	1.30E+04[b]	2.37E+01	1.30E+00[b]	4.30E+02[b]
Phenanthrene	1.15E+00[b]	2.08E+04	4.46E+00[b]	1.12E-04[b]
Trichloroethene	1.28E+03	6.07E+01	2.42E+00	6.90E+01

[a] Information from http://rais.ornl.gov/cgi-bin/tox/TOX_search, unless noted otherwise.

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] Information from NMED (2014, 600115).

Table G-4.1-1
Exposure Parameter Values Used to Calculate Chemical SSLs for the Industrial and Residential Scenarios

Parameters	Residential Values	Industrial Values
Target HQ	1	1
Target cancer risk	10^{-5}	10^{-5}
Averaging time (carcinogen/mutagen)	70 yr × 365 d	70 yr × 365 d
Averaging time (noncarcinogen)	Exposure duration × 365 d	Exposure duration × 365 d
Skin absorption factor	Semivolatile organic compound (SVOC) = 0.1	SVOC = 0.1
	Chemical-specific	Chemical-specific
Adherence factor–child	0.2 mg/cm^2	n/a[a]
Body weight–child	15 kg (0–6 yr of age)	n/a
Cancer slope factor–oral (chemical-specific)	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$
Inhalation unit risk (chemical-specific)	(µg/m^3)	(µg/m^3)
Exposure frequency	350 d/yr	225 d/yr
Exposure time	24 h/d	8 h/day
Exposure duration–child	6 yr[b]	n/a
Age-adjusted ingestion factor for carcinogens	36,750 mg/kg	n/a
Age-adjusted ingestion factor for mutagens	25,550 mg/kg	n/a
Soil ingestion rate–child	200 mg/d	n/a
Particulate emission factor	6.61×10^9 m^3/kg	6.61×10^9 m^3/kg
Reference dose–oral (chemical-specific)	(mg/kg-d)	(mg/kg-d)
Reference dose–inhalation (chemical-specific)	(mg/kg-d)	(mg/kg-d)
Exposed surface area–child	2690 cm^2/d	n/a
Age-adjusted skin contact factor for carcinogens	112266 mg/kg	n/a
Age-adjusted skin contact factor for mutagens	166833 mg/kg	n/a
Volatilization factor for soil (chemical-specific)	(m^3/kg)	(m^3/kg)
Body weight–adult	80 kg	80 kg
Exposure duration[c]	30 yr[d]	25 yr
Adherence factor–adult	0.07 mg/cm^2	0.12 mg/cm^2
Soil ingestion rate–adult	100 mg/d	100 mg/d
Exposed surface area–adult	6032 cm^2/d	3470 cm^2/d

Note: Parameter values from NMED (2014, 600115).

[a] n/a = Not applicable.

[b] The child exposure duration for mutagens is subdivided into 0–2 yr and 2–6 yr.

[c] Exposure duration for lifetime resident is 26 yr. For carcinogens, the exposures are combined for child (6 yr) and adult (20 yr).

[d] The adult exposure duration for mutagens is subdivided into 6–16 yr and 16–30 yr.

Table G-4.2-1
Residential Carcinogenic
Screening Evaluation for AOC 57-006

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	Excess Cancer Risk
Chromium	58.6	96.6	6.07E-06
Bis(2-ethylhexyl)phthalate	0.269	380	7.08E-09
		Total Excess Cancer Risk	**6E-06**

*SSLs from NMED (2014, 600115).

Table G-4.2-2
Residential Noncarcinogenic
Screening Evaluation for AOC 57-006

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	HQ
Antimony	1.12(U)	31.3	3.58E-02
Barium	99.9	15,600	6.40E-03
Copper	13.5	3130	4.33E-03
Selenium	0.358	391	9.16E-04
Zinc	64	23,500	2.72E-03
Methylene Chloride	0.0028	409	6.85E-06
Trichloroethene	0.000726	6.77	1.07E-04
		HI	**0.05**

*SSLs from NMED (2014, 600115).

Table G-4.2-3
Industrial Noncarcinogenic
Screening Evaluation for AOC 57-007

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	HQ
Antimony	0.488	519	9.40E-04
Perchlorate	0.000841	908	9.26E-07
Zinc	55.7	389,000	1.43E-04
Fluoranthene	0.0145	33,700	4.30E-07
Methylene Chloride	0.00277	5130	5.40E-07
Phenanthrene	0.0134	25,300	5.30E-07
Trichloroethene	0.00294	36.5	8.05E-05
		HI	**0.001**

*SSLs from NMED (2014, 600115).

Table G-4.2-4
Residential Carcinogenic
Screening Evaluation for AOC 57-007

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	Excess Cancer Risk
Arsenic	1.95	4.25	4.59E-06
Chromium	25.4	96.6	2.63E-06
Bis(2-ethylhexyl)phthalate	0.13	380	3.42E-09
Butylbenzylphthalate	0.339	2800[b]	1.21E-09
Dichlorobenzene[1,4-]	0.00043	32.8	1.31E-10
		Total Excess Cancer Risk	**7E-06**

[a] SSLs from NMED (2014, 600115) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.2-5
Residential Noncarcinogenic
Screening Evaluation for AOC 57-007

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	HQ
Antimony	0.474	31.3	1.51E-02
Barium	102	15,600	6.54E-03
Copper	14.2	3130	4.54E-03
Cyanide (Total)	0.73	11.2	6.52E-02
Lead	13.5	400	3.37E-02
Mercury	3.56	23.5	1.51E-01
Perchlorate	0.00112	54.8	2.04E-05
Selenium	1.11(U)	391	2.84E-03
Silver	1.62	391	4.13E-03
Zinc	58.6	23,500	2.49E-03
Benzoic Acid	2.83	250,000[b]	1.13E-05
Fluoranthene	0.0145	2320	6.25E-06
Methylene Chloride	0.00299	409	7.31E-06
Phenanthrene	0.0134	1740	7.70E-06
Trichloroethene	0.00294	6.77	4.34E-04
		HI	**0.3**

[a] SSLs from NMED (2014, 600115) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.3-1
Residential Noncarcinogenic Screening of Vapor Intrusion for AOC 57-006

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	HQ
Methylene chloride	0.0028	62.7	4.47E-05
Tricloroethene	0.000726	0.209	3.47E-03
		HI	**0.004**

[a] Maximum detected concentration.

[b] Vapor-intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-4.3-2
Residential Carcinogenic Screening of Vapor Intrusion for AOC 57-007

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	Cancer Risk
Dichlorobenzene[1,4-]	0.00043	0.27	1.62E-08
		Total Excess Cancer Risk	**2E-08**

[a] Maximum detected concentration.

[b] Vapor-intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-4.3-3
Residential Noncarcinogenic Screening of Vapor Intrusion for AOC 57-007

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	HQ
Methylene chloride	0.00299	89.9	3.32E-05
Trichloroethene	0.00294	0.687	4.28E-03
		HI	**0.004**

[a] Maximum detected concentration.

[b] Vapor-intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-5.4-1
ESLs for Terrestrial Receptors

COPC	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Inorganic Chemicals (mg/kg)											
Antimony	46	na*	na	na	na	na	2.6	2.6	2.4	78	11
Arsenic	820	850	120	42	26	18	140	15	32	6.8	18
Barium	41000	28000	8600	820	930	1000	2900	1300	1800	330	110
Chromium	1800	1000	200	68	40	28	750	45	110	na	na
Copper	4000	1300	92	38	22	15	240	38	64	80	70
Cyanide	2800	0.59	0.4	0.1	0.1	0.1	660	310	340	na	na
Lead	3700	630	95	21	16	14	330	72	120	1700	120
Mercury	61	0.29	0.066	0.07	0.022	0.013	20	1.7	3	0.05	34
Selenium	90	81	4.3	1	0.87	0.75	1.9	0.66	0.83	4.1	0.52
Silver	4300	670	14	11	4.3	2.6	140	14	24	na	560
Zinc	7800	2400	250	350	85	48	1600	98	170	120	160
Organic Chemicals (mg/kg)											
Benzoic acid	1800	na	na	na	na	na	3.7	1	1.3	na	na
Bis(2-ethylhexyl)phthalate	380	8.1	0.1	20	0.04	0.02	2400	0.59	1.1	na	na
Butylbenzylphthalate	18000	na	na	na	na	na	2000	90	160	na	na
Dichlorobenzene[1,4-]	380	na	na	na	na	na	10	0.88	1.5	1.2	na
Fluoranthene	3300	na	na	na	na	na	230	22	38	10	na
Methylene Chloride	4200	na	na	na	na	na	3	9	2.6	na	1600
Phenanthrene	1700	na	na	na	na	na	52	10	15	5.5	na
Trichloroethene	37000	na	na	na	na	na	150	42	55	na	na

Note: ESLs from ECORISK Database, Version 3.2 (LANL 2014, 262559).

*na = Not available.

Table G-5.4-2
Minimum ESL Comparison for AOC 57-006

COPC	EPC (mg/kg)	ESL (mg/kg)	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	1.1(U)	2.4	Deer mouse	**0.46**
Zinc	53.6	48	American Robin (insectivore)	**1.12**
Organic Chemicals (mg/kg)				
Methylene Chloride	0.00248	2.6	Deer mouse	0.001
Trichloroethene	0.000539	42	Montane Shrew	0.00001

Note: Bolded values indicate HQs greater than 0.3. Data qualifiers are defined in Appendix A.

Table G-5.4-3
HI Analysis for AOC 57-006

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Antimony	1.1(U)	0.024	na*	na	na	na	na	**0.42**	**0.42**	**0.46**	0.014	0.1
Zinc	53.6	0.007	0.022	0.21	0.15	**0.63**	**1.12**	0.034	**0.55**	**0.32**	**0.45**	0.34
	HI	0.03	0.02	0.2	0.2	0.6	1	0.5	1	0.8	0.5	0.4

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.0. Data qualifiers are defined in Appendix A.

*na = Not available.

Table G-5.4-4
Minimum ESL Comparison for AOC 57-007

COPC	EPC (mg/kg)	ESL (mg/kg)	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	0.475	2.4	Deer mouse	0.2
Arsenic	1.80	6.8	Earthworm	0.27
Barium	109.6	110	Plant	**1**
Chromium	23.1	28	American Robin (insectivore)	**0.82**
Copper	15.7	15	American Robin (insectivore)	**1.05**
Cyanide (Total)	0.73	0.1	American Robin (all diets)	**7.3**
Lead	13.8	14	American Robin (insectivore)	**0.99**
Mercury	4.04	0.013	American Robin (insectivore)	**311**
Selenium	1.11(U)	0.52	Plant	**2.13**
Silver	3.08	2.6	American Robin (insectivore)	**1.18**
Zinc	59.5	48	American Robin (insectivore)	**1.24**
Organic Chemicals (mg/kg)				
Benzoic Acid	2.83	1	Montane Shrew	**2.83**
Bis(2-ethylhexyl)phthalate	0.13	0.02	American Robin (insectivore)	**6.5**
Butylbenzylphthalate	0.339	90	Montane Shrew	0.0038
Dichlorobenzene[1,4-]	0.00043	0.88	Montane Shrew	0.00049
Fluoranthene	0.0145	10	Earthworm	0.0015
Methylene Chloride	0.00299	2.6	Deer mouse	0.0012
Phenanthrene	0.0134	5.5	Earthworm	0.0024
Trichloroethene	0.00294	42	Montane Shrew	0.00007

Note: Bolded values indicate HQs greater than 0.3. Data qualifiers are defined in Appendix A.

Table G-5.4-5
HI Analysis for AOC 57-007

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Barium	109.6	0.0027	0.0039	0.013	0.13	0.12	0.11	0.038	0.084	0.061	**0.33**	**1**
Chromium	23.1	0.013	0.023	0.12	**0.34**	**0.58**	**0.82**	0.031	**0.51**	0.21	na*	na
Copper	15.7	0.0039	0.012	0.17	**0.41**	**0.71**	**1.05**	0.066	**0.41**	0.25	0.2	0.22
Cyanide (Total)	0.73	0.0003	**1.24**	**1.83**	**7.3**	**7.3**	**7.3**	0.0011	0.0024	0.0021	na	na
Lead	13.8	0.0037	0.022	0.15	**0.66**	**0.86**	**0.99**	0.042	0.19	0.12	0.0081	0.12
Mercury	4.04	0.066	**13.9**	**61**	**57.7**	**184**	**311**	0.2	**2.38**	**1.35**	**80.8**	0.12
Selenium	1.11(U)	0.012	0.014	0.26	**1.11**	**1.28**	**1.48**	**0.58**	**1.68**	**1.34**	0.27	**2.13**
Silver	3.08	0.0007	0.0046	0.22	0.28	**0.72**	**1.18**	0.022	0.22	0.13	na	0.0055
Zinc	59.5	0.0076	0.025	0.24	0.17	**0.7**	**1.24**	0.037	**0.61**	**0.35**	**0.5**	**0.37**
Benzoic Acid	2.83	0.0016	na	na	na	na	na	**0.76**	**2.83**	**2.18**	na	na
Bis(2-ethylhexyl)phthalate	0.13	0.0003	0.016	**1.3**	0.0065	**3.25**	**6.5**	0.0001	0.22	0.12	na	na
HI		0.1	**15**	**66**	**68**	**199**	**332**	**2**	**9**	**6**	**82**	**4**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.
*na = Not available.

Table G-5.5-1
PAUFs for Ecological Receptors for AOC 57-006

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	0.000000236
American Robin	0.42	16.8	0.0000595
Deer Mouse	0.077	3	0.000333
Desert Cottontail	3.1	124	0.00000806
Montane Shrew	0.39	15.6	0.0000641
Red Fox	1038	41,520	0.0000000241

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (0.001 ha) divided by the population area.

Table G-5.5-2
Adjusted HIs at AOC 57-006

COPECs	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Antimony	1.1(U)	5.8E-10	na*	na	na	na	na	3.4E-06	2.7E-05	0.00015	0.014	0.1
Zinc	53.6	1.7E-10	5.3E-09	5.1E-08	9.1E-06	3.7E-05	6.6E-05	2.7E-07	3.5E-05	0.00011	**0.45**	**0.34**
Adjusted HI		8E-10	5E-09	5E-08	9E-06	4E-05	7E-05	4E-06	6E-05	0.0003	0.5	0.4

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.

*na = Not available.

Table G-5.5-3
PAUFs for Ecological Receptors for AOC 57-007

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	0.0000071
American Robin	0.42	16.8	0.00179
Deer Mouse	0.077	3	0.01
Desert Cottontail	3.1	124	0.000242
Montane Shrew	0.39	15.6	0.00192
Red Fox	1038	41,520	0.00000072

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (0.03 ha) divided by the population area.

Table G-5.5-4
Adjusted HIs for AOC 57-007

COPECs	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Barium	109.6	1.9E-09	2.8E-08	9.0E-08	0.00024	0.00021	0.0002	9.1E-06	1.6E-04	6.1E-04	**0.33**	**1**
Chromium	23.1	9.3E-09	1.6E-07	8.2E-07	0.00061	0.001	0.0015	7.4E-06	0.00099	0.0021	na*	na
Copper	15.7	2.8E-09	8.6E-08	1.2E-06	0.00074	0.0013	0.0019	1.6E-05	0.0008	0.0025	0.2	0.22
Cyanide (Total)	0.73	1.9E-10	8.8E-06	1.3E-05	0.013	0.013	0.013	2.7E-07	4.5E-06	2.2E-05	na	na
Lead	13.8	2.7E-09	1.6E-07	1.0E-06	0.0012	0.0015	0.0018	1.0E-05	0.00037	0.0012	0.0081	0.12
Mercury	4.04	4.8E-08	9.9E-05	0.00043	0.1	**0.33**	**0.56**	4.9E-05	0.0046	0.014	**80.8**	0.12
Selenium	1.11(U)	8.9E-09	9.7E-08	1.8E-06	0.002	0.0023	0.0026	0.00014	0.0032	0.013	0.27	**2.13**
Silver	3.08	5.2E-10	3.3E-08	1.6E-06	0.0005	0.0013	0.0021	5.3E-06	0.00042	0.0013	na	0.0055
Zinc	59.5	5.5E-09	1.8E-07	1.7E-06	0.0003	0.0013	0.0022	9.0E-06	0.0012	0.0035	**0.5**	**0.37**
Benzoic Acid	2.83	1.1E-09	na	na	na	na	na	0.00019	0.0054	0.022	na	na
Bis(2-ethylhexyl)phthalate	0.13	2.5E-10	1.1E-07	9.2E-06	1.2E-05	0.0058	0.012	1.3E-08	0.00042	0.0012	na	na
Adjusted HI		8E-08	0.0001	0.0005	0.1	0.4	0.6	0.0004	0.02	0.06	**82**	**4**

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.

*na = Not available.

Table G-5.5-5
LOAEL-Based ESLs for Terrestrial Receptors

COPEC	Receptor	LOAEL–Based ESL* (mg/kg)
Barium	Earthworm	3200
	Plant	260
Mercury	Earthworm	0.5
Selenium	Plant	3
Zinc	Earthworm	930
	Plant	810

*LOAEL-based ESLs from ECORISK Database, Version 3.2 (LANL 2014, 262559).

Table G-5.5-6
HI Analysis Using LOAEL-Based ESLs at AOC 57-007

COPEC	EPC (mg/kg)	Earthworm	Plant
Barium	109.6	0.03	**0.42**
Mercury	4.04	**8.08**	n/a*
Selenium	1.11(U)	n/a	**0.37**
Zinc	59.5	0.06	0.07
	HI	**8**	0.9

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1.
*n/a = Not applicable.

Attachment G-1

ProUCL Files
(on CD included with this document)

Attachment G-2

Vapor Intrusion Model Spreadsheets
(on CD included with this document)

Attachment G-3

Ecological Scoping Checklist

G3-1.0 AREAS OF CONCERN 57-006 AND 57-007

G3-1.1 Part A—Scoping Meeting Documentation

Site ID	Areas of Concern (AOCs) 57-006 and 57-007
Form of site releases (solid, liquid, vapor). Describe all relevant known or suspected mechanisms of release (spills, dumping, material disposal, outfall, explosive testing, etc.), and describe potential areas of release. Reference locations on a map as appropriate.	AOC 57-006 is the former location of a plastic-lined 55-gal. drum that was buried in the ground at Technical Area 57 (TA-57) beneath a trailer (structure 57-23) that served as an analytical chemistry laboratory. The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer was used to dispose of wastewater associated with chemical analyses. The sink drained to a leach field (AOC 57-007) near the trailer. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to the polyethylene drum. When the drum was full, its contents were transported to Los Alamos National Laboratory for disposal. In 1994, the drum was removed as part of a voluntary corrective action (VCA). The chemistry trailer was removed from the site in March 1994. The site of the former waste drum is currently vegetated with grasses. The site of the leach field is currently vegetated with grasses, shrubs, and small trees. The ground surface where the trailer was located is level, and then slopes to the southeast toward a drainage swale. An elevated electrical conduit rack runs across the site roughly parallel to the road.
List of Primary Impacted Media **(Indicate all that apply.)**	**Surface soil –** X **Surface water/sediment –** **Subsurface –** X **Groundwater –** **Other, explain –**
Vegetation Class based on Geographic Information System (GIS) Vegetation Coverage **(Indicate all that apply.)**	**Water** – **Bare ground/unvegetated** – **Spruce/fir/aspen/mixed conifer** – X **Ponderosa pine –** **Piñon juniper/juniper savannah** – **Grassland/shrubland** – X **Developed** – X **Burned –**
Is threatened and endangered (T&E) habitat present? **If applicable, list species known or suspected of using the site for breeding or foraging.**	No threatened and endangered (T&E) species habitat is present at these AOCs. See additional information regarding the Jemez Mountain salamander in Attachment G-4.
Provide a list of neighboring/ contiguous/upgradient sites, including a brief summary of COPCs and the form of releases for relevant sites, and reference a map as appropriate. **(Use this information to evaluate the need to aggregate sites for screening.)**	None

Surface Water Erosion Potential Information Surface water erosion potential is based on site observations.	The ground surface where the trailer was located is level and then slopes to the southeast toward a drainage swale.

G3-1.2 Part B—Site Visit Documentation

Site ID	AOCs 57-006 and AOC 57-007
Date of Site Visit	10/14/2014
Site Visit Conducted by	Randall Ryti and Pattie Baucom

Receptor Information:

Estimate cover.	**Relative vegetative cover (high, medium, low, none)** = Medium-High **Relative wetland cover (high, medium, low, none)** = None **Relative structures/asphalt, etc., cover (high, medium, low, none)** = None
Field Notes on the GIS vegetation class to assist in Verifying the Arcview Information	Vegetation in the vicinity of the AOCs is aspen, shrub, and grassy meadow.
Are ecological receptors present at the site (yes/no/uncertain)? **Describe the general types of receptors present at the site (terrestrial and aquatic), and make notes on the quality of habitat present at the site.**	Terrestrial receptors, including mammals and birds, could use this site for both foraging and nesting. Because the date of the site visit was in October, vertebrate activity would be starting to decrease. However, invertebrates (grasshoppers) and one small mammal were noted in the area. Fossorial activity was noted in the slope leading to the southwest. The area is located within a remote, fairly inactive site, increasing its attractiveness to ecological receptors.

Contaminant Transport Information:

Surface Water Transport/ Field Notes on the Erosion Potential, Including a Discussion of the Terminal Point of Surface Water Transport (if applicable)	The area near these AOCs is relatively level to modestly sloping to the southeast toward a drainage swale. Thus, there is some potential for migration via surface water transport.
Are there any off-site transport pathways (surface water, air, or groundwater) (yes/no/uncertain)? Provide explanation.	There is limited potential for erosion and migration from AOC 57-006 given its location on flat ground. The leach field (AOC 57-007) is located on a very modest slope leading to the southeast. Thus, there is some potential for off-site surface water transport from that area. A pathway to groundwater is unlikely because groundwater is greater than 1000 ft below ground surface.

Ecological Effects Information:

Physical Disturbance **(Provide a list of major types of disturbances, including erosion and construction activities; review historical aerial photos where appropriate.)**	AOC 57-006 is within the developed area (close to an on-site dirt road) but still has moderate vegetative cover (primarily grasses). AOC 57-007 has little evidence of disturbance although it was clear the area had been regraded in the past. Currently, the vegetative cover is high and includes grasses, forbs, shrubs (wild roses), and trees (aspen).
Are there obvious ecological effects (yes/no/uncertain)? **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No. There is minimal to no evidence for ecological effects.

No Exposure/Transport Pathways:

If there are no complete exposure pathways to ecological receptors on-site and no transport pathways to off-site receptors, the remainder of the checklist should not be completed. Stop here and provide additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). At a minimum, the potential for future transport should include the likelihood that future construction activities could make contamination more available for exposure or transport.
Not applicable.

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature and extent of contamination (yes/no/uncertain)? **Provide explanation** **(consider whether the maximum value was captured by existing sample data).**	The investigation approach in the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936) included sampling to determine whether chemicals of potential concern are present and if a release has occurred in the vicinity of these AOCs. The initial results indicated arsenic was greater than the residential screening level. Spot removal and step-out sampling from the AOCs was conducted.
Do existing or proposed data for the site address potential transport pathways of site contamination (yes/no/uncertain)? **Provide explanation (consider whether other sites should be aggregated to characterize potential ecological risk).**	Samples were collected within and around the leach field as well as in the drainage from the leach field to address potential transport pathways.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.

Some aspen were cut down several years ago near a power line corridor. However, aspen saplings of 2–3 m in height are evident so there have been little to no impacts of these management efforts. Leach field cobble 20–40-mm size were noted on the ground surface.

G3-1.3 Part C—Ecological Pathways Conceptual Exposure Model

Provide answers to Questions A to V to develop the Ecological Pathways Conceptual Exposure Model

Question A:

Could soil contaminants reach receptors through vapors?

- **Volatility of the hazardous substance (volatile chemicals generally have Henry's law constant >10^{-5} atm-m^3/mol and molecular weight <200 g/mol).**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: Three volatile organic compounds (VOCs) were detected. Most of the detected concentrations were similar to the estimated quantitation limit (EQL).

Question B:

Could the soil contaminants reach receptors through fugitive dust carried in air?

- **Soil contamination would have to be on the actual surface of the soil to become available for dust.**
- **In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.**

Answer (likely/unlikely/uncertain): Likely

Provide explanation: Some COPCs were detected in the surface soil.

Question C:

Can contaminated soil be transported to aquatic ecological communities (use SOP 2.01 run-off score and terminal point of surface water runoff to help answer this question)?

- **If the SOP 2.01 run-off score* for each SWMU and/or AOC included in the site is equal to zero, this suggests that erosion at the site is not a transport pathway. (*Note that the runoff score is not the entire erosion potential score; rather, it is a subtotal of this score with a maximum value of 46 points.)**
- **If erosion is a transport pathway, evaluate the terminal point to see whether aquatic receptors could be affected by contamination from this site.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: There is no aquatic habitat present at these AOCs.

Question D:

Is contaminated groundwater potentially available to biological receptors through seeps or springs or shallow groundwater?

- **Known or suspected presence of contaminants in groundwater.**
- **The potential for contaminants to migrate through groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The depth to regional groundwater is greater than 1000 ft. There are no seeps, springs, or shallow groundwater in the vicinity of these AOCs.

Question E:

Is infiltration/percolation from contaminated subsurface material a viable transport and exposure pathway?

- **The potential exists for contaminants to migrate to groundwater.**
- **The potential exists for contaminants to migrate through groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The depth to regional groundwater is greater than 1000 ft. There are no seeps, springs, or shallow groundwater in the vicinity of these AOCs.

Question F:

Might erosion or mass wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

- **This question is only applicable to release sites located on or near the mesa edge.**
- **Consider the erodability of surficial material and the geologic processes of canyon/mesa edges.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: These AOCs are not located near the mesa edge, so mass wasting is not relevant. There is minimal evidence of erosion at the site.

Question G:

Could airborne contaminants interact with receptors through the respiration of vapors?

- **Contaminants must be present as volatiles in the air.**
- **Consider the importance of the inhalation of vapors for burrowing animals.**
- **Foliar uptake of vapors is typically not a significant exposure pathway.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 1

Terrestrial Animals: 1

Provide explanation: Some VOCs were detected but at very low concentrations.

Question H:

Could airborne contaminants interact with plants through the deposition of particulates or with animals through the inhalation of fugitive dust?

- **Contaminants must be present as particulates in the air or as dust for this exposure pathway to be complete.**
- **Exposure through the inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 3

Terrestrial Animals: 3

Provide explanation: Surface soil contamination is present at these AOCs.

Question I:

Could contaminants interact with plants through root uptake or rain splash from surficial soils?

- **Contaminants in bulk soil may partition into soil solution, making them available to roots.**
- **Exposure of terrestrial plants to contaminants is present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 3

Provide explanation: Surface soil contamination is present at these AOCs.

Question J:

Could contaminants interact with receptors through food-web transport from surficial soils?

- **The chemicals may bioaccumulate in animals.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 3

Provide explanation: COPCs are present in the surface soil.

Question K:

Could contaminants interact with receptors through the incidental ingestion of surficial soils?

- **Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil, or groom themselves clean of soil.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 3

Provide explanation: COPCs are present in the surface soil.

Question L:

Could contaminants interact with receptors through dermal contact with surficial soils?

- **Significant exposure through dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 2

Provide explanation: Low concentrations of lipophilic COPCs were detected infrequently in surface soil.

Question M:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: No radionuclides were identified as COPCs.

Question N:

Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- **Contaminants may be taken up by terrestrial plants whose roots are in contact with surface waters.**
- **Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash) in an area that is only periodically inundated with water.**
- **Contaminants in sediment may partition into soil solution, making them available to roots.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 0

Provide explanation: No water or sediment is present at these AOCs.

Question O:

Could contaminants interact with receptors through food-web transport from water and sediment?

- **The chemicals may bioconcentrate in food items.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 0

Provide explanation: No water or sediment is present at these AOCs.

Question P:

Could contaminants interact with receptors through the ingestion of water and suspended sediments?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.**
- **Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 0

Provide explanation: No water or sediment is present at these AOCs.

Question Q:

Could contaminants interact with receptors through dermal contact with water and sediment?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.**
- **Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 0

Provide explanation: No water or sediment is present at these AOCs.

Question R:

Could suspended or sediment-based contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: No water or sediment is present at these AOCs.

Question S:

Could contaminants bioconcentrate in free-floating aquatic plants, attached aquatic plants, or emergent vegetation?

- **Aquatic plants are in direct contact with water.**
- **Contaminants in sediment may partition into pore water, making them available to submerged roots.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Aquatic Plants/Emergent Vegetation: 0

Provide explanation: There is no aquatic habitat at these AOCs.

Question T:

Could contaminants bioconcentrate in sedimentary or water-column organisms?

- **Aquatic receptors may actively or incidentally ingest sediment while foraging.**
- **Aquatic receptors may be directly exposed to contaminated sediments or may be exposed to contaminants through osmotic exchange, respiration, or ventilation of sediment pore waters.**
- **Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Aquatic Animals: 0

Provide explanation: There is no aquatic habitat at these AOCs.

Question U:

Could contaminants bioaccumulate in sedimentary or water column organisms?

- **Lipophilic organic contaminants and some metals may concentrate in an organism's tissues.**
- **Ingestion of contaminated food items may result in contaminant bioaccumulation through the food web.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Aquatic Animals: 0

Provide explanation: There is no aquatic habitat at these AOCs.

Question V:

Could contaminants interact with aquatic plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **The water column acts to absorb radiation; therefore, external irradiation is typically more important for sediment-dwelling organisms.**

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

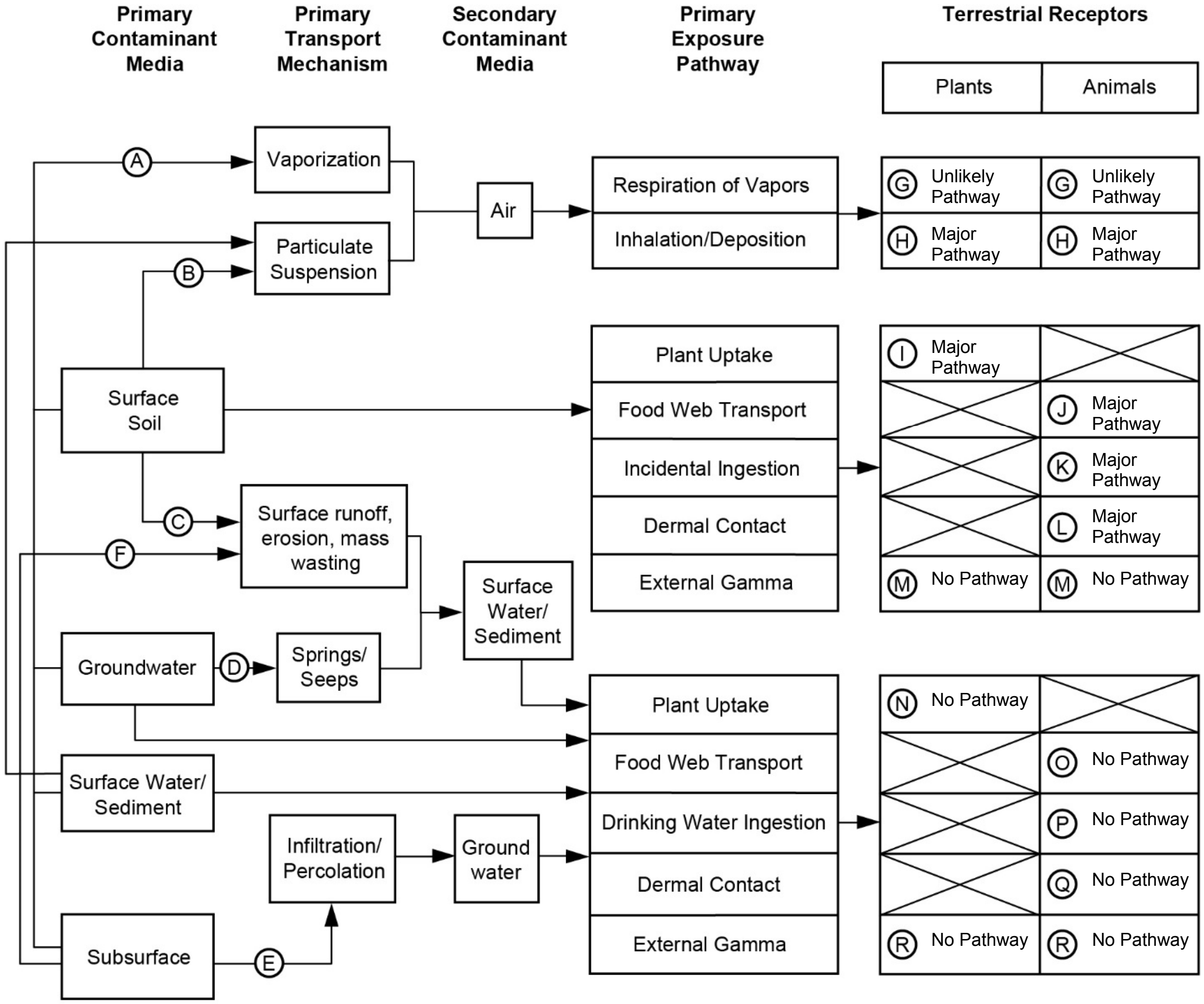
Aquatic Plants: 0

Aquatic Animals: 0

Provide explanation: There is no aquatic habitat at these AOCs.

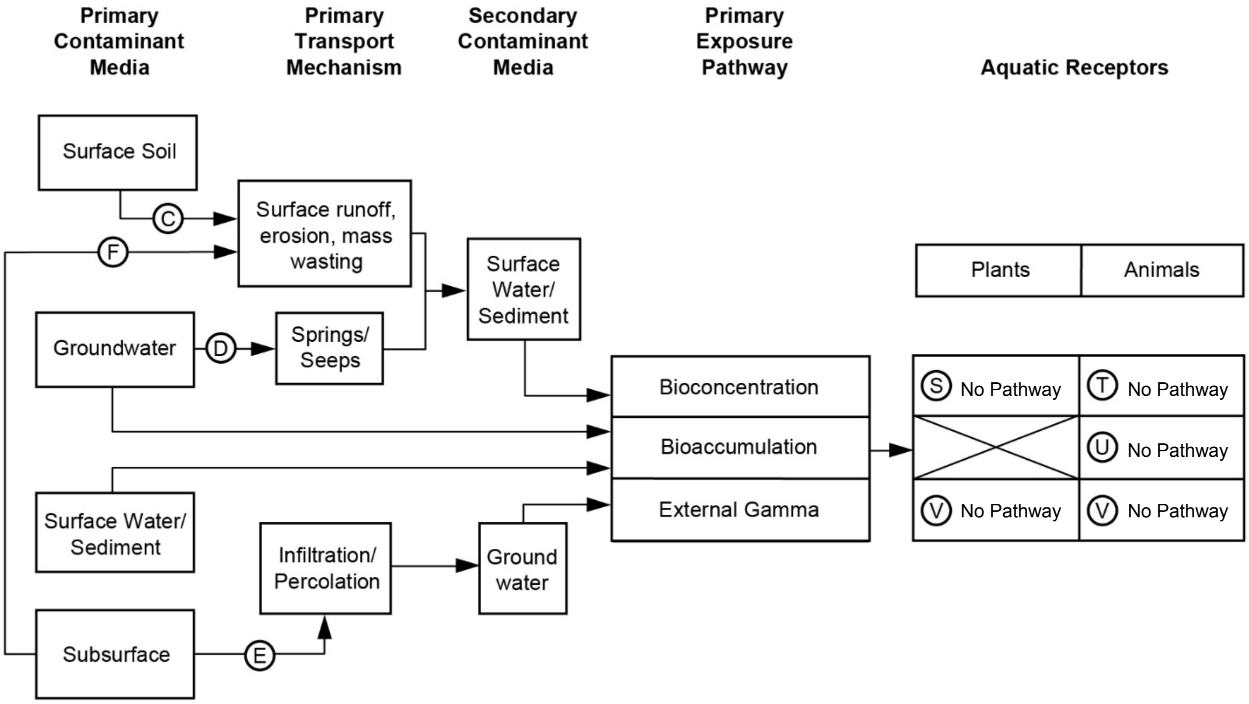
Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



Ecological Scoping Checklist
Aquatic Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



Signatures and certifications:

Checklist completed by:

Name (printed): Randall Ryti

Name (signature): Randall Ryti

Organization: Neptune and Company, Inc.

Date completed: October 29, 2014

Checklist reviewed by:

Name (printed): Richard Mirenda

Name (signature): Richard Mirenda

Organization: Los Alamos National Laboratory

Date reviewed: February 5, 2015

G3-2.0 REFERENCES

The following list includes all documents cited in this attachment. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the ESH 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.

LANL (Los Alamos National Laboratory), April 2012. "Investigation Work Plan for Technical Area 57 Aggregate Area (Fenton Hill)," Los Alamos National Laboratory document LA-UR-12-20545, Los Alamos, New Mexico. (LANL 2012, 214550)

NMED (New Mexico Environment Department), July 11, 2012. "Approval with Modifications, Investigation Work Plan for Technical Area 57 Aggregate Area (Fenton Hill)," New Mexico Environment Department letter to P. Maggiore (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2012, 520936)

Attachment G-4

Jemez Mountain Salamander Report

Los Alamos
NATIONAL LABORATORY
EST. 1943

memorandum

Environmental Protection Division
Environmental Stewardship Services (ENV-ES)

To/MS: Todd Haagenstad, ER, M992
From/MS: Charles D. Hathcock, ENV-ES, J978
Phone/Fax: 5-3366/Fax 5-8858
Symbol: ENV-DO-15-0039
Date: FEB 10 2015

SUBJECT: ANALYSIS OF BIOLOGICAL RESOURCE REQUIREMENTS FOR THE INVESTIGATION AND REMEDIATION OF AREAS OF CONCERN (AOCS) 57-006 AND 57-007 IN THE TECHNICAL AREA 57 AGGREGATE AREA (FENTON HILL)

Enclosed with this distribution is an analysis conducted by ENV-ES biologists to document requirements under the Los Alamos National Laboratory Habitat Management Plan for the closure of AOCs 57-006 and 57-007 at the Fenton Hill facility. This analysis was requested by Todd Haagenstad (ER) and will be included with the AOC closure report to the New Mexico Environment Department.

Enclosures: (1) Analysis of Biological Resource Requirements for the investigation and remediation of areas of concern (AOCs) 57-006 and 57-007 in the Technical Area 57 Aggregate Area (Fenton Hill), LA-UR-15-20706

CDH/mrm

Cy: Alison M. Dorries, ENV-DO, (E-File)
Patricia E. Gallagher, ENV-ES, (E-File)
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ENCLOSURE 1

Analysis of Biological Resource Requirements for the Investigation and Remediation of Areas of Concern (AOCs) 57-006 and 57-007 in the Technical Area 57 Aggregate Area (Fenton Hill), Los Alamos National Laboratory Report

LA-UR-15-20706

ENV-ES-15-0039

FEB 10 2015

Date: ________________________________

LA-UR-15-20706

February 2015

Analysis of Biological Resource Requirements for the Investigation and Remediation of Areas of Concern (AOCs) 57-006 and 57-007 in the Technical Area 57 Aggregate Area (Fenton Hill)

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared for: Todd Haagenstad, Environmental Restoration (ER)

Prepared by: Charles Hathcock, Biologist
LANL Environmental Stewardship Services (ENV-ES)

In September 2012 the U.S. Fish and Wildlife Service (USFWS) proposed the Jemez Mountains Salamander (*Plethodon neomexicanus*; JMS) as Endangered under the Endangered Species Act (77 FR 56482) and the final listing of the JMS as Endangered was on September 10, 2013 (78 FR 55599). Critical habitat was designated on November 20, 2013 (78 FR 69569).

Critical habitat was not designated on Los Alamos National Laboratory (LANL) property; however, the species is known to occur on LANL property and Los Alamos National Security, LLC (LANS) biologists delineated habitat (Hathcock 2013) for inclusion into the LANL Habitat Management Plan (LANL 2014; HMP). The purpose of the HMP is to provide a management strategy for the protection of threatened and endangered species and their habitats on LANL property. The HMP provides work requirements that have already been approved by the USFWS to ensure that LANL operations do not adversely affect threatened or endangered species or their habitats.

The entire footprint of Technical Area (TA) -57 is comprised of either developed or undeveloped core habitat for the JMS as defined by LANL's HMP. The previously disturbed footprint at TA-57 is developed core habitat and the undeveloped treed areas are undeveloped core habitat. The east side of New Mexico Highway 126 is listed as Critical Habitat for the JMS by the USFWS. The general area around and including Fenton Hill is within the known range for the species.

Both Areas of Concern (AOCs) 57-006 and 57-007, and their sampling locations, are within developed core habitat for JMS (Figure 1). The only restriction in the HMP for work in developed core habitat for the JMS is to plan soil disturbance activities to avoid monsoon rain events (generally July – mid-September) when the JMS may be found on the surface. In undeveloped core habitat, work activities that disturb the soil or change the canopy cover would not be authorized.

Surveys for the JMS at TA-57 have been conducted by federal and state permitted LANS biologists in 2012, 2013, and 2014 during the monsoon season and no JMSs were detected. Historical surveys were completed at the site on June 23, 1985 and no JMSs were detected. Directly east across NM Highway 126 a survey from 1991 did not detect any JMS. The nearest JMS detection to TA-57 is 0.75 miles NNE in designated critical habitat on the east side of the highway. In a 2 mile radius of TA-57, all of the positive detections of JMS occurred on treed undeveloped slopes. The TA-57 complex is situated on a flat mesa top with very little change in elevation. The likelihood of JMS occurring on the site is very low and occurrence of a JMS in the developed core habitat areas would essentially be zero. In a mark–recapture study conducted by the New Mexico Department of Game and Fish (NMDGF), the average distance of 32 movements measured via recapture either in the same year or from year to year, measured over the course of approximately 10 years within a 164-ft-by-164-ft (50-m-by-50-m) plot, was 19.6 ft (5.98 m), with a maximum distance moved from original capture site of 60.7 ft (18.5 m) (NMDGF 2000). In this same study, one salamander was observed near the same log nearly 5 years later. The data from this study suggest that JMS generally move very little. Based on this, possible exposure to any of the sample sites in the developed core habitat by a JMS moving across the landscape is null.

Citations:

Hathcock, C.D. 2013. Threatened and Endangered Species Habitat Management Plan Area of Environmental Interest Site Plan for the Jemez Mountains Salamander. Los Alamos National Laboratory report LA-UR-13-25061.

Los Alamos National Laboratory (LANL). 2014. Threatened and Endangered Species Habitat Management Plan for Los Alamos National Laboratory. Los Alamos National Laboratory report LA-UR-14-21863.

New Mexico Department of Game and Fish (NMDGF). 2000. Status of Endemic New Mexico Salamanders Performance Report.

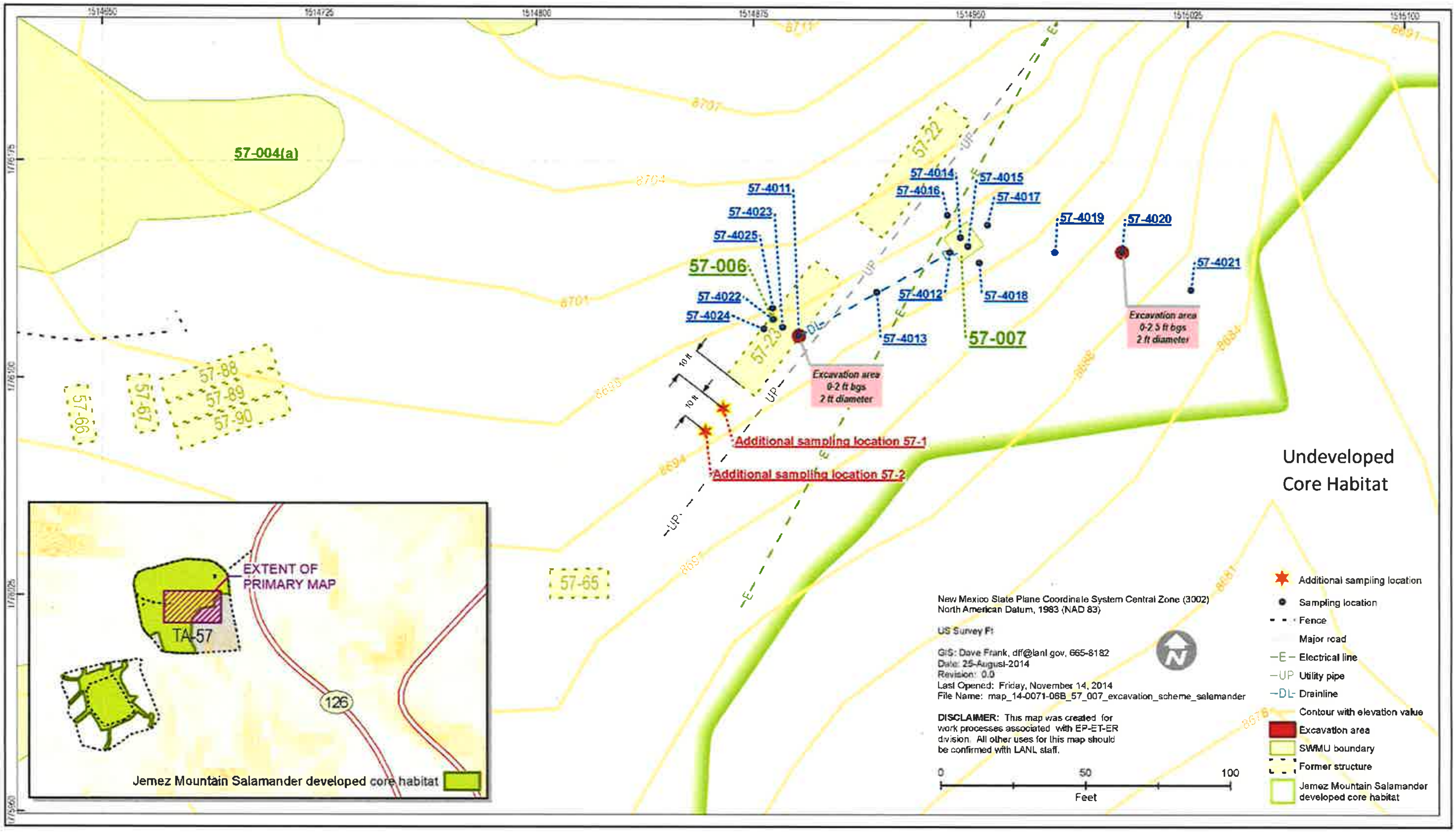

Figure 1. Both AOCs 57-006 and 57-007, and their sampling locations, in relation to developed core habitat for Jemez Mountains salamander.

Appendix H

Documentation of Past Investigations and Corrective Actions at New Mexico Oil Conservation Division–Regulated Sites

The Investigation Work Plan for Technical Area 57 Aggregate Area (Fenton Hill) (hereafter, the work plan) described how sites at Technical Area 57 (TA-57), identified as areas of concern (AOCs), were associated with geothermal energy research, were regulated by the New Mexico Oil Conservation Division (NMOCD), and were closed under a discharge plan issued by NMOCD. The work plan contained a reference to NMOCD's termination of that discharge plan and indicated that no further actions were required by NMOCD for sites regulated under the plan. The New Mexico Environment Department's (NMED's) approval with modifications for the investigation work plan requested supporting documentation related to the NMOCD's termination of the discharge plan, which is provided in this appendix. Specifically, documentation was requested related to past investigations and corrective actions at the closed sites. The five AOCs regulated by NMOCD are 57-001(b), 57-001(c), 57-002, 57-004(a), and 57-004(b).

Activities related to geothermal research at TA-57 (i.e., the Hot Dry Rock Program) were regulated under Discharge Plan GW-031, issued by NMOCD in June 1984 and most recently reissued on June 5, 2000. Discharge Plan GW-031 was terminated on August 29, 2003, following closure of the final regulated activities at TA-57. Activities regulated under the discharge plan included installing and operating geothermal exploration/production wells and storing drilling muds and geothermal fluids in ponds as well as disposing of drilling muds and geothermal fluids.

AOC 57-004(a)

AOC 57-004(a) consists of two former settling ponds (GTP-1E and GTP-1W) that were reconfigured into a 1-million-gal. lined pond. Construction began in 1975, and the pond was closed in 2002 as part of the final NMOCD closure activities at TA-57. Final closure activities at TA-57 were conducted in accordance with the Closure Plan for Fenton Hill Geothermal 1-MG Service Pond and EE-2A Production Well prepared in August 2002 (Attachment H-1). The 1-MG Service Pond [AOC) 57-004(a)] and the EE-2A production well were the final two sites at TA 57 regulated under Discharge Plan GW-031. The closure plan was approved by NMOCD on August 15, 2002 (Attachment H-2). Los Alamos National Laboratory (the Laboratory) initiated closure activities in October 2003 and submitted a progress report to NMODC on February 7, 2003 (Attachment H-3). This progress report described closure activities, including removal and characterization of the pond contents, removal of the pond liner, and soil sampling and analysis. The progress report also included a proposed plan for backfilling the 1-MG pond following removal of its contents and the liner. This backfill plan was approved by NMOCD on February 14, 2003 (Attachment H-4). Following approval of the backfill plan, closure activities were completed and a final closure report was submitted by the Laboratory to NMODC on August 13, 2003 (Attachment H-5). The final report also included a request to terminate Discharge Plan GW-031 because all activities regulated by NMOCD since the plan was originally issued had now been closed. NMOCD approved the Laboratory's request to terminate Discharge Plan GW-031 on August 29, 2003 (Attachment H-6).

AOC 57-004(b)

AOC 57-004(b), also known as the 5-Million Gallon Pond or the Milagro Pond, is a 5-million-gal., plastic-lined storage pond. The pond was constructed in 1982 and originally used as a holding pond for circulated fluids from geothermal wells in accordance with the discharge plan. In1995, the pond was closed for purposes of geothermal activities and modified for use in the Milagro gamma-ray observatory project. The pond was cleaned out, instrumented with over 700 photomultiplier tubes, refilled with purified water, and covered with a light-proof cover consisting of a synthetic membrane. The water used to fill the pond was treated using granular activated carbon ion exchange (i.e., softening) and disinfected with ultraviolet light.

As part of the modification of the pond for use by the Milagro Project in 1995–1996, it was necessary to remove its contents. NMOCD approved land application of approximately 3.7 million gal. of water from the pond to approximately 22 acres of U.S. Forest Service (USFS) land located southwest of the pond. This discharge occurred from May 1995 to October 1995. The NMOCD approval required the application area to be bermed to prevent runoff from a 100-yr flood and also required the Laboratory to collect soil samples within and downgradient of the land application before and after application and for a period of 5 yr following application (1995–1999). Two samples collected in the application area after application was completed showed elevated concentrations of arsenic (18 mg/kg and 24 mg/kg). Three samples collected downgradient of the application area did not show an increase in arsenic above pre-application concentrations. Samples from the two locations in the application area collected in 1996 1 yr after application showed that arsenic concentrations had attenuated to pre-application concentrations (Attachment H-7).

Along with land application of the water, the sludge in the pond and the pond liner were removed and disposed of off-site. Before it was removed, two samples of the sludge were collected in June 1995. Arsenic concentrations in the sludge were 726 mg/kg and 1410 mg/kg. The pond was then relined in 1996 in accordance with specifications approved by NMOCD (Attachment H-8).

After the Milagro observatory became operational, it was necessary to remove water from the pond in 1998 to perform maintenance. The NMOCD approved land application of approximately 2.5 million gal. of water to 7 acres of USFS land located on the northern boundary of the facility. The discharge occurred from April 1998 to June 1998. Because of the high quality of the water used in the pond, no sampling was required as a condition of discharge. Closure of both land application areas was requested in October 2000. (Attachment H-8).

AOCs 57-001(b), 57-001(c), and 57-002

AOCs 54-001(b) and 57-001(c), two former settling ponds, and AOC 57-002, a sludge disposal pit, were closed before1990, and NMOCD closure records are not part of the Resource Conservation and Recovery Act (RCRA) corrective action records. Subsequent to closure under the NMOCD discharge permit, these three AOCs were investigated as part of a RCRA facility investigation (RFI) performed by the Laboratory. The RFI data, therefore, are more representative of current conditions, including the locations and concentrations of residual contaminants, than the NMOCD closure documentation. The RFI report, which also includes AOC 57-004(a), is presented as Attachment H-9. It should be noted, however, that some of the information in the RFI report for AOC 57-004(a) has been superseded by the data collected during NMOCD closure.

Attachments H-1 to H-9

Documentation
(on CD included with this document)