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Investigation Report for Potrillo and Fence Canyons, Revision 1

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EXECUTIVE SUMMARY

This investigation report for Potrillo and Fence Canyons presents the results of sediment studies Los Alamos National Laboratory (the Laboratory) conducted in 2010 and the results of earlier stormwater and potential shallow groundwater studies. The investigations reported herein address sediment and surface water potentially impacted by solid waste management units (SWMUs) and areas of concern (AOCs) located within the Potrillo and Fence watershed. Investigations occurred along 11 km (7 mi) of canyon bottom downcanyon of SWMUs or AOCs. The objectives of the investigations included defining the nature and extent of chemicals of potential concern (COPCs) in sediment and assessing the potential risks to human health and the environment from these COPCs. Analytical data from stormwater samples were also evaluated. The investigations address the sources, fate, and transport of COPCs in Potrillo and Fence Canyons and evaluate the need for additional characterization or remedial actions.

Sediment investigations included geomorphic mapping, associated geomorphic characterization, and sediment sampling in nine investigation reaches located downcanyon from SWMUs or AOCs in Technical Area 15 (TA-15) and TA-36. Surface-water investigations included evaluating analytical data from stormwater samples collected at one stream gage in Potrillo Canyon.

Sediment COPCs in Potrillo and Fence Canyons include 14 inorganic chemicals, 24 organic chemicals, and 6 radionuclides. These COPCs are derived from a variety of sources, including Laboratory SWMUs and AOCs and natural sources such as noncontaminated soil, sediment, and bedrock. Assessments in this report focus on the subset of sediment COPCs considered most important for evaluating potential ecological or human health risk and for understanding contaminant transport. The relative importance of the sediment COPCs was determined by comparing COPC concentrations with human health residential screening action levels and soil screening levels and with ecological screening levels.

No persistent surface water occurs in Potrillo or Fence Canyons; therefore, surface water does not present potential chronic ecological or human health risks in the investigation area, and no surface water COPCs were identified. Stormwater comparison values were exceeded by one inorganic chemical, aluminum, and by gross-alpha radiation in samples from Potrillo Canyon. However, these results do not present potential acute risks, and available data indicate they represent natural background conditions.

The results of this investigation indicate potential human health risks in Potrillo and Fence Canyons are within acceptable limits for present-day and reasonably foreseeable future land uses. The site-specific human health risk assessment using residential screening values and a recreational exposure scenario indicates no unacceptable risks from carcinogens (incremental cancer target risk of 1×10^{-5}), noncarcinogens (hazard index of 1.0), or radionuclides (target dose limit of 15 mrem/yr) from COPCs in sediment.

Chemicals of potential ecological concern (COPECs) identified in the ecological risk screening assessment were compared with results from other watersheds where more detailed biota investigations have been conducted. This comparison indicated concentrations of COPECs in Potrillo and Fence Canyons derived from Laboratory SWMUs or AOCs are not likely to produce adverse ecological impacts, and no additional biota investigations, mitigation, or monitoring is required.

The conceptual model indicates the conditions for sediments are likely to stay the same or improve because of decreases in contaminant concentrations after peak releases; therefore, no further monitoring of sediments is necessary. However, several firing sites in the watershed remain active, and additional releases are possible. Potential contaminant transport from these sites will be characterized in the Potrillo and Fence Canyons Aggregate Area investigation and monitored under the requirements of the National Pollutant Discharge Elimination System Individual Permit for Stormwater Discharges from certain SWMUs and AOCs at Los Alamos National Laboratory.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility under the U.S. Department of Energy (DOE) that is managed by Los Alamos National Security, LLC. The Laboratory is located in north-central New Mexico, approximately 90 km (60 mi) northeast of Albuquerque and 30 km (20 mi) northwest of Santa Fe. The Laboratory comprises an area of 103 km^2 (40 mi^2), mostly on the Pajarito Plateau, which consists of a series of mesas separated by eastward-draining canyons. It also includes part of White Rock Canyon along the Rio Grande to the east. The Laboratory is currently investigating sites potentially contaminated by past operations, both inside and outside the current Laboratory boundary, to ensure contaminants do not threaten human health or the environment. The sites under investigation are designated as solid waste management units (SWMUs) or areas of concern (AOCs). In addition to investigations at SWMUs and AOCs, contamination in canyon bottoms and in groundwater is being investigated on a watershed basis between the sources and the Rio Grande, the master drainage in the region.

1.1 Purpose and Scope

This investigation report presents the results of sediment studies conducted in 2010 and surface water data collected from 2003 to 2009 in Potrillo and Fence Canyons and their tributaries. This area is collectively referred to in this report as the Potrillo and Fence watershed and is shown in Figure 1.1-1. The investigations reported herein address sediment and surface water potentially impacted by SWMUs and AOCs located within the watershed. These media are collectively referred to as canyons media in this report. Only one regional groundwater well has been completed in the watershed, CdV-R-15-3, at the head of Potrillo Canyon next to the watershed divide with Cañon de Valle, as part of investigations of groundwater beneath the Cañon de Valle watershed. Results of investigations of groundwater from that well will be included in a subsequent investigation report on Water Canyon and Cañon de Valle.

The investigations were conducted to fulfill the requirements of several documents. The "South Canyons Investigation Work Plan" (hereafter, the work plan) (LANL 2006, 093713) describes the Laboratory's work scope and the regulatory requirements for characterizing the Potrillo and Fence watershed. A companion document, the "South Canyons Historical Investigation Report" (the HIR) (LANL 2006, 093714) contains a review of SWMUs and AOCs in the watershed, the history of releases, and contaminant data collected before the work plan was prepared. The New Mexico Environment Department (NMED) approved the work plan in 2007 following the Laboratory's responses to a notice of disapproval (NOD) (LANL 2007, 095405; NMED 2007, 095025; NMED 2007, 095490). The requirement to prepare and implement the work plan was also included by reference in Section IV.B.6.b.i of the Compliance Order on Consent (the Consent Order). The Consent Order specified an August 31, 2011, deadline for the Potrillo and Fence Canyons investigation report, and this deadline was subsequently changed to December 31, 2010 (LANL 2010, 109145; NMED 2010, 109742).

The investigations conducted under the work plan also followed the technical strategy presented in the "Core Document for Canyons Investigations" (hereafter, the canyons core document) (LANL 1997, 055622). The canyons core document was prepared after a pilot study in Los Alamos and Pueblo Canyons was implemented in 1996, with the goal of standardizing the technical strategy for work in canyons at the Laboratory. In 1998, NMED approved the core document following the Laboratory's response to a request for supplemental information (LANL 1998, 057666; NMED 1998, 058638).

Data collected during the investigations included in this report are used to (1) define the nature and extent of contamination within canyon bottoms in the Potrillo and Fence watershed; (2) update the conceptual model for contaminant distribution and transport within these canyons; (3) assess potential present-day human health and ecological risk from contaminants within these canyons; (4) determine and recommend potential remedial actions, if needed, that may be appropriate to achieve or maintain site conditions at an acceptable risk level; and (5) provide support for decisions at SWMUs and AOCs. The assessments in this report are conducted using sediment data collected in 2010 and surface water data collected from 2003 to 2009 to evaluate current environmental conditions. Data from environmental surveillance sediment sampling are compared with current concentrations and help to identify any temporal trends in contamination.

This report addresses characterization and risk assessment within Potrillo and Fence Canyons, encompassing approximately 11.0 km (6.8 mi) of canyon bottom downcanyon of SWMUs and AOCs at Technical Area 15 (TA-15) and TA-36. The characterization and assessment approach used in this investigation provides an integrating perspective on historical and current contaminant releases to the canyon bottoms and subsequent contaminant redistribution resulting from various transport processes. This approach facilitates the development of conceptual models that describe expected spatial and temporal trends in contaminant concentrations, thus supporting recommendations for long-term monitoring. The results also support the Laboratory’s watershed approach by providing information on the extent of contamination associated with SWMUs and AOCs and SWMU and AOC aggregates in the Potrillo and Fence watershed and by helping to identify and prioritize remedial activities within the watershed.

1.2 Organization of Investigation Report

This investigation report includes the following sections, following the outline used in the NMED-approved “Mortandad Canyon Investigation Report” (LANL 2006, 094161; NMED 2007, 095109) and subsequent canyons investigation reports. Section 1 is an introduction to the report and to the Potrillo and Fence watershed. Section 2 provides background information on the sources and history of contaminant releases, previous investigations of canyons media, and remediation activities that have occurred in the watershed. Section 3 describes the scope of activities in this investigation. Section 4 introduces the field investigations. Section 5 describes the regulatory context of this investigation. Section 6 presents screening level (SL) assessments that identify chemicals of potential concern (COPCs) and that help focus subsequent sections on the subset of the most important COPCs for evaluating potential human health risk. Section 7 presents a physical system conceptual model, including discussions of the nature, sources, extent, fate, and transport of select COPCs that are most relevant for evaluating potential human health and ecological risk and contaminant transport. Section 8 presents ecological screening assessments and human health risk assessments and results. Section 9 presents conclusions and recommendations. Acknowledgements of those who contributed to this report are listed in section 10. Section 11 presents references cited in this report and the map data sources.

This report has the following appendixes. Appendix A presents a list of acronyms and abbreviations, a table showing conversion of metric units to U.S. customary units, and data qualifier definitions. Appendix B presents field investigation methods and results. Appendix C presents analytical results from sediment and water samples and summarizes data quality. Data packages are included as Attachment C-1 on DVD. Analytical data from the Sample Management Database (SMDB) and Water Quality Database (WQDB) used in this report are on DVD in Attachment C-2. Appendix D presents supporting information on spatial contaminant trends. Appendix E presents supporting information on risk and statistics. Supplemental tables for Appendixes B, C, and E are provided on CD in Attachment 1. Appendix F presents stormwater analytical results and comparisons with target levels.

1.3 Watershed Description

Potrillo and Fence Canyons are located within the Water Canyon watershed. The Potrillo Canyon watershed heads on the Pajarito Plateau in TA-15 and has a maximum elevation of approximately 2215 m (7270 ft) above sea level (asl). Potrillo Canyon extends approximately 11.4 km (7.0 mi) to Water Canyon at an elevation of approximately 1765 m (5795 ft) asl, approximately 1.6 km (1.0 mi) above the Rio Grande (Figure 1.1-1). Fence Canyon is a major tributary to Potrillo Canyon that has its headwaters in TA-36. Its watershed has a maximum elevation of approximately 2180 m (7160 ft) asl and extends approximately 6.4 km (4.0 mi) to Potrillo Canyon at an elevation of approximately 1955 m (6415 ft) asl. The combined watershed of Potrillo and Fence Canyons has a drainage area of 11.7 km^2 (4.5 mi^2), of which 95% is on Laboratory land and 5% is on private land and Los Alamos County land in and adjacent to the community of White Rock. The part of the watershed upcanyon from NM 4, the focus of this investigation, is entirely on Laboratory land.

Bedrock geologic units exposed within the Potrillo and Fence watershed consist entirely of the Tshirege Member of the Bandelier Tuff upcanyon of NM 4 (Griggs and Hem 1964, 092516; Smith et al. 1970, 009752; Dethier 1997, 049843). Basaltic rocks of the Cerros del Rio volcanic field are exposed farther downcanyon.

The biological setting of the Potrillo and Fence watershed is discussed in section 2.2.3 of the investigation work plan (LANL 2006, 093713), and notes on specific sediment investigation reaches are included in Attachment E-1. Details about the hydrology of the watershed are provided in section 7 and Appendix B of this report.

1.4 Current Land Use

The portion of the Potrillo and Fence watershed downcanyon from SWMUs and AOCs is located largely on DOE land, with some private land and Los Alamos County land located along the northeast edge of the watershed east of NM 4. Laboratory activities in or near the canyon bottoms include several active firing areas in TA-36: Eenie and Lower Slobbovia in Potrillo Canyon and Minie in Fence Canyon (Figure 1.1-1). There is no public access to the watershed west of NM 4. East of NM 4, the watershed is open to the public for hiking, horseback riding, and other activities.

2.0 BACKGROUND

Releases from SWMUs and AOCs within the Potrillo and Fence watershed have occurred as a result of dispersal from firing sites and related activities in TA-15 and TA-36 (LANL 2006, 093714). SWMUs and AOCs in the watershed are shown in Figure 2.0-1. These canyons also receive stormwater runoff from roads, parking lots, and other developed areas in these TAs. Previous sampling results from within these canyons indicated contamination from inorganic chemicals, organic chemicals, and radionuclides (LANL 2006, 093714). Additional sampling has been proposed and/or conducted to further define the nature and extent of contamination at SWMUs and AOCs located in the Potrillo and Fence Canyons Aggregate Area (LANL 2009, 106657.8).

The following sections summarize the sources and history of contaminant releases as well as investigations that have addressed contaminant distribution and concentration in canyons media. Remediation activities implemented to reduce contamination in source areas are also discussed.

2.1 Sources and History of Contaminant Releases and Remediation

2.1.1 TA-15

TA-15 (R Site) includes the headwaters of Potrillo Canyon and was used for open-air explosives detonation beginning in 1944 (LANL 2006, 093714, pp.18–19). Firing Site A [SWMU 15-004(b)] and Firing Site B [SWMU 15-004(c)] were located at the head of the south fork of Potrillo Canyon and used from late 1944 to approximately 1953. A voluntary corrective action (VCA) was conducted at Firing Site B in 1996 to remove lead-contaminated soils (LANL 1996, 055046). Firing Site E-F [SWMU 15-004(f)] has been the most extensively used firing site at the Laboratory, both in terms of length of use and quantities of uranium expended. E-F was established in 1947 and last used in 1981. Most of the activities at E-F occurred before 1974, involving both natural and depleted uranium. Consolidated Unit 15-003-00 includes a burn pad (structure 15-003) and a firing point [SWMU 15-006(a)], which are associated with tests at the Pulsed High-Energy Radiographic Machine Emitting X-rays (PHERMEX) facility. PHERMEX was established in 1961 and used until 1987, with most of the activity occurring before 1971.

2.1.2 TA-36

TA-36 (Kappa Site) includes the headwaters of Fence Canyon and a large part of the Potrillo Canyon watershed and has been used for open-air explosives detonation since 1950 (LANL 2006, 093714, pp.19–21). The Fence Canyon watershed includes two firing sites in TA-36: Meenie [AOC 36-004(b)] and Minie [AOC 36-004(c)]. Both Meenie and Minie were completed in 1950, and activities are still occurring at Minie. The Potrillo Canyon watershed includes four firing sites in TA-36: Eenie [AOC 36-004(a)], I-J [AOC 36-004(e)], Lower Slobbovia [SWMU 36-004(d)], and Skunk Works [SWMU 36-004(d)]. Activities began at these firing sites in 1950 and still occur at Eenie and Lower Slobbovia.

2.1.3 Cerro Grande Fire

In May 2000, the Cerro Grande fire burned the upper part of the Potrillo Canyon watershed. Approximately 1.0 km^2 (0.4 mi^2) of the watershed was within the burn perimeter (BAER 2000, 072659), comprising 8% of the Potrillo and Fence watershed. The area within the burn perimeter was classified as low-severity burn or not burned. No part of the Fence Canyon watershed burned. Various naturally occurring inorganic chemicals (e.g., barium, cobalt, and manganese) and anthropogenically created fallout radionuclides (e.g., cesium-137, plutonium-239/240, and strontium-90) were concentrated in Cerro Grande ash at levels exceeding that of background sediments before the fire, and the transport of ash has resulted in elevated levels of these analytes in post-fire sediment deposits in some canyons (Katzman et al. 2001, 072660; Kraig et al. 2002, 085536; LANL 2004, 087390). Elevated levels of inorganic chemicals and radionuclides that can be attributed to the transport of ash have also been found in stormwater samples in some canyons (Gallaher and Koch 2004, 088747).

2.2 Potential Contamination in Canyons Media

Potential contamination in sediment and surface water in the Potrillo and Fence watershed has been evaluated in several previous studies dating back to 1973. Some key studies, summarized below, provide background and supplemental data for the investigations presented in this report. Relevant information from these studies is also included in subsequent sections of this report.

2.2.1 Environmental Surveillance Program

The Laboratory's Environmental Surveillance Program has conducted investigations of sediment, surface water, and potential alluvial groundwater in the Potrillo and Fence watershed since 1973. Sediment investigations have included the sampling of the active stream channels in Potrillo and Fence Canyons. Surface water investigations have included sampling of stormwater at two stream gages within Potrillo Canyon. Sediment and stormwater analyses are reported in the annual environmental surveillance reports (e.g., LANL 2010, 111232), and summaries of results from active channel sediment and stormwater sampling in Potrillo and Fence Canyons through 2005 are presented in the HIR (LANL 2006, 093714). Additionally, flow measurements are made at stream gages in Potrillo and Fence Canyons and reported in annual surface water reports (e.g., Ortiz and McCullough 2010, 109826). This work supports the evaluation of long-term trends in contamination in different media and provides an understanding of the role of stormwater transport.

In 1989, two boreholes, PCTH-1 and FCO-1, were drilled in Potrillo and Fence Canyons west of NM 4 to evaluate potential perched groundwater zones (Purtymun and Stoker 1990, 007508). Both holes were dry. PCTH-1 was plugged and abandoned, and FCO-1 was completed as a monitoring well. In 1991, two additional holes (POTO-4 and POTO-5) were cored in Potrillo Canyon between Skunk Works and Lower Slobbovia and were completed as observation wells at different depths (Purtymun 1995, 045344, p. 331). Both wells were dry.

2.2.2 Resource Conservation and Recovery Act and Consent Order Investigations

Since 1994, the Laboratory has conducted studies of canyons media in the Potrillo and Fence watershed as part of Resource Conservation and Recovery Act and Consent Order investigations. Results of these investigations have been presented in several reports (LANL 1996, 054733; LANL 2006, 093714). The work presented in this investigation report builds on these previous studies.

2.2.3 Special Studies

From 1983 to 1991, a study was conducted to evaluate the fate and transport of uranium from firing sites in Potrillo Canyon (Becker 1991, 015317). This study covered the 8 km of Potrillo Canyon above NM 4 and included the sampling of stormwater and snowmelt runoff, atmospheric deposition, soil, and sediment; measurements of runoff discharge; and installation of boreholes to evaluate moisture content and potential alluvial saturation. This study identified an area near Lower Slobbovia with high transmission losses where runoff infiltrated and sediment was deposited. This observation is important for development of the conceptual model for contaminant transport in Potrillo Canyon.

3.0 SCOPE OF ACTIVITIES

The scope of activities in this report includes investigations of sediment in the Potrillo and Fence watershed, as presented in the work plan and subsequent documents (LANL 2006, 093713; NMED 2007, 095025; LANL 2007, 095405; NMED 2007, 095490). This report also presents stormwater data collected and observations of potential shallow groundwater in the watershed obtained as part of other investigations. These investigations are discussed below.

3.1 Sediment Investigations

The sediment investigations presented in this report focused on characterizing the nature, extent, and concentrations of COPCs in post-1942 sediment deposits in a series of reaches in the Potrillo and Fence watershed. Some sampling of pre-1943 sediment deposits also occurred in the investigation reaches. Data from these reaches were used to evaluate potential human health and ecological risks and to identify spatial trends of COPCs at a watershed scale, including variations in COPC concentrations at increasing distances from SWMUs and AOCs. The investigation methods are discussed in section 4 and Appendix B, section B-1.0, of this report; in the investigation work plan (LANL 2006, 093713); and in the canyons core document (LANL 1997, 055622; LANL 1998, 057666).

The scope of this investigation included characterization of seven reaches identified in the work plan (LANL 2006, 093713, p. 47) and two additional reaches (F-3 and PO-4) requested by NMED (NMED 2007, 095025; NMED 2007, 095490). Table 3.1-1 lists the sediment investigation reaches, providing the approximate length and distance of each reach from the Rio Grande as well as additional information on the reaches. Locations of reaches are shown in Figure 3.1-1.

3.2 Surface Water and Potential Shallow Groundwater Investigations

The surface water investigations discussed in this report include the presentation and summary of stormwater analyses obtained at one gaging station in Potrillo Canyon, E267, as part of the Laboratory's Environmental Surveillance Program. Stormwater samples have been collected from an additional gage in the Potrillo Canyon watershed, E269, along a tributary east of NM 4 (LANL 2006, 093714). Because this location is not downgradient of any SWMUs or AOCs, the E269 data are not evaluated for potential contamination, although they provide useful information on stormwater composition from a background location.

Data on flow measurements obtained at E267 are also summarized in this report and are used to assess runoff frequency in Potrillo Canyon above NM 4. Limited measurements of runoff events have been made at two additional gages in Potrillo and Fence Canyons, E266 and E267.5, although no rating curves have been developed for these gages and consequently no discharge estimates are available. Locations of gaging stations are shown in Figure 3.2-1.

The investigations of potential shallow groundwater presented in this report include observations from six holes drilled in Potrillo Canyon and one hole drilled in Fence Canyon. Two of the Potrillo Canyon holes and the Fence Canyon hole were completed as monitoring wells, but only the Fence Canyon hole, FCO-1, has been maintained as a monitoring well. A transducer was installed in FCO-1 in 2008 to measure any transient groundwater, but water levels have remained below the screen since the installation (Koch and Schmeer 2010, 108926). Because FCO-1 has been dry since installation, it was removed from the Interim Facility-Wide Groundwater Monitoring Plan in 2010 (LANL 2010, 109830). Locations of wells and holes in Potrillo and Fence Canyons are shown in Figure 3.2-1.

3.3 Deviations from Planned Activities

In its response to NMED's NOD on the work plan, the Laboratory specified that after the Phase 1 sediment investigation was completed, a Phase 1 summary report would be prepared to present the results and propose a Phase 2 investigation, if appropriate (LANL 2007, 095405). Because the deadline for the investigation report was changed from August 31, 2011, to December 31, 2010 (LANL 2010, 109145; NMED 2010, 109742), the time between completion of the Phase 1 investigations and preparation of this investigation report was not sufficient to prepare a summary report or to conduct Phase 2 investigations. All information that would have been contained in the Phase 1 summary report is presented in this investigation report, and any recommendations for additional work are proposed in section 9 of this investigation report.

4.0 FIELD INVESTIGATIONS

Field investigations in the Potrillo and Fence watershed included investigations of sediment in nine investigation reaches. No surface water or groundwater investigations were conducted as part of the implementation of the work plan (LANL 2006, 093713), although surface water data and observations from monitoring wells and other holes obtained from other investigations were compiled and summarized. The approaches and methods of these investigations are discussed briefly in the following sections. A more detailed discussion of the methods and of the field investigations results is presented in Appendix B.

4.1 Sediment

Sediment investigations in the Potrillo and Fence watershed included detailed geomorphic characterization and sediment sampling in a series of discrete reaches, following the general process described in the NMED-approved work plan and canyons core document (LANL 2006, 093713; LANL 1997, 055622). The geomorphic characterization in these reaches included preparing a detailed geomorphic map delineating the horizontal extent of geomorphic units with varying physical characteristics and/or age. The geomorphic characterization also included measuring the thickness of potentially contaminated post-1942 sediment deposits to estimate the volume of potentially contaminated sediment in each reach. Several methods were used to identify the bottom of post-1942 sediment deposits, including determining the depth of buried trees and associated buried soils and noting the presence or absence of materials imported to the watersheds after 1942 (e.g., quartzite gravel and plastic). The base of post-1942 sediment was not always well defined, and the thickness measurements and sediment sampling included pre-1943 sediment at many locations to avoid underestimating the depth of contamination.

Plates 1 and 2 present geomorphic maps of the sediment investigation reaches in the Potrillo and Fence watershed, including sample locations and stratigraphic description locations within these reaches. The horizontal extent of contaminated or potentially contaminated sediment deposits in each reach is delineated by the extent of the channel (“c”) and floodplain (“f”) units in these maps. Section B-1.0 of Appendix B includes more detailed discussion and presentation of the field investigation methods and results, including sediment thickness measurements. Field data on the volume of sediment in the different geomorphic units in a reach were used to help allocate samples for analysis at off-site laboratories. All analytical results of the sediment sampling incorporated in this investigation report are presented in Attachment C-2 in Appendix C (on DVD).

4.2 Surface Water and Potential Shallow Groundwater Investigations

The surface water and potential shallow groundwater field investigations in Potrillo and Fence Canyons were designed to monitor potential stormwater transport of contaminants and the potential presence of shallow groundwater and associated contamination. Analytical results for surface water sampling are discussed in section 7.2.2, and the data are provided in Attachment C-2 in Appendix C. Water-quality field parameters, including pH, specific conductance, temperature, and turbidity, were measured for each surface water sample collected. Flow measurements from gaging stations in the watershed are summarized in section 7.2.2. No shallow groundwater has been observed, and therefore no groundwater samples have been collected from the Potrillo and Fence watershed.

5.0 REGULATORY CRITERIA

This section provides information on the regulatory context, human health SLs, ecological screening levels (ESLs), applicable water-quality standards, and other SLs for the Potrillo and Fence Canyons investigation.

5.1 Regulatory Context

Requirements governing canyons investigations are discussed in Section IV.B of the Consent Order. As described in Section IV.B, the canyons investigations primarily focus on fate and transport of contaminants from the point of origin to each canyon watershed drainage system and, if necessary, to the regional aquifer and to the Rio Grande.

The canyon bottoms addressed in this investigation report are potentially contaminated with both hazardous and radioactive components. NMED, pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 5400.5, Radiation Protection of the Public and the Environment, 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.

The regulatory requirements for conducting canyons investigations under the Consent Order are implemented through work plans approved by NMED. The approved work plan for Potrillo and Fence Canyons is the “South Canyons Investigation Work Plan” (LANL 2006, 093173; LANL 2007, 095405; NMED 2007, 095490).

Surface-water discharges are subject to a permit under Section 402 of the federal Clean Water Act (CWA), including stormwater discharges. Stormwater discharges from certain SWMUs and AOCs are regulated by an Individual Permit (IP) issued by Region 6 of the U.S. Environmental Protection Agency (EPA), pursuant to the National Pollutant Discharge Elimination System (NPDES) permit program (Authorization to Discharge under the National Pollutant Discharge Elimination System, NPDES Permit No. NM0030759, effective November 1, 2010). This permit covers stormwater runoff from sites with significant industrial activity [see 40 Code of Federal Regulations 122.26(b)(14)].

The assessments in this report are primarily risk-based for all media and contaminants. Concentrations of chemicals and radionuclides in sediment are compared with various risk-based SLs, which are described in sections 5.2 and 5.3. Stormwater comparison values are discussed in section 5.4.

5.2 Human Health SLs

Soil screening levels (SSLs) for inorganic and organic chemicals and screening action levels (SALs) for radionuclides used in the initial COPC screen in section 6 are media-specific concentrations derived for residential exposure. If environmental concentrations of contaminants are below SALs or SSLs, then the potential for adverse human health effects is highly unlikely. For sediment COPCs with carcinogen or noncarcinogen endpoints, SSLs from NMED guidance (NMED 2009, 108070) were used, if available. If values were not available from NMED, then the residential screening value from the EPA regional SL tables, available at http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm, was used as the SSL (adjusted to 10^{-5} risk to conform with NMED SSLs). The SSLs for noncarcinogens are based on a hazard quotient (HQ) of 1.0. The SSLs for carcinogens are based on a cancer risk level of 10^{-5}. For nonradionuclide COPCs without SSLs, approved surrogate chemicals were used (NMED 2003, 081172), where applicable. SALs for radionuclides were obtained from Laboratory guidance (LANL 2005, 088493;

LANL 2009, 107655). The radionuclide SALs have a target dose limit of 15 mrem/yr, which is consistent with DOE guidance (DOE 2000, 067489).

The initial screening comparisons of sediment data to residential SSLs and SALs are provided in section 6. Additional information regarding the potential for human health risks from COPCs in affected media in Potrillo and Fence Canyons is provided in section 8.2.

5.3 Ecological Screening Levels

ESLs are used to determine chemicals of potential ecological concern (COPECs) for sediment. The document “Screening Level Ecological Risk Assessment Methods, Revision 2” (LANL 2004, 087630), contains information about how ESLs are derived. ESLs are developed for a suite of receptors designed to represent individual feeding guilds. Receptors such as the robin and kestrel are modeled with multiple diets to represent multiple feeding guilds. Concentrations of each COPC in sediment were compared with ESLs from the ECORISK Database Version 2.5 (LANL 2010, 110846); these comparisons are discussed in section 6. Additional information regarding the potential for ecological risks from COPCs in affected media in Potrillo and Fence Canyons is provided in section 8.1.

5.4 Stormwater Comparison Values

Stormwater discharges are regulated under the CWA, and no applicable standards for stormwater are available. The IP contains target action levels for specific contaminants in stormwater, but these action levels apply only at the monitoring locations specified in the permit. For purposes of assessing the relative quality of stormwater discharges, stormwater monitoring data obtained from Potrillo Canyon downgradient of SWMUs and AOCs are compared to the following values from the State of New Mexico Standards for Interstate and Intrastate Surface Waters (Section 20.6.4 New Mexico Administrative Code [NMAC]):

- livestock watering (20.6.4.900[F] and 20.6.4.900[J] NMAC)
- wildlife habitat (20.6.4.900[G] and 20.6.4.900[J] NMAC)
- acute aquatic life (20.6.4.900[H], 20.4.6.900[I], and 20.6.4.900[J] NMAC)
- human health (persistent) (20.6.4.11[G] NMAC)

Stormwater concentrations are compared with these values in section 6.

6.0 CANYONS CONTAMINATION

This section describes the methodology and results of screening assessments conducted to identify COPCs in sediment samples collected in Potrillo and Fence Canyons. The screening process for stormwater data is also described. Identifying COPCs forms the basis for evaluating contamination in canyons media. COPCs identified in this section are used in the ecological risk assessment in section 8.1 and are evaluated in the human health risk assessment in section 8.2. A subset of these COPCs is discussed as part of the conceptual model development in section 7. Section 6.1 briefly describes how the data were prepared for the screening processes. Section 6.2 presents the screen for sediment, and section 6.3 presents the screen for stormwater. The term “sediment” includes all post-1942 sediment deposits in the canyon bottoms, including deposits in abandoned channels and floodplains as well as in active stream channels; therefore, sediment includes alluvial soil as defined in some other studies.

6.1 Data Preparation

Data packages for the analytical data for all media are presented in Attachment C-1 in Appendix C. The data used in the assessments were obtained from the SMDB and the WQDB and are presented in Attachment C-2 in Appendix C. The samples collected, analytical methods, and data-quality issues are summarized in Appendix C, and data qualifiers are defined in Appendix A.

Certain analytical results were not evaluated in the screens and subsequent risk assessments for the following reasons.

- Duplicate sample results for analytes analyzed by a less sensitive method—For example, semivolatile organic compound (SVOC) results from samples that were also analyzed by a volatile organic compound (VOC), polycyclic aromatic hydrocarbon (PAH), or high explosive (HE) analytical method. The duplicate results from the SVOC method are excluded from the screen because the VOC, PAH, and HE analytical methods provide lower detection limits.
- Field duplicate results—Results are from samples obtained for quality assurance/quality control (QA/QC) purposes and not as characterization data.
- Results from surface water samples collected before 2003—Results from samples collected in 2003 and later are used in the screens because these data are most representative of current site conditions.
- Results from surface water samples collected from background areas—Results from samples collected from the E269 gage, along a tributary to Potrillo Canyon east of NM 4, are not used in the screens because no SWMUs or AOCs are upgradient.

The only surface water sample collected from the Potrillo watershed after 2002 that was assigned a media code other than “stormwater” (WT) was from a short-duration, rain-on-snow event in January 2008. This event was more similar to typical stormwater events than snowmelt runoff that provides persistent flow in other canyons, and this sample is included as part of the stormwater screen in section 6.3.

6.2 Sediment COPCs

This section presents the process for screening analytical results obtained from sediment samples collected in Potrillo and Fence Canyons. Samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-1 in Appendix C. Sampling locations are shown on Plates 1 and 2. Analytical results were screened to develop a list of COPCs, as presented in section 6.2.1.

6.2.1 Identification of Sediment COPCs

Inorganic and radionuclide COPCs in sediment are identified by a screening process that includes comparing the maximum concentrations by reach with Laboratory-specific sediment background values (BVs) (LANL 1998, 059730). Analytes are retained as COPCs using rules specific to the class of analyte. This process is discussed below.

For inorganic chemicals, an analyte is retained as a COPC in a reach if

- the analyte has a BV and a detected or nondetected result in the reach exceeds the BV, or
- the analyte does not have a BV but has at least one detected result in the reach.

For radionuclides, an analyte is retained as a COPC in a reach if

- the analyte has a BV and at least one detected result in the reach exceeds the BV, or
- the analyte does not have a BV but has at least one detected result in the reach.

There are no BVs for organic chemicals, and retaining an organic chemical as a COPC is based on detection status. For organic chemicals, an analyte is retained as a COPC in a reach if at least one result is detected in the reach.

A total of 14 inorganic chemicals, 24 organic chemicals, and 6 radionuclides were retained as COPCs in sediment in Potrillo and Fence Canyons. Maximum sample results in each reach (which include detection limits for some inorganic chemicals) for these COPCs are presented in Tables 6.2-1, 6.2-2, and 6.2-3 for inorganic chemicals, organic chemicals, and radionuclides, respectively. ESLs and residential SSLs and SALs are included in the tables for comparison purposes. The assessment of the potential for adverse ecological risks, including the screen against ESLs, is presented in section 8.1. The assessment of the potential for adverse effects on human health, including the screen against residential SSLs and SALs, is presented in section 8.2.

6.2.2 Comparison of Sediment COPC Concentrations to Residential SSLs and SALs

Maximum concentrations (including detection limits for inorganic chemicals) of sediment COPCs in each reach were compared with residential SSLs for inorganic and organic chemicals or residential SALs for radionuclides to identify which COPCs are most important for understanding potential human health risk. One radionuclide COPC, thorium-228, has a maximum concentration exceeding the residential SAL in reach PO-2 and is highlighted in gray in Table 6.2-3. No inorganic or organic COPCs have maximum concentrations exceeding residential SSLs in Potrillo and Fence Canyons.

6.3 Stormwater

This section presents the process for screening analytical results obtained from stormwater samples collected in Potrillo Canyon. Stormwater samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-2 in Appendix C.

6.3.1 Stormwater Screen against Comparison Values

The first step in the stormwater screen (Table F-1) is an evaluation of detected analyte concentrations in filtered and nonfiltered stormwater samples against the lowest comparison value applicable for that field preparation from the State of New Mexico Standards for Interstate and Intrastate Surface Waters (Section 20.6.4 NMAC), as described in section 5.4. The stormwater comparison values are presented in Table F-2 and include values for livestock watering, wildlife habitat, human health persistent, and acute aquatic life. Table F-1 presents the results of the stormwater screen for analytes with concentrations exceeding a comparison value grouped by location, field preparation, and analyte type. These analytes are discussed further in section 7.2.2.

The only gaging station in Potrillo and Fence Canyons for which surface water samples are available is gage E267, Potrillo above SR-4, in reach PO-4.

The stormwater comparison values were exceeded by one inorganic chemical (aluminum) in filtered samples. No inorganic or organic chemicals in nonfiltered samples had concentrations greater than the comparison values. The stormwater comparison value for gross-alpha radiation was exceeded in nonfiltered samples. Both aluminum and gross-alpha radiation commonly exceed these comparison values in background locations on the Pajarito Plateau (e.g., LANL 2010, 111232). Table F-1 in Appendix F summarizes the number of stormwater results by analyte exceeding the lowest comparison value and the basis for the comparison value.

6.3.2 Comparison of Stormwater Concentrations to Acute Exposure Benchmarks

Analytes with concentrations greater than comparison values were further evaluated relative to the potential for acute exposure to human health or ecological receptors. The acute exposure benchmarks for the protection of ecological receptors are a subset of the comparison values discussed in section 6.3.1. Specifically, the comparison values associated with acute aquatic life address the protection of ecological receptors to acute exposures; these benchmark comparisons are discussed in section 6.3.2.1. No analytes exceeded persistent human health comparison values so no analytes are evaluated further for human health exposures. Both livestock watering and wildlife habitat values are protective of the potential for adverse effect based on chronic exposures and therefore do not pertain to effects associated with acute exposures. The only analyte exceeding these chronic comparison values (gross-alpha radiation) is not evaluated further because chronic exposures from stormwater are not realistic. However, aluminum concentrations are greater than acute ecological comparison values and this analyte is discussed further below.

6.3.2.1 Acute Ecological Comparisons

The maximum detected concentration of one analyte (aluminum) exceeded stormwater comparison values based on acute aquatic life criteria. Because the stormwater comparison values are based on an acute exposure, the acute aquatic life standards are also used as the benchmarks for acute ecological exposures. Table F-1 summarizes the maximum detected concentrations of the analytes exceeding an acute benchmark. Because Potrillo and Fence Canyons have no persistent water, no aquatic receptors or pathways exist, and these analytes in stormwater are not discussed further. Section 8.1 contains more information on ecological receptors and exposure pathways.

6.4 Summary

Table 6.4-1 presents a summary of the COPCs in sediment and detected analytes in stormwater in Potrillo and Fence Canyons. Table 6.4-1 indicates which COPCs have maximum results that exceed residential SSLs and SALs for sediment and which stormwater analytes have maximum detected concentrations that exceed acute exposure benchmark values.

7.0 PHYSICAL SYSTEM CONCEPTUAL MODEL

This section discusses aspects of the physical system conceptual model relevant for understanding the nature, sources, extent, fate, and transport of contaminants in the Potrillo and Fence watershed, particularly in sediment and surface water. The discussion includes COPCs included in evaluations of potential human health risk in section 8.2 and COPCs identified as relevant for evaluating potential present-day ecological risk in section 8.1. Some additional COPCs are discussed to provide insights into potential releases from SWMUs or AOCs. As used in this section, “contaminant” refers to COPCs known to represent releases from Laboratory SWMUs or AOCs or other anthropogenic sources, whereas “COPC” is a more general term that also includes analytes identified in section 6 that may or may not represent such releases.

The following discussion is divided into two sections. Section 7.1 uses spatial variations in COPC concentration in sediments to identify sources and describe the distribution and transport of contaminants. Section 7.2 describes the hydrology of the watershed, including surface water.

7.1 COPCs in Sediments

The following sections first use spatial variations in concentrations of sediment COPCs in Potrillo and Fence Canyons to identify sources, in part distinguishing COPCs that are present because of releases from SWMUs or AOCs from COPCs derived from other sources, such as natural background variations. Because of mixing of sediment from various sources during transport, contaminant concentrations are generally highest near the point of release and decrease downcanyon (e.g., Marcus 1987, 082301; Graf 1996, 055537; LANL 2004, 087390; Reneau et al. 2004, 093174; LANL 2006, 094161; LANL 2009, 106939; LANL 2009, 107453; LANL 2009, 107497). Therefore, the spatial distribution of contaminants can directly indicate their source or sources. Figures D-1.1-1, D-1.1-2, and D-1.1-3 in Appendix D show all sample results for all COPCs plotted against distance from the Rio Grande, which help to identify sources and possible outliers in the data set. COPCs associated with natural background variations also commonly have concentrations that vary with particle size, and comparisons of their concentrations and particle size distribution with those in background sediment samples are useful in evaluating the presence of contamination.

7.1.1 Inorganic Chemicals in Sediments

This section focuses on spatial variations of select inorganic chemicals in Potrillo and Fence Canyons. No inorganic COPCs in Potrillo and Fence Canyon sediment have maximum detected concentrations greater than residential SSLs, and none are included in the human health risk assessment discussed in section 8.2. Four inorganic chemicals detected in sediment samples are important for assessing potential ecological risk and were considered as potential study design COPECs, as discussed in section 8.1: cadmium, copper, selenium, and vanadium. Several additional inorganic chemicals have spatial distributions that indicate releases from SWMUs or AOCs, including beryllium and cobalt. The spatial distribution of these inorganic chemicals (discussed below) indicates they are derived from a variety of sources, including SWMUs or AOCs and naturally occurring soils and bedrock. Once in the canyon bottoms, most of these inorganic chemicals adsorb to sediment particles and organic matter (Salomons and Forstner 1984, 082304) and can be remobilized by floods that scour the stream bed or erode banks, being transported varying distances downcanyon.

Supporting information on spatial variations in inorganic chemicals in Potrillo and Fence Canyons is included in Appendix D. Table D-1.2-1 presents average concentrations in each reach for inorganic chemicals discussed in this section, substituting one-half of the detection limit for nondetected sample results. Table D-1.2-1 presents the upper and lower bounds on these averages using either the detection limit or zero for nondetects, respectively, which indicate uncertainties in the average values. This table shows that average concentrations of these inorganic chemicals are generally lower in coarse facies sediment than in fine facies sediment, as found in other canyons (LANL 2004, 087390; LANL 2006, 094161; LANL 2009, 107416; LANL 2009, 106939; LANL 2009, 107453; LANL 2009, 107497). Figure 7.1-1 and the discussions in the following sections focus on data from fine facies sediment. Figure 7.1-1 and Table D-1.2-1 also show the uncertainty in the average concentration of some inorganic chemicals that exists in some reaches because of elevated detection limits and/or detected concentrations close to detection limits.

The plots in Figure 7.1-1 include both the sediment BV for each inorganic chemical, which is an estimate of the upper level of background concentrations, and the average value from the background sediment data set, where available (averages from McDonald et al. 2003, 076084, Table 10, pp. 49-50). The background averages are included to be consistent with the presentation of averages from potentially contaminated samples, although averages for fine facies sediment are expected to be higher than the entire background data set, which also includes coarse facies samples. For reaches where an inorganic chemical is not a COPC, the average background concentration is plotted in Figure 7.1-1.

Figure 7.1-2 presents relations of concentrations of select inorganic COPCs with silt and clay content in Potrillo and Fence Canyon sediment samples and background samples (background data from McDonald et al. 2003, 076084). These plots help identify outliers in the data set that indicate anthropogenic contamination as well as sample results indicative of natural background variations.

Beryllium is a known contaminant at the E-F firing site in the upper Potrillo Canyon watershed, and the sediment data indicate limited transport of beryllium into the canyon bottom at low concentrations. Beryllium is only a COPC in reach PO-1 (Table 6.2-1), immediately downgradient from the firing site, and 20% of the PO-1 samples have beryllium above the BV of 1.31 mg/kg, at 1.37 and 1.62 mg/kg. One of these samples also has the highest cadmium, cobalt, copper, and uranium-238 concentrations in PO-1. Average beryllium concentrations in PO-1 are below the BV, indicating small releases (Table D-1-2-1).

Cadmium is an important COPC for evaluating potential ecological risk in Potrillo and Fence Canyons and has maximum detected concentrations exceeding the sediment BV of 0.4 mg/kg in three investigation reaches (PO-1, PO-2, and PO-3; Table 6.2-1). In addition, nondetected cadmium results are above the BV in most reaches (except PO-2 and PO-3), accounting for 28% of the samples. All Fence Canyon results above the BV were nondetects. The maximum cadmium concentration, 0.884 mg/kg, is from the active channel in reach PO-3, in a coarse-grained sample that also has the highest iron, vanadium, and zinc in this data set. The high concentrations of metals in this sample indicate the presence of naturally occurring magnetite-rich black sands (e.g., Reneau et al. 1998, 062050) and not Laboratory contamination. However, the PO-1 and PO-2 samples with cadmium detected above the BV also are elevated in COPCs with known releases from firing sites, indicating one or more Laboratory sources for cadmium in the upper Potrillo Canyon watershed. Average cadmium concentrations in fine facies sediment are below the BV in all reaches, indicating these releases were small (Figure 7.1-1 and Table D-1-2-1). A plot of detected cadmium concentrations versus silt and clay content (Figure 7.1-2) illustrates that cadmium in a few PO-1 and PO-2 samples is only slightly elevated above the BV and above concentrations in other reaches and that the single cadmium result above the BV in PO-3 in a coarse-grained sample is anomalously high.

The distribution of cobalt is similar to other metals and indicates releases from Laboratory sites. Cobalt has maximum concentrations exceeding the sediment BV of 4.73 mg/kg in three reaches, PO-1, PO-2, and FS-1 (Table 6.2-1), and the sediment data indicate limited transport of cobalt into the canyon bottoms at low concentrations. The highest cobalt concentration in PO-1, 5.41 mg/kg, is in the same sample with the highest cadmium, copper, and uranium-238 concentrations. Similarly, the highest cobalt concentration in FS-1, 5.75 mg/kg, is in the sample with the highest copper and lead concentrations. Average cobalt concentrations in all reaches are below the BV, indicating small releases (Table D-1-2-1).

Copper is an important COPC for evaluating potential ecological risk in Potrillo and Fence Canyons and has maximum detected concentrations exceeding the sediment BV of 11.2 mg/kg in three investigation reaches (FS-1, PO-1, and PO-2; Table 6.2-1). The maximum copper concentration, 52 mg/kg, is from a fine-grained sample in PO-1, downcanyon from the E-F firing site, indicating releases from this site. Data from stormwater samples have also indicated the transport of copper from firing sites at the Laboratory (LANL 2009, 108621, p. 223). Average copper concentrations are above the BV in both coarse and fine facies sediment in PO-1 but below the BV in FS-1 and PO-2 (Figure 7.1-1 and Table D-1-2-1). The spatial distribution of copper indicates the largest releases into the upper part of Potrillo Canyon and downcanyon decreases in concentration. These data also indicate relatively small releases into the head of the south fork of Fence Canyon. A plot of copper concentration versus silt and clay content (Figure 7.1-2) illustrates the high copper concentrations relative to background in PO-1 samples with a range in particle size and also the slightly elevated concentrations in FS-1 and PO-2.

Selenium is an important COPC for evaluating potential ecological risk in Potrillo and Fence Canyons and has maximum detected concentrations exceeding the sediment BV of 0.3 mg/kg in five investigation reaches (PO-2, PO-3, PO-4, F-1, FS-1; Table 6.2-1). Selenium has a high frequency of nondetects in this data set, 90%, and detection limits for these samples are above the BV, which complicates evaluating the concentrations, sources, and distribution of selenium. The maximum selenium concentration, 1.63 mg/kg, is from the active channel in reach PO-3. Other metals are not elevated in this PO-3 sample, and the source of this selenium is not known. However, the PO-2 sample with detected selenium above the BV is also elevated in other metals, such as copper, suggesting releases from one or more Laboratory sites. Average selenium concentrations in fine facies sediment are above the BV in all reaches, although these averages are affected by the high frequency of nondetects and elevated detection limits, and the spatial pattern of selenium does not indicate significant releases (Figure 7.1-1 and Table D-1-2-1).

Vanadium is an important COPC for evaluating potential ecological risk in Potrillo and Fence Canyons and has maximum detected concentrations exceeding the sediment BV of 19.7 mg/kg in seven investigation reaches (F-2, F-3, FS-1, PO-1, PO-3, PO-4, and POS-1; Table 6.2-1). The maximum vanadium concentration, 32.7 mg/kg, is from a coarse-grained sediment sample from the active channel in PO-3, in a sample that also has the highest cadmium, iron, and zinc concentrations in this data set (sample CAPO-10-23483). The second highest vanadium concentration is from a coarse-grained sample in F-2 that is also elevated in iron and zinc concentrations. Black magnetite-rich sands on the Pajarito Plateau are elevated in iron, vanadium, zinc, and other metals (Reneau et al. 1998, 062050), and the composition of these F-2 and PO-3 samples indicates the presence of black sands. Average concentrations are below the BV in all reaches, and the spatial pattern of vanadium does not indicate significant releases from Laboratory sites (Figure 7.1-1 and Table D-1-2-1). A plot of vanadium concentration versus silt and clay content (Figure 7.1-2) shows the anomalous vanadium in the coarse-grained F-2 and PO-3 samples. Figure 7.1-2 also shows that most samples share a positive correlation between vanadium concentration and silt and clay content that indicates naturally occurring vanadium. However, the slightly higher vanadium concentrations in PO-1 where other metals and uranium isotopes have their highest concentrations suggest possible small releases of vanadium into the upper Potrillo Canyon watershed.

Zinc is one of several inorganic COPCs that has its maximum concentration in reach PO-3, 117 mg/kg, downcanyon from the Lower Slobbovia and Skunk Works firing sites. Zinc concentrations above the sediment BV of 60.2 mg/kg were measured in three samples from Potrillo and Fence Canyons, from reaches F-2, PO-1, and PO-3, all from coarse-grained active channel samples. These samples also have the three highest iron concentrations in this data set and are elevated in other metals such as vanadium, and this composition indicates the presence of naturally occurring black magnetite-rich sands that are common in Pajarito Plateau stream channels (Reneau et al. 1998, 062050) and not Laboratory releases.

7.1.2 Organic Chemicals in Sediments

This section focuses on spatial variations of select organic chemicals in Potrillo and Fence Canyons. No organic chemicals in Potrillo and Fence Canyon sediments have maximum detected concentrations greater than residential SSLs, and none are included in the human health risk assessment in section 8.2.

One organic chemical detected in sediment samples, the SVOC di-n-butylphthalate, is important for assessing potential ecological risk, as discussed in section 8.1. One explosive compound, triaminotrinitrobenzene (TATB), was detected in Fence Canyon sediments and has a spatial distribution that indicates releases from Laboratory sites. Although Aroclor-1242, Aroclor-1254, and Aroclor-1260 were detected in Fence Canyon sediment, the concentrations are below screening levels and are not of concern for risk. The spatial distribution of these organic chemicals is discussed in this section. Because none of these chemicals were detected in Potrillo Canyon sediments, this discussion is restricted to Fence Canyon. Table D-1.2-2 presents average concentrations for these organic chemicals in coarse and fine facies samples in Fence Canyon, substituting one-half of the detection limit for nondetected sample results. This table also presents the upper and lower bounds on these averages, using either the detection limit or zero for nondetects, respectively.

The SVOC di-n-butylphthalate was detected in three sediment samples from two reaches in the upper part of Fence Canyon, F-1 and FS-1. The highest concentration of di-n-butylphthalate, 1.66 mg/kg, and the highest frequency of detects, 20%, were in reach FS-1 and indicate releases from one or more sites in the south fork Fence Canyon drainage basin. The single detection in reach F-1, 0.25 mg/kg, was less than the FS-1 results and below the detection limit for other samples of about 0.35 mg/kg. Average di-n-butylphthalate concentrations in coarse and fine facies samples in these reaches are shown in Table D-1.2-2, and indicate the uncertainty that exists in the average concentration of di-n-butylphthalate in each reach because of a high frequency of nondetects.

The explosive compound TATB was detected in four sediment samples from two reaches in the upper part of Fence Canyon, F-2 and FS-1. The highest concentration of TATB, 3.56 mg/kg, and the highest frequency of detects, 30%, were from reach FS-1 and indicate releases from one or more sites in the south fork Fence Canyon drainage basin. The single detection reach F-2, 0.9 mg/kg, is below the detection limit of 1 mg/kg for most samples in this data set. Average TATB concentrations in coarse and fine facies samples in these reaches are presented in Table D-1.2-2 and indicate the uncertainty that exists in the average concentration of TATB in each reach because of a high frequency of nondetects.

PCBs were detected in the three upcanyon reaches in Fence Canyon, F-1, F-2, and FS-1 (Table 6.2-2), at concentrations well below residential SSLs (maximum of 0.0063 mg/kg for Aroclor-1260 in FS-1 versus the SSL of 1.7 mg/kg). PCBs have low solubilities and a strong affinity for organic material and sediment particles (Chou and Griffin 1986, 083419). PCBs were widely used in electric transformers and other industrial applications (Walker et al. 1999, 082308, pp. 364-365), and their widespread use is consistent with their occurrence in Fence Canyon sediments. The sediment data indicate PCBs were derived from multiple sources in the watershed and their concentrations decrease downcanyon from these sources, as discussed below. Average PCB concentrations in coarse and fine facies samples in each Fence Canyon reach are presented in Table D-1.2-2 and indicate that average concentrations of PCBs are generally lower in coarse facies sediment than in fine facies sediment. This table also indicates the uncertainty that exists in the average concentration of PCBs in some reaches because of a high frequency of nondetects. Aroclor-1242 was detected in one sample from reach F-2, at 0.0033 mg/kg (3% detection frequency in the Fence Canyon watershed). Aroclor-1254 was detected in one sample each from reaches F-1 and F-2 at 0.0026 and 0.0031 mg/kg, respectively (5% detection frequency in the watershed). Aroclor-1260 was detected in one sample from F-1, 0.0028 mg kg/kg, and two samples from FS-1 at 0.0056 and 0.0063 mg/kg, respectively (8% detection frequency in the watershed). The low concentrations, the low frequency of detects, and the absence of detections downcanyon in reach F-3, above NM 4, indicate small releases and limited downcanyon transport of PCBs in Fence Canyon.

7.1.3 Radionuclides in Sediments

Four radionuclides in sediments in Potrillo Canyon are identified as important for evaluating potential human health risk in section 8.2: thorium-228, uranium-234, uranium-235/236, and uranium-238. Uranium-238 in Potrillo Canyon is also identified as important for evaluating ecological risk in section 8.1. Table D-1.2-3 in Appendix D shows average concentrations of these four radionuclides in fine and coarse facies sediment in each reach where they are COPCs. Only a single radionuclide sample result in Fence Canyon was above sediment BVs: cesium-137 at 1.04 pCi/g in reach F-3 compared with the BV of 0.9 pCi/g, but below the maximum result from the background sediment data set of 1.28 pCi/g (LANL 1998, 059730; McDonald et al. 2003, 076084). Therefore, the discussion in this section is limited to Potrillo Canyon.

Thorium-228 was detected above the sediment BV of 2.28 pCi/g and the residential SAL of 2.3 pCi/g in a single sample from reach PO-2, at 2.43 pCi/g. This detection is less than the BV for the Bandelier Tuff unit exposed in this part of Potrillo Canyon (unit Qbt 2, 2.52 pCi/g; LANL 1998, 059730) and indicates that naturally occurring thorium associated with the local geologic unit is the probable source for this thorium-228. Thorium isotopes have also been found above the sediment BVs elsewhere at the Laboratory derived from local tuff units (LANL 2009, 106939; LANL 2009, 107453).

Uranium-234, uranium-235/236, and uranium-238 were each detected above the sediment BVs in reaches PO-1, POS-1, and PO-2 but not downcanyon in reaches PO-3 or PO-4. Figure 7.1-3 shows the spatial variations in average concentrations of the uranium isotopes in fine facies sediment in Potrillo Canyon, with the highest concentrations of each found in reach PO-1 downcanyon from the E-F firing site. Data from POS-1 indicate smaller releases into the drainage basin of the south fork of Potrillo Canyon. Figure 7.1-4 shows the concentrations of uranium-238 plotted against silt and clay content, showing that in PO-1 and POS-1 uranium is elevated in both coarse-grained and fine-grained sediment, but that farther downcanyon in PO-2 the uranium-238 is concentrated in fine-grained samples with relatively high silt and clay content. Comparison of uranium-238 and uranium-235/236 concentrations in samples from the Potrillo watershed indicates that, for samples with uranium-238 concentration above 10 pCi/g, approximately 65% of the samples have depleted uranium, with uranium-238/235 ratios greater than 21.72 (Figure 7.1-5). Figure 7.1-5 indicates that the uranium contamination in Potrillo Canyon sediment includes a combination of natural and depleted uranium, and the average uranium-238/235 ratio in the PO-1 samples, 23.78, indicates slightly depleted uranium, on average. This finding is consistent with historical information that indicates approximately 68% of the uranium used at the E-F firing site was natural uranium (LANL 2006, 093714, p. 18). The downcanyon extent of this uranium is somewhere between reaches PO-2 and PO-3, and the sediment data indicate no transport of uranium past NM 4 or to the Rio Grande from Potrillo Canyon. Data from the environmental surveillance program sediment sampling station in Potrillo Canyon above NM 4, extending back to 2002 for isotopic uranium analyses, also indicate no uranium above BVs at this location (e.g., LANL 2010, 111232).

7.1.4 Summary of Sources and Distribution of Key Sediment COPCs

The data discussed in the previous sections indicate sediment COPCs in Potrillo and Fence Canyons have a variety of sources, including Laboratory TAs and associated SWMUs or AOCs and natural background. Table 7.1-1 summarizes the inferred primary sources of the sediment COPCs discussed above and also the inferred downcanyon extent of COPCs that are or that may be derived from Laboratory sources. These inferences are made based on their concentrations, spatial distribution, relation to other COPCs, and other information, as discussed in the previous sections. Sources and downcanyon extent for these COPCs are discussed further below.

7.1.4.1 Natural Background Variability

Sediment data from different canyons indicate that natural background concentrations for many inorganic chemicals and radionuclides are more variable than that found in the original sediment background data set used to develop BVs for the Laboratory (LANL 1998, 059730; McDonald et al. 2003, 076084). As a result, sediment concentrations can be elevated above BVs even where no Laboratory releases have occurred (e.g., LANL 2006, 094161; LANL 2009, 106939; LANL 2009, 107416; LANL 2009, 107453; LANL 2009, 107497). In the Potrillo and Fence Canyons sediment data set, the spatial distribution of some inorganic and radionuclide COPCs indicates they are dominantly or entirely derived from naturally occurring materials, representing locally elevated background levels. These analytes include zinc and thorium-228. For several inorganic COPCs, including cadmium, selenium, and vanadium, these data indicate the concentrations are predominantly naturally derived, with possible minor releases from Laboratory TAs (Table 7.1-1). The elevated concentrations of several metals in some coarse-grained active channel samples, including iron, vanadium, and zinc, indicate the presence of naturally occurring black magnetite-rich sands common in Pajarito Plateau stream channels (Reneau et al. 1998, 062050).

7.1.4.2 TA-15

The spatial distribution of COPCs indicates the inactive E-F firing site in TA-15 is the most important source of contaminants in Potrillo Canyon sediment. The metals beryllium and copper and the radionuclides uranium-234, uranium-235/236, and uranium-238 have their highest concentrations in reach PO-1, a short distance downcanyon from the E-F firing site, and all these contaminants have been identified previously as COPCs at the E-F firing site (LANL 2006, 093714, p. 18). These uranium isotopes and some metals are also elevated above BVs in reach POS-1, indicating additional sources in the drainage basin of the south fork of Potrillo Canyon, such as Firing Sites A and B at the head of the basin. The downcanyon extent of these COPCs is somewhere between reaches PO-2 and PO-3, approximately 2.1 to 4.8 km (1.3 to 3.0 mi) above NM 4 and 6.8 to 9.6 km (4.2 to 5.9 mi) above the Rio Grande.

7.1.4.3 TA-36

The spatial distribution of COPCs indicates one or more SWMUs in the vicinity of the Minie firing site in TA-36 constitute the most important source or sources of contaminants in Fence Canyon. The metals cobalt and copper and the organic chemicals Aroclor-1260, di-n-butylphthalate, and TATB have their highest concentrations in Fence Canyon in reach FS-1, in the south fork of Fence Canyon downcanyon from Minie. Reach FS-1 also has the only result for lead above the sediment BV in Potrillo and Fence Canyons. Maximum concentrations of metals in FS-1 were only slightly above BV, however, and detected concentrations of organic chemicals were orders of magnitude below SSLs and ESLs. Di-n-butylphthalate and PCBs have also been detected in reach F-1 downcanyon from the Meenie firing site, indicating additional releases into the upper part of Fence Canyon. The downcanyon extent of these COPCs is somewhere between reaches F-2 and F-3, approximately 0.4 to 3.5 km (0.2 to 2.2 mi) above NM 4 and 5.8 to 8.8 km (3.6 to 5.5 mi) above the Rio Grande.

Data from reach PO-3 does not indicate the presence of recognizable contaminants in sediments derived from firing activities at Lower Slobbovia or Skunk Works in the middle part of Potrillo Canyon. Despite known releases of uranium from these firing sites, uranium isotopes are not present above sediment BVs in reach PO-3.

7.1.5 Temporal Trends in Contaminant Concentration

Data on sediment contamination in other canyons at the Laboratory indicate the concentrations were highest at the time of peak releases and subsequently decreased over time as contaminated and noncontaminated sediment mixed (e.g., Malmon 2002, 076038; LANL 2004, 087390; Reneau et al. 2004, 093174; LANL 2006, 094161). These same temporal trends have also been documented in other regions (e.g., Lewin et al. 1977, 082306; Rowan et al. 1995, 082303). Although no direct data on temporal trends in sediment contamination from Potrillo or Fence Canyons are available, contaminant concentrations in these canyons are expected to follow the same trends found elsewhere and decrease over time because of decreases in the release of contaminants. The most important contaminant source in the Potrillo and Fence watershed is the E-F firing site in upper Potrillo Canyon, which had its largest releases between 1947 and 1973 (LANL 2006, 093714, p. 18). Therefore, contaminant concentrations in Potrillo Canyon sediment were probably highest before the mid-1970s and decreased after that.

7.1.6 Downcanyon Attenuation of Runoff and Sediment Deposition

Runoff generated in the upper parts of watersheds on the Pajarito Plateau attenuates downcanyon because of transmission losses into the alluvium. This attenuation of runoff results in the deposition of large volumes of sediment, which can also contain large percentages of the total contaminant inventory in a watershed (e.g., LANL 2004, 087390; Reneau et al. 2004, 093174; LANL 2006, 094161). A study in Potrillo Canyon has documented the infiltration of runoff in the area upcanyon from reach PO-3, including the canyon bottom next to Lower Slobbovia (Becker 1991, 015317), although the sediment volume and the contaminant inventory in this area have not been documented. A similar area of runoff attenuation and sediment deposition probably also occurs in Fence Canyon between reaches F-2 and F-3, although this part of Fence Canyon has not been investigated. Additional investigations would be required to determine the sediment volumes and contaminant inventories in these parts of Potrillo and Fence Canyons, which would also be required to determine watershed-scale contaminant inventories.

7.2 Conceptual Model for Hydrology and Contaminant Transport in Water

The conceptual model for hydrology and contaminant transport in water focuses on pathways originating in the Potrillo and Fence watershed where Laboratory operations have been conducted. This discussion focuses on surface water hydrology and evaluations of potential shallow groundwater. Figure 7.2-1 shows a conceptual hydrogeologic cross-section that follows the Potrillo Canyon floor.

7.2.1 Hydrology of Surface Water and Potential Shallow Groundwater

Potrillo and Fence Canyons are classified as dry canyons, as described by Birdsell et al. (2005, 092048). Dry canyons generally head on the Pajarito Plateau, have relatively small catchment areas (less than 13 km^2), experience infrequent surface flows, and have limited or no saturated alluvial systems. The hydrologic conditions yield little downcanyon near-surface contaminant migration and are characterized by very slow unsaturated water flow from the surface to the regional aquifer. Because surface-water flow is infrequent and shallow alluvial groundwater is not common, contaminants largely remain near their original sources, including in sediment. Net infiltration beneath dry canyons is low, with rates generally believed to be less than tens of millimeters per year and commonly on the order of 1 mm/yr or less (similar to dry mesas). Finally, transport times to the regional aquifer beneath dry canyons are expected to exceed hundreds of years.

7.2.1.1 Surface Water

Figure 7.2-1 shows a conceptual hydrogeologic cross-section for Potrillo Canyon and illustrates many of the features of the dry canyon conceptual model. The canyon heads on the Pajarito Plateau in the south-central part of the Laboratory and has a relatively small drainage area of 11.7 km^2 (4.5 mi^2), as described in section 1.3. Surface water flow in the canyon is ephemeral and occurs as runoff, primarily following infrequent, intense thunderstorms or during snowmelt. Its source is direct precipitation and runoff from surrounding mesa tops, including stormwater from parking lots and roof top drainage. No active outfalls exist in the watershed.

Based on studies in Potrillo Canyon from 1984 to 1991 (Becker 1991, 015317), runoff derived from the upper part of the Potrillo Canyon watershed completely infiltrates the alluvium during most events and does not propagate past Lower Slobbovia. Any contaminants transported on sediment particles in each runoff event would be deposited in the area where water infiltrates. Any dissolved contaminants could potentially be transported in the subsurface through the alluvium and into underlying tuff. In addition, leaching experiments indicated that uranium associated with sediment particles could potentially be dissolved by infiltrating runoff or precipitation and transported in the subsurface (Becker 1991, 015317).

The only gaging station in Potrillo and Fence Canyons with a published record is E267, in Potrillo Canyon above NM 4 (Figure 3.2-1). Published data from this gage from 1995 to 2009 (e.g., Ortiz and McCullough, 2010, 109826) indicate an average of two to three runoff events per year, with no flow recorded in some years. These data are summarized in Table B-2.0-1. Observations from 1984 to 1991 indicate runoff events at this location can be derived entirely from runoff generated in the watershed east of Lower Slobbovia during localized thunderstorms (Becker 1991, 015317).

7.2.1.2 Potential Shallow Groundwater

Available observations have not indicated any alluvial or perched shallow groundwater beneath Potrillo or Fence Canyons, as discussed below. These observations suggest surface water runoff infiltrating the alluvium does not perch either within the alluvium or in the underlying weathered tuff but instead migrates under unsaturated conditions.

Borehole PCTH-1 was cored to a depth of 74 ft in Potrillo Canyon above NM 4 in 1989 and was dry (LANL 2006, 093714, p. 72). Alluvial well FCO-1 was completed to a depth of 15 ft in Fence Canyon above NM 4 in 1989 and was also dry (LANL 2006, 093714, p. 76). FCO-1 is completed in alluvium and has been dry during all subsequent visits (section 2.2.1). Table B-2.0-2 indicates the number of times since 1997 that water levels were measured in FCO-1; it was found to be dry for 100% of the 37 measurement events (Koch and Schmeer 2009, 105181). A pressure transducer was installed in FCO-1 in January 2008 to continuously record water levels, if present. The transducer data for the period from January 2008 through October 2009 indicate the well was continuously dry (Table B-2.0-2).

Based on studies in Potrillo Canyon from 1984 to 1991 (Becker 1991, 015317), the most likely location for alluvial or shallow perched groundwater to exist is along a 1.2-km stretch of canyon, including the area next to Lower Slobbovia where the canyon bottom widens. In 1989, three boreholes, POTM-1, POTM-2, and POTM-3, located in the upstream, middle, and downstream portions of this area, respectively (Figure 3.2-1), were completed as neutron moisture holes to depths of 47 to 54 ft to study infiltration within this reach. None of these holes encountered standing water. The moisture content in the cuttings from POTM-1 and POTM-3 was low, with no excess moisture observed. In POTM-2, the moisture content in the cuttings was low (10% to 20% by volume) to a depth of 35 ft. However, below 35 ft, the cuttings indicated elevated moisture content to the bottom of the hole (61 ft).

The results of neutron moisture measurements and estimated volumetric moisture contents from the day the wells were installed are shown in Figure 7.2-2. Each of these three boreholes had a paired shallow borehole drilled to approximately 1.5 to 3 m depths, and moisture data from the shallow boreholes are also shown in Figure 7.2-2. The following summarizes the moisture profiles for these boreholes (Becker 1991, 015317).

- The neutron moisture log for POTM-1 recorded on August 23, 1989, showed the highest levels of moisture at 8 to 9 ft, with volumetric moisture content recorded at 29% to 34%. Below this depth, volumetric moisture dropped to below 7.7% from 9 to 38 ft and increased to 8% to 16% from 38 to 46 ft.
- The neutron moisture log for POTM-2 recorded on August 24, 1989, showed increased moisture at three depths: 2 ft, 9 to 10 ft, and 48 to 49 ft. Volumetric moisture content at 2 ft was 29%, at 9 to 10 ft it varied between 29% and 32%, and at 48 to 49 ft it was 31%.
- The neutron moisture log for POTM-3 recorded on August 23, 1989, showed moisture readings below 7.7% down to its total depth at 48 ft. The neutron moisture data indicate that the alluvium within this reach is unsaturated.

The alluvium in POTM-1 and POTM-2 shows higher moisture content than in POTM-3, suggesting greater infiltration of water into the underlying tuff (probably unit Qbt 1g) at those locations. The moisture content from unit Qbt 1g (below about 6 m) in these boreholes was compared with data from other locations at the Laboratory to estimate likely water percolation rates through the unsaturated tuff. The moisture contents of Qbt 1g in boreholes POTM-1 and POTM-3 are similar to those measured at Material Disposal Area (MDA) G (Krier et al. 1997, 056834) and in borehole CDBM-1 in Cañada del Buey (Rogers et al. 1996, 055543). Percolation rates at MDA G and in Cañada del Buey are estimated to be less than 1 mm/yr. The moisture content of Qbt 1g in borehole POTM-2 is similar to that observed at borehole MCM-5.1 in Mortandad Canyon; Rogers et al. (1996, 055543) estimate a percolation rate at that well to be approximately 1.5 mm/yr. This comparison indicates low water percolation rates in the area identified as being the most likely infiltration zone in Potrillo Canyon (Becker 1991, 015317).

Two vadose zone observation wells, POTO-4 and POTO-5, were installed in 1991 near Lower Slobbovia to further study infiltration within this reach (Purtymun 1995, 045344). POTO-4 has three completion zones, POTO-4A, POTO-4B, and POTO-4C at 164, 89, and 38 ft, respectively. POTO-5 has two completion zones, POTO-5A and POTO-5B, at 77 and 27 ft, respectively. These wells were dry when completed. No further data could be found for these wells.

7.2.2 Stormwater COPCs

As discussed in section 6.4, two analytes in stormwater samples from Potrillo Canyon exceeded comparison values: aluminum and gross-alpha radiation at gage E267 above NM 4. Both aluminum and gross-alpha radiation commonly exceed these comparison values at background locations on the Pajarito Plateau (e.g., LANL 2010, 111232). For example, in 2001 to 2003, stormwater samples were collected from a tributary drainage to Potrillo Canyon below NM 4, at gage E269 (Figure 3.2-1), a location with no upgradient SWMUs or AOCs. Aluminum in filtered samples from E269 had a maximum concentration of 1890 µg/L (LANL 2006, 093714, Table 6.2-2, p. 393), exceeding the comparison value of 750 µg/L. Gross-alpha radiation in nonfiltered samples had a maximum concentration of 516 pCi/L (LANL 2006, 093714, Table 6.2-4, p. 396), exceeding the comparison value of 15 pCi/L and the maximum sample result from E267 (170 pCi/L). In addition, aluminum and alpha-emitting radionuclides have not been identified as COPCs in sediment in either the Potrillo Canyon reach that includes E267 (PO-4) or in the next upcanyon reach (PO-3) (section 6.2). Therefore, these data indicate the aluminum and gross-alpha radiation measured in stormwater samples at E267 record background conditions and not Laboratory-derived contamination.

8.0 RISK ASSESSMENTS

8.1 Screening Level Ecological Risk Assessment

Steps 1 and 2 of the eight-step EPA Ecological Risk Assessment Guidance for Superfund (ERAGS) (EPA 1997, 059370) are the screening level ecological risk assessment (SLERA) (LANL 2004, 087630), which identifies COPECs and ecological receptors potentially at risk. This section presents ecological screening results based on the comparison of ESLs with available sediment data. Additional information on the screening methodology and development of ESLs is provided in the SLERA methods document (LANL 2004, 087630). The ESLs used for screening soil and sediment data in this report are from ECORISK Database, Version 2.5 (LANL 2010, 110846). Where DOE and Laboratory-specific Biota Concentration Guidelines (BCGs) for radionuclides are more conservative than radiological ESLs, maximum radionuclide concentrations in each reach are compared with the DOE and Laboratory-specific BCGs (DOE 2002, 085637; DOE 2004, 085639). These screening assessments identified COPECs and formed the basis for determining whether to proceed to the baseline ecological risk assessment (ERAGS Steps 3 to 8).

8.1.1 Problem Formulation for Ecological Screening

An in-depth generic problem formulation is given in section 3.0 of the SLERA methods document along with a detailed development of assessment endpoints from which screening receptors were selected (LANL 2004, 087630). A summary, as applied to canyon bottoms in the Potrillo and Fence watershed, is presented below.

Historical contaminant releases into the Potrillo and Fence watershed have occurred from multiple SWMUs and/or AOCs, as discussed in section 2.1 and indicated by sediment data (section 7.1). Mechanisms of contaminant release to the Potrillo and Fence watershed include releases to soil from open-detonation firing sites and contaminants mobilized by stormwater runoff. Potential Laboratory contaminant sources are in TA-15 and TA-36. For ecological receptors, the primary impacted media in the canyons are sediment deposits (soils) in the canyon bottom. Sediment in the canyon bottom is not exposed to persistent water; therefore, the sediment in all geomorphic units (active and abandoned channels and floodplains) is evaluated as soil by comparing COPC concentrations with the soil ESLs. Because no persistent surface water is present in Potrillo and Fence Canyons, no mechanism exists for water or active channel sediment to interact with aquatic receptors or the aquatic food web. Therefore, no exposure pathway to an aquatic community exists.

An ecological scoping checklist was completed for representative sediment investigation reaches within Potrillo and Fence Canyons; the completed ecological scoping checklist is provided in Attachment E-1 of this document. A separate Part B, the site visit documentation section of the checklist, was completed for each of the reaches visited while the scoping checklist was being completed. Many of the reaches within Potrillo and Fence Canyons have ponderosa pine as the dominant overstory vegetation, although some reaches also contain mixed conifer, piñon, or juniper trees, depending on elevation and microclimate. These reaches include narrow high-walled areas, wider areas with grass beneath the tree cover, and particularly toward the lower end of the watershed, some wide open areas with shrubs and large forbs but little tree cover. Upper reaches of the watershed were subject to low-severity burn during the May 2000 Cerro Grande fire (BAER 2000, 072659); vegetation has regenerated in these areas. Abundant wildlife, including small mammals and birds, has been seen within many of the canyon reaches.

All sediment results are screened against the minimum soil ESLs for terrestrial receptors for a particular chemical or radionuclide. The ESLs for soil developed for each of the receptors consider both direct exposure and (except for plants and earthworms) uptake through food. The toxicity reference values (TRVs) used to develop the ESLs are based on no observed adverse effect levels (NOAELs) for survival, growth, or reproduction. These are conservative estimates of concentrations of a chemical or radionuclide that have shown no effect on individuals in scientific studies presented in the literature. The development of TRVs and the values for TRVs and ESLs are documented in the ECORISK Database, Version 2.5 (LANL 2010, 110846).

8.1.2 Ecological Screening Approach for the Potrillo and Fence Watershed

Sediment has been sampled extensively within Potrillo and Fence Canyons. To evaluate whether the concentrations of chemicals and radionuclides represent a potential risk to ecological receptors in the canyon, the maximum detected concentration of each COPC in each reach was compared with the appropriate ESLs. Maximum COPC concentrations in soil (as defined in section 8.1.1) were compared with the minimum soil ESLs for terrestrial receptors (Tables 8.1-1 through 8.1-3).

The DOE soil BCGs for cesium-137 and strontium-90 are more restrictive than soil ESLs for these radionuclides. As documented in “Site-Representative Biota Concentration Guides at Los Alamos” (McNaughton et al. 2008, 106501), the Laboratory has developed site-specific BCGs for both cesium-137 and strontium-90 following guidance stated in DOE Standard 1153-2002. The Laboratory site-representative soil BCG published for cesium-137 (2000 pCi/g) is less restrictive than the soil ESL of 680 pCi/g. Strontium-90, which has a Laboratory site-representative BCG of 300 pCi/g, was not detected in Potrillo and Fence Canyons. Because the DOE and Laboratory site-representative soil BCGs are less restrictive than soil ESLs for radionuclides, a BCG evaluation to supplement the ESL screen was not necessary for Potrillo and Fence Canyons.

8.1.3 Data Evaluation for Screening of Soil

The data evaluation in section 6 determined which chemicals and radionuclides were retained as COPCs. As discussed in section 6.2, a total of 14 inorganic chemicals, 24 organic chemicals, and 6 radionuclides were retained as COPCs in sediment in Potrillo and Fence Canyons. Maximum sample results in each reach for these COPCs are presented in Tables 6.2-1, 6.2-2, and 6.2-3 for inorganic chemicals, organic chemicals, and radionuclides, respectively.

Evaluation of the sample data before ecological screening follows a similar approach to that used in the “Los Alamos and Pueblo Canyons Investigation Report” (LANL 2004, 087390, pp. 6-2–6-5); the “Mortandad Canyon Biota Investigation Work Plan” (LANL 2005, 089308, pp. B-4–B-7); the “Pajarito Canyon Biota Investigation Work Plan” (LANL 2006, 093553); the “Sandia Canyon Biota Investigation Work Plan” (LANL 2006, 093553); the “North Canyons Investigation Report, Revision 1” (LANL 2009, 107416); and the “Cañada del Buey Investigation Report, Revision 1” (LANL 2009, 107497). All COPCs are compared with minimum soil ESLs to identify COPECs, as presented in section 8.1.4.

8.1.4 Results of the Screening Comparison for Soil

As explained in the SLERA methods document (LANL 2004, 087630, p. 31), the criterion for retaining a COPC as a COPEC is an HQ greater than 0.3. This HQ is calculated based on dividing the maximum detected concentration of a chemical or radionuclide COPC by the minimum ESL applicable to that medium. The COPECs identified by the minimum ESL comparisons are further defined as potential study design COPECs based on an HQ greater than 3. An HQ greater than 3 represents levels that may potentially impact receptors and is therefore appropriate for determining the COPECs that should be included in site-specific biota studies in Potrillo and Fence Canyons, if required. The same criterion of an HQ greater than 3 was used to refine the list of COPECs for the baseline ecological risk assessment studies conducted in Los Alamos and Pueblo Canyons (LANL 2004, 087390, p. 8-2); Mortandad Canyon (LANL 2006, 094161, p. 96); Pajarito Canyon (LANL 2009, 106939, p. 64); and Sandia Canyon (LANL 2009, 107453, p. 77). In consideration of threatened and endangered (T&E) species, COPEC concentrations are evaluated using an HQ greater than 1 to ensure protection of each individual within the population. In Potrillo and Fence Canyons, the American kestrel is a surrogate receptor species for the Mexican spotted owl; therefore, any HQ greater than 1 for the kestrel (a top carnivore) is evaluated.

Table 8.1-1 provides the HQ for the maximum detected concentration of each inorganic COPC in soil. Antimony was not detected above the BV so this COPC is not evaluated in the screening-level ecological risk assessment. Table 8.1-2 shows the same HQ evaluation for radionuclide COPCs, and Table 8.1-3 shows the HQ evaluation for organic COPCs. The HQs in these three tables are based on a comparison with the minimum soil ESLs, which are designed for the protection of terrestrial receptors and aerial herbivores, insectivores, omnivores, and carnivores (robin and kestrel). Surrogate ESLs are used for endosulfan II (based on the ESL for endosulfan); endosulfan sulfate (based on the ESL for endrin); and benzo(g,h,i)perylene (based on the ESL for pyrene). COPECs with an HQ greater than 3 (or greater than 1 for the American kestrel) are shaded in gray in these tables. Analytes for which no ESLs are available include perchlorate, butylbenzene[tert-], isopropyltoluene[4-], and TATB; these analytes are evaluated in section 8.1.6.

Sediment COPECs identified with maximum soil ESL HQs greater than 3 (or HQs greater than 1 for the American kestrel) included four inorganic chemicals and one organic chemical in eight reaches (Tables 8.1-1 and 8.1-3). No maximum detected radionuclide concentrations exceeded an HQ of 3 (or HQs greater than 1 for the American kestrel [flesh diet]).

8.1.5 Evaluation of Potrillo and Fence Canyons COPEC Concentrations for Biota Studies

The COPECs, exposure pathways, and receptors in Potrillo and Fence Canyons are similar to those previously investigated in the Los Alamos and Pueblo, Mortandad, Pajarito, and Sandia watersheds (LANL 2004, 087390; LANL 2005, 089308; LANL 2005, 089308; LANL 2006, 093553; LANL 2009, 106939; LANL 2009, 107453). Therefore, aspects of the study designs and conclusions from biological investigations performed in these watersheds complement the ecological risk assessment process in Potrillo and Fence Canyons. Contaminant concentrations, risk measures, and results that are less than results from previous studies (or “bounded by” previous studies) can be evaluated against analogous COPEC and media measurements in Potrillo and Fence Canyons to determine potential risks.

This section describes the approach and results for evaluating COPEC concentrations in Potrillo and Fence Canyons with soil concentrations and results of biota studies from other canyons where ecological risk has been evaluated. This assessment approach follows those presented in the NMED-approved documentation for the “Mortandad Canyon Biota Investigation Work Plan” (LANL 2005, 089308); the “Mortandad Canyon Investigation Report” (LANL 2006, 094161); the “Pajarito Canyon Biota Investigation Work Plan” (LANL 2006, 093553); the “Sandia Canyon Biota Investigation Work Plan” (LANL 2007, 099152); the “North Canyons Investigation Report, Revision 1” (LANL 2009, 107416); and the “Cañada del Buey Investigation Report, Revision 1”(LANL 2009, 107497). In brief, the assessment approach for these canyons included identifying COPECs for each assessment endpoint entity (e.g., terrestrial plants) and the measures of exposure, effect, and ecosystem characteristics for each assessment endpoint. If COPEC concentrations in Potrillo and Fence Canyon soils are less than concentrations in the soils evaluated in previous canyons investigation reports with site-specific biota investigations, and if these reports concluded no unacceptable ecological risk to this assessment endpoint exist, then biota studies are not necessary in Potrillo and Fence Canyons.

Potential study design COPECs for Potrillo and Fence Canyons and potentially affected receptors are summarized in Table 8.1-4. Potentially affected receptors are determined by comparing the receptor-specific ESLs to the concentrations measured in Potrillo and Fence Canyons samples. Specifically, receptors are identified in Table 8.1-4 if the receptor-specific HQ is greater than 3 (or greater than 1 for the American kestrel). Relevant COPEC exposure data for each assessment endpoint were assembled from the Los Alamos and Pueblo Canyons, Mortandad Canyon, Pajarito Canyon, and Sandia Canyon investigation reports (LANL 2005, 089308; LANL 2006, 093553; LANL 2009, 106939; LANL 2009, 107453). The types of data are summarized below, along with the rationale for including these previous studies.

All potential study design COPECs identified for Potrillo and Fence Canyons have biota-relevant data from the above-referenced investigations. Samples with biota-relevant exposure data from the previous canyons investigation reports are tabulated in Attachment 1, Table E-2.0-1 (on CD). Table E-2.0-1 lists the sediment samples (all sediment including the active channel) evaluated for terrestrial receptors (plants, small mammals, and birds).

Primary Producer (Plant): Results from plant surveys, plant toxicity tests (seedling germination), and associated COPEC concentrations in sediment previously obtained for the Los Alamos and Pueblo, Mortandad, Pajarito, and Sandia Canyons biota investigations are relevant to the Potrillo and Fence Canyons assessment process. Toxicity tests performed for these previous investigations are particularly relevant because they measured plant survival and growth across a gradient of COPEC concentrations collected from discrete locations in these watersheds. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in Potrillo and Fence Canyon sediment that are less than concentrations correlated to effects (or no effects) observed in previous studies. All plant-relevant COPECs identified for Potrillo and Fence Canyons have plant-relevant sediment data from these previous investigations. As discussed above, plant-relevant COPECs are listed in Table 8.1-4 and are those with HQs greater than 3 based on the plant ESL. Samples associated with plant-relevant exposure data from the previous canyons investigation reports are tabulated in Attachment 1, Table E-2.0-1.

Table 8.1-5 shows the maximum detected concentrations of COPECs with HQs greater than 3 for plants in Potrillo and Fence Canyons and compares these concentrations with the maximum detected concentrations in reaches used for plant toxicity tests in the Los Alamos and Pueblo, Mortandad, Pajarito, and Sandia watersheds. Both plant COPECs (selenium and vanadium) had maximum detected concentrations in Potrillo and Fence Canyons less than those measured in previous investigations.

Ground-Dwelling Small Mammals (Shrews and Mice): Abundance, diversity, and reproductive status of small mammals (shrews and mice) were previously investigated in the Los Alamos, Pueblo, Mortandad, and Sandia watersheds by conducting field surveys, comparing COPEC concentrations with ESLs, and modeling dietary uptake. Small mammal population surveys to measure diversity and relative abundance provide information on a reach scale (composite samples were collected from trapping arrays) and therefore are not directly comparable with the discrete samples from the Potrillo and Fence Canyon reaches. In the Pajarito watershed, survival and ecological risk were evaluated using dietary exposure modeling of collocated soil and earthworm tissues. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in Potrillo and Fence Canyons compared with those reported in previous studies collected from discrete locations or composite samples representing reaches in these watersheds. The only COPEC (cadmium) identified for Potrillo and Fence Canyons that is relevant to small mammals has corresponding small mammal–relevant soil data (corresponding to the trapping arrays or dietary sources) from these previous investigations. As discussed above, ground-dwelling small mammal–relevant COPECs are listed in Table 8.1-4 and are those with HQs greater than 3 based on the lower of the shrew or mouse ESL. Samples associated with ground-dwelling mammal-relevant exposure data from previous canyons investigations are tabulated in Attachment 1, Table E-2.0-1. Sediment data from those investigations are compared with maximum detected Potrillo and Fence Canyons sediment concentrations in Table 8.1-6.

Although sediment data from the other investigations represent data relevant to both the mouse and shrew, maximum detected sediment results were compared with the ESLs for shrews because ESLs for shrews are generally more conservative. Use of the shrew ESL applies an additional level of conservatism, because the lack of flowing water in Potrillo and Fence Canyons indicates shrews are not likely to occupy these reaches. Maximum detected sediment concentrations of cadmium, the only mammal COPEC in Potrillo and Fence Canyons reaches, are lower than in previous investigations.

Terrestrial Avian Consumer (Robin): Avian consumers (insectivorous, omnivorous, and herbivorous robins) were previously evaluated in the Mortandad, Pajarito, and Sandia Canyon investigations using nest box studies. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in Potrillo and Fence Canyons that are less than the soil concentrations reported in previous studies. All COPECs identified for Potrillo and Fence Canyons that are relevant to birds have corresponding bird-relevant soil data (corresponding to reaches where nest box studies were completed) from previous investigations. Samples associated with avian consumer-relevant exposure data from the canyons investigation reports are tabulated in Attachment 1, Table E-2.0-1. As discussed above, terrestrial avian consumer-relevant COPECs are listed in Table 8.1-4 and are those with HQs greater than 3 based on the robin ESLs. Sediment data from the previous studies from locations relevant to birds were summarized and maximum COPEC concentrations are compared with maximum Potrillo and Fence Canyons sediment concentrations in Table 8.1-7. The American robin is modeled as the representative for insectivorous birds, omnivorous birds, and herbivorous birds. The minimum ESL for each COPEC based on any of the three robin diets was used in the ESL screen.

Three of the four avian COPECs (cadmium, copper, and vanadium) had Potrillo and Fence Canyons maximum detected concentrations less than concentrations detected in previous investigations. Di-n-butylphthalate was the only potential study design COPEC where Potrillo and Fence Canyons maximum detected concentrations are greater than those in previous investigations, although the difference is small (1.66 mg/kg in Fence Canyon compared with 1.54 mg/kg in Pajarito Canyon).

Avian Predator (Kestrel): Avian carnivores (represented by the kestrel with the flesh diet) were previously evaluated in the Mortandad, Pajarito, and Sandia Canyon investigations using dietary exposure modeling from small-mammal tissues. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in Potrillo and Fence Canyons that are less than soil concentrations reported in previous studies. A single COPEC (di-n-butylphthalate) relevant to the kestrel was identified for Potrillo and Fence Canyons (Table 8.1-4), and it has corresponding relevant soil data (corresponding to reaches where dietary exposure to small mammals was assessed) from these previous investigations. Samples associated with avian predator-relevant exposure data from previous canyons investigations are tabulated in Attachment 1, Table E-2.0-1.

The kestrel modeled with a 100% flesh diet is used to represent all avian top carnivores, including the Mexican spotted owl. Because the Mexican spotted owl represents a T&E species, an HQ greater than 1 (instead of an HQ greater than 3) was used to evaluate COPECs for potential ecological risk. Sediment data from bird-relevant locations from the previous studies are compared with maximum Potrillo and Fence Canyons sediment concentrations in Table 8.1-8. Concentrations of di-n-butylphthalate in Potrillo and Fence Canyons sediment were not bounded by previous investigations.

Unbounded COPECs: One potential study design COPEC, di-n-butylphthalate, had a maximum concentration in Potrillo and Fence Canyons sediment samples that is greater than previous canyons investigation results. Thus, di-n-butylphthalate is an “unbounded COPEC,” and Table 8.1-9 summarizes information relevant to this COPEC in Potrillo and Fence Canyons. Di-n-butylphthalate was detected in three samples in Potrillo and Fence Canyons from reaches FS-1 (2 detects out of 10 samples) and F-1 (1 detect out of 10 samples). Table 8.1-9 provides the lowest observed adverse effect level– (LOEAL-) based ESL, in addition to the NOAEL-based ESL for an additional exposure evaluation. The LOAEL represents the lowest exposure with the potential for adverse effects and therefore provides an upper bound for the range of exposures likely to be associated with no adverse effects. Average exposures for the kestrel with the flesh diet are bounded between the NOAEL- and LOAEL-based ESLs (average exposure is closer to the NOAEL than the LOAEL), suggesting adverse effects are not likely for this COPEC and receptor. Average exposures for the robin are bounded by the maximum concentrations from previous biota investigations. In addition, the area encompassed by the investigation reaches is small compared with the home range or population area estimated for avian receptors. For example, the investigation reaches are all 200 m in length with the width of the potentially contaminated sediment deposits varying from approximately 2 to 10 m. Thus, the total area of each investigation reach is less than 0.2 ha. In contrast, the population areas for the robin and kestrel are approximately 17 and 4200 ha, respectively, which is 40 times larger than the home ranges (0.42 ha for robin and 106 ha for kestrel; EPA 1993, 059384). The population area use factor for the investigation reach would be approximately 0.01 or less (less than 0.2 ha divided by 17 ha), and the LOAEL-based HQ for the maximum detected di-n-butylphthalate concentrations would be 15 (1.66 mg/kg divided by the LOEAL-based ESL of 0.11 mg/kg). Thus, the HQ based on the LOAEL and adjusted for population area use factors would be less than 1 for avian species and would not suggest ecological risks to these receptors. Therefore, adverse effects of the only unbounded COPEC, di-n-butylphthalate, are unlikely and biota studies are not warranted. All other maximum COPEC concentrations are less than those from previous relevant biota investigations. Adverse ecological effects are not suggested for these COPECs, and further biota studies are not warranted.

8.1.6 Ecological Risk Assessment Uncertainties

There are several ecological risk assessment uncertainties related to Potrillo and Fence Canyons. Uncertainties associated with established soil ESLs fall into two main categories. The first group is associated with COPECs, including toxicity and bioavailability (or transfer factors between soil and food). The second group relates to receptors, including feeding rates, the amount of incidental soil ingestion, and diets. These uncertainties are addressed by selecting inputs to the soil ESL calculations that are conservative. For some detected COPCs, no ESLs were available for ecological screening, and it is therefore not possible to evaluate potential ecological impacts from these COPCs. Sediment COPCs that were detected in Potrillo and Fence Canyons but have no ESLs include one inorganic chemical (perchlorate) and three organic chemicals (butylbenzene[tert-], isopropyltoluene[4-], TATB). These COPECs are discussed further below.

Perchlorate was detected in 14 of 90 samples, and its highest detected result (0.0040 mg/kg) was less than 2 times the maximum nondetect (0.0024 mg/kg). The NMED residential SSL for perchlorate is 54.8 mg/kg, indicating the potential toxicity is low. Because of the potentially low toxicity, perchlorate is not retained as a COPEC for further evaluation.

Butylbenzene[tert-] was detected only once in 90 samples, with a maximum concentration of 0.000334 mg/kg. The minimum ESL for benzene (24 mg/kg for the deer mouse) is used to screen the butylbenzene[tert-] maximum concentration (0.000334 mg/kg) and results in a maximum HQ of less than 0.01. Therefore, butylbenzene[tert-] is not retained as a COPEC for further evaluation.

Isopropyltoluene[4-] was detected in 4 out of 90 samples, and the maximum detected value (0.00066 mg/kg) was less than the maximum nondetect (0.0012 mg/kg). The minimum ESL for toluene (23 mg/kg for the montane shrew) was used to screen isopropyltoluene[4-] and resulted in a maximum HQ of less than 0.01. Therefore, isopropyltoluene[4-] is not retained as a COPEC for further evaluation.

TATB was detected in 4 out of 90 samples, but the maximum detect (3.56 mg/kg) was about 4 times the maximum detection limit (1 mg/kg). The minimum ESL for 1,3,5-trinitrobenzene (6.6 mg/kg for the deer mouse) is used to screen TATB and results in a maximum HQ of 0.5. Therefore, TATB is not retained as a COPEC for further evaluation.

8.1.7 Summary of the SLERA

COPECs were identified for Potrillo and Fence Canyons based on the comparison of maximum detected concentrations against applicable soil ESLs. Where COPEC concentrations in Potrillo and Fence Canyons sediment samples resulted in an HQ greater than 3, they were compared with concentrations reported in previous biota studies where associated effects information indicated no unacceptable ecological risks. Based on this information, no COPECs in sediment are recommended for additional biota studies, and no potential adverse ecological impacts to receptors exist in the Potrillo and Fence watershed.

8.2 Human Health Risk Assessment

The human health risk assessment evaluates the potential risk to human health in Potrillo and Fence Canyons from COPCs identified in section 6 of this report. The risk assessment approach used in this report follows NMED guidance (NMED 2009, 108070) and is organized in seven major sections. The approach utilizes media- and scenario-specific SLs to evaluate the potential for human health risks from sediment in Potrillo and Fence Canyons. Risks from surface water are not quantitatively evaluated because no persistent surface water occurs in Potrillo and Fence Canyons. Section 8.2.1 provides the basis for selecting the exposure scenarios for the human health risk assessment. In section 8.2.2, the data collection and evaluation processes described in previous sections of the report are summarized, focusing on aspects of data analysis that are pertinent to the risk assessment. Section 8.2.2 also lays out the logic for selecting COPCs for the human health risk assessment. Section 8.2.3 describes the calculation of exposure point concentrations. The exposure scenarios are described in section 8.2.4. Risk characterization (section 8.2.5) is based on the sum of fractions (SOFs) method for evaluating the potential for additive effects with COPCs that are classified as noncarcinogens, carcinogens, or radionuclides. Uncertainty related to the various assumptions and inputs used in the risk assessment is evaluated in section 8.2.6 to support interpretation of the risk characterization. A summary of the risk assessment is provided in section 8.2.7.

8.2.1 Problem Formulation

The risk assessment uses information pertaining to current and reasonably foreseeable future land use in Potrillo and Fence Canyons to assess potential impacts under reasonable maximum exposure (RME) conditions. The canyon bottoms in Potrillo and Fence Canyons are entirely on Laboratory land. There are active sites in the watershed, but none are located within the 100-yr floodplain. The area west of NM 4 is closed to public access, and the area east of NM 4 is open to the public for recreation, as discussed in section 1.4.

The assessment employs the recreational exposure scenario, which combines extended backyard exposures for both adult trail user and child, to represent potential exposure to contaminated sediment in Potrillo and Fence Canyons. This is a conservative assessment because access to canyon bottoms is restricted to workers on official business in areas of the watershed requiring a human health risk assessment. Such official business is limited to environmental work associated with collecting samples or related activities. The trail user scenario describes an adult individual who contacts contaminated sediment while hiking or jogging in the canyons. The extended backyard scenario describes an older child (age 6–11 yr old) living in a home sufficiently close to the canyon that he or she may use as an extension of the play areas immediately surrounding the home. The Potrillo and Fence Canyon reaches were also evaluated for residential exposures as a supplemental exposure scenario for comparison purposes only.

8.2.2 Data Collection and Evaluation

The approach to sampling design, data collection, and characterization is described in sections 3 and 4 and in Appendix B. Sampling locations, sample results, and data quality for data used in the human health risk assessment are presented in Appendix C. Section 6 describes how sediment data within reaches were combined for comparison with BVs. Antimony was not detected above the BV so this COPC is not evaluated in the human health risk assessment. Persistent surface waters are not present in Potrillo and Fence Canyons; therefore, surface water data were not evaluated. Stormwater is discussed in section 6.

Identifying COPCs for the Human Health Risk Assessment

The COPCs for the human health risk assessment are identified based on SL comparisons and calculations using residential SSLs and SALs. This approach is similar to that described and used in previous canyons investigation reports (LANL 2004, 087390; LANL 2006, 094161; LANL 2009, 106939; LANL 2009, 107416; LANL 2009 107453; LANL 2009, 107497). This process includes calculating a ratio, which is the maximum concentration of an analyte in a reach divided by the SL. Ratios based on maximum detected concentrations for all COPCs within a reach are summed to calculate the SOF for the risk type. An SOF is the sum of these ratios for each risk type (i.e., carcinogens [SOF_{ca}], noncarcinogens [SOF_{nc}], and radionuclides [SOF_{rad}]. If a reach has an SOF greater than 1.0 for a risk type, all COPCs in the reach for that risk type with a ratio greater than 0.1 are retained and evaluated in the site-specific risk assessment. The COPCs with a ratio less than or equal to 0.1 are excluded because they are not likely to contribute substantially to risk. If the ratio for an individual COPC was greater than 0.1 but the SOF for the reach and risk type was less than 1.0, the COPC was not evaluated further.

Sediment COPCs

The human health SLs for nonradionuclides in sediment used in this screening assessment are the NMED residential SSLs (NMED 2009, 108070). For chemicals for which NMED does not provide a value, the residential screening value from the current EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) was used as the SL (carcinogens are adjusted to a 10^{-5} risk level to be consistent with the NMED target risk level). NMED-approved surrogate compounds were used for some COPCs that lack NMED or EPA SLs (NMED 2003, 081172). Residential SALs were used for radionuclides based on 15 mrem/yr and derived using RESRAD Version 6.5 (LANL 2009, 107655).

Tables 8.2-1 to 8.2-3 present the residential SSLs and SALs used to calculate the ratios based on the maximum detected concentrations for each COPC. These tables also provide the SOFs for each reach for each risk type for all sediment COPCs. The COPCs and reaches shaded gray are those retained for further evaluation. Table 8.2-1 provides the results for noncarcinogens and indicates no COPCs are retained for further evaluation. Table 8.2-2 provides the results for carcinogens and indicates no COPCs are retained for further evaluation. Table 8.2-3 provides the results for radionuclides and indicates four COPCs (thorium-228, uranium-234, uranium-235, and uranium-238) are retained for further evaluation.

Surface-Water COPCs

No persistent surface water occurs in Potrillo and Fence Canyons; therefore, water is not evaluated under the recreational scenario.

COPC Summary

Table 8.2-4 summarizes the analyte classes and reaches retained for further evaluation.

8.2.3 Calculating Exposure Point Concentrations

According to the EPA (1989, 008021), the measure of exposure appropriate for a risk assessment is the average concentration of a contaminant throughout an exposure unit or a geographic area to which humans are exposed. This premise is based on the assumption that over a period of time, a receptor would contact all parts of the exposure unit. A receptor is not likely to be exposed to only the maximum or any other particular detected concentration of a chemical for the full period of exposure. A conservative estimate of the average concentration of a chemical across an exposure unit (the exposure point concentration [EPC]) is the upper confidence limit (UCL) (typically a 95% UCL) of the mean. Different methods are available to estimate the 95% UCL, depending upon the underlying distribution of the data set.

The investigation approach for sediment resulted in representative samples associated with different geomorphic units and sediment facies within each reach. These data are combined to estimate means and UCLs of the means for COPCs retained for the human health risk assessment in each reach. The EPA software ProUCL Version 4.00.05 (EPA 2010, 109944) was used to calculate the sediment UCLs. If the recommended calculated UCL was less than the maximum detected value for a COPC within a reach, then the UCL suggested by ProUCL was used as the EPC. Further details on the calculation of the UCLs used in this risk assessment are provided in Appendix E, section E-3, and in the ProUCL technical guidance (EPA 2009, 110368). The input and output files for the ProUCL calculations are provided as Attachment E-2.

8.2.4 Exposure Scenarios

Table 8.2-5 summarizes the exposure pathways evaluated for the recreational and residential scenarios.

8.2.4.1 Recreational Scenario

The human health risk assessment focuses on potential doses resulting from direct exposure to contaminants in sediment through ingestion, inhalation, and external irradiation. No persistent surface water is present and no groundwater is available in Potrillo and Fence Canyons, so the water pathways were not evaluated. Stormwater data were compared with comparison values in section 6.

Stormwater is not included as part of the quantitative human health risk assessment because stormwater is transient and does not occur frequently enough to sustain chronic exposures, and the qualitative assessment suggests unacceptable acute effects. Exposure to groundwater is not evaluated because no groundwater in Potrillo and Fence Canyons is available for human use under current or reasonably foreseeable future conditions for the recreational scenario. Exposures to the recreational receptor are evaluated at the scale of sediment investigation reaches. This local-scale evaluation is protective compared with an assessment based on a larger scale encompassing numerous reaches and areas between reaches because it includes areas closest to contaminant sources where contaminant concentrations are highest.

Exposure parameters were selected to provide an RME estimate of potential exposures. As discussed in EPA guidance (1989, 008021), the RME estimate is generally the principal basis for evaluating potential health impacts. In general, an RME estimate of risk is at the high end of a risk distribution (i.e*.,* 90th to 99.9th percentiles) (EPA 2001, 085534). An RME scenario assesses risk to individuals whose behavioral characteristics may result in much higher potential exposure than seen in the average individual.

The recreational scenario addresses limited site use for outdoor activities, such as hiking, playing, and jogging. The receptor for this scenario is anticipated to be an adult hiker or a child playing in the canyon over an extended period of time. Therefore, receptors for the recreational scenario are defined as adults and older children (6–11 yr old). A complete description of the parameter values and associated rationale is provided in Laboratory guidance (LANL 2010, 108613). Exposure parameters for the recreational scenario are provided in Appendix E, section E-3. Recreational SALs are from Laboratory guidance (LANL 2009, 107655). Table 8.2-6 presents a summary of SALs for COPCs evaluated for the recreational scenario.

8.2.4.2 Residential Scenario

Dose estimates for the residential scenario are provided as a supplemental scenario in Appendix E, section E-3. Residential SALs are from Laboratory guidance (LANL 2009, 107655). Exposure parameters and results for the residential scenario are provided in Appendix E, section E-3.

8.2.5 Risk Characterization

Potential human health effects were assessed using the ratios of EPCs to SALs for each COPC retained in this assessment for each of the scenarios evaluated. These ratios were summed (SOFs) for an investigation reach within the COPC class. A SOF less than 1.0 indicates exposure is not likely to result in an unacceptable radiation dose. The SOF values are then multiplied by the target effect level (i.e., dose = 15 mrem/yr) to provide dose estimates.

Table 8.2-7 presents the COPC and recreational dose estimates for reaches PO-1 and PO-2. The sediment EPCs used in these calculations are presented in Table 8.2-8. Results for the supplemental exposure scenario (residential) are provided in Appendix E, section E-3.

The target dose limit used for calculating SALs related to soil pathways is 15 mrem/yr, which is consistent with guidance from DOE (2000, 067489). Exposure to radionuclides was evaluated for sediment in reaches PO-1 and PO-2, and the radionuclide dose for each of these reaches was less than 1 mrem/yr (Table 8.2-7). The Laboratory's Environmental ALARA (as low as reasonably achievable) Program (LANL Program Description PD410, p. 7) states, "quantitative ALARA evaluations are not necessary for Laboratory activities that have a potential for public exposure that is less than a 3-mrem TEDE [total effective dose equivalent] individual dose…." The maximum calculated radiation dose for the recreational user is 0.5 mrem/yr for exposure to sediment in reach PO-1. Therefore, radiation exposures to the public for the Potrillo and Fence Canyons are ALARA for the recreational scenario.

8.2.6 Uncertainty Analysis

The uncertainty analysis uses qualitative and semiquantitative information to evaluate the uncertainty associated with the dose estimates presented. The uncertainty analysis is organized according to the major aspects of the human health risk assessment: data collection and evaluation (section 8.2.6.1), exposure assessment (section 8.2.6.2), and toxicity assessment (section 8.2.6.3).

8.2.6.1 Data Collection and Evaluation

The COPCs identified in section 6 were retained for evaluation in the human health risk assessment. COPCs retained for calculation of EPCs were those with ratios greater than 0.1 for endpoints with SOF values greater than 1.0 for the residential screen. Thus, the COPCs retained represent an inclusive list of potential human health risk drivers.

One of the COPCs retained for the human health risk assessments, thorium-228, has its inferred source in naturally occurring material in the Potrillo and Fence watershed (see section 7.1, Table 7.1-1). The assessment is protective by including this COPC in the evaluation of the potential human health effects.

The possibility of underestimating EPCs for investigation reaches is another potential source of uncertainty. Three approaches were used to minimize that possibility. First, the emphasis of the geomorphic characterization and sediment sampling was to identify and sample post-1942 sediment deposits, which focuses sampling on potentially contaminated material, excluding areas not impacted by dispersion of contaminants by post-1942 floods. The process of characterizing reaches and focusing on sampling is discussed further in section 4.1 and in section B-1.0 of Appendix B. Second, UCLs on the average sediment concentrations were used as EPCs to minimize the chance of underestimating concentrations in a reach. Third, sampling was biased to fine facies sediment deposits where concentrations are generally highest, as discussed in section 7.1, with fewer samples collected from coarse facies sediment deposits where concentrations are generally lower.

8.2.6.2 Exposure Assessment

Uncertainty pertaining to exposure parameters was addressed in the human health risk assessment by using RME estimates for several exposure parameters (Appendix E, section E-3). The use of RME assumptions, coupled with upper-bound estimates of the average concentration of COPCs in sediment, is intended to produce a protective bias in the risk calculations. The results of the risk assessment, discussed in section 8.2.5, include the key COPCs and exposure pathways associated with potential health impacts. This evaluation of uncertainty in exposure is focused on these COPCs and pathways.

Key exposure pathways for contaminated sediment for the recreational scenario include incidental soil ingestion, inhalation, and external irradiation. A common source of protective bias in the exposure assessment for these pathways is that the entire 1-h daily exposure time defined for the recreational scenario is spent on contaminated sediment deposits within a reach. To the extent that time may be spent in other canyon areas, such as uncontaminated stream terraces, colluvial slopes, or bedrock areas during recreational activities, exposure to contaminated sediment deposits is overestimated.

Each scenario is evaluated at the scale of an investigation reach. The risk assessment does not attempt to integrate exposure across multiple reaches. By assessing each reach separately, the impacts of local variability in COPC concentrations upon the results are preserved. The assessment is protective and thus likely overestimates risks and doses by assuming that all exposures occur within sediment investigation reaches (roughly 200 m long), including areas closest to SWMUs and AOCs where contaminant concentrations would be highest. Risks and doses for more realistic exposures from multiple reaches within Potrillo and Fence Canyons are therefore expected to be lower. Because each reach is treated equally from an exposure perspective, no consideration is made regarding ease of access or land area available for recreation. In addition, it is implicitly assumed that all exposure for a single individual takes place in one investigation reach, rather than some random combination of some or all of the investigation reaches and intervening areas.

For radionuclides, the exposure assessment should evaluate incremental exposures that are greater than background. The EPCs are calculated that include background concentrations. Background exposures are not negligible because radiation doses are based on concentrations of isotopic thorium and isotopic uranium that have a background component in all reaches. Thus, the dose was overestimated, particularly for thorium-228, which has an EPC less than the sediment BV (1.75 pCi/g versus 2.33 pCi/g). Incidental ingestion has a second exposure characteristic in addition to time spent on-site that was biased in a protective manner. Adult soil ingestion was assumed to be 100 mg/d, which is twice the EPA-recommended value for adults (EPA 1997, 066596).

8.2.6.3 Toxicity Assessment

The primary uncertainty associated with the screening values is related to the derivation of toxicity values used in their calculation. Toxicity values (slope factors [SFs] and reference doses [RfDs]) were used to derive the screening values used in this screening evaluation (NMED 2009, 108070). Uncertainties were identified in five areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) interindividual variability in the human population, (3) the derivation of RfDs and SFs, (4) the chemical form of the COPC, and (5) the use of surrogate chemicals.

Extrapolation from Animals to Humans. The SFs and RfDs are often determined by extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist between other animals and humans in chemical absorption, metabolism, excretion, and toxic response. 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 into each of these steps, resulting in the overestimation of potential risk.

Individual Variability in the Human Population. For noncarcinogenic effects, the degree of human variability in physical characteristics is important in determining the risks that can be expected at low exposures and in determining the NOAEL. The NOAEL uncertainty factor approach incorporates a factor of 10 to reflect the possible interindividual variability in 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 environmental matrix and not available for absorption into the human body. However, the exposure scenarios default to the assumption that the COPCs are bioavailable. This assumption can lead to an overestimation of the total risk.

Use of Surrogate Chemicals. The use of surrogates for chemicals that do not have EPA-approved or provisional toxicity values also contributes to uncertainty in risk assessment. Surrogates were used to establish toxicity values for benzo[g,h,i]perylene, endosulfan II, endosulfan sulfate, isopropyltoluene[4-], and TATB based on structural similarity (NMED 2003, 081172). The overall impact of surrogates on the risk-screening assessment is minimal because the COPCs were detected at low concentrations, had HQs less than 0.1, and were not retained for further evaluation.

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 over- 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.

8.2.7 Summary of the Human Health Risk Assessment

The potential human health impacts associated with COPCs in Potrillo and Fence Canyons were assessed relative to a radiological dose criterion of 15 mrem/yr for sediment, a chemical cancer risk criterion of 1.0×10^{-5}, and a chemical hazard criterion of 1.0. No carcinogens or systematic COPCs were retained for risk evaluations and thus no adverse effects from chemicals are inferred.

For the two reaches evaluated for radionuclide COPCs (PO-1 and PO-2), the radionuclide doses for the recreational scenario were all less than 1 mrem/yr (0.5 mrem/yr and 0.4 mrem/yr, respectively), and the equivalent risks based on the RESRAD Version 6.3 slope factors were all less than 1.0×10^{-5} (1E-6 and 9E-7, respectively). Because the calculated doses are all less than the 3-mrem ALARA guidance (section 8.2.5), radiation exposures to the public for the Potrillo and Fence Canyons are ALARA.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The results of this investigation indicate the nature and extent of contamination in canyons media in Potrillo and Fence Canyons are defined, and human health risks are acceptable for present-day and reasonably foreseeable future land uses. In addition, ecological screening of sediment and surface water data indicates little to no potential for adverse ecological effects to terrestrial or aquatic systems. Therefore, corrective actions are not needed to mitigate unacceptable risks in Potrillo and Fence Canyons. Potential corrective actions at SWMUs or AOCs within the Potrillo and Fence watershed are addressed separately as part of aggregate area investigations.

Investigations of sediment in Potrillo and Fence Canyons indicate inorganic, organic, and radionuclide COPCs are present in sediment. These COPCs are derived from several sources, including Laboratory SWMUs and AOCs and natural sources, such as noncontaminated soils, sediments, and bedrock. Only one analyte, thorium-228, has a single result above human health screening levels, and this thorium-228 is probably naturally derived. The risk assessments and screening assessments show potential human health risks are within acceptable regulatory limits, and no adverse ecological effects exist under current conditions. The conceptual model indicates these conditions for sediments are likely to stay the same or improve because of decreases in contaminant concentrations after peak releases; therefore, no further monitoring of sediments in Potrillo and Fence Canyons is necessary. However, several firing sites in the watershed remain active and additional releases are possible. Potential contaminant transport from these sites will be characterized in the Potrillo and Fence Canyons Aggregate Area investigation and monitored under the requirements of the IP.

The spatial distribution of sediment COPCs in Potrillo and Fence Canyons indicates contaminants have been released and transported downcanyon from TA-15 and TA-36. The primary contaminant source in the Potrillo Canyon watershed is the former E-F firing site in TA-15, and the highest concentrations of uranium isotopes, copper, and other analytes are found in the closest downcanyon reach, PO-1. The primary contaminant source in the Fence Canyon watershed is one or more SWMUs in the vicinity of the Minie firing site in TA-36, and the highest concentrations of several organic chemicals are found in the closest downcanyon reach, FS-1. Maximum concentrations of organic chemicals are orders of magnitude below SSLs and ESLs. Additionally, concentrations decrease downcanyon, and no Laboratory-derived COPCs have been identified in the farthest downcanyon reaches, F-3 and PO-4 above NM 4, indicating Laboratory sites in the Potrillo and Fence watershed are not a recognizable source of contaminants past NM 4 or to the Rio Grande.

No persistent surface water or shallow groundwater has been identified in the Potrillo and Fence Canyon watershed. Investigations of stormwater in Potrillo Canyon indicate only two analytes, aluminum and gross-alpha radiation, are above comparison values in the main stream channel above NM 4. Because aluminum is not a COPC in any Potrillo Canyon reach and alpha-emitting radionuclides are not COPCs in sediment in lower Potrillo Canyon (reaches PO-3 and PO-4), and because these analytes are also elevated above surface water comparison values in background areas, available data indicate aluminum and gross-alpha radiation are naturally occurring and do not represent Laboratory releases. However, stormwater in Potrillo and Fence Canyons will continue to be monitored under the requirements of the IP.

The site-specific human health risk assessment uses residential screening values and a recreational exposure scenario to conservatively represent the present-day and reasonably foreseeable future land use in Potrillo and Fence Canyons. The assessment of potential chronic exposure includes only COPCs in sediment because no persistent surface water occurs in Potrillo and Fence Canyons. The assessment results indicate no unacceptable risks from carcinogens (incremental cancer risk criterion of 1×10^{-5}), noncarcinogens (hazard index of 1), or radionuclides (target dose limit of 15 mrem/yr) from COPCs in sediment.

COPECs identified in the initial ecological screening were compared with results from other watersheds where more detailed biota investigations have been conducted. This comparison indicates the concentrations of COPECs in Potrillo and Fence Canyons derived from Laboratory SWMUs or AOCs are not likely to produce adverse ecological impacts. Therefore, no additional biota investigations, mitigation, or monitoring is required.

10.0 ACKNOWLEDGEMENTS

The following are the primary contributors to this report.

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In addition, the following individuals contributed to associated fieldwork, laboratory analysis, map preparation, and/or data analysis: Paul Chamberlain, Paul Drakos, Phil Goetze, Keith Greene, William Hardesty, Rick Kelley, Liz Miller, Jim Riesterer, and Emily Schultz-Fellenz.

11.0 REFERENCES AND MAP DATA SOURCES

11.1 References

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

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

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11.2 Map Data Sources

Active firing sites; Digitized from a map of Firing Sites and Access Control of Los Alamos National Laboratory; Los Alamos National Laboratory, Environment and Remediation Support Services; Unknown; 2010.

Drainage; Los Alamos National Laboratory, Environment and Remediation Support Services; 1:24,000; June 2, 2004.

Gaging stations; Los Alamos National Laboratory, Water Quality and Hydrology Group; Unknown; June 13, 2005.

Geomorphology; Los Alamos National Laboratory, Environmental and Remediation Support Services; 1:200; Work in progress.

Inactive firing sites; Digitized from a map of Firing Sites and Access Control of Los Alamos National Laboratory; Los Alamos National Laboratory, Environment and Remediation Support Services; Unknown; 2010.

2000 LIDAR Hypsography; Los Alamos National Laboratory, Earth and Environmental Sciences GISLab; 1:1,200; Draft.

Monitoring wells; Los Alamos National Laboratory, Waste and Environmental Sciences Division; 1:2,500; December 20, 2010.

Other holes; Los Alamos National Laboratory, Waste and Environmental Sciences Division; 1:2,500; December 20, 2010.

Property boundaries (including LANL boundary); SSMO Site Planning and Project Initiation Group; Unknown; August 16, 2010.

Roads; Los Alamos National Laboratory, SSMO Site Planning and Project Initiation Group; Unknown; December 15, 2005.

SWMUs and AOCs; Los Alamos National Laboratory, ESH&Q WES Environmental Data and Analysis Group; 1:2,500; December 9, 2010.

Technical area boundaries; Los Alamos National Laboratory, SSMO Site Planning and Project Initiation Group; Unknown; September 19, 2007.

Watershed; Los Alamos National Laboratory, Environment and Remediation Support Services; 1:2,500; October 27, 2006.

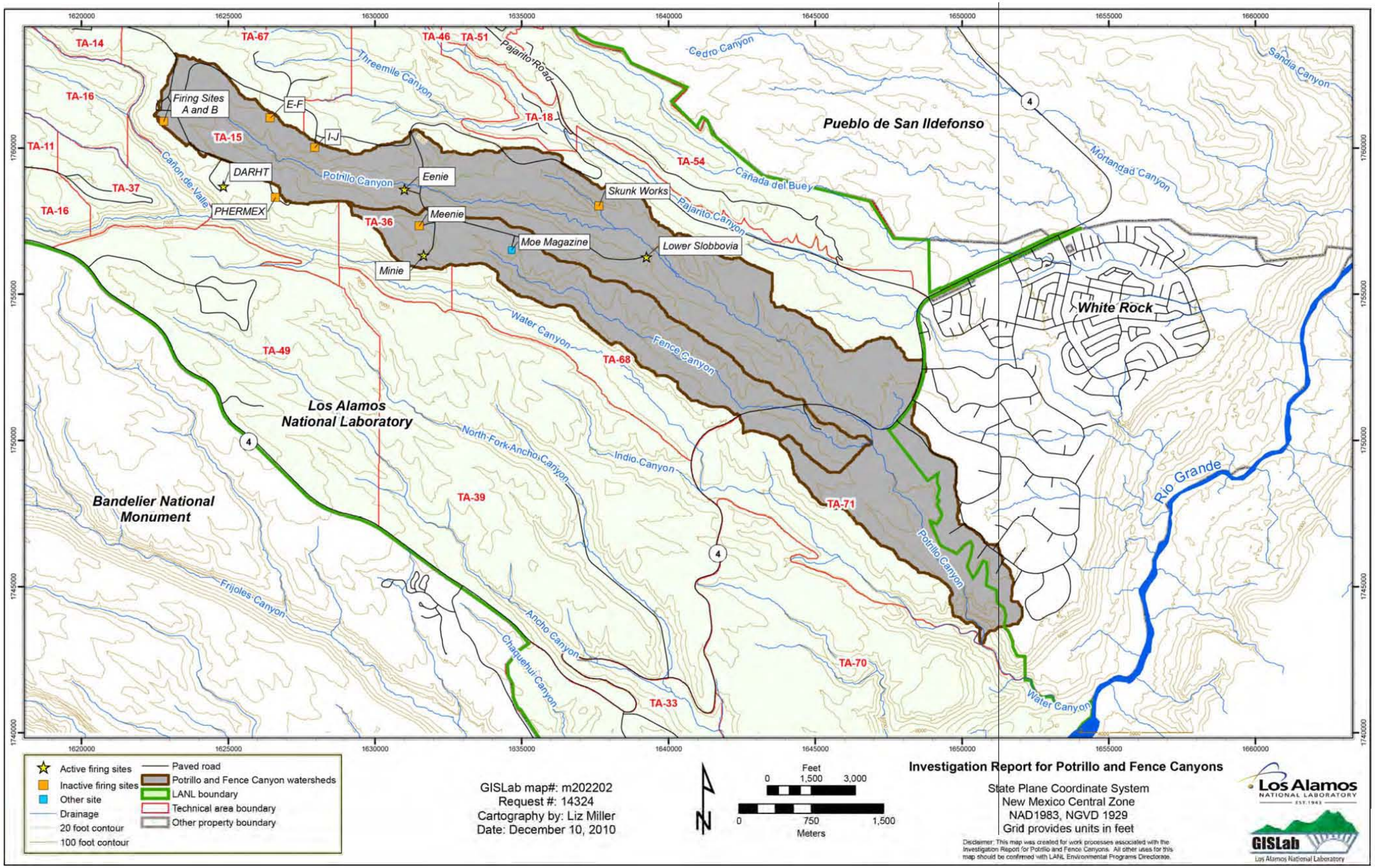


Figure 1.1-1 Potrillo and Fence watershed showing TA boundaries and firing sites

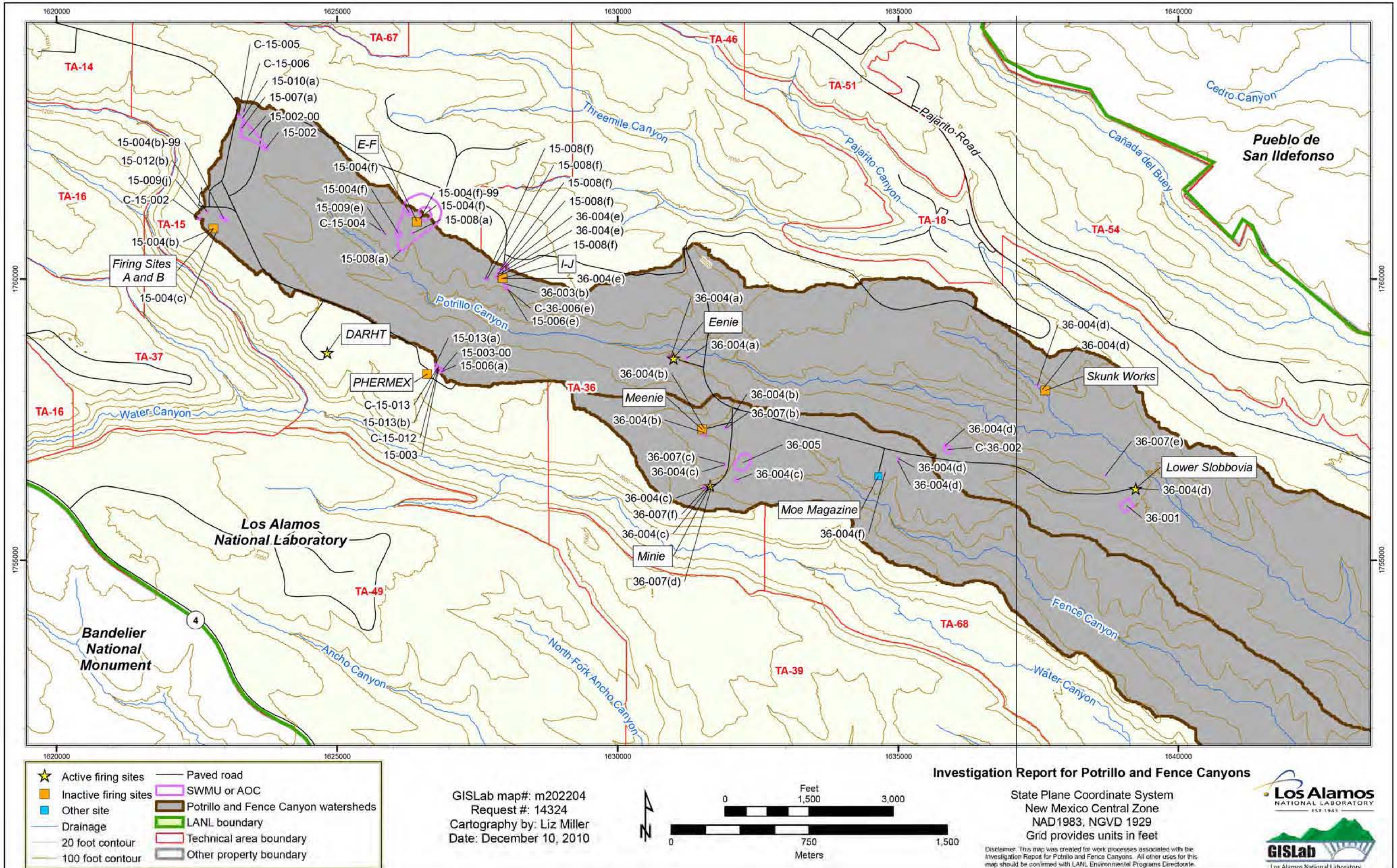


Figure 2.0-1 Potrillo and Fence watershed showing SWMUs and AOCs

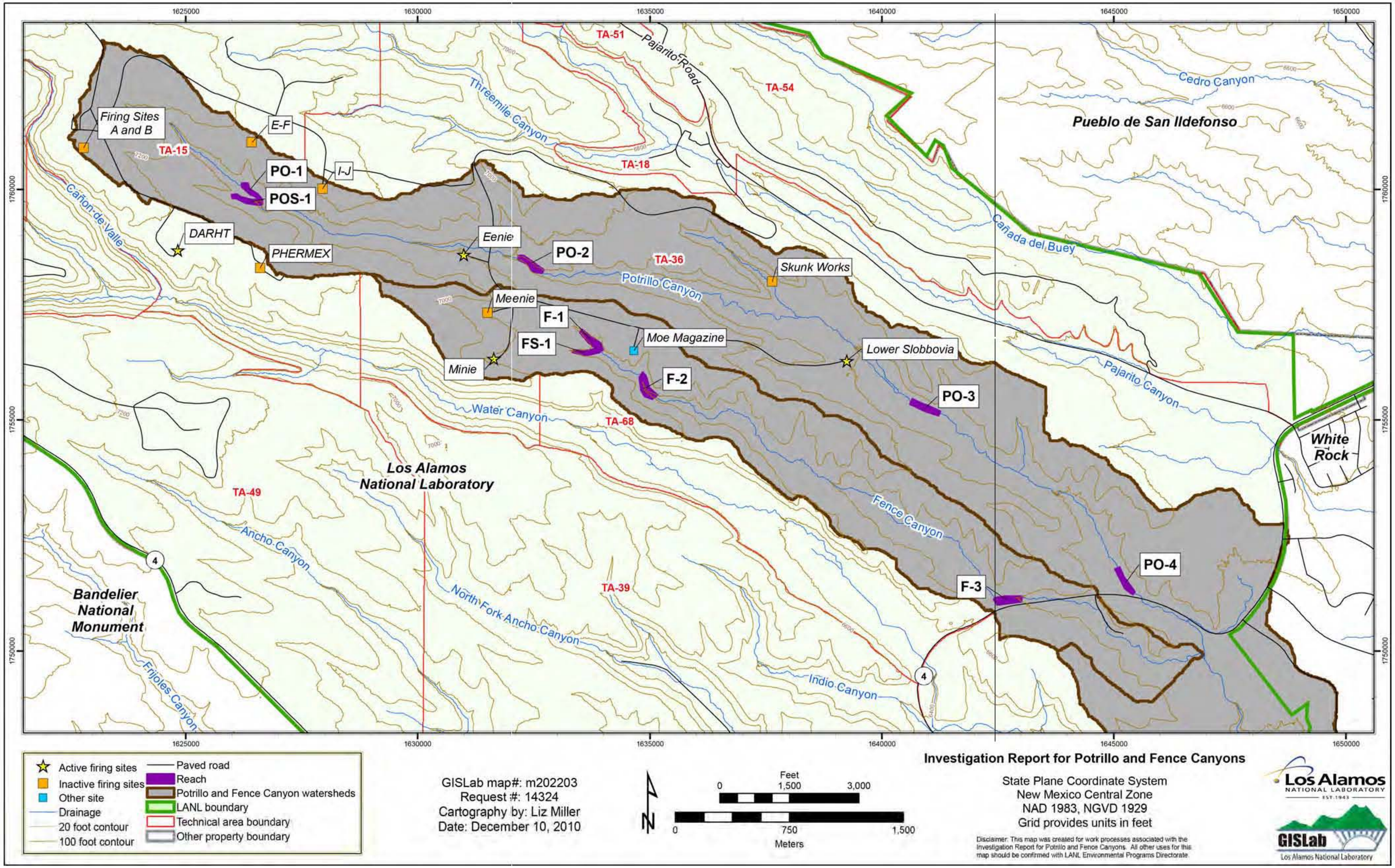


Figure 3.1-1 Potrillo and Fence watershed showing sediment investigation reaches

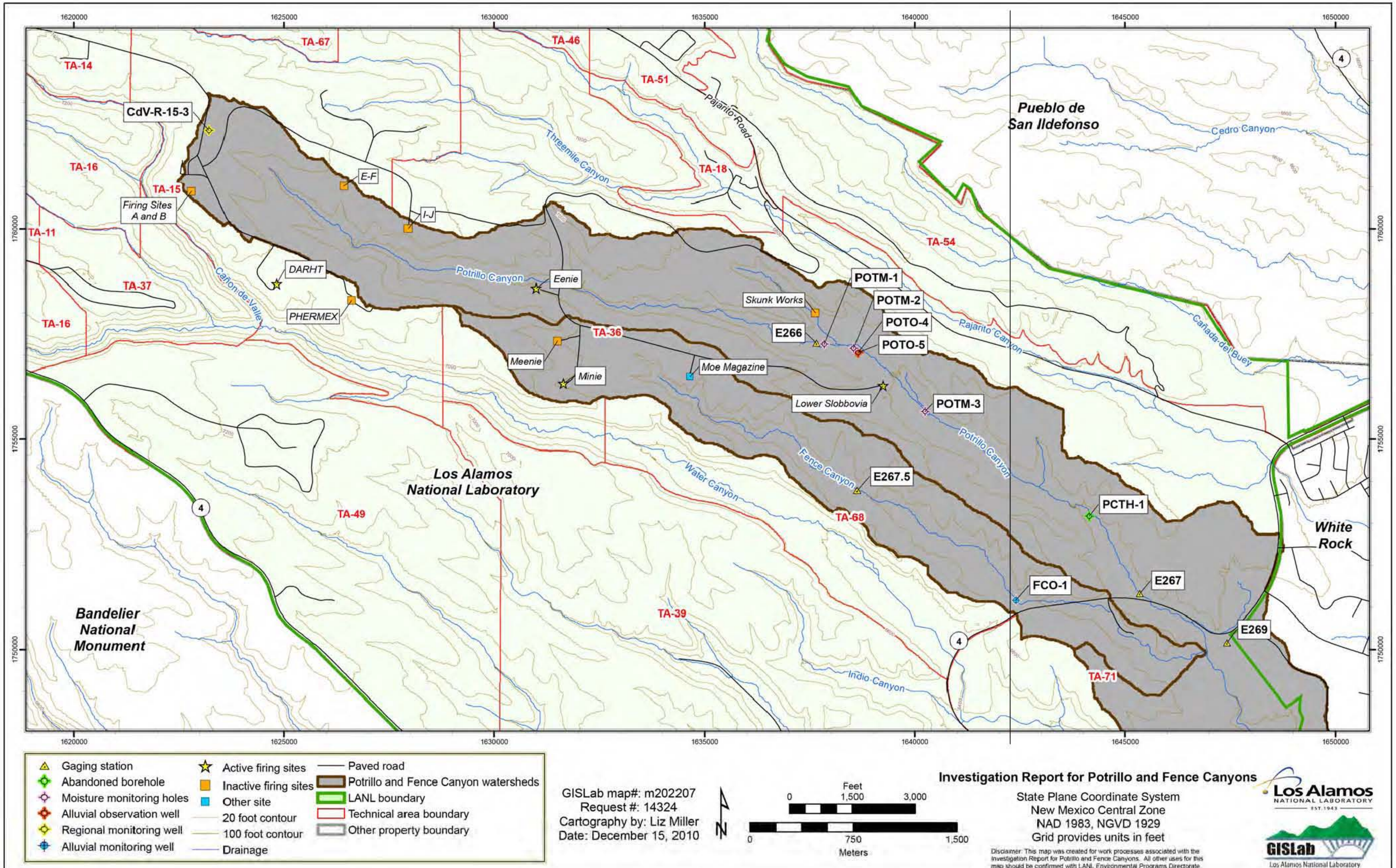


Figure 3.2-1 Potrillo and Fence watershed showing gages, wells, and other holes

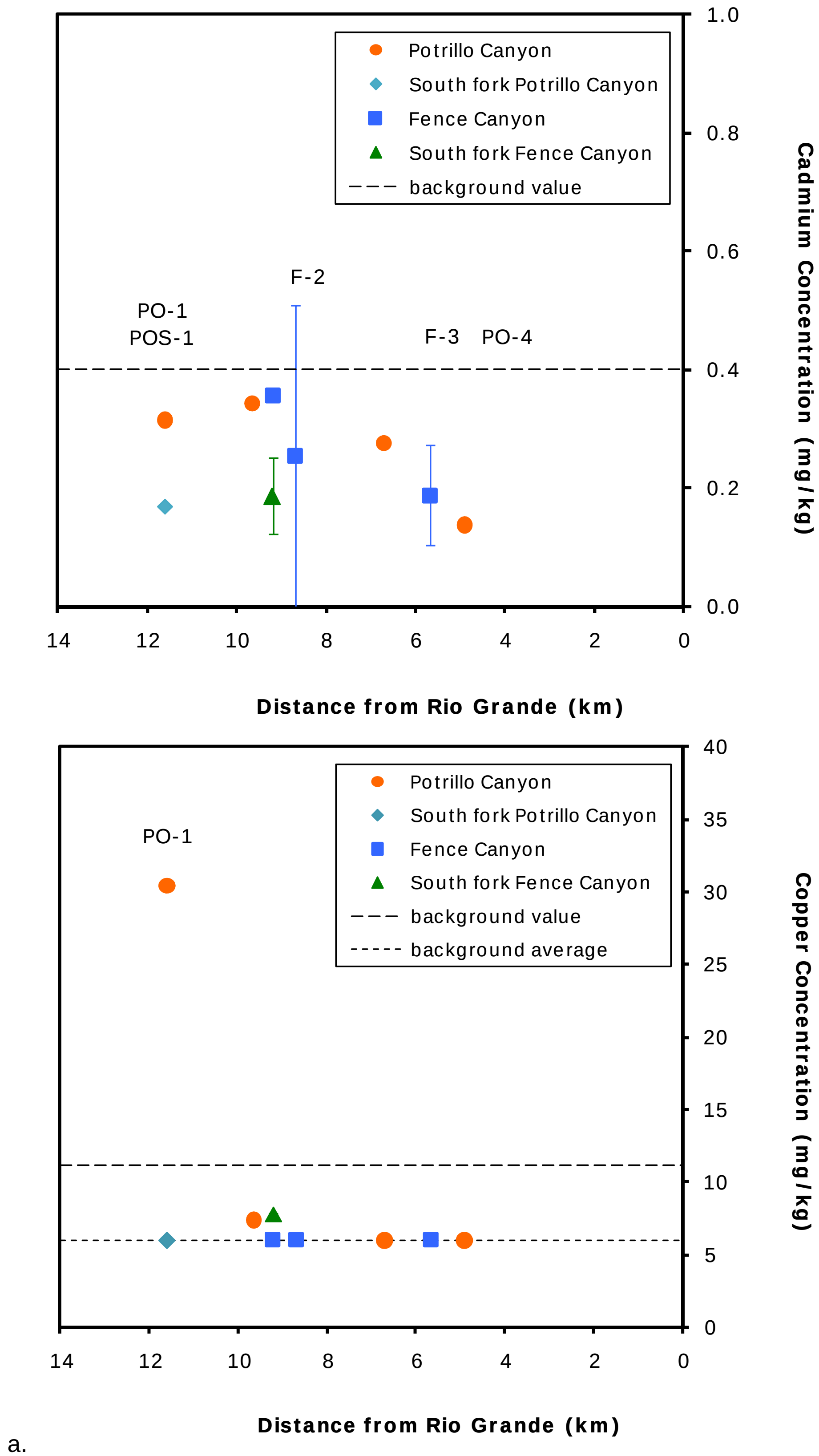
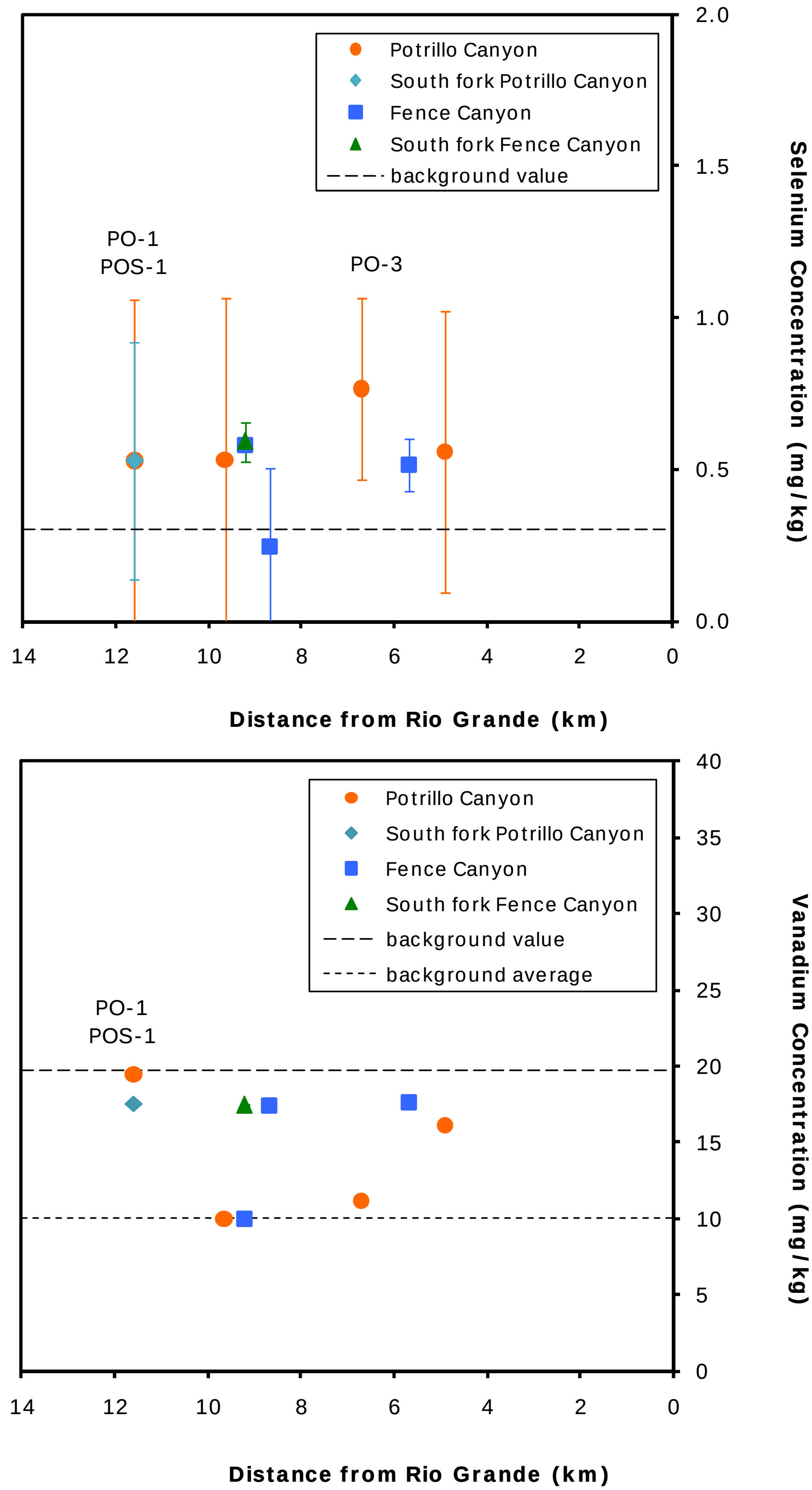


Figure 7.1-1 **Estimated average concentrations of select inorganic chemicals in fine facies sediment in Potrillo and Fence Canyons**



b.

Figure 7.1-1 (continued) Estimated average concentrations of select inorganic chemicals in fine facies sediment in Potrillo and Fence Canyons

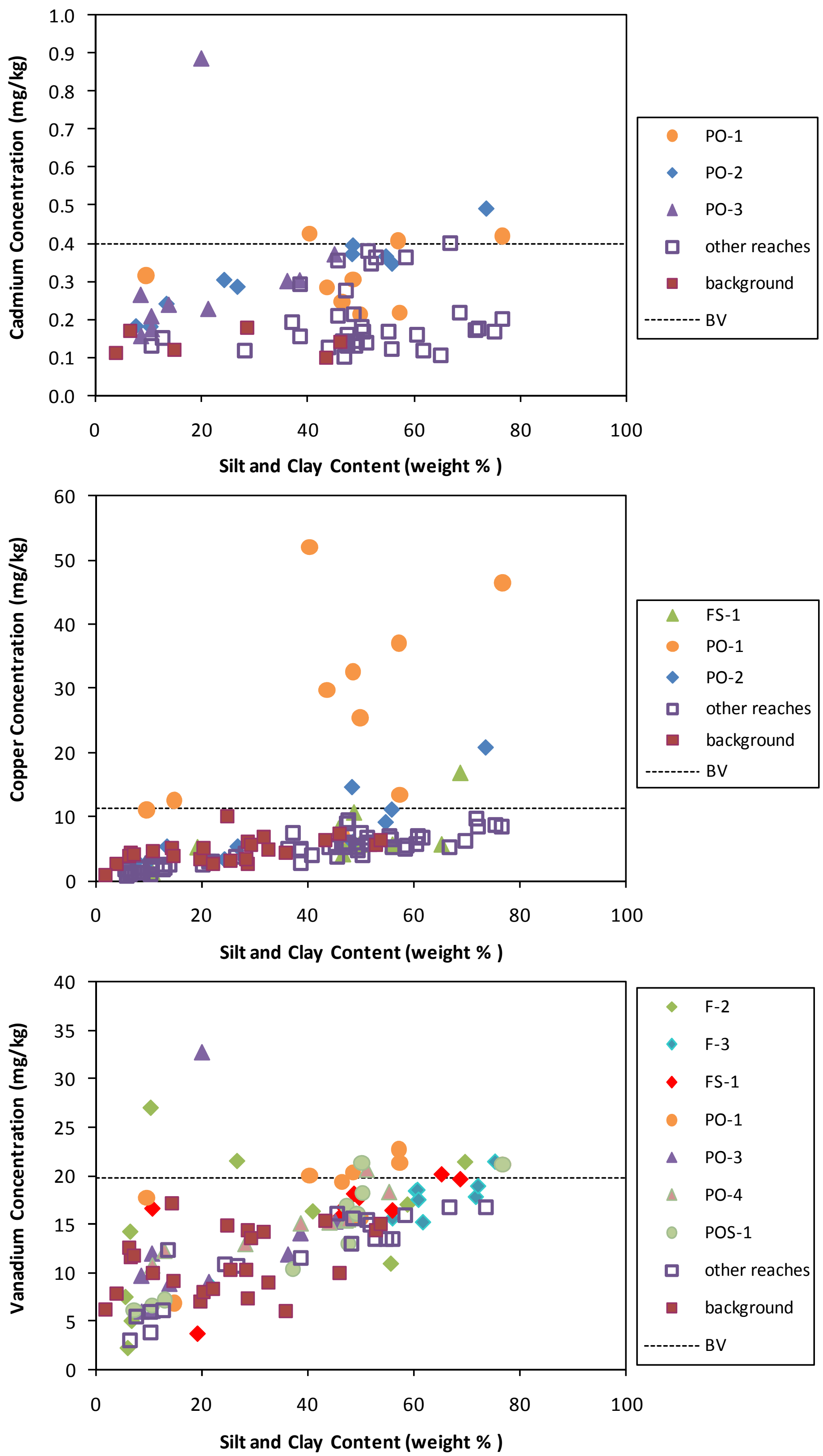


Figure 7.1-2 Concentrations of select inorganic chemicals in Potrillo and Fence Canyons and background sediment samples versus silt and clay content

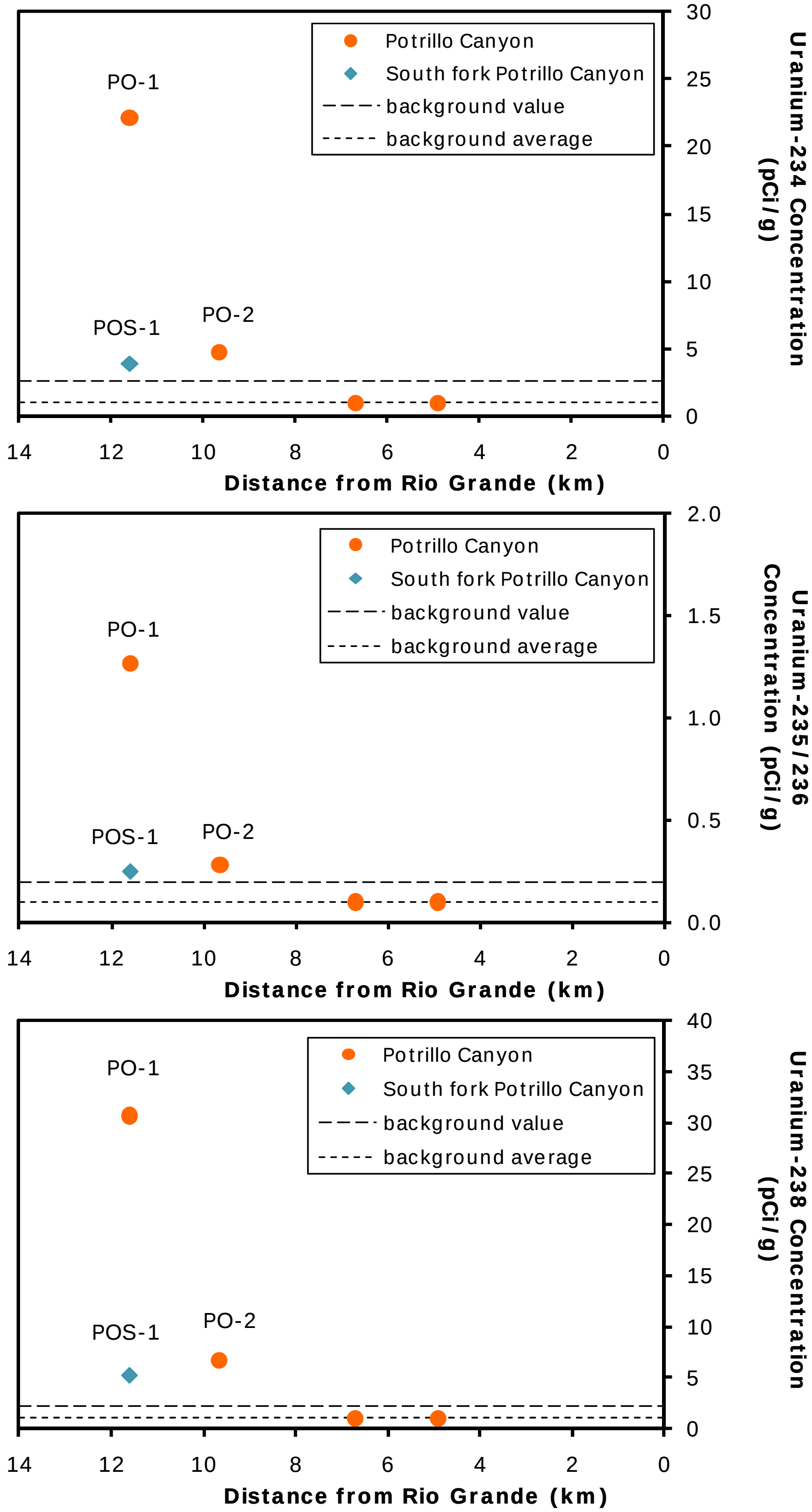


Figure 7.1-3 Estimated average concentrations of uranium isotopes in fine facies sediment in Potrillo Canyon

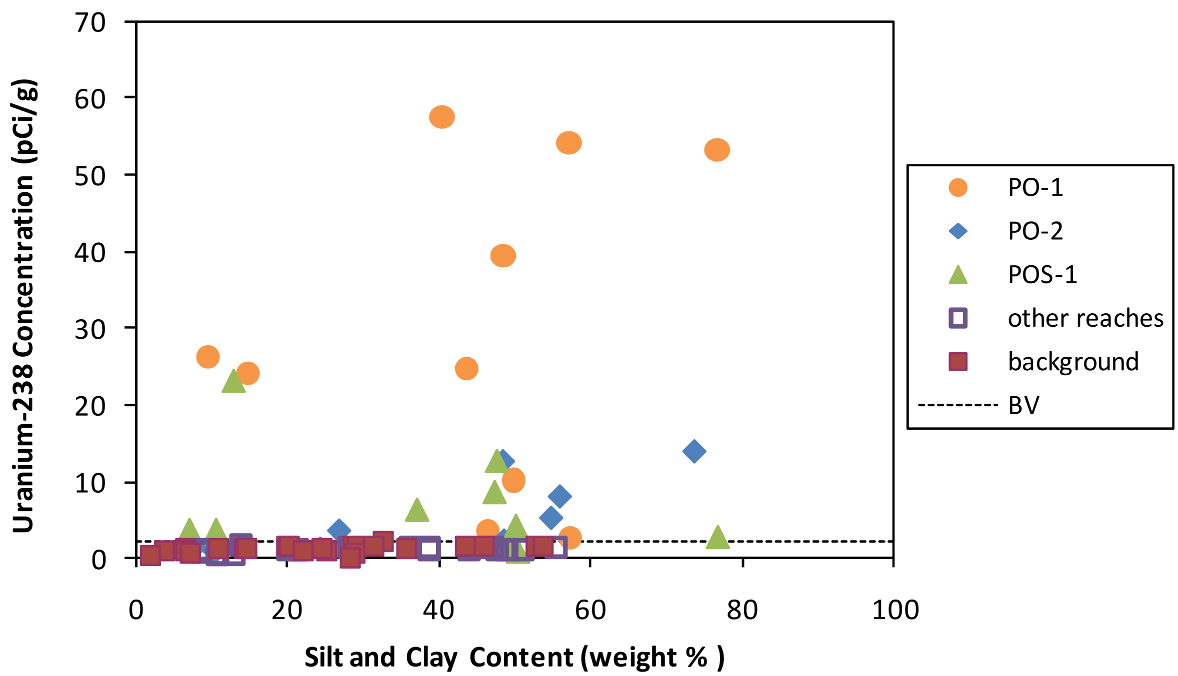
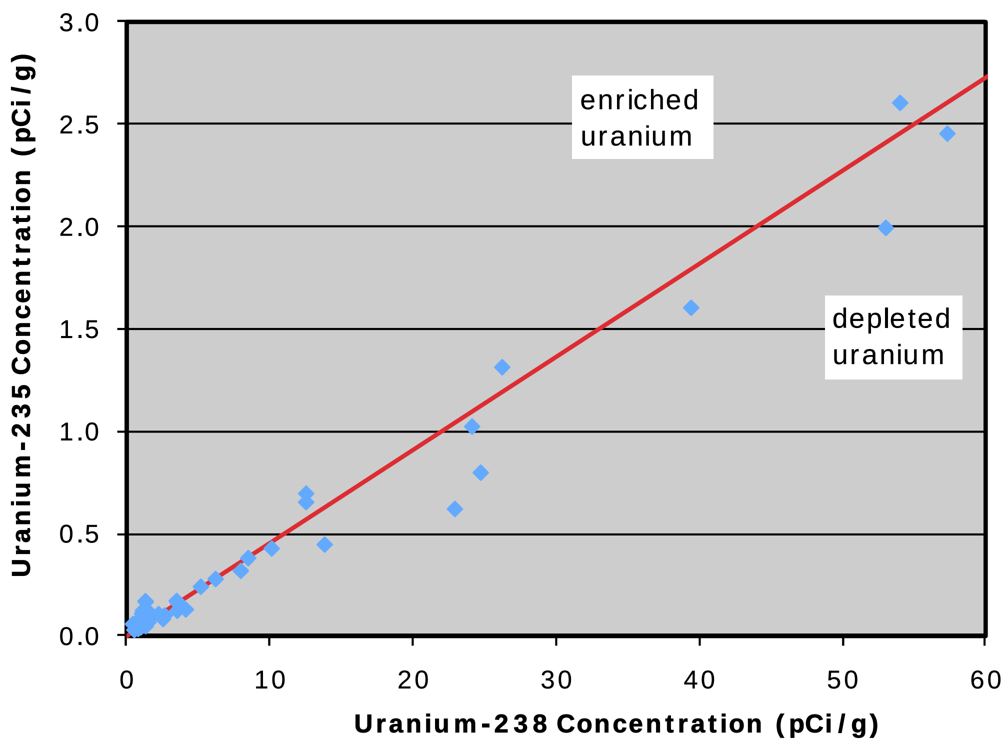
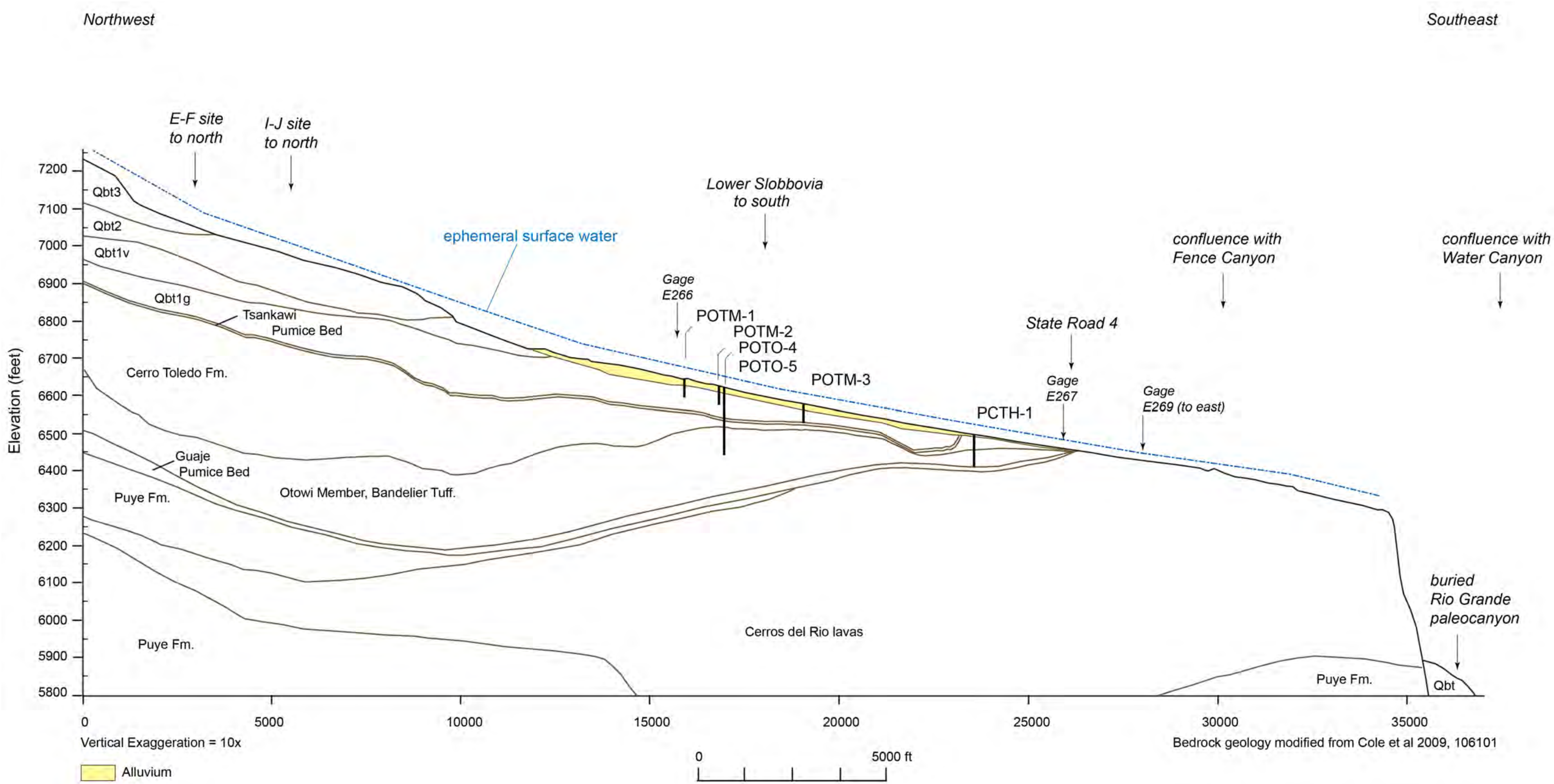


Figure 7.1-4 Concentrations of uranium-238 in Potrillo Canyon and background sediment samples versus silt and clay content



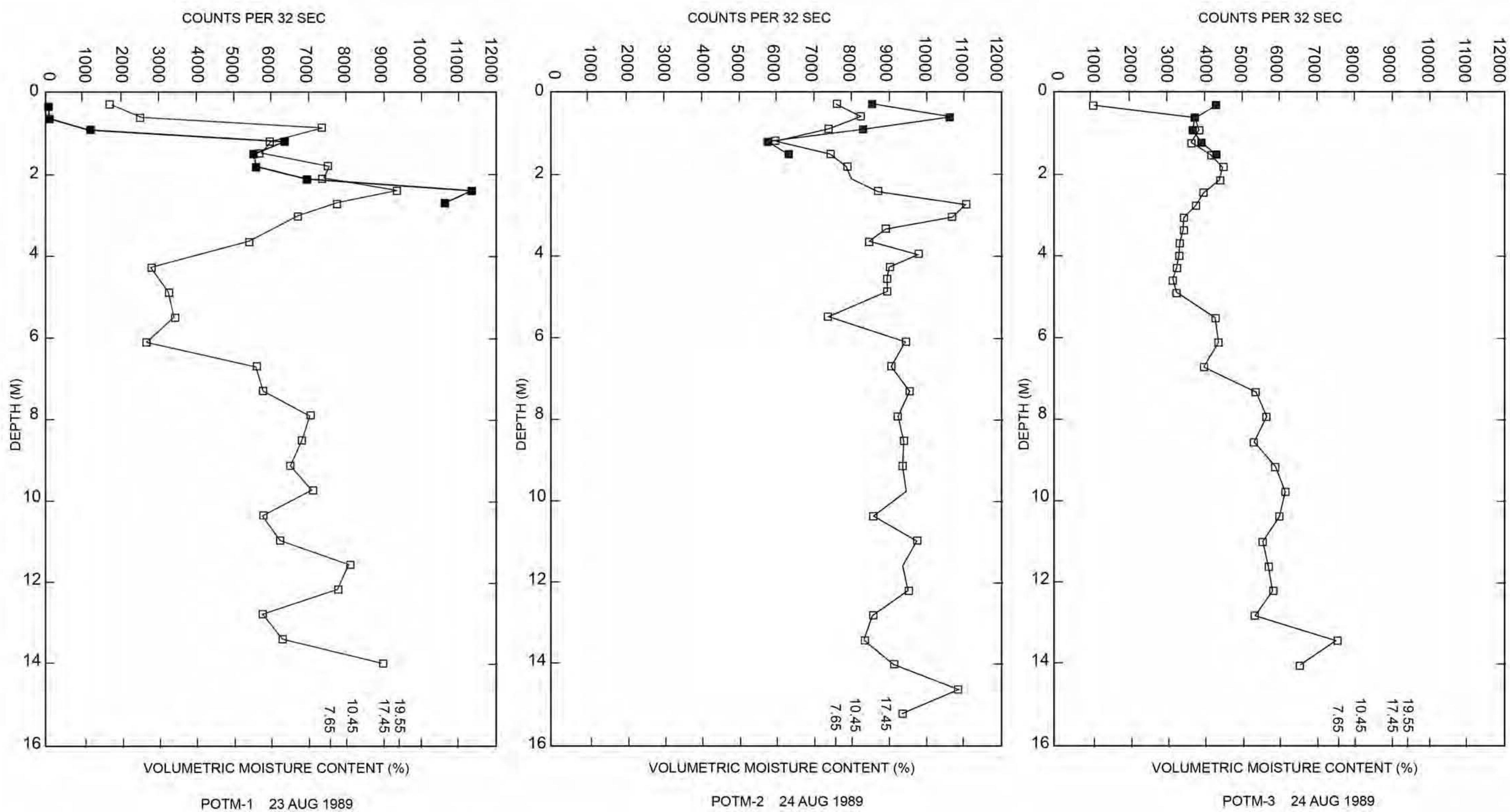
Note: The red line indicates values expected in natural uranium, and values plotting below the line indicate depleted uranium.

Figure 7.1-5 Plot of uranium-238 versus uranium-235/236 concentrations in Potrillo Canyon sediment samples



Note: Line of section follows the main stream channel.

Figure 7.2-1 Conceptual hydrogeologic cross-section for Potrillo Canyon



Notes: Solid boxes are measurements from shallow wells placed immediately adjacent to the main wells. In the deep wells, the upper 1.5 to 3 m of casing were cemented up to the ground surface to prevent surface water from flowing down the casing. Figure modified from Becker (1991, 015317).

Figure 7.2-2 Results from neutron moisture measurements for POTM-1, POTM-2, and POTM-3, on the day each well was drilled

Table 3.1-1
Sediment Investigation Reaches in Potrillo and Fence Canyons

Subwatershed	Investigation Reach	Approximate Distance From Rio Grande to Midpoint of Reach (km)	Reach Length* (km)	Notes
Fence Canyon	F-1	9.21	0.20	Downcanyon from Meenie
	F-2	8.70	0.20	Downcanyon from Moe magazine
	F-3	5.67	0.20	Upcanyon from NM 4
South fork Fence Canyon	FS-1	9.21	0.20	Downcanyon from Minie
Potrillo Canyon	PO-1	11.60	0.20	Downcanyon from E-F
	PO-2	9.65	0.20	Downcanyon from Eenie
	PO-3	6.70	0.20	Downcanyon from Lower Slobbovia
	PO-4	4.91	0.20	Upcanyon from NM 4
South fork Potrillo Canyon	POS-1	11.60	0.20	Downcanyon from Firing Sites A and B

*Length refers to area mapped and characterized.

Table 6.2-1
Inorganic COPCs in Potrillo and Fence Canyon Sediment Samples

Reach	Antimony	Barium	Beryllium	Cadmium	Cobalt	Copper	Iron	Lead	Manganese	Perchlorate	Selenium	Silver	Vanadium	Zinc
Sediment BV[a]	**0.83**	**127**	**1.31**	**0.4**	**4.73**	**11.2**	**13800**	**19.7**	**543**	**na[b]**	**0.3**	**1**	**19.7**	**60.2**
Minimum Soil ESL[c]	**0.05**	**110**	**2.5**	**0.27**	**13**	**15**	**na**	**14**	**220**	**na**	**0.52**	**2.6**	**0.025**	**48**
Residential SSL[d]	**31.3**	**15600**	**156**	**77.9**	**23[e]**	**3130**	**54800**	**400**	**10700**	**54.8**	**391**	**391**	**391**	**23500**
POS-1	1.11 (U)[g]	152	—[f]	0.52 (U)[g]	—	—	—	—	—	—	1.11 (UJ)[g]	—	21.3	—
PO-1	1.14 (U)[g]	157	1.62	0.473 (U)[h]	5.41	52	19000	—	—	0.00273	1.11 (U)[g]	1.06	22.7	89.3
PO-2	1.15 (U)[g]	149	—	0.492 (J)	5.97	20.7	—	—	—	0.000759 (J)	1.27	—	—	—
PO-3	1.08 (U)[g]	—	—	0.884	—	—	26200	—	—	0.0006 (J)	1.63	1.01	32.7	117
PO-4	1.12 (U)[g]	—	—	0.511 (U)[g]	—	—	—	—	—	0.00401	1.14 (U)[h]	—	20.6	—
FS-1	1.1 (U)[g]	158	—	0.519 (U)[g]	5.75	16.7	—	21.2	548	0.000569 (J)	1.09 (UJ)[h]	—	20.1	—
F-1	1.17 (U)[g]	—	—	0.491 (U)[g]	—	—	—	—	—	0.000924 (J)	1.14 (U)[h]	—	—	—
F-2	1.07 (U)[g]	—	—	0.533 (U)[g]	—	—	19100	—	—	—	1.06 (U)[g]	—	27	81.2
F-3	1.07 (U)[g]	148	—	0.513 (U)[g]	—	—	—	—	—	0.00113 (J)	1.09 (U)[g]	—	21.4	—

Notes: Values are in mg/kg. Values are maximum values greater than the sediment BV for analytes with a BV, and the maximum detected value for analytes without a BV. Data qualifiers are defined in Appendix A.

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

[b] na = Not available.

[c] ESLs are from the ECORISK Database, Version 2.5 (LANL 2010, 110846).

[d] SSLs are from NMED (2009, 108070) unless otherwise noted.

[e] SSL from EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

[f] — = Not a COPC in that reach (not detected, not detected above BV, or not analyzed).

[g] The analyte is a COPC only because the maximum nondetect concentration is greater than the BV in that reach.

[h] The maximum detected sample result is greater than the BV in that reach, but the value is not displayed because the detected concentration is less than the maximum nondetect result.

Table 6.2-2
Organic COPCs in Potrillo and Fence Canyon Sediment Samples

Reach	Aroclor-1242	Aroclor-1254	Aroclor-1260	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[g,h,i]perylene	Benzo[k]fluoranthene	Benzoic Acid	Butylbenzene[tert-]	Butylbenzylphthalate	Chrysene
Minimum Soil ESL[a]	**0.041**	**0.041**	**0.14**	**3**	**53**	**18**	**24**	**62**	**1**	**na**[b]	**90**	**2.4**
Residential SSL[c]	**2.22**	**1.12**	**2.22**	**6.21**	**0.62**	**6.21**	**1720**[d]	**62.1**	**240000**[e]	**130**[f]	**2600**[e]	**621**
POS-1	—[g]	—	—	—	—	—	—	—	—	—	—	0.00697 (J)
PO-1	—	—	—	—	—	0.00183 (J)	—	—	—	—	0.133 (J)	0.00724
PO-2	—	—	—	—	—	—	—	—	0.601 (J)	—	—	—
PO-3	—	—	—	—	—	—	—	—	0.524 (J)	—	—	—
PO-4	—	—	—	—	—	—	—	—	—	—	—	—
FS-1	—	—	0.0063	—	—	—	—	—	0.687 (J)	—	—	—
F-1	—	0.0026 (J)	0.0028 (J)	0.00993	—	—	0.00408	—	—	0.000334 (J)	—	0.00587
F-2	0.0033 (J)	0.0031 (J)	—	0.035	0.0681	—	0.0258	—	—	—	—	0.0309
F-3	—	—	—	—	—	—	—	0.00249	—	—	—	—

Table 6.2-2 (continued)

Reach	DDE[4,4'-]	DDT[4,4'-]	Di-n-butylphthalate	Dibenz[a,h] anthracene	Endosulfan II	Endosulfan Sulfate	Fluoranthene	Isopropyltoluene[4-]	Phenanthrene	Pyrene	TATB	Toluene
Minimum Soil ESL[a]	**0.11**	**0.044**	**0.011**	**12**	**0.64**[h]	**0.0014**[i]	**10**	**na**	**5.5**	**10**	**na**	**23**
Residential SSL[c]	**14.3**	**17.2**	**6110**	**0.62**	**367**[h]	**18.3**[i]	**2290**	**3210**[j]	**1830**	**1720**	**2200**[e,k]	**5570**
POS-1	—	—	—	—	—	—	0.0342	—	0.014 (J)	0.0166	—	—
PO-1	0.000458 (J)	—	—	—	—	—	—	—	—	0.00276 (J)	—	—
PO-2	—	—	—	—	—	—	—	—	—	—	—	—
PO-3	—	—	—	—	—	—	—	—	—	—	—	—
PO-4	—	—	—	—	—	—	—	—	—	—	—	—
FS-1	0.00105 (J)	0.000399 (J)	1.66	—	—	—	—	0.000657 (J)	0.0134 (J)	0.00445 (J)	3.56	0.0005 (J)
F-1	—	—	0.25 (J)	0.00585	—	0.00064 (J)	0.0241	—	0.0152 (J)	0.0256	—	—
F-2	—	—	—	—	—	—	0.0583	0.000524 (J)	0.0328 (J)	0.0477	0.9 (J)	—
F-3	0.000422 (J)	—	—	0.00371	0.000401 (J)	—	—	—	—	—	—	—

Notes: Values are in mg/kg. Values are maximum detected values. Data qualifiers are defined in Appendix A.

[a] ESLs are from the ECORISK Database, Version 2.5 (LANL 2010, 110846).

[b] na = Not available.

[c] SSLs are from NMED (2009, 108070) unless otherwise noted.

[d] Pyrene used as a surrogate for benzo[g,h,i]perylene.

[e] SSL from EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

[f] SSL from EPA Region 6 (2007, 099314).

[g] — = Not a COPC in that reach (not detected or not analyzed).

[h] Endosulfan used as a surrogate for endosulfan II.

[i] Endrin used as a surrogate for endosulfan eulfate.

[j] Isopropylbenzene used as a surrogate for isopropyltoluene[4-].

[k] 1,3,5-Trinitrobenzene used as a surrogate for TATB.

Table 6.2-3
Radionuclide COPCs in Potrillo and Fence Canyon Sediment Samples

Reach	Cesium-137	Thorium-228	Tritium	Uranium-234	Uranium-235/236	Uranium-238
Sediment BV[a]	**0.9**	**2.28**	**0.093**	**2.59**	**0.2**	**2.29**
Minimum Soil ESL[b]	**680**	**43**	**36000**	**51**	**55**	**55**
Residential SAL[c]	**5.6**	**2.3**	**750**	**170**	**17**	**87**
POS-1	1.48	—[d]	—	9.53	0.693	23
PO-1	—	—	0.094	44.3 (J+)	2.6 (J+)	57.4 (J+)
PO-2	—	2.43	—	10.4	0.651	13.9
PO-3	—	—	—	—	—	—
PO-4	—	—	—	—	—	—
FS-1	—	—	—	—	—	—
F-1	—	—	—	—	—	—
F-2	—	—	—	—	—	—
F-3	1.04	—	—	—	—	—

Notes: Values are in pCi/g. Values are maximum detected values greater than the sediment BV. Grey shading indicates the residential SAL was exceeded. Data qualifiers are defined in Appendix A.

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

[b] ESLs are from the ECORISK Database, Version 2.5 (LANL 2010, 110846).

[c] SALs are from LANL (2009, 107655).

[d] — = Not a COPC in that reach (not detected, not detected above BV, or not analyzed).

Table 6.4-1
Summary of Stormwater Analytes with Concentrations Greater Than Comparison Values

Analytes	Sediment	Stormwater
Inorganic Chemicals		
Aluminum	—[a]	X[b]
Antimony	X	—
Arsenic	—	X
Barium	X	X
Beryllium	X	X
Boron	—	X
Cadmium	X	X
Chromium	—	X
Cobalt	X	X
Copper	X	X
Iron	X	X
Lead	X	X
Manganese	X	X
Mercury	—	X
Molybdenum	—	X
Nickel	—	X
Selenium	X	X
Silver	X	X
Strontium	—	X
Thallium	—	X
Tin	—	X
Uranium	—	X
Vanadium	X	X
Zinc	X	X
Other Inorganic Chemicals		
Ammonia as Nitrogen	—	X
Calcium	—	X
Cyanide [Total]	—	X
Cyanide, Amenable to Chlorination	—	X
Fluoride	—	X
Magnesium	—	X
Nitrate-Nitrite as Nitrogen	—	X
Perchlorate	X	—
Potassium	—	X
Silicon Dioxide	—	X

Table 6.4-1 (continued)

Analytes	Sediment	Stormwater
Sodium	—	X
Total Kjeldahl Nitrogen	—	X
Explosive Compounds		
TATB	X	—
Pesticides and PCBs		
Aroclor-1242	X	—
Aroclor-1254	X	—
Aroclor-1260	X	—
DDE[4,4'-]	X	—
DDT[4,4'-]	X	—
Endosulfan II	X	—
Endosulfan Sulfate	X	—
SVOCs		
Benzo[a]anthracene	X	—
Benzo[a]pyrene	X	—
Benzo[b]fluoranthene	X	—
Benzo[g,h,i]perylene	X	—
Benzo[k]fluoranthene	X	—
Benzoic Acid	X	—
Butylbenzylphthalate	X	—
Chrysene	X	—
Di-n-butylphthalate	X	—
Dibenz[a,h]anthracene	X	—
Fluoranthene	X	—
Phenanthrene	X	—
Pyrene	X	—
VOCs		
Butylbenzene[tert-]	X	—
Isopropyltoluene[4-]	X	—
Toluene	X	—
Radionuclides		
Americium-241	—	X
Cesium-137	X	—
Gross alpha	—	X
Gross beta	—	X
Plutonium-239/240	—	X
Potassium-40	—	X
Radium-226	—	X
Strontium-90	—	X

Table 6.4-1 (continued)

Analytes	Sediment	Stormwater
Thorium-228	X	X
Thorium-230	—	X
Thorium-232	—	X
Tritium	X	—
Uranium-234	X	X
Uranium-235/236	X	X
Uranium-238	X	X

Note: Grey shading indicates analyte exceeded SAL or SSL for sediment or comparison value for stormwater.

[a] — = Analyte is not a COPC in sediment or not detected in stormwater.

[b] X = Analyte is a COPC in sediment or was detected in stormwater.

Table 7.1-1
Inferred Primary Sources and Downcanyon Extent of Select COPCs in Sediment in Potrillo and Fence Canyons

Type of COPC	COPC	Inferred Primary Source(s) in the Potrillo and Fence Watershed[a]	Inferred Downcanyon Extent from Laboratory Sources[b]
Inorganic chemical	Beryllium	TA-15	Potrillo Canyon between reaches PO-1 and PO-2
	Cadmium	Natural background and minor releases from TA-15 and possibly TA-36	Potrillo Canyon between reaches PO-2 and PO-3
	Cobalt	TA-15 and TA-36	Potrillo Canyon between reaches PO-2 and PO-3 and Fence Canyon between reaches FS-1 and F-2
	Copper	TA-15 and TA-36	Potrillo Canyon between reaches PO-2 and PO-3 and Fence Canyon between reaches FS-1 and F-2
	Selenium	Natural background and possibly minor releases from TA-15	n/a[c]
	Vanadium	Natural background and possibly minor releases from TA-15	n/a
	Zinc	Natural background	n/a
Organic chemical	Aroclor-1242	TA-36	Fence Canyon between reaches F-2 and F-3
	Aroclor-1254	TA-36	Fence Canyon between reaches F-2 and F-3
	Aroclor-1260	TA-36	Fence Canyon between reaches F-1 and F-2
	Di-n-butylphthalate	TA-36	Fence Canyon between reaches F-1 and F-2
	TATB	TA-36	Fence Canyon between reaches F-2 and F-3
Radionuclide	Thorium-228	Natural background	n/a
	Uranium-234	TA-15	Potrillo Canyon between reaches PO-2 and PO-3
	Uranium-235/236	TA-15	Potrillo Canyon between reaches PO-2 and PO-3
	Uranium-238	TA-15	Potrillo Canyon between reaches PO-2 and PO-3

[a] Primary source(s) indicated by maximum concentrations and/or spatial distribution.

[b] Downcanyon extent indicates area where COPC remains detected and/or above background and can probably or possibly be traced to an upcanyon Laboratory source.

[c] n/a = Not applicable (inferred source is natural background).

Table 8.1-1
HQs Based on Maximum Detected Concentrations of
Inorganic COPCs in Potrillo and Fence Canyon Sediment Samples and Soil ESLs

Reach	Antimony	Barium	Beryllium	Cadmium	Cobalt	Copper	Iron	Lead	Manganese	Perchlorate	Selenium	Silver	Vanadium	Zinc
Sediment BV[a] (mg/kg)	**0.83**	**127**	**1.31**	**0.4**	**4.73**	**11.2**	**13800**	**19.7**	**543**	**na[b]**	**0.3**	**1**	**19.7**	**60.2**
Minimum Soil ESL[c] (mg/kg)	**0.05**	**110**	**2.5**	**0.27**	**13**	**15**	**pH dependent[d]**	**14**	**220**	**na**	**0.52**	**2.6**	**0.025**	**48**
ESL for kestrel (flesh diet [mg/kg])	**na**	**37000**	**na**	**580**	**3500**	**1600**	**pH dependent[d]**	**810**	**90000**	**na**	**97**	**840**	**170**	**2400**
POS-1	—[e]	1.4	—	—	—	—	—	—	—	—	—	—	850	—
PO-1	—	1.4	0.65	1.6	0.42	3.5	5< pH <8	—	—	no ESL	—	0.41	910	1.9
PO-2	—	1.4	—	1.8	0.46	1.4	—	—	—	no ESL	2.4	—	—	—
PO-3	—	—	—	3.3	—	—	5< pH <8	—	—	no ESL	3.1	0.39	1300	2.4
PO-4	—	—	—	—	—	—	—	—	—	no ESL	1.4	—	820	—
FS-1	—	1.4	—	—	0.44	1.1	—	1.5	2.5	no ESL	1.8	—	800	—
F-1	—	—	—	—	—	—	—	—	—	no ESL	1.3	—	—	—
F-2	—	—	—	—	—	—	5< pH <8	—	—	—	—	—	1100	1.7
F-3	—	1.4	—	—	—	—	—	—	—	no ESL	—	—	860	—

Notes: Gray shading indicates HQ greater than 3.0 (or HQ greater than 1.0 for T&E receptors [kestrel with flesh diet]). Values reported are HQs (unitless).

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

[b] na = Not available.

[c] ESLs are from the ECORISK Database, Version 2.5 (LANL 2010, 110846).

[d] EPA EcoSSL (EPA 2003, 111415).

[e] — = Not a COPC (no detected value above BV).

Table 8.1-2
HQs Based on Maximum Detected Concentrations of Radionuclide COPCs in Potrillo and Fence Canyon Sediment Samples and Soil ESLs

Reach	Cesium-137	Thorium-228	Tritium	Uranium-234	Uranium-235/236	Uranium-238
Sediment BV[a] (mg/kg)	**0.9**	**2.28**	**0.093**	**2.59**	**0.2**	**2.29**
Minimum Soil ESL[b] (mg/kg)	**680**	**43**	**36000**	**51**	**55**	**55**
ESL for Kestrel (Flesh Diet [mg/kg])	**2900**	**1600**	**580000**	**190000**	**10000**	**4200**
POS-1	<0.01	—[c]	—	0.19	0.01	0.42
PO-1	—	—	<0.01	0.87	0.05	1.0
PO-2	—	0.06	—	0.2	0.01	0.25
PO-3	—	—	—	—	—	—
PO-4	—	—	—	—	—	—
FS-1	—	—	—	—	—	—
F-1	—	—	—	—	—	—
F-2	—	—	—	—	—	—
F-3	<0.01	—	—	—	—	—

Notes: No gray shading based on HQ less than 3.0 (or HQ less than 1.0 for T&E receptors [kestrel with flesh diet]). Values reported are HQs (unitless). HQ = 1 for uraniun-238.

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

[b] ESLs are from the ECORISK Database, Version 2.5 (LANL 2010, 110846).

[c] — = Not a COPC.

Table 8.1-3
HQs Based on Maximum Detected Concentrations of Organic COPCs in Potrillo and Fence Canyon Sediment Samples and Soil ESLs

Reach	Aroclor-1242	Aroclor-1254	Aroclor-1260	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[g,h,i]perylene	Benzo[k]fluoranthene	Benzoic Acid	Butylbenzene[tert-]	Butylbenzylphthalate	Chrysene
Minimum Soil ESL[a] (mg/kg)	**0.041**	**0.041**	**0.14**	**3**	**53**	**18**	**24**	**62**	**1**	**na[b]**	**90**	**2.4**
ESL for kestrel (flesh diet [mg/kg])	**1.4**	**0.22**	**4.6**	**64**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**
POS-1	—[c]	—	—	—	—	—	—	—	—	—	—	<0.01
PO-1	—	—	—	—	—	<0.01	—	—	—	—	<0.01	<0.01
PO-2	—	—	—	—	—	—	—	—	0.60	—	—	—
PO-3	—	—	—	—	—	—	—	—	0.52	—	—	—
PO-4	—	—	—	—	—	—	—	—	—	—	—	—
FS-1	—	—	0.05	—	—	—	—	—	0.69	—	—	—
F-1	—	0.06	0.02	<0.01	—	—	<0.01	—	—	no ESL	—	<0.01
F-2	0.08	0.08	—	0.01	<0.01	—	<0.01	—	—	—	—	0.01
F-3	—	—	—	—	—	—	—	<0.01	—	—	—	—

Table 8.1-3 (continued)

Reach	DDE[4,4'-]	DDT[4,4'-]	Di-n-butylphthalate	Dibenz[a,h]anthracene	Endosulfan II	Endosulfan Sulfate	Fluoranthene	Isopropyltoluene[4-]	Phenanthrene	Pyrene	TATB	Toluene
Minimum Soil ESL[a] (mg/kg)	**0.11**	**0.044**	**0.011**	**12**	**0.64**	**0.0014**	**10**	**na**	**5.5**	**10**	**na**	**23**
ESL for kestrel (flesh diet [mg/kg])	**0.3**	**1.2**	**0.24**	**na**	**1100**	**0.02**	**na**	**na**	**na**	**460**	**na**	**na**
POS-1	—	—	—	—	—	—	<0.01	—	<0.01	<0.01	—	—
PO-1	<0.01	—	—	—	—	—	—	—	—	<0.01	—	—
PO-2	—	—	—	—	—	—	—	—	—	—	—	—
PO-3	—	—	—	—	—	—	—	—	—	—	—	—
PO-4	—	—	—	—	—	—	—	—	—	—	—	—
FS-1	0.01	0.01	150[d]	—	—	—	—	no ESL	<0.01	<0.01	no ESL	<0.01
F-1	—	—	23[d]	<0.01	—	0.46	<0.01	—	<0.01	<0.01	—	—
F-2	—	—	—	—	—	—	0.01	no ESL	0.01	<0.01	no ESL	—
F-3	<0.01	—	—	<0.01	<0.01	—	—	—	—	—	—	—

Notes: Gray shading indicates HQ greater than 3.0 (or HQ greater than 1.0 for T&E receptors [kestrel with flesh diet]). Values reported are HQs (unitless).

[a] ESLs are from the ECORISK Database, Version 2.5 (LANL 2010, 110846).

[b] na = Not available.

[c] — = Not a COPC.

[d] HQ greater than 1.0 for kestrel (flesh diet); HQ greater than 3.0 and 1.0 for di-n-butylphthalate.

Table 8.1-4
COPECs Considered for Study Design for Potrillo and Fence Canyons

Analyte	Potrillo Watershed Maximum Concentration (mg/kg)	Minimum ESL (mg/kg)	Assessment Endpoint Where Potrillo and Fence Canyons Sample HQ > 3
Cadmium	0.884	0.27	Shrew, robin (insectivore)
Copper	52	15	Robin (insectivore)
Selenium	1.63	0.52	Plant
Vanadium	32.7	0.025	Plant, robin (insectivore), robin (omnivore), robin (herbivore)
Di-n-butylphthalate	1.66	0.011	Robin (insectivore), robin (omnivore), robin (herbivore), kestrel (intermediate carnivore), kestrel (top carnivore)*

* An HQ of 1.0 was considered for the American kestrel (top carnivore with flesh diet), which is a surrogate receptor for the Mexican spotted owl.

Table 8.1-5
Comparison of Concentrations for Plant COPECs in
Potrillo and Fence Canyons with Concentrations from Sediment Used in Previous Plant Studies

COPEC	Sediment BV (mg/kg)	Plant ESL (mg/kg)	Potrillo and Fence Canyons Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)	Sandia Canyon Maximum (mg/kg)
Selenium	0.3	0.52	1.63	0.819	Not detected	15	8.64
Vanadium	19.7	0.025	32.7	20.3	29.7	35.9	111

Note: Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the Potrillo watershed.

Table 8.1-6
Comparison of Concentrations for
Small Mammal COPECs in Potrillo and Fence Canyons with
Concentrations from Sediment Used in Previous Mammal Studies

COPEC	Sediment BV (mg/kg)	Shrew ESL (mg/kg)	Potrillo and Fence Canyons Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Sandia Canyon Maximum (mg/kg)
Cadmium	0.4	0.27	0.884	7.1	0.8	8.69

Note*:* Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in Potrillo watershed.

Table 8.1-7
Comparison of Concentrations for Bird COPECs in Potrillo and Fence Canyons with Concentrations from Sediment Used in Previous Bird Studies

COPEC	Sediment BV (mg/kg)	Bird ESL[a] (mg/kg)	Potrillo and Fence Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)	Sandia Canyon Maximum (mg/kg)
Cadmium	0.4	0.29	0.884	0.85	3.63	8.69
Copper	11.2	15	52	90	383	223
Vanadium	19.7	6.7	32.7	53.1	86.1	111
Di-n-butylphthalate	na[b]	0.011	1.66	Not detected	1.54	0.106

Note: Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in Potrillo and Fence Canyons.

[a] ESL is lowest ESL for birds, American robin (avian insectivore).

[b] na = Not available.

Table 8.1-8
Comparison of Concentrations for Kestrel with Flesh Diet (Mexican Spotted Owl Surrogate) COPECs in Potrillo and Fence Canyons with Concentrations from Sediment Used in Previous Mammal Studies

COPEC	Sediment BV (mg/kg)	Kestrel ESL (mg/kg)	Potrillo and Fence Canyons Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Sandia Canyon Maximum (mg/kg)
Di-n-butylphthalate	na*	0.24	1.66	Not detected	Not detected	0.106

Note: No gray shading because there were detected concentrations from previous studies.
*na = Not available.

Table 8.1-9
Summary of Potrillo and Fence Canyons Soil COPECs Unbounded by Previous Canyons Biota Investigations

COPEC	Receptor	Soil ESL (mg/kg)		Potrillo and Fence Canyons COPEC Concentrations (mg/kg)			Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)	Sandia Canyon Maximum (mg/kg	Comment
		NOAEL-Based	LOAEL-Based[a]	Count of Detected/ Unbounded/Total Results	Reach Average[b] and Maximum Detect	Affected Reach					
Di-n-butylphthalate	Mexican spotted owl	0.24	2.4	1/1/10	0.34/0.25	F-1	Not detected	Not detected	Not studied	Not measured	Reach average is between the NOAEL and LOEAL-based ESLs.
				2/2/10	0.49/1.66	FS-1					
Di-n-butylphthalate	Robin	0.011	0.11	1/1/10	0.34/0.25	F-1	Not studied	Not detected	1.54	0.106	Reach average is bounded by previous studies.
				2/2/10	0.49/1.66	FS-1					

[a] LOAEL is from the literature. The NOAEL was derived by applying an uncertainty factor of 0.1.

[b] Average includes one detected result and nine nondetects in reach F-1 and two detected results and eight nondetects in reach FS-1.

Table 8.2-1
Residential Risk Ratios Used to Identify Sediment COPCs for Human Health Risk Assessment, Noncarcinogens

Reach	Antimony	Barium	Beryllium	Cadmium	Cobalt	Copper	Iron	Lead	Manganese	Perchlorate	Selenium	Silver	Vanadium	Zinc
Residential SSL[a] (mg/kg)	**31.3**	**15600**	**156**	**77.9**	**23[b]**	**3130**	**54800**	**400**	**10700**	**54.8**	**391**	**391**	**391**	**23500**
POS-1	—[c]	0.01	—	—	—	—	—	—	—	—	—	—	0.05	—
PO-1	—	0.01	0.01	0.01	0.24	0.02	0.35	—	—	<0.01	—	<0.01	0.06	<0.01
PO-2	0.02	0.01	—	0.01	0.26	0.01	—	—	—	<0.01	<0.01	—	—	—
PO-3	—	—	—	0.01	—	—	0.48	—	—	<0.01	<0.01	<0.01	0.08	<0.01
PO-4	—	—	—	—	—	—	—	—	—	<0.01	<0.01	—	0.05	—
FS-1	—	0.01	—	—	0.25	0.01	—	0.05	0.05	<0.01	<0.01	—	0.05	—
F-1	—	—	—	—	—	—	—	—	—	<0.01	<0.01	—	—	—
F-2	—	—	—	—	—	—	0.35	—	—	—	—	—	0.07	<0.01
F-3	—	0.01	—	—	—	—	—	—	—	<0.01	—	—	0.05	—

Table 8.2-1 (continued)

Reach	Aroclor-1254	Benzo[g,h,i]perylene	Benzoic Acid	Butylbenzene[tert-]	Di-n-butylphthalate	Endosulfan II	Endosulfan Sulfate	Fluoranthene	Isopropyltoluene[4-]	Phenanthrene	Pyrene	Toluene	TATB	SOF
Residential SSL[a] (mg/kg)	**1.12**	**1720[d]**	**240000[b]**	**130[b]**	**6110**	**367[e]**	**18.3[f]**	**2290**	**3210[g]**	**1830**	**1720**	**5570**	**2200[bh]**	
POS-1	—	—	—	—	—	—	—	<0.01	—	<0.01	<0.01	—	—	0.06
PO-1	—	—	—	—	—	—	—	—	—	—	<0.01	—	—	0.69
PO-2	—	—	<0.01	—	—	—	—	—	—	—	—	—	—	0.31
PO-3	—	—	<0.01	—	—	—	—	—	—	—	—	—	—	0.58
PO-4	—	—	—	—	—	—	—	—	—	—	—	—	—	0.05
FS-1	—	—	<0.01	—	<0.01	—	—	—	<0.01	<0.01	<0.01	<0.01	<0.01	0.43
F-1	<0.01	<0.01	—	<0.01	<0.01	—	<0.01	<0.01	—	<0.01	<0.01	—	—	<0.01
F-2	<0.01	<0.01	—	—	—	—	—	<0.01	<0.01	<0.01	<0.01	—	<0.01	0.42
F-3	—	—	—	—	—	<0.01	—	—	—	—	—	—	—	0.06

[a] SSLs are from NMED (2009, 108070) unless otherwise noted.

[b] SSL from EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

[c] — = Not a COPC.

[d] Pyrene used as a surrogate for benzo[g,h,i]perylene.

[e] Endosulfan used as a surrogate for endosulfan II.

[f] Endrin used as a surrogate for endosulfan sulfate.

[g] Isopropylbenzene used as a surrogate for isopropyltoluene[4-].

[h] 1,3,5-Trinitrobenzene used as a surrogate for TATB.

Table 8.2-2
Residential Risk Ratios Used to Identify Sediment COPCs for Human Health Risk Assessment, Carcinogens

Reach	Aroclor-1242	Aroclor-1260	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Butylbenzylphthalate	Chrysene	DDE[4,4'-]	DDT[4,4'-]	Dibenz[a,h]anthracene	SOF
Residential SSL[a]	**2.22**	**2.22**	**6.21**	**0.62**	**6.21**	**62.1**	**2600**[b]	**621**	**14.3**	**17.2**	**0.62**	
POS-1	—[c]	—	—	—	—	—	—	<0.01	—	—	—	<0.01
PO-1	—	—	—	—	<0.01	—	<0.01	<0.01	<0.01	—	—	<0.01
PO-2	—	—	—	—	—	—	—	—	—	—	—	—
PO-3	—	—	—	—	—	—	—	—	—	—	—	—
PO-4	—	—	—	—	—	—	—	—	—	—	—	—
FS-1	—	<0.01	—	—	—	—	—	—	<0.01	<0.01	—	<0.01
F-1	—	<0.01	<0.01	—	—	—	—	<0.01	—	—	0.01	0.01
F-2	<0.01	—	0.01	0.11	—	—	—	<0.01	—	—	—	0.12
F-3	—	—	—	—	—	<0.01	—	—	<0.01	—	0.01	<0.01

[a] SSLs are from NMED (2009, 108070) unless otherwise noted.

[b] SSL from EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) and adjusted to a target risk of 10^{-5}.

[c] — = Not a COPC.

Table 8.2-3
Residential Dose Ratios Used to Identify
Sediment COPCs for Human Health Risk Assessment, Radionuclides

Reach	Cesium-137	Thorium-228	Tritium	Uranium-234	Uranium-235/236	Uranium-238	SOF
Residential SAL* (pCi/g)	**5.6**	**2.3**	**750**	**170**	**17**	**87**	
POS-1	0.26	—	—	0.06	0.04	0.26	0.63
PO-1	—	—	<0.01	0.26	0.15	0.66	1.1
PO-2	—	1.1	—	0.06	0.04	0.16	1.3
PO-3	—	—	—	—	—	—	—
PO-4	—	—	—	—	—	—	—
FS-1	—	—	—	—	—	—	—
F-1	—	—	—	—	—	—	—
F-2	—	—	—	—	—	—	—
F-3	0.19	—	—	—	—	—	0.19

Note: Shaded cells indicate reaches with SOFs greater than 1.0 and analytes with ratios greater than 0.1.
*SALs are from LANL (2009, 107655).

Table 8.2-4
Reaches and Analyte Classes
Evaluated for Sediment Exposure

Reach	Analyte Class
PO-1	Radionuclide
PO-2	Radionuclide

Table 8.2-5
Site-Specific Exposure Scenarios and Complete Exposure Pathways

Exposure Pathways	Exposure Scenarios	
	Recreational	Residential
Incidental ingestion of soil	X[a]	X
Inhalation of dust	X	X
Dermal contact with soil	X	X
Ingestion of surface water	—[b]	—
Dermal contact with surface water	—	—
External irradiation	X	X

[a] X = Complete pathway.
[b] — = Incomplete pathway.

Table 8.2-6
Dose-Based SLs

COPC	End Point	Target Adverse-Effect Level	Recreational SAL (pCi/g)
Thorium-228	Radionuclide	15 mrem/yr	78
Uranium-234	Radionuclide	15 mrem/yr	3200
Uranium-235	Radionuclide	15 mrem/yr	520
Uranium-238	Radionuclide	15 mrem/yr	2100

Note: All SALs from LANL (2009, 107655).

Table 8.2-7
Dose Ratios Based on EPCs for Sediment, Recreational Scenario, Radionuclides

Reach	Thorium-228	Uranium-234	Uranium-235	Uranium-238	SOF	Total Dose (mrem/yr)
Recreational SL (pCi/g)	78	3200	520	2100		
PO-1	—*	0.010	0.003	0.020	0.033	0.5
PO-2	0.022	—	—	0.005	0.027	0.4

Note: Recreational SALs are from LANL (2009, 107655).

*— = Not a COPC.

Table 8.2-8
EPCs for Sediment COPCs

Reach	End Point	Analyte	UCL (mg/kg)
PO-1	Radionuclide	Uranium-234	30.5
PO-1	Radionuclide	Uranium-235	1.77
PO-1	Radionuclide	Uranium-238	41.6
PO-2	Radionuclide	Thorium-228	1.75
PO-2	Radionuclide	Uranium-238	9.48

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

ALARA	al low as reasonably achievable
AOC	area of concern
asl	above sea level
ASTM	American Society for Testing and Materials
BCG	Biota Concentration Guidelines (DOE)
BV	background value
CCV	continuing calibration verification
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
COPEC	chemical of ecological concern
CRDL	contract-required detection limit
CWA	Clean Water Act
DCF	dose conversion factor
DER	duplicate error ratio
DOE	Department of Energy (U.S.)
DRI	Desert Research Institute
ED	exposure duration
EDL	estimated detection limit
EPA	Environmental Protection Agency (U.S.)
EPC	exposure point concentration
ERAGS	Ecological Risk Assessment Guidance for Superfund (EPA)
ESL	ecological screening level
GIS	geographic information system
HE	high explosives
HIR	historical investigation report
HQ	hazard quotient
ICPES	inductively coupled plasma emission spectroscopy
ICV	initial calibration verification
IP	Individual Permit (for stormwater discharges from SWMUs/AOCs)
IS	internal standard
Laboratory	Los Alamos National Laboratory
LAL	lower acceptance level
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
MSD	matrix spike duplicate
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NOAEL	no observed adverse effect level
NOD	notice of disapproval
NPDES	National Pollutant Discharge Elimination System
%R	percent recovery
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHERMEX	Pulsed High-Energy Radiographic Machine Emitting X-rays
QA	quality assurance
QC	quality control
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RME	reasonable maximum exposure
RPD	relative percent difference
RPF	Records Processing Facility
SAL	screening action level
SL	screening level
SLERA	screening level ecological risk assessment
SMDB	Sample Management Database
SOF	sum of fractions
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
TATB	triaminotrinitrobenzene

TPU	total propagated uncertainty
TRV	toxicity reference value
UAL	upper acceptance level
UCL	upper confidence limit
VCA	voluntary corrective action
VOC	volatile organic compound
WQDB	Water Quality Database

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 Investigation Methods and Results

B-1.0 SEDIMENT INVESTIGATIONS IN REACHES

This appendix summarizes the methods used and the results of field investigations of potentially contaminated sediment deposits in reaches in Potrillo and Fence Canyons conducted in 2010 as part of implementation of the “South Canyons Investigation Work Plan” (LANL 2006, 093713). Geomorphic mapping at a scale of 1:200 occurred in each reach and focused on delineating geomorphic units with differences in physical characteristics and/or contaminant levels. These maps are presented on Plates 1 and 2. Unit designations followed those used in previous reports on canyons in and near the Los Alamos National Laboratory (LANL or the Laboratory) (e.g., LANL 2004, 087390; LANL 2006, 094161; LANL 2009, 106939; LANL 2009, 107453; LANL 2009, 107416; LANL 2009, 107497), with “c” designating post-1942 channel units and “f” designating post-1942 floodplain units. Summaries of the physical characteristics of post-1942 geomorphic units in the Potrillo and Fence Canyons investigation reaches are presented in Table B-1.0-1. Schematic cross-sections illustrating the topographic setting and sediment characteristics in different units in some of the investigation reaches are presented in Figure B-1.0-1.

Sediment thickness measurements distinguished between fine facies sediment, with typical median particle size of silt to fine sand (0.015 to 0.25 mm) in the less than 2-mm fraction, and coarse facies sediment, with typical median particle size of coarse to very coarse sand (0.5 to 2 mm) in the less than 2-mm fraction. Samples with median particle size of medium sand (0.25 to 0.5 mm) were classified either as fine or coarse facies, depending on the stratigraphic context and the particle size of adjacent layers. Coarse facies sediment is characteristic of material transported along the streambeds as bed load, and fine facies sediment is characteristic of material transported in suspension (Malmon 2002, 076038, pp. 94-97; Malmon et al. 2004, 093018). Several methods were used to identify the bottom of post-1942 sediment deposits, including determining the depth of buried trees and associated buried soils and noting the presence or absence of materials imported to the watershed after 1942 (e.g., quartzite gravel, plastic). Sediment thickness measurements from the Potrillo and Fence Canyons investigation reaches are presented in Table B-1.0-2 (see Attachment 1 on CD included with this report). Where uncertainty existed in the thickness of post-1942 sediment because of the absence of distinct stratigraphic breaks at depth, measurements were biased high to avoid underestimating the possible vertical extent of potentially contaminated sediment. Therefore, the thickness measurements and sediment sampling included some pre-1943 sediment.

Average facies thickness in each unit was combined with unit area, as determined from digitized geomorphic maps, to obtain an estimated unit volume. The estimates of unit volume were combined with estimates of relative contaminant levels to allocate samples using a stratified sample allocation process (Gilbert 1987, 056179, pp. 45-57) designed to reduce uncertainties in the contaminant inventory in each reach. In this process, samples were preferentially allocated to units and sediment facies with a large portion of the total inventory (e.g., Ryti et al. 2005, 093019). Because no previous data existed on relative contaminant concentrations in different units and sediment facies in the Potrillo and Fence Canyon reaches, it was assumed that concentrations were 3 times higher in fine facies sediment relative to coarse facies sediment, based on previous results from other canyons. One result of this sample allocation process is a high bias in sample results because a disproportionately large number of samples were collected from the potentially more contaminated fine facies sediment.

Variations in the estimated width of potentially contaminated post-1942 geomorphic units and the volumes of post-1942 sediment in each investigation reach are shown in Table B-1.0-3 (see Attachment 1 on CD). Sediment volumes are normalized by reach length, and shown in units of cubic meters per kilometer (m^3/km). The average width of the area affected or potentially affected by post-1942 floods varies from 2.0 m in upper Fence Canyon (reach F-1) to 12.6 m in lower Potrillo Canyon (reach PO-4). Estimated volumes of post-1942 sediment vary from 535 m^3/km in F-1 to 4085 m^3/km in PO-4. The relative volume of coarse and fine facies sediment also varies between reaches. The estimated percentage of coarse facies sediment is least in lower Fence Canyon (reach F-3, 6%) and greatest in middle Fence Canyon (reach F-2, 66%) or middle Potrillo Canyon (reach PO-3, 57-77%) (Table B-1.0-3). (More uncertainty exists in the thickness and volume of post-1942 sediment in PO-3 than other reaches because of more gradual changes in sediment characteristics with depth.)

Particle-size analyses of sediment samples were obtained at an off-site laboratory at the Desert Research Institute (DRI) following the procedures described in Janitzky (1986, 057674) to examine the effect of particle-size distribution on contaminant concentrations. Organic-matter content was also determined for sediment samples at DRI using the loss-on-ignition method to provide additional information about the physical characteristics of potentially contaminated sediment deposits, and pH data were also obtained because ecological screening levels can be pH-dependant for some analytes (aluminum and iron). Particle size, organic matter, and pH data from the Potrillo and Fence Canyons investigation reaches are presented in Table B-1.0-4 (see Attachment 1 on CD).

Dendrochronological analyses (tree-ring dating) were performed in some reaches to provide supplemental information on the age of sampled sediment deposits in Potrillo and Fence Canyons. Sediments burying trees of known age are constrained to be younger than the trees, and sediments beneath the base of trees are constrained to be older. In some cases, nearby trees of different ages can provide more precise determination of the ages of sediment deposits. For example, two adjacent trees of different ages can be buried by different thicknesses of sediment recording a variable number of floods since the germination of each tree and approximate ages for such floods, or different age trees can be buried by the same thickness of sediment recording the absence of deposition during specific time periods. Cores were collected from 15 trees in Potrillo and Fence Canyons using a 5-mm-diameter increment borer. Each tree was assigned a unique three-letter three-number identifier following the general convention used by the Laboratory of Tree-Ring Research at the University of Arizona, with the designation “FEN and “POT” chosen to indicate trees cored in Fence and Potrillo Canyons, respectively. These trees are located at or near sediment sampling locations, and data on the tree diameter and the thickness of sediment burying each tree were recorded. These analyses followed the methodology described in Stokes and Smiley (1996, 057644) and Phipps (1985, 058477), and the process is discussed further in Reneau et al. (1998, 065407; Appendix B, section B-1.0). Results of the dendrochronological analyses from the Potrillo and Fence Canyons investigation reaches are presented in Table B-1.0-5 (see Attachment 1 on CD). The most trees were cored in reach PO-3, in middle Potrillo Canyon, including nine ponderosa pines that have estimated pith dates of 1971 to 1984 (e.g., Figure B-1.0-1c). These trees were buried by 3 to 18 cm of sediment, and sediment younger and older than these trees was sampled. In reach PO-1, sediment that buried another Ponderosa pine with a pith date of 1954 (Figure B-1.0-1b) had the highest concentrations of uranium-234 and uranium-235/236 in Potrillo Canyon, and the second highest concentration of uranium-238.

B-2.0 WATER INVESTIGATIONS

This section provides additional information concerning stream-flow measurements and observations of wells in Potrillo and Fence Canyons since 1995. Stream-flow measurements at gage E267 in Potrillo Canyon (Figure 3.2-1) were compiled from annual surface water data reports (e.g., Ortiz and McCullough 2010, 109826) and were used to evaluate flow magnitude and frequency. These data are summarized in Table B-2.0-1. Field visits to alluvial well FCO-1 were compiled from annual groundwater level status reports (Koch and Schmeer 2010, 108926) and are summarized in Table B-2.0-2.

B-3.0 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. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

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

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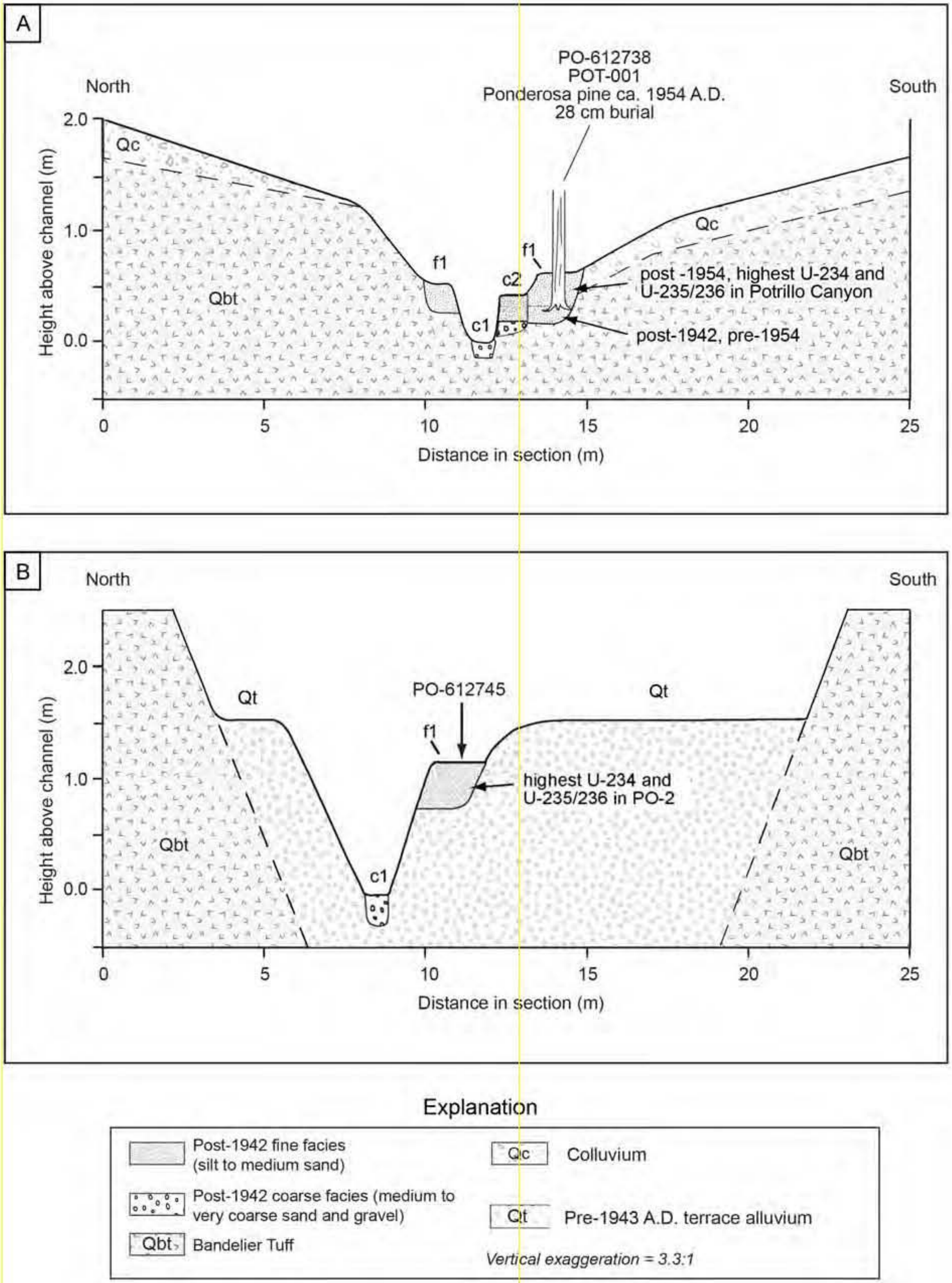
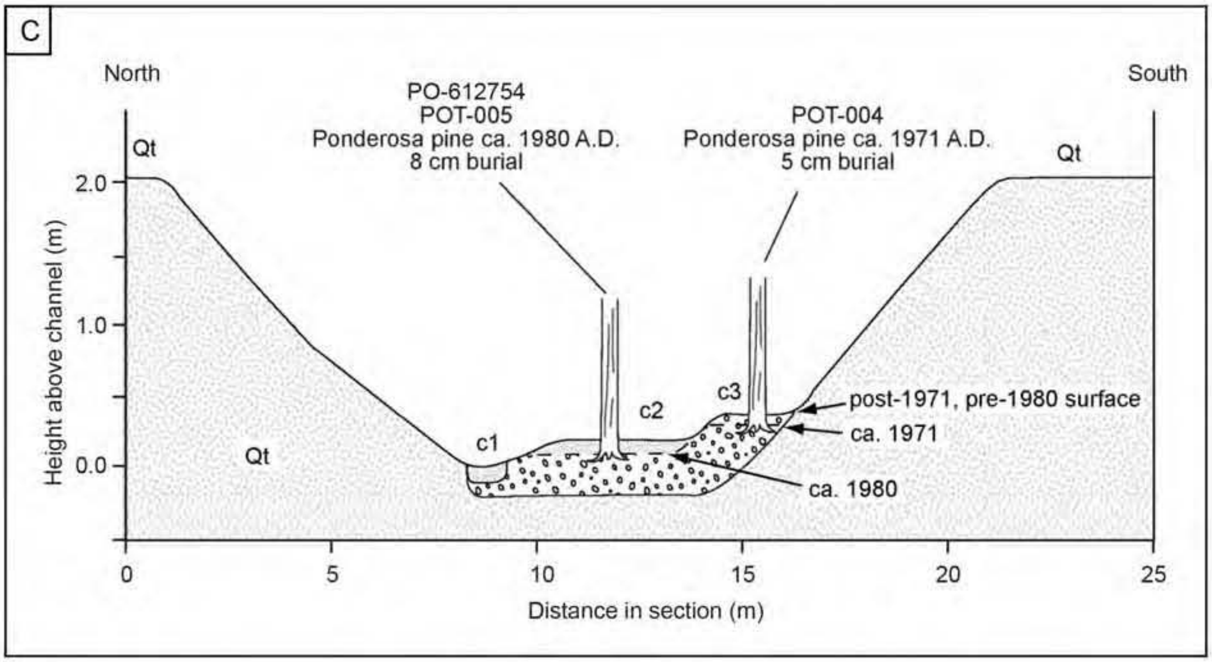


Figure B-1.0-1 Schematic cross-sections showing post-1942 coarse facies and fine facies sediment deposits in reaches PO-1 (a), PO-2 (b), PO-3 (c), and PO-4 (d)



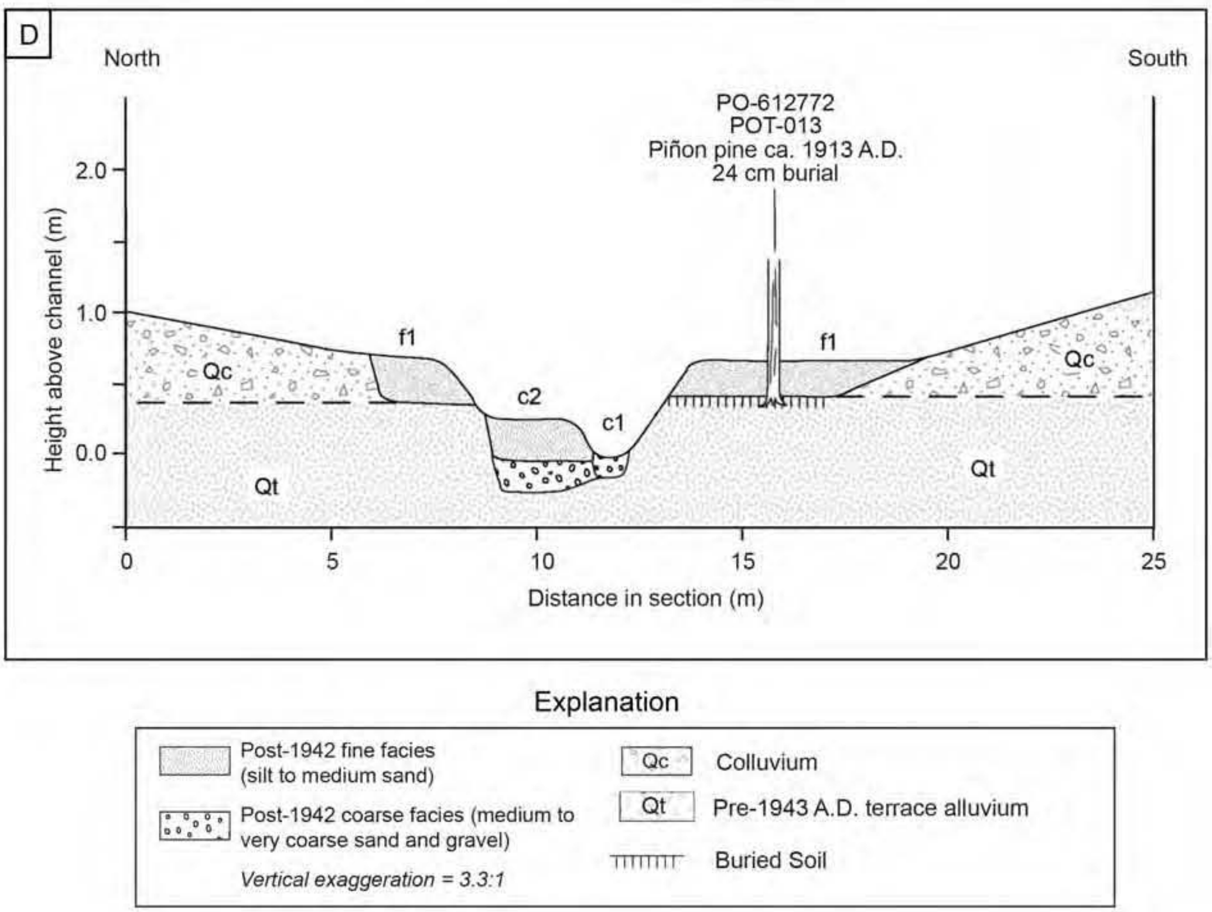


Figure B-1.0-1 (continued) Schematic cross-sections showing post-1942 coarse facies and fine facies sediment deposits in reaches PO-1 (a), PO-2 (b), PO-3 (c), and PO-4 (d)

Table B-1.0-1
Physical Characteristics of Post-1942
Geomorphic Units in the Potrillo and Fence Canyons Investigation Reaches

Reach	Geomorphic Unit	Average Unit Width (m)[a]	Sediment Facies	Estimated Average Sediment Thickness (m)	Typical Median Particle Size Class (<2 mm fraction)	Notes
F-1	c1	1.1	Fine	0.04	vfs[b]	Active channel
			Coarse	0.21	vcs	
	c1br	0.01	n/a[c]	0.00	n/a	Active channel on bedrock
	c2	0.2	Fine	0.30	csi	Abandoned post-1942 channel
			Coarse	0.18	cs	
	f1	0.6	Fine	0.20	csi	Post-1942 floodplain
			Coarse	0.03	ms[b]	
	f2	0.1	Fine	0.13	vfs	Possible post-1942 floodplain
	Total	**2.0**				
F-2	c1	1.2	Fine	0.02	csi	Active channel
			Coarse	0.19	cs	
	c2	0.8	Fine	0.08	ms	Younger abandoned post-1942 channel
			Coarse	0.19	cs	
	c3	0.4	Fine	0.18	csi	Older abandoned post-1942 channel
			Coarse	0.15	cs	
	f1	0.3	Fine	0.25	vfs	Post-1942 floodplain
			Coarse	0.03	ms[b]	
	f2	0.1	Fine	0.10	vfs[b]	Possible post-1942 floodplain
	Total	**2.7**				
F-3	c1	1.6	Fine	0.13	csi[b]	Active channel
			Coarse	0.08	cs	
	c2	3.1	Fine	0.20	csi	Abandoned post-1942 channel
			Coarse	0.01	cs[b]	
	f1	6.1	Fine	0.24	csi	Post-1942 floodplain
	f2	1.7	Fine	0.13	csi	Possible post-1942 floodplain
	Total	**12.5**				

Table B-1.0-1 (continued)

Reach	Geomorphic Unit	Average Unit Width (m)[a]	Sediment Facies	Estimated Average Sediment Thickness (m)	Typical Median Particle Size Class (<2 mm fraction)	Notes
FS-1	c1	0.9	Fine	0.05	csi	Active channel
			Coarse	0.20	cs	
	c1br	0.2	n/a	0.00	n/a	Active channel on bedrock
	c2	0.4	Fine	0.25	vfs	Abandoned post-1942 channel
			Coarse	0.15	cs	
	f1	0.7	Fine	0.20	vfs	Post-1942 floodplain
			Coarse	0.02	ms[b]	
	f2	0.4	Fine	0.40	csi	Possible post-1942 floodplain
	Total	**2.6**				
PO-1	c1	0.9	Fine	0.05	vfs[b]	Active channel
			Coarse	0.11	cs	
	c1br	0.1	n/a	0.00	n/a	Active channel on bedrock
	c2	1.2	Fine	0.25	vfs	Abandoned post-1942 channel
			Coarse	0.06	vcs	
	f1	2.2	Fine	0.26	csi	Post-1942 floodplain
			Coarse	0.02	ms[b]	
	f2	1.1	Fine	0.09	csi	Possible post-1942 floodplain
			Coarse	0.01	ms[b]	
	Total	**5.5**				
PO-2	c1	1.6	Fine	0.02	vfs[b]	Active channel
			Coarse	0.24	vcs	
	c2	1.0	Fine	0.16	csi	Abandoned post-1942 channel
			Coarse	0.25	cs	
	f1	2.2	Fine	0.32	vfs	Post-1942 floodplain
			Coarse	0.01	ms[b]	
	f2	1.0	Fine	0.10	ms	Possible post-1942 floodplain
	Total	**5.9**				
PO-3	c1	1.5	Fine	0.08	ms	Active channel
			Coarse	0.30	cs	
	c2	3.9	Fine	0.09	fs	Younger abandoned post-1942 channel
			Coarse	0.24	cs	
	c3	1.0	Fine	0.05	fs[b]	Older abandoned post-1942 channel
			Coarse	0.35	cs	
	Total	**6.4**				

Table B-1.0-1 (continued)

Reach	Geomorphic Unit	Average Unit Width (m)[a]	Sediment Facies	Estimated Average Sediment Thickness (m)	Typical Median Particle Size Class (<2 mm fraction)	Notes
PO-4	c1	1.7	Fine	0.11	vfs[b]	Active channel
			Coarse	0.34	cs	
	c2	3.2	Fine	0.37	vfs	Abandoned post-1942 channel
			Coarse	0.11	cs	
	f1	7.7	Fine	0.23	vfs	Post-1942 floodplain
	Total	**12.6**				
POS-1	c1	1.1	Fine	0.03	vfs[b]	Active channel
			Coarse	0.21	cs	
	c1br	0.1	n/a	0.00	n/a	Active channel on bedrock
	c2	1.0	Fine	0.18	vfs	Abandoned post-1942 channel
			Coarse	0.05	cs[b]	
	f1	0.5	Fine	0.15	csi	Post-1942 floodplain
			Coarse	0.01	ms[b]	
	f2	0.8	Fine	0.05	vfs	Possible post-1942 floodplain
			Coarse	0.01	ms[b]	
	Total	**3.5**				

Note: vfs = very fine sand; vcs = very coarse sand; csi = coarse silt; cs = coarse sand; ms = medium sand.

[a] Average unit width is total area of unit in reach divided by reach length.

[b] No particle size data from unit; median particle size inferred based on data from other units and field descriptions.

[c] n/a = Not applicable.

Table B-2.0-1
Summary of Surface Water Measurements from Gage E267

Water Year	Days with Flow	Volume of Water (acre ft)	Peak Discharge (cfs*)
1995	3	3.5	63
1996	1	0.2	0.76
1997	1	0.2	3.3
1998	1	0.7	3.9
1999	8	6.6	39
2000	5	0.7	7
2001	4	1.4	6.8
2002	2	0.6	15
2003	7	15	20
2004	0	0	0
2005	2	0.24	12
2006	3	0.58	7.6
2007	1	0.10	4.1
2008	2	0.14	2.0
2009	1	0	0.03
Average	2.7	2.0	12.3

*cfs = Cubic foot per second.

Table B-2.0-2
Manual Water-Level Observations for Well FCO-1

Date	Comments	Date	Comments
6/9/1997	Dry	9/14/2005	Dry
10/13/1997	Dry	6/23/2006	Dry
3/25/1998	Dry	9/8/2006	Dry
5/29/1998	Dry	12/15/2006	Dry
7/28/1998	Dry	1/24/2007	Dry
3/3/1999	Dry	3/15/2007	Dry
6/23/1999	Dry	5/24/2007	Dry
8/30/1999	Dry	6/6/2007	Dry
11/15/1999	Dry	9/5/2007	Dry
3/26/2000	Dry	10/17/2007	Dry
5/16/2000	Dry	1/16/2008	Dry
8/30/2000	Dry	4/8/2008	Dry
10/8/2000	Dry	4/25/2008	Dry
4/16/2002	Dry	7/18/2008	Dry
8/19/2002	Dry	10/7/2008	Dry
11/13/2002	Dry	3/23/2009	Dry
2/19/2003	Dry	7/2/2009	Dry
5/18/2003	Dry	10/7/2009	Dry
4/7/2004	Dry		

Note: Data from Koch and Schmeer (2010, 108926).

Appendix C

Analytical Data

C-1.0 ANALYTICAL RESULTS

All available data packages are included as Attachment C-1 on DVD. Sediment and surface water data from Potrillo and Fence Canyons are presented on DVD as Attachment C-2. Data obtained from Los Alamos National Laboratory's (LANL's or the Laboratory's) Sample Management Database (SMDB) and Water Quality Database (WQDB) are grouped by sediment and surface water. Data are further subdivided in Attachment C-2 into analytical data (those data used in analyses presented in this report), field quality control (QC) data, and rejected data.

C-1.1 SMDB and WQDB Data

The following files containing SMDB and WQDB data are included as Attachment C-2 on DVD:

- Potrillo and Fence Canyons Sediment Analytical Data
- Potrillo and Fence Canyons Sediment Field QC Data
- Potrillo and Fence Canyons Sediment Rejected Data
- Potrillo and Fence Canyons Surface Water Analytical Data
- Potrillo and Fence Canyons Surface Water Field QC Data
- Potrillo and Fence Canyons Surface Water Rejected Data

C-2.0 SUMMARY OF SAMPLES COLLECTED

Samples collected in Potrillo and Fence Canyons and analyses performed by analytical laboratories are summarized in Tables C-2.0-1 (sediment), and C-2.0-2 (surface water) that are included in Attachment 1 on CD. Tables C-2.0-1 and C-2.0-2 include all sediment and surface water samples (respectively) collected. However, only the surface water data from samples collected in 2003 and later are used in the chemical of potential concern (COPC) screens because these data are most representative of current site conditions. Media code definitions are provided in Table C-2.0-3.

C-3.0 SAMPLE COLLECTION METHODS

Historical stormwater samples have been collected using an automated pump sampler, direct container grab sampling, or single-stage samplers.

Current Laboratory standard operating procedures (SOPs) for surface water sampling methods are

- SOP-5213, Collecting Storm Water Runoff Samples and Inspecting Samplers; and
- SOP-5224, Spring and Surface Water Sampling.

Historical sediment samples have been collected using a spade and scoop. The current Laboratory SOP for this sediment sampling method is

- SOP-06.09, Spade and Scoop Method for Collection of Soil Samples.

C-4.0 ANALYTICAL PROGRAM

Data validation for data from the WQDB is performed by an outside contractor that validates the analytical data according to U.S. Environmental Protection Agency (EPA) protocols. All the data from the analytical laboratories that provide Level IV data packages are validated. Level IV data packages are defined as those containing chain-of-custody forms, quality assurance (QA) and QC documentation, the analytical laboratory form 1 (a summary of the analytical results), and the raw analytical data. Data validation packages are included in Attachment C-1 (on DVD).

Data validation for data from the SMDB is performed by the same outside contractor. Data validation procedures were implemented in accordance with the requirements of the Laboratory "Quality Assurance Project Plan Requirements for Sampling and Analysis" (LANL 1996, 054609) and the Laboratory's analytical services statements of work (SOWs) for contract laboratories (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962). All data obtained from the SMDB included in this report have accompanying Level IV data packages and have undergone routine validation according to SOPs specific to the analyte type (inorganic chemicals, organic chemicals, or radionuclides). The current SOPs include the following (available at http://int.lanl.gov/environment/all/qa/adep.shtml):

- SOP-5161, Routine Validation of Volatile Organic Data
- SOP-5162, Routine Validation of Semivolatile Organic Compound (SVOC) Analytical Data
- SOP-5163, Routine Validation of Organochlorine Pesticide and PCB Analytical Data
- SOP-5164, Routine Validation of High Explosive Analytical Data
- SOP-5165, Routine Validation of Metals Analytical Data
- SOP-5166, Routine Validation of Gamma Spectroscopy, Chemical Separation Alpha Spectrometry, Gas Proportional Counting, and Liquid Scintillation Analytical Data
- SOP-5167, Routine Validation of General Chemistry Analytical Data
- SOP-5191, Routine Validation of LC/MS/MS Perchlorate Analytical Data (SW-846 EPA Method 6850)

Some analytical results were rejected for various reasons and are not usable. In some instances, the analysis was rerun and a valid result was obtained and is presented in the report. However, some rejected data represent data issues, and thus there is no valid result for the analyte for the given sample. Rejected results that represent data issues are provided in Attachment C-2 (on DVD) and are discussed in section C-9.0. Field duplicates are used for QC purposes and are not included in the summary tables in section 6. When duplicate analytical results for an analyte in the same sample resulting from two methods are available, the result obtained from the more sensitive method (i.e., lower detection limit) is presented in the summary tables in section 6 of the investigation report. Reporting qualifiers are presented in parentheses next to the results in the summary tables. Data qualifier definitions are listed in Appendix A.

C-5.0 INORGANIC CHEMICAL ANALYSIS METHODS

The analytical methods used for inorganic chemicals are listed in Tables C-5.0-1 (sediment) and C-5.0-2 (surface water).

Laboratory control samples (LCSs), method blanks, matrix spike (MS) samples, and laboratory duplicate samples were analyzed to assess accuracy and precision of inorganic chemical analyses. Each of these

QA/QC sample types is defined in the analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233; 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. The analytical results for the samples were qualified according to National Functional Guidelines (EPA 1994, 048639) if the individual LCS recovery indicated an unacceptable bias in the measurement of individual analytes. The LCS recoveries should be within the control limits of 75%–125% (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

Method blanks are used as a measurement of bias and potential cross-contamination. All target analytes should be below the contract-required detection limit (CRDL) in the blank (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

The accuracy of inorganic chemical analyses is also assessed using MS samples. An MS sample is designed to provide information about the effect of each sample matrix on the sample preparation procedures and analytical technique. The spike sample recoveries should be within the acceptance range of 75%–125% (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

Analyzing laboratory duplicate samples assesses the precision of analyses. All relative percent differences (RPDs) between the sample and laboratory duplicate should be ±35% for sediment samples and ±20% for water samples (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

The validation of inorganic chemical data using QA/QC samples and other methods may result in the rejection of the data or the assignment of various qualifiers to individual sample results. Data qualifier definitions are presented in Appendix A.

Inorganic Chemical Background Values

It is important to note that the previously used analytical services SOW (LANL 1995, 049738) was issued before the widespread use of axial view inductively coupled plasma emission spectroscopy (ICPES) (also known as trace ICPES). With the advent of axial view ICPES, detection limits for inorganic chemicals have greatly improved. For example, antimony soil detection limits for the older radial view ICPES are typically on the order of 12 mg/kg, whereas axial view ICPES detection limits are as low as 0.5 mg/kg.

“Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory” (LANL 1998, 059730) was developed after axial view ICPES was widely used. However, because some of the samples were collected and analyzed before widespread axial view ICPES use, not all detection limits are below the background values (BVs). If inorganic chemical sample results with detection limits above the BVs were reported, they are presented in section 6, Table 6.2-1, of the investigation report.

C-6.0 ORGANIC CHEMICAL ANALYSIS METHODS

The analytical methods used for organic chemicals are listed in Tables C-6.0-1 (sediment) and C-6.0-2 (surface water).

QC samples are designed to produce a quantitative measure of the reliability of a specific part of an analytical procedure. The results of the QC samples provide confidence about whether the analyte is present and whether the concentration reported is correct. The validation of organic chemical data using QA/QC samples and other methods may result in rejecting the data or in assigning various qualifiers to individual sample results. Data qualifier definitions are presented in Appendix A.

Calibration verifications, instrument-performance checks, LCSs, method blanks, MS samples, surrogates, and internal standards (ISs) were analyzed to assess the accuracy and precision of the organic chemical analyses. Each of these QA/QC sample types is defined in the analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962) and is described briefly below.

Calibration verification, which consists of initial and continuing verification, is the establishment of 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 and the individual calibration standards used to perform the calibration. The continuing calibration ensures that the initial calibration is still holding and is correct as the instrument is used to process samples. The continuing calibration also serves to determine whether 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 representative of the target analytes, and it serves as a monitor of the overall performance of a “controlled” sample. Daily, the LCS is the primary demonstration of the ability to analyze samples with good qualitative and quantitative accuracy. The analytical results for the samples were qualified according to National Functional Guidelines (EPA 1999, 066649) if the individual LCS recoveries were not within method-specific acceptance criteria. The LCS recoveries should be within the control limits of 75%–125% (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

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 and which is extracted and analyzed in the same manner as the corresponding environmental samples. Method blanks are used to assess the potential for sample contamination during extraction and analysis. All target analytes should be below the CRDL in the method blank (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

The accuracy of organic chemical analyses is also assessed by using MS samples that are aliquots of the submitted samples spiked with a known concentration of the target analyte(s). MS samples are used to measure the ability to recover prescribed analytes from a native sample matrix. Spiking typically occurs before sample preparation and analysis. The spike sample recoveries should be within the acceptance range of 75%–125% (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

A surrogate compound (surrogate) is an organic chemical compound used in the analyses of organic target analytes that is similar in composition and behavior to the target analytes but that is not normally found in environmental samples. Surrogates are added to every blank, sample, and spike to evaluate the efficiency with which analytes are recovered during extraction and analysis. The recovery percentage of the surrogates must be within specified ranges or the sample may be rejected or assigned a qualifier (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

The ISs are chemical compounds added to every blank, sample, and standard extract at a known concentration. They are used to compensate for (1) analyte concentration changes that might occur during storage of the extract and (2) quantitation variations that can occur during analysis. ISs are used as the basis for quantitation of target analytes. The percent recovery (%R) for ISs should range between 50% and 200% (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

C-7.0 RADIOCHEMICAL ANALYSIS METHODS

Radionuclides were analyzed by the methods listed in Tables C-7.0-1 (sediment) and C-7.0-2 (surface water).

Radionuclides with reported values less than the minimum detectable concentration (MDC) were qualified as not detected (U). Each radionuclide result was also compared with the corresponding total propagated uncertainty (TPU). If the result was less than 3 times the TPU, the radionuclide was qualified as not detected (U).

The precision and bias of radiochemical analyses performed at off-site fixed laboratories were assessed using MS samples, LCSs, method blanks, and laboratory tracers. The analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962) specify that spike sample recoveries should be within ±25% of the certified value. LCSs were analyzed to assess the accuracy of radionuclide analyses. The LCSs serve as a monitor of the overall performance of each step during the analysis, including the radiochemical separation preparation. The analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962) specify that LCS recoveries should be within ±25% of the certified value. Method blanks are also used to assess bias. The analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962) specify that the method blank concentration should not exceed the required minimum detectable activity.

C-8.0 OTHER ANALYSIS METHODS

Other analyses in Potrillo and Fence Canyons surface water samples include dissolved organic carbon, pH, specific conductance, specific gravity, total dissolved solids, total organic carbon, and total suspended solids. These analyses were conducted by the methods listed in Table C-8.0-1.

C-9.0 DATA QUALITY

Data-quality issues, including rejected analytical results, are summarized by media. Because of the large number of records, the following sections provide a summary of the reasons for qualification, and the qualification is not addressed by individual records.

C-9.1 Sediment Data

A total of 19,170 results from sediment samples in Potrillo and Fence Canyons reaches were reported. Of these results, 60 results were rejected during data validation. These rejected results represent less than 1% of all the sediment results and do not affect the ability to assess the contaminants within Potrillo and Fence Canyons.

A total of 10 inorganic chemical results, all perchlorate, were rejected (R) because the LCS %R was less than 10%. A total of 50 radionuclide results for samples analyzed by gamma spectroscopy were rejected (R) for cesium-134 and cesium-137 because spectral interference prevented positive identification of the analytes. No organic chemical results were rejected (R).

A total of 501 inorganic chemical results were qualified as estimated (J, J-, or J+), or estimated, not detected (UJ).

Inorganic chemical results detected between the method detection limit (MDL) and the estimated detection limit (EDL) were qualified as estimated (J).

Inorganic chemical results were qualified as J, J-, J+, or UJ for of one of the following reasons.

- The analyte was considered estimated because the results are greater than 5 times the amount in the method blank.
- The associated MS recovery was less than the lower acceptance level (LAL) but greater than 10%.
- The associated MS recovery was greater than the upper acceptance level (UAL).
- The result was reported as estimated by the analytical laboratory.

A total of 1368 organic chemical results were qualified as estimated—either detected (J) or not detected (UJ).

Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), and Pesticides and Polychlorinated Biphenyls (PCBs): The results were qualified as J or UJ because either the result was reported as estimated by the analytical laboratory or the initial calibration verification (ICV) and/or continuing calibration verification (CCV) were recovered outside the method-specific limits.

Polycyclic Aromatic Hydrocarbons (PAHs): PAH results were qualified as J or UJ because either the surrogate was less than the LAL but greater than 10%R, the associated LCS recovery was less than the LAL but greater than 10%R, the extraction holding time was exceeded by less than 2 times the published method for holding time, or the result was reported as estimated by the analytical laboratory.

Explosive Compounds: Explosive compound results were qualified as J or UJ because the MS/MS duplicate (MSD) RPD was greater than 30%, the recovery limits were 70% to 130%, and the RPD was less than or equal to 30%; the ICV and/or CCV were recovered outside the method limits; or the results was reported as estimated by the analytical laboratory.

C-9.2 Surface Water Data

A total of 1043 results from surface water samples collected in Potrillo Canyon were reported. The results from these samples are provided in Attachment C-2 (on DVD). Of the 1043 results reported, 80 results were rejected during data validation, representing 8% of the data set. Seventy of these rejected results were from one unfiltered sample collected in 2003. Because several sampling events of the same location have occurred since 2003, these rejected results do not affect the ability to assess the contaminants within Potrillo Canyon.

Three inorganic chemical results and 69 organic chemical results were rejected (R) because of unspecified QC failures.

Eight radionuclide results were rejected (R) for at least one of the following reasons: the associated duplicate sample has a duplicate error ratio (DER) greater than 4, the associated MS recovery was less than 10%, results are less than 3 times the MDC, and/or unspecified QC failures.

A total of 93 inorganic chemical results were qualified as J, J-, J+ or UJ for at least one of the following reasons.

- The extraction/analytical holding time was exceeded by less than 2 times the published method for holding times.
- The MS was not analyzed with the samples for unspecified reasons.

- The serial dilution RPD failed.
- The duplicate sample was not analyzed with the samples for unspecified reasons.
- The sample result is greater than 5 times the concentration of the related analyte in the initial calibration blank/continuous calibration blank.
- The result was reported as estimated by the analytical laboratory.
- The results are greater than 5 times the amount in the method blank.
- The analyte was recovered below the LAL but greater than 30% in the associated spike sample.
- Negative blank samples results were greater than the MDL.
- Unspecified QC failure occurred.

A total of 23 organic chemical results were qualified as UJ.

PCBs: PCB results were qualified as UJ because the surrogate recovery was less than the LAL but greater than or equal to 10%R.

Explosive Compounds: Explosive compound results were qualified as UJ because either the ICV and/or CCV were recovered outside the method limits or an unspecified QC failure.

A total of 34 radionuclide results were qualified as J, J-, J+, or UJ because of at least one of the following.

- The associated tracer recovery was less than 10%.
- The associated sample concentration was less than or equal to the MDC.
- The tracer was less than the LAL but greater than 10%R.
- The associated tracer recovery was less than 30% but greater than 10%.
- The associated duplicate sample has a DER of greater than 2 but less than 4.
- Associated duplicate sample has DER or relative error ratio greater than the analytical laboratory's acceptance limits.
- The LCS %R was less than the LAL but greater than 10%.
- Planchets were flamed.
- Results were less than 3 times the MDC.
- Unspecified QC failure occurred.

Three other results (total dissolved solids, total suspended solids and pH) were qualified as J because either the holding time was exceeded or an unspecified QC failure occurred.

C-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. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF and are used to locate the document at the RPF and, where applicable, in the master reference set.

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

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

EPA (U.S. Environmental Protection Agency), October 1999. “USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review,” EPA540/R-99/008, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1999, 066649)

LANL (Los Alamos National Laboratory), July 1995. “Statement of Work (Formerly Called "Requirements Document") - Analytical Support, (RFP number 9-XS1-Q4257), (Revision 2 - July, 1995),” Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1995, 049738)

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

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

LANL (Los Alamos National Laboratory), December 2000. “University of California, Los Alamos National Laboratory (LANL), I8980SOW0-8S, Statement of Work for Analytical Laboratories,” Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2000, 071233)

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 C-2.0-3
Media Code Definitions

Media Code	Media Description
SED	Sediment
WM	Snowmelt
WT	Stormwater

Table C-5.0-1
Analytical Methods Used for Inorganic Chemicals in Sediment

Analytical Suite	Analytical Method
Metals	SW-846:6010B
	SW-846:6020
	SW-846:7471A
Perchlorate	SW-846:6850
Cyanide (Total)	SW-846:9012A

Table C-5.0-2
Analytical Methods Used for Inorganic Chemicals in Surface Water

Analytical Suite	Analytical Method
GENINORG	ASTM:D5057
	EPA:120.1
	EPA:150.1
	EPA:160.1
	EPA:160.2
	EPA:160.4
	EPA:200.7
	EPA:200.8
	EPA:300.0
	EPA:310.1
	EPA:314.0
	EPA:335.1
	EPA:335.2
	EPA:335.3
	EPA:350.1
	EPA:351.2
	EPA:353.1
	EPA:365.4
	EPA:410.1
	EPA:410.4
	EPA:415.1
	Field
	Gravimetric
	SM:4500
	SM:A2320B
	SM:A2340B
	Specific Gravity
	SW-846:9012A
	SW-846:9050A
METALS	Cold vapor atomic absorption
	EPA:200.7
	EPA:200.8
	EPA:245.1
	EPA:245.2
	Electrothermal vapor atomic absorption
	ICPES
	ICPMS
	Kinetic phosphorescence analysis

Table C-6.0-1
Analytical Methods for
Organic Chemicals in Sediment

Analytical Suite	Analytical Method
Explosive Compounds	SW-846:8321A_MOD
PAHs	SW-846:8310
PCBs	SW-846:8082
Pesticides/PCBs	SW-846:8081A
SVOCs	SW-846:8270C
VOCs	SW-846:8260B

Table C-6.0-2
Analytical Methods
for Organic Chemicals in Surface Water

Analytical Suite	Analytical Method
HEXP	High Explosives
	SW-846:8321
	SW-846:8330
PCB	EPA:608
	PCB
SVOA	Semivolatile organic analysis

Table C-7.0-1
Analytical Methods for Radionuclide Analysis in Sediment

Analytical Suite	Analytical Method
Americium-241 (AM_241)	HASL-300:AM-241
Gamma Spectroscopy (GAMMA_SPEC)	EPA:901.1
Tritium (H3)	EPA:906.0
Isotopic Plutonium (ISO_PU)	HASL-300:ISOPU
Isotopic Thorium (ISO_TH)	HASL-300:ISOTH
Isotopic Uranium (ISO_U)	HASL-300:ISOU
Strontium-90 (SR_90)	EPA:905.0

Table C-7.0-2
Analytical Methods for
Radionuclide Analysis in Surface Water

Analytical Suite	Analytical Method
RAD	Alpha Spec
	EPA:900
	EPA:901.1
	EPA:903.1
	EPA:904
	EPA:905.0
	EPA:906.0
	Gamma Spec
	Gas Flow Proportional Counting
	Gross Alpha
	Gross Beta
	Gross Gamma
	HASL-300
	Liquid scintillation counting

Table C-8.0-1
Analytical Methods
for Other Analyses in Surface Water

Analyte	Analytical Method
Dissolved Organic Carbon	EPA:415.1
pH	EPA:150.1
	Field
Specific Conductance	EPA:120.1
	SW-846:9050A
Specific Gravity	ASTM:D5057
	Specific Gravity
Total Dissolved Solids	EPA:160.1
Total Organic Carbon	EPA:415.1
Total Suspended Solids	EPA:160.2
	Gravimetric

Attachments C-1 and C-2

Data Packages and Data from the
Sample Management and Water Quality Databases
(on DVD included with this document)

Appendix D

Contaminant Trends

D-1.0 SEDIMENT

This section presents information on contaminants in sediments in Potrillo and Fence Canyons that supports the physical system conceptual model discussed in section 7 and the risk assessments presented in section 8 of the investigation report. It includes information on spatial variations in the concentrations of chemicals of potential concern (COPCs) that helps identify contaminant sources and provides an understanding of the effects of sediment redistribution by floods on contaminant concentrations and potential exposure to receptors.

D-1.1 Spatial Variations in Sample Results for COPCs

Figures D-1.1-1 through D-1.1-3 consist of plots showing sample results for all COPCs identified in sediment in Potrillo and Fence Canyons plotted versus distance from the Rio Grande. Figure D-1.1-1 shows inorganic COPCs, Figure D-1.1-2 shows organic COPCs, and Figure D-1.1-3 shows radionuclide COPCs. These plots help to identify sources for the COPCs and show how concentrations change with distance from sources. Different colors on these plots are used for the main canyons of Potrillo and Fence Canyons and their south forks. Each sample is plotted at a location represented by the distance from the Rio Grande to the approximate midpoint of the reach. For inorganic and organic chemicals, nondetected sample results are shown by an open circle, and the detected sample results are represented by a filled circle. For radionuclides, detect status is not indicated because radionuclide sample results are not censored. Only sediment data from the Los Alamos National Laboratory's (LANL's or the Laboratory's) Sample Management Database with complete data packages and that are validated are included in these plots.

It should be noted that the sample results in Figure D-1.1-1 are biased high as a result of biases accompanying sample collection, as discussed in section B-1.0 of Appendix B. Specifically, samples were typically biased toward geomorphic units and sediment facies with higher concentrations of contaminants, and units and facies with low concentrations (e.g., coarse facies sediment in the active channels) are underrepresented. In addition, some of these results could not be reproduced by resampling in this investigation.

D-1.2 Average Concentrations of Select Sediment COPCs

Tables D-1.2-1 through D-1.2-3 present average concentrations of sediment COPCs in Potrillo and Fence Canyons that are discussed in section 7.1 of the investigation report. These calculated averages are used in the figures in section 7.1, and they support the identification of sources for the COPCs and examination of how concentrations change with distance from sources and vary with sediment facies. Averages were calculated separately for fine facies samples and coarse facies samples to highlight differences between concentrations in these facies.

For inorganic and organic COPCs with nondetected sample results, upper and lower bounds on average concentrations were calculated by replacing the sample result for nondetects with either the detection limit or zero, respectively, and the midpoint of this range was also calculated by substituting one-half of the detection limit for nondetects. For some COPCs and some reaches, considerable uncertainty exists in average concentrations because of a high frequency of nondetects and/or detection limits that are elevated above sediment background values, although for most COPCs and most reaches, uncertainties related to nondetects do not obscure the general spatial trends in COPC concentration. If improved estimates of average concentrations were warranted, these estimates could be refined using the more robust nondetect replacement methods used in Appendix E.

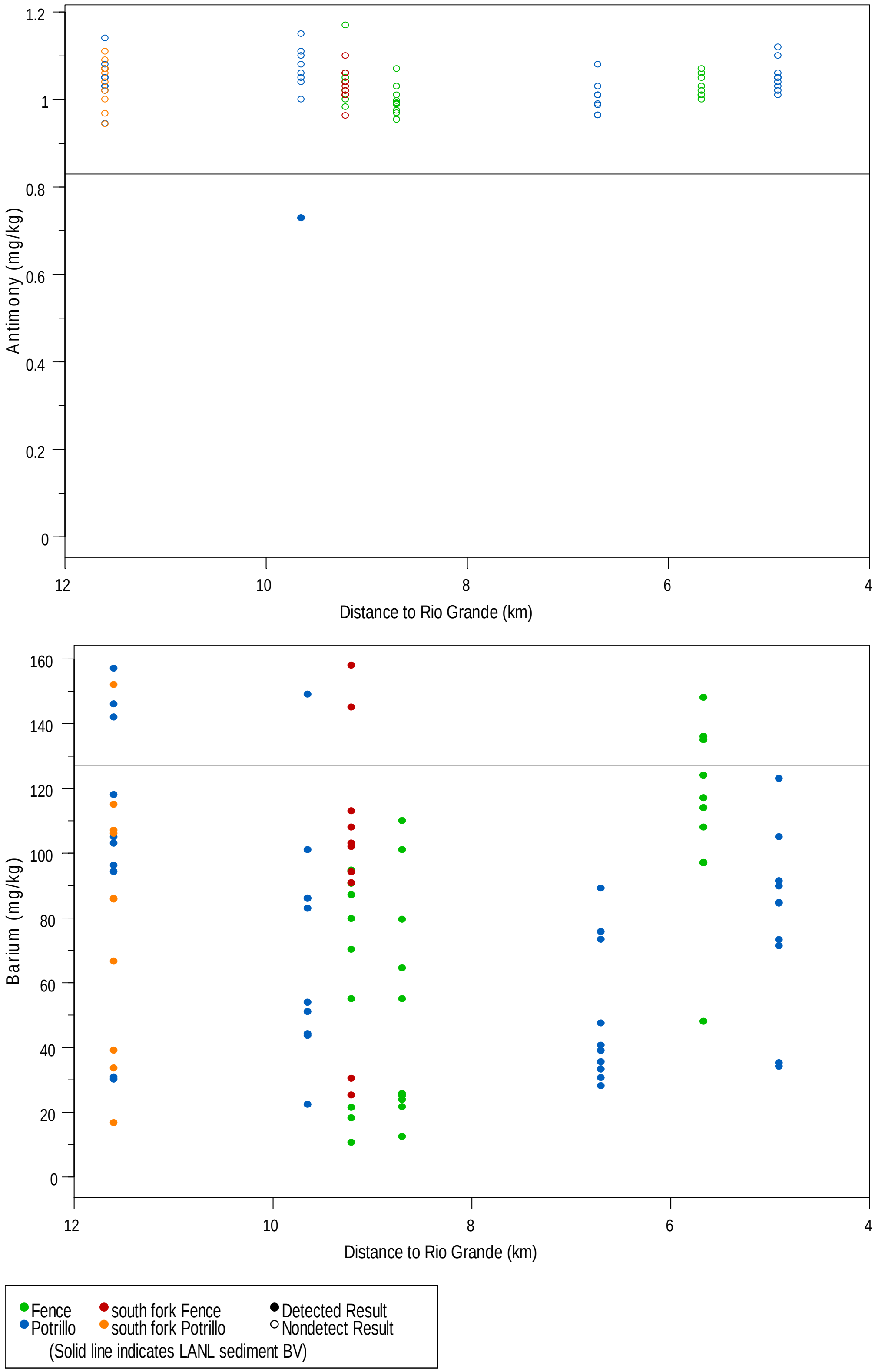


Figure D-1.1-1 Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in Potrillo and Fence Canyons

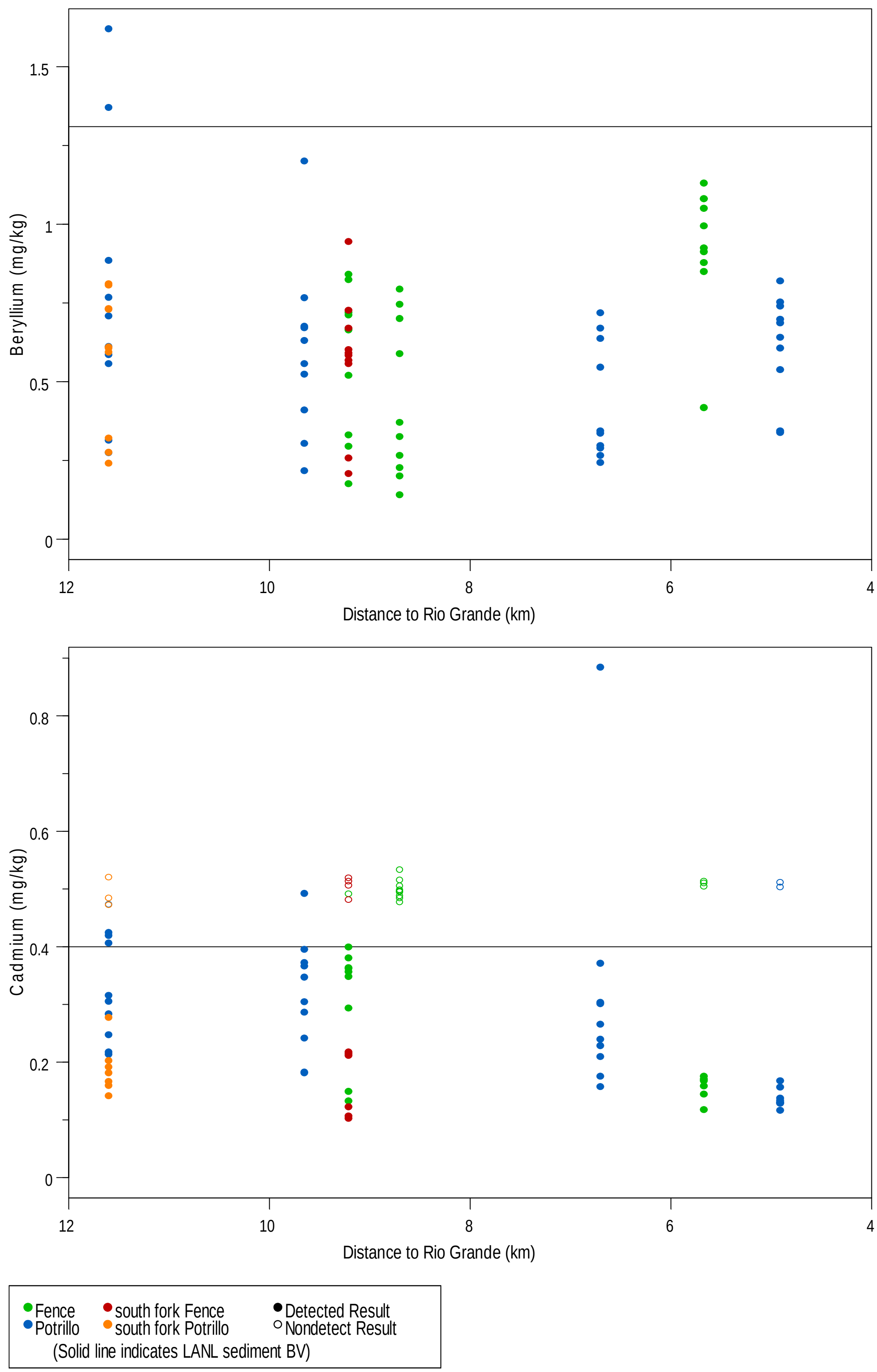


Figure D-1.1-1 (continued) Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in Potrillo and Fence Canyons

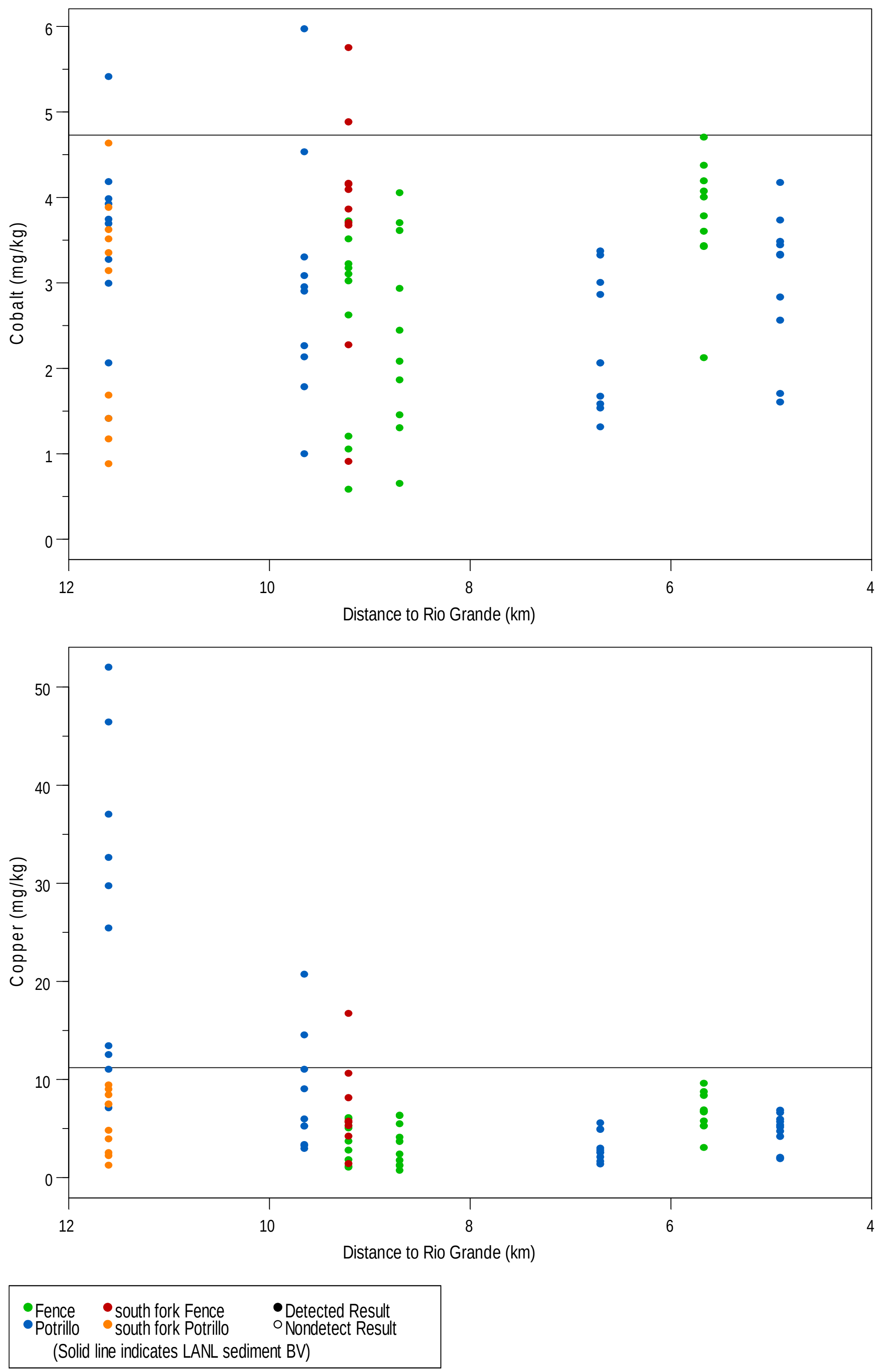


Figure D-1.1-1 (continued) **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in Potrillo and Fence Canyons**

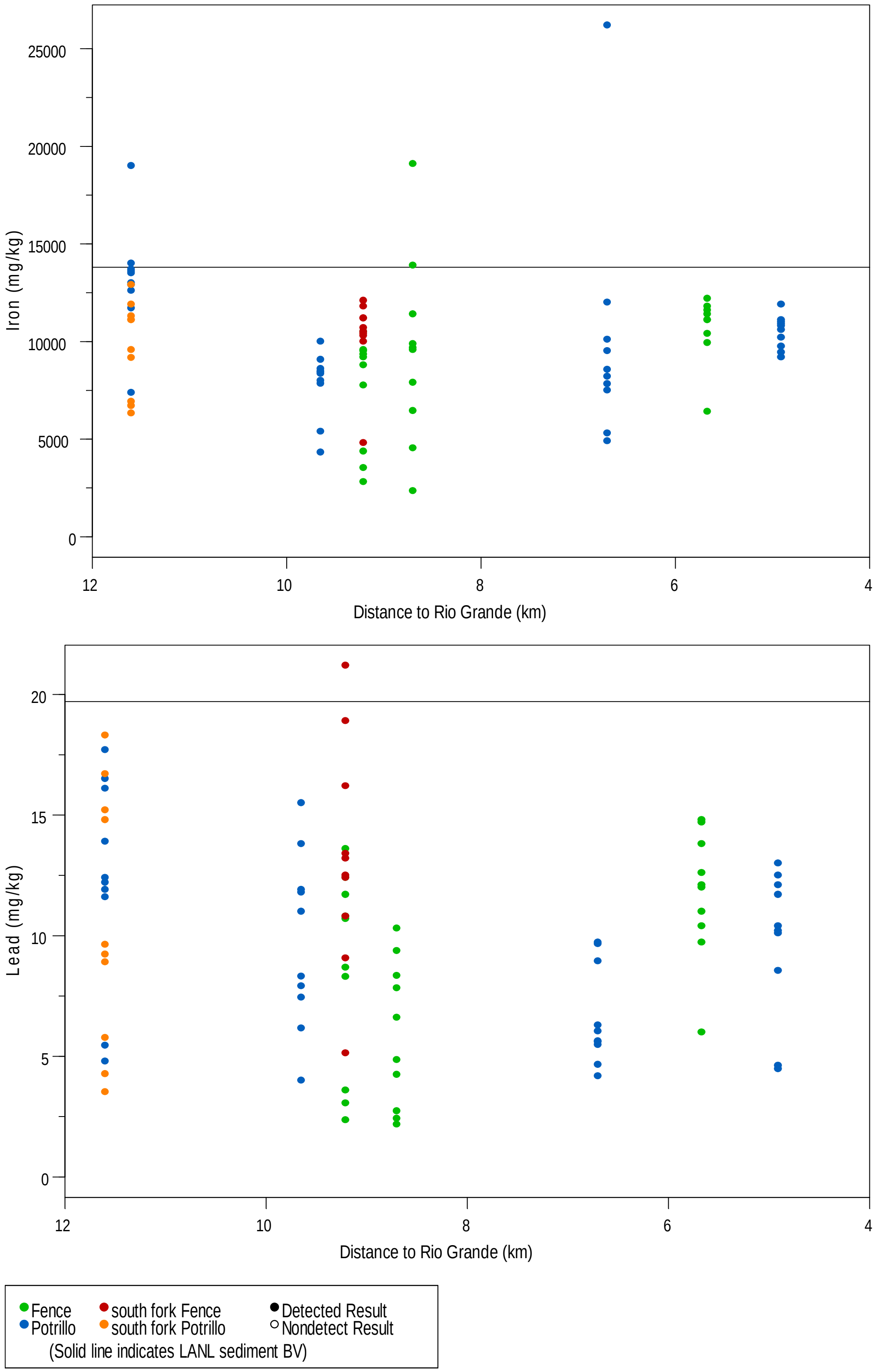
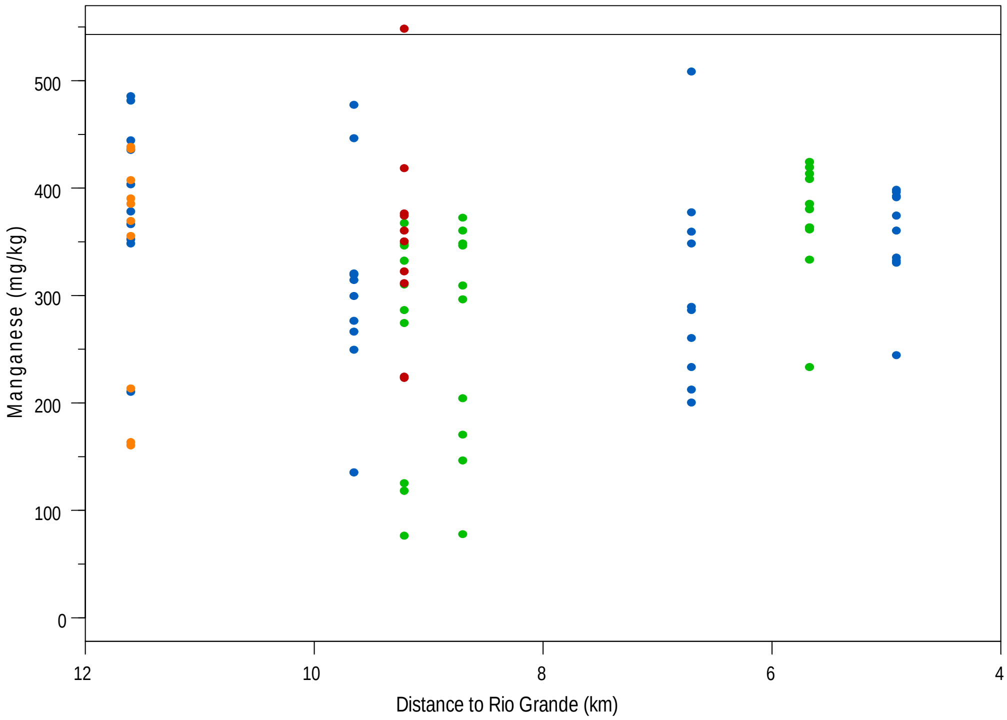


Figure D-1.1-1 (continued) **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in Potrillo and Fence Canyons**



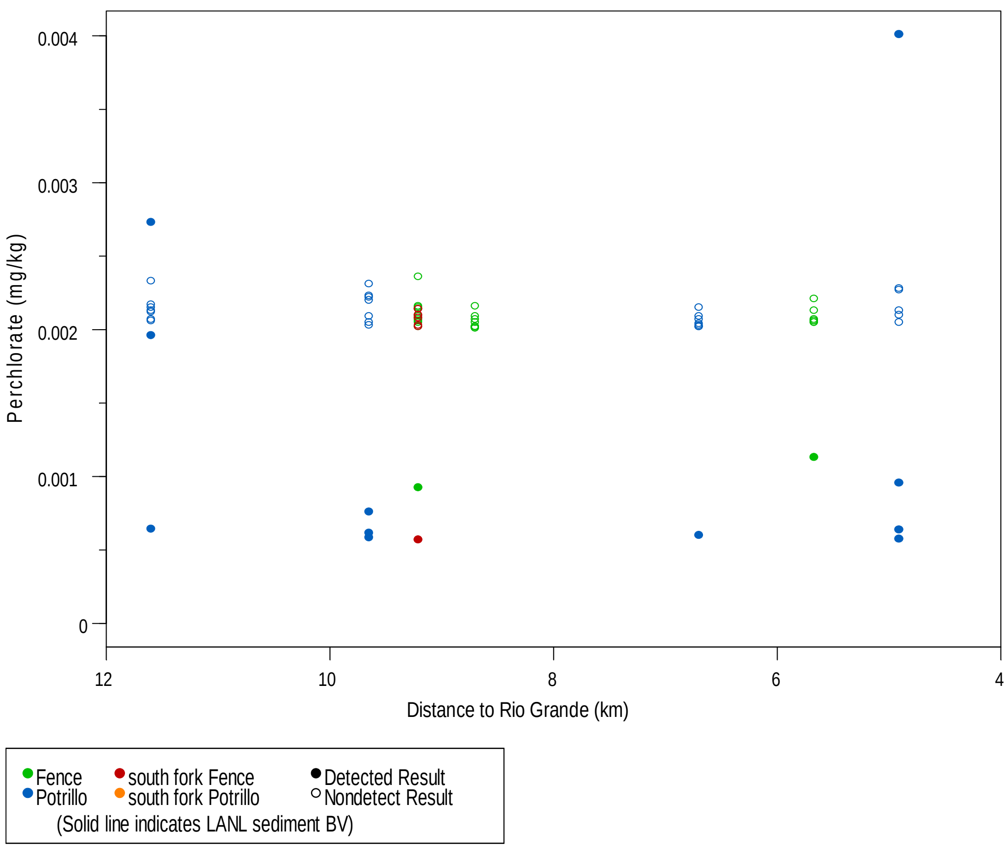


Figure D-1.1-1 (continued) Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in Potrillo and Fence Canyons

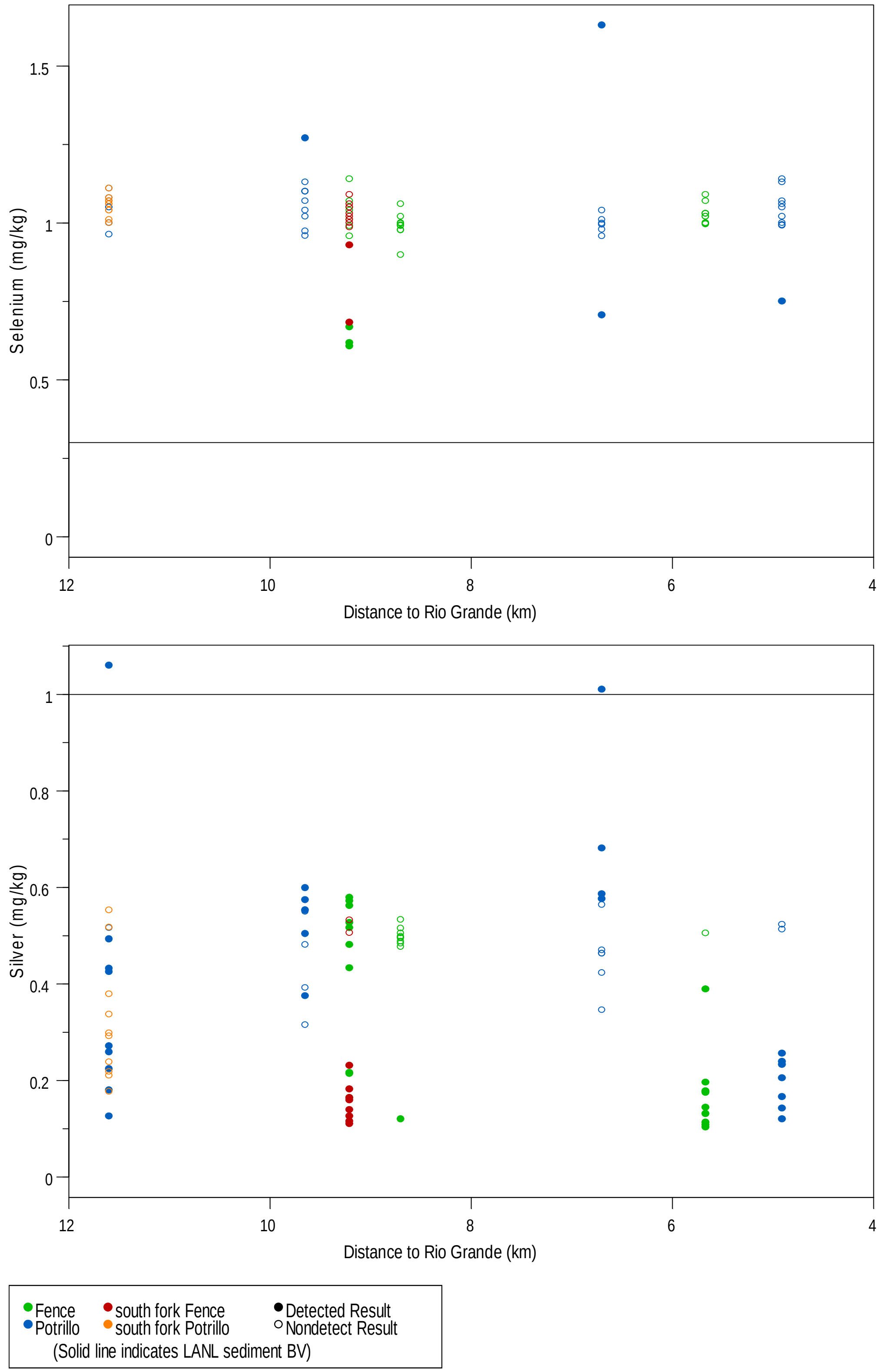


Figure D-1.1-1 (continued) Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in Potrillo and Fence Canyons

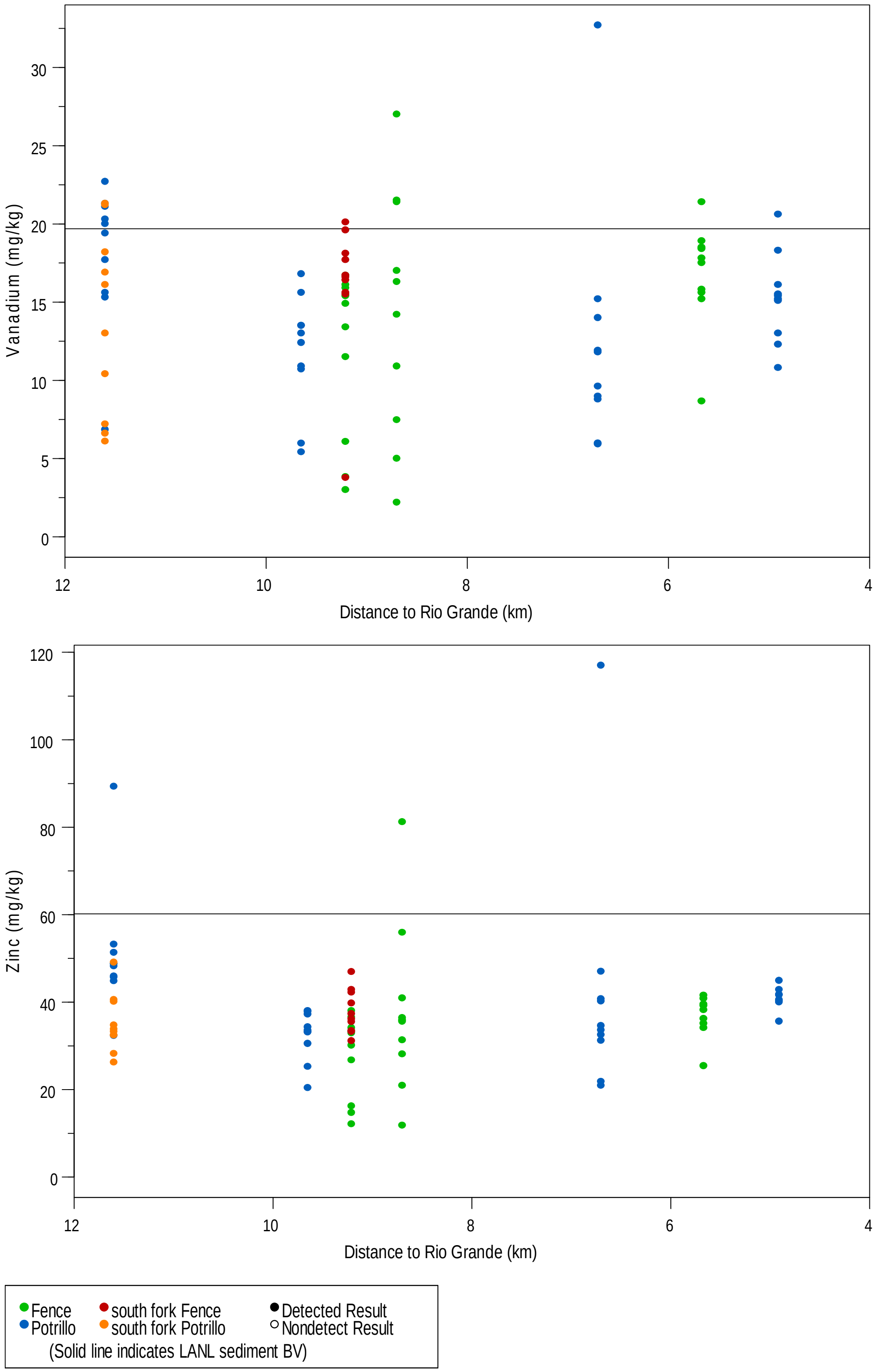


Figure D-1.1-1 (continued) Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in Potrillo and Fence Canyons

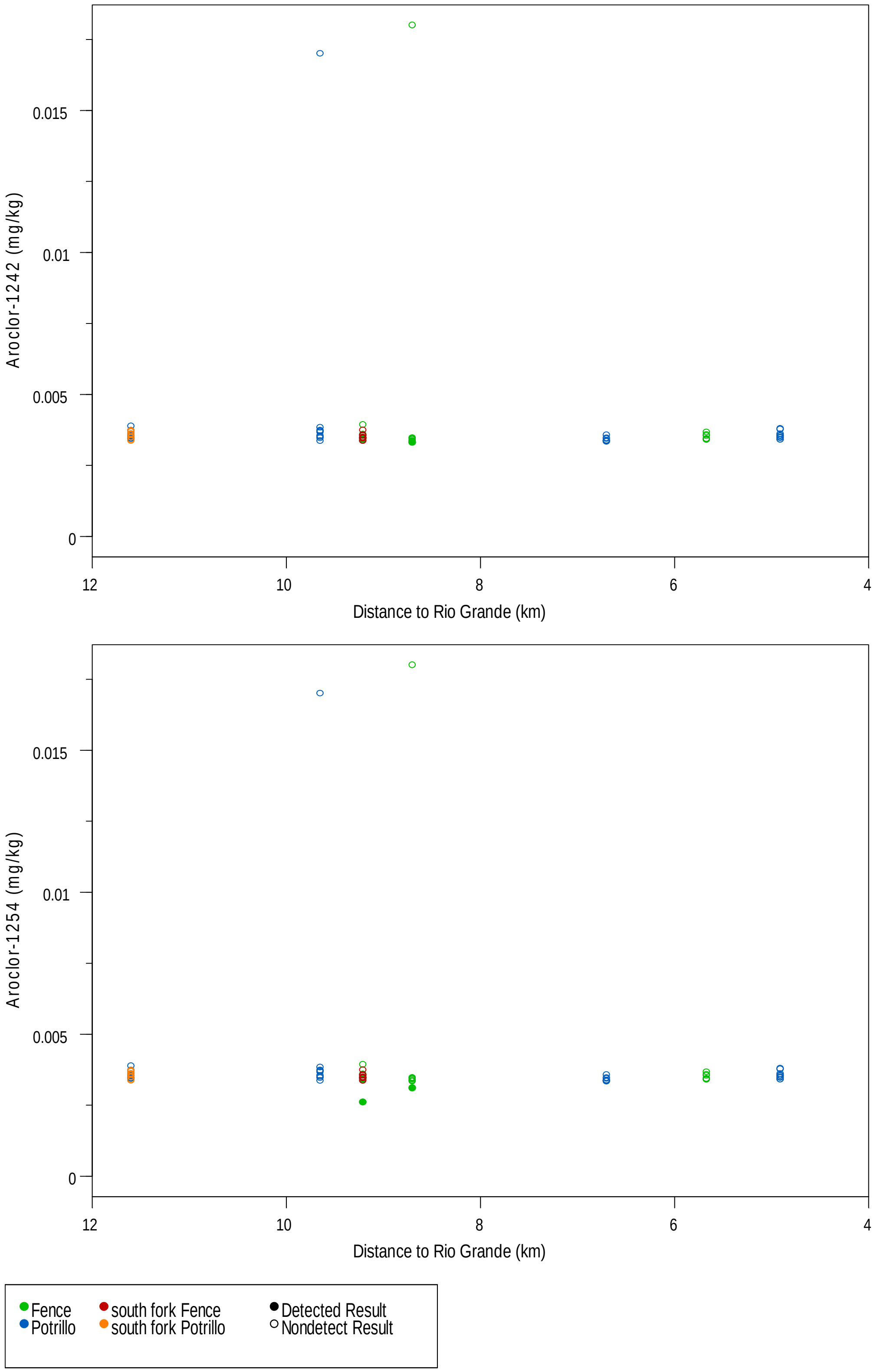


Figure D-1.1-2 Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons

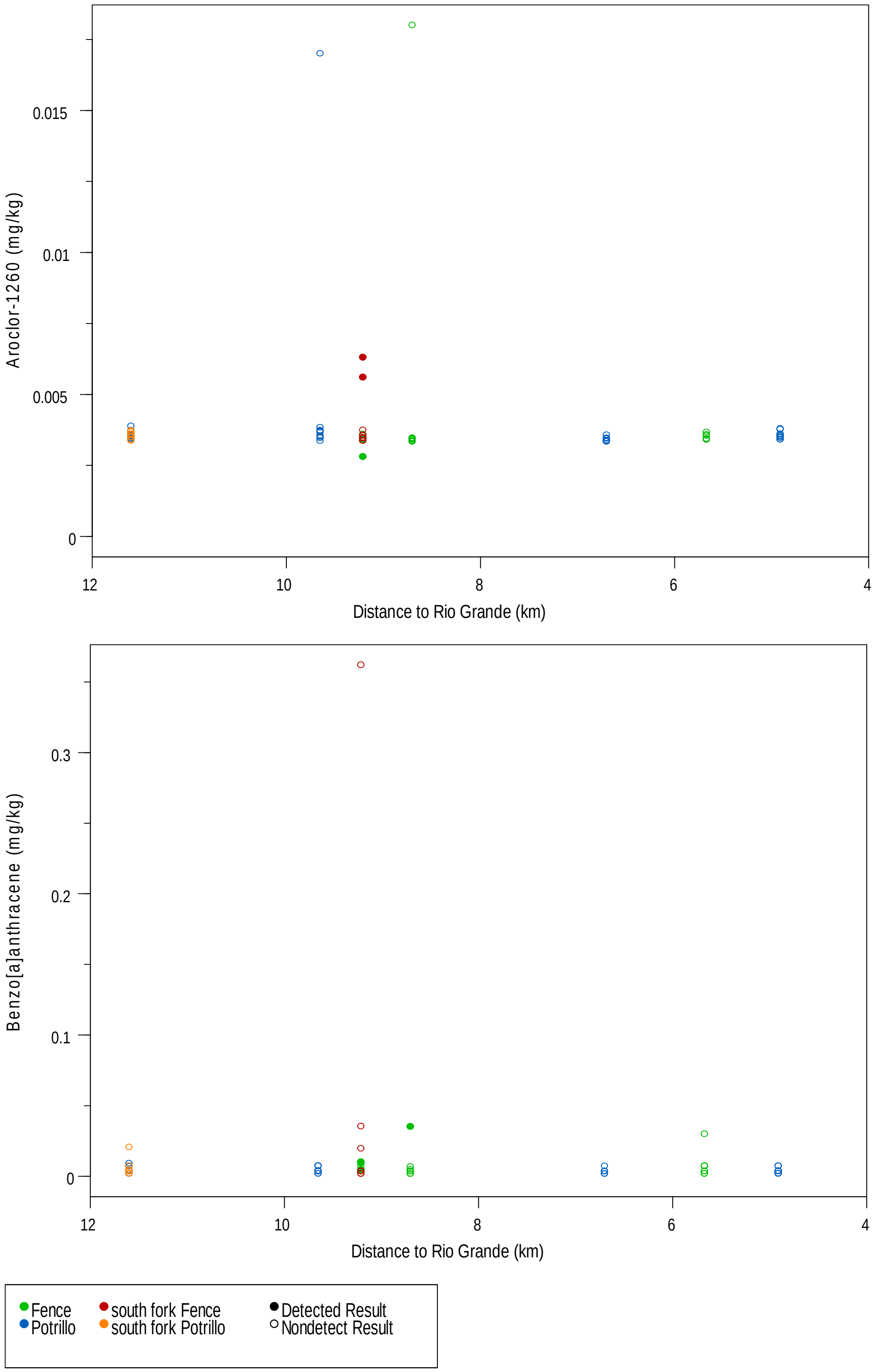


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons**

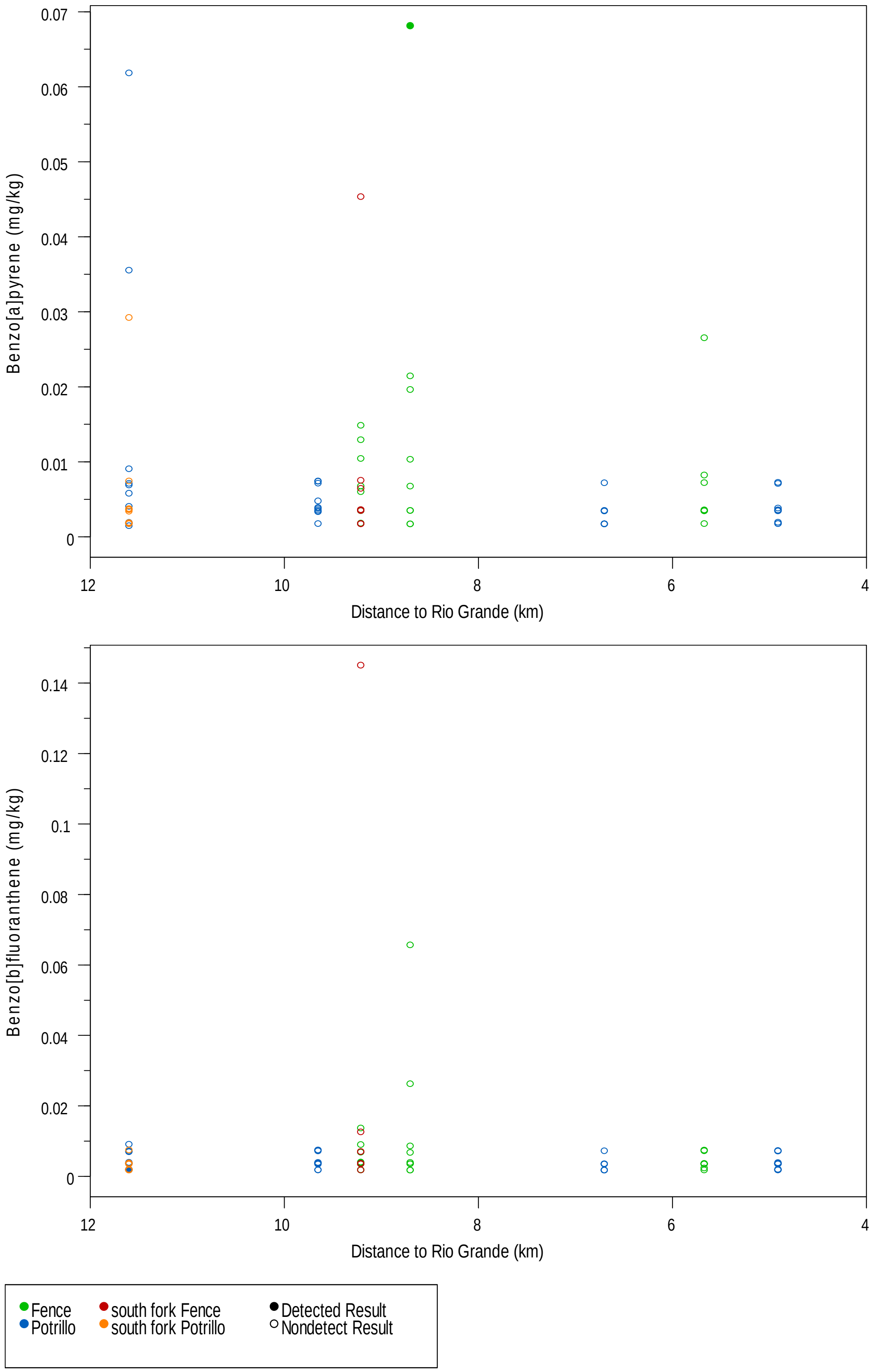
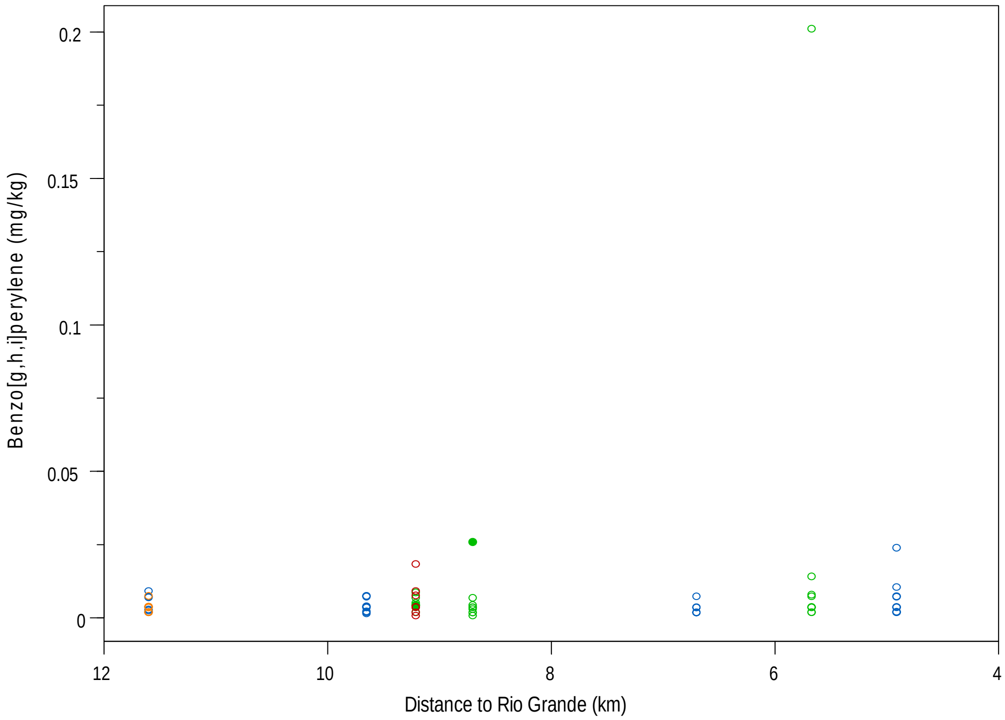


Figure D-1.1-2 (continued) Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons



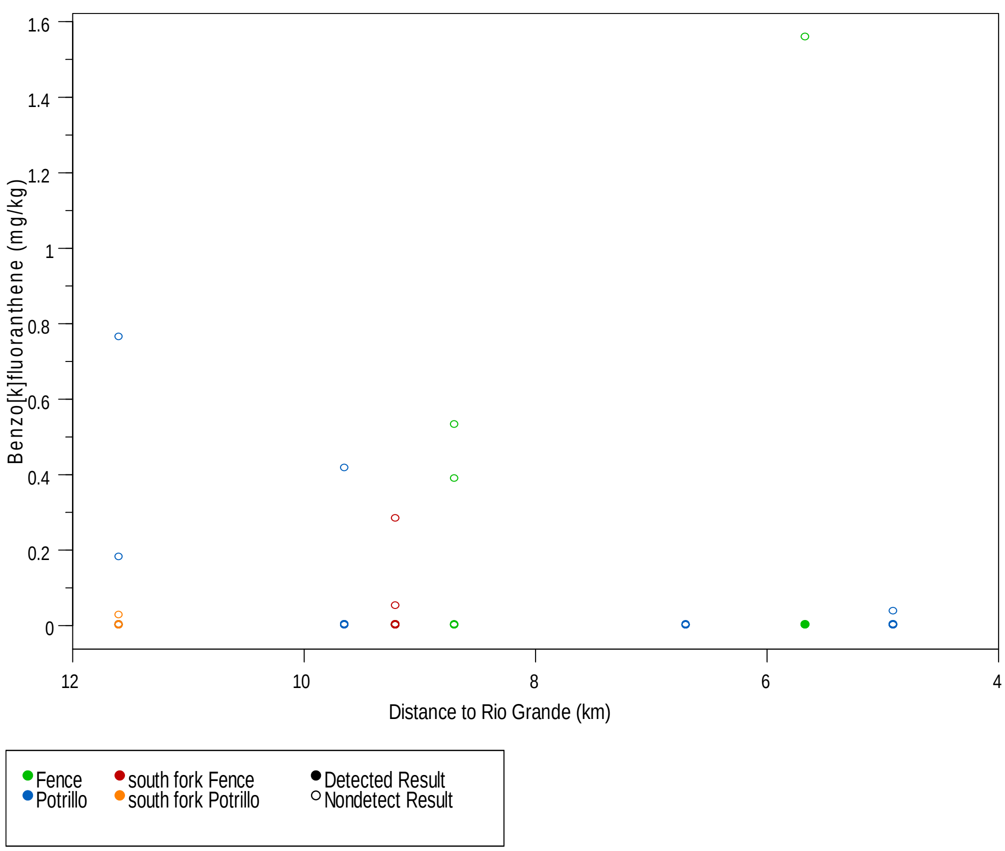
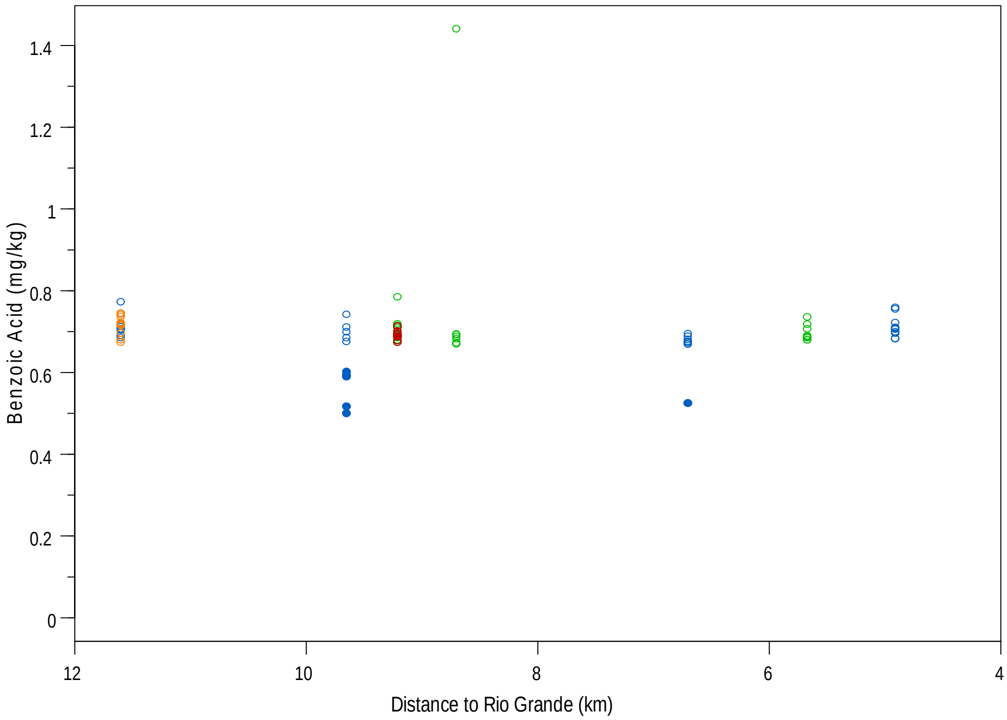


Figure D-1.1-2 (continued) Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons



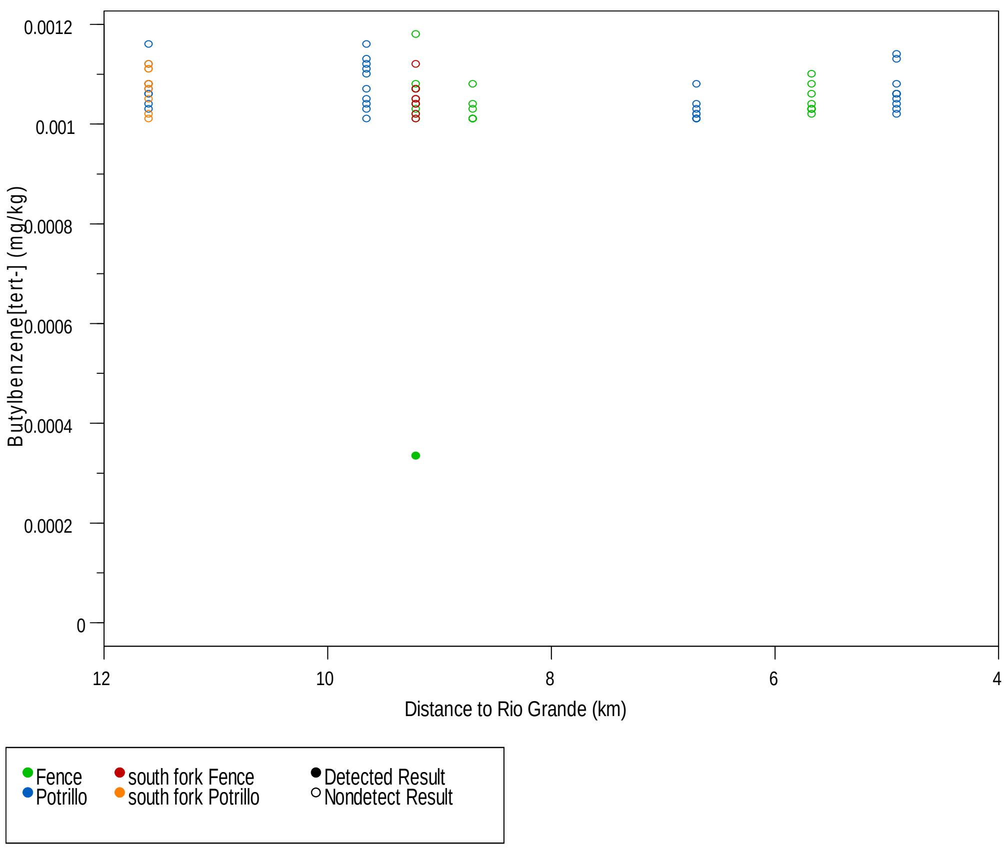


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons**

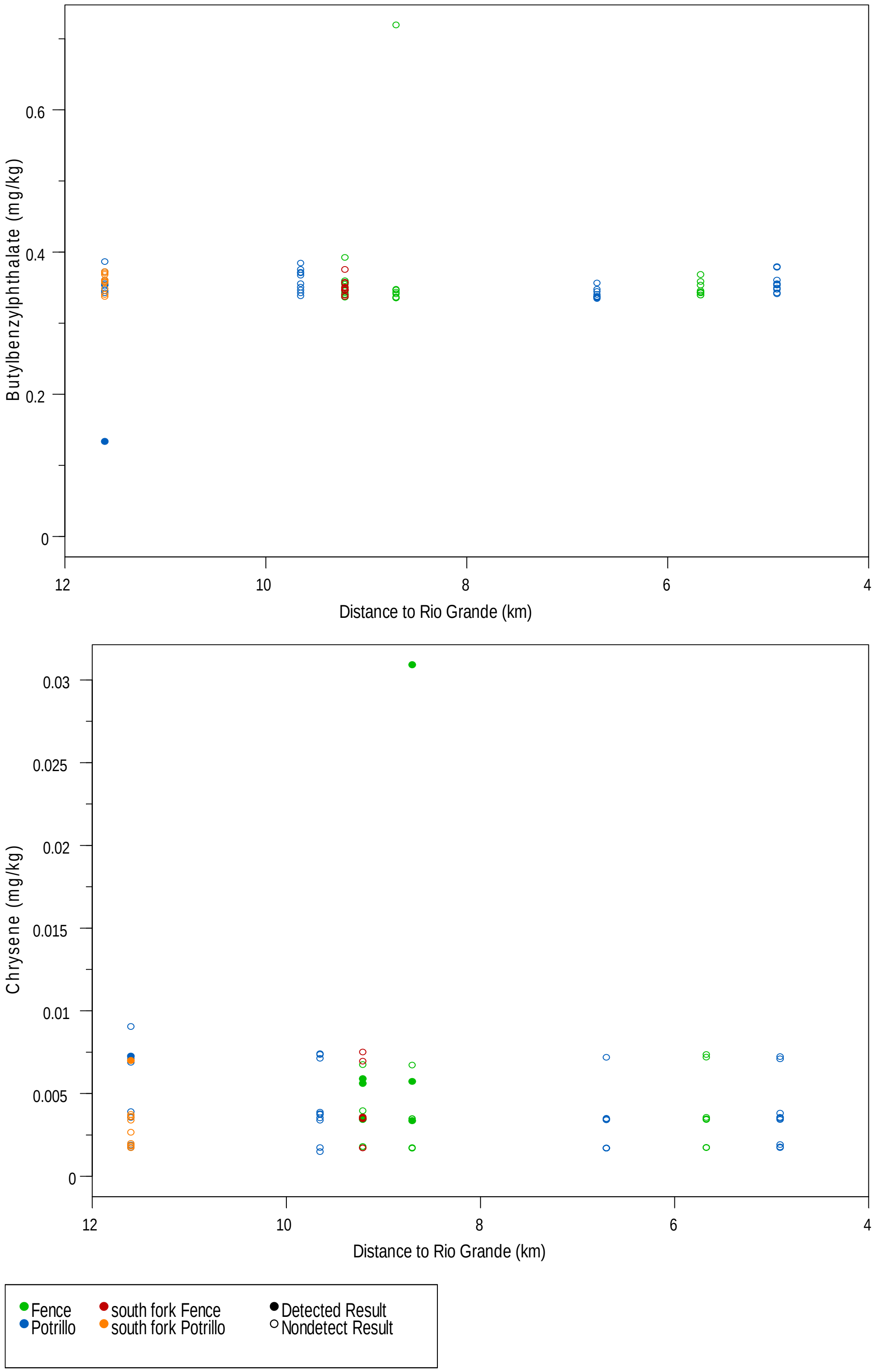


Figure D-1.1-2 (continued) Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons

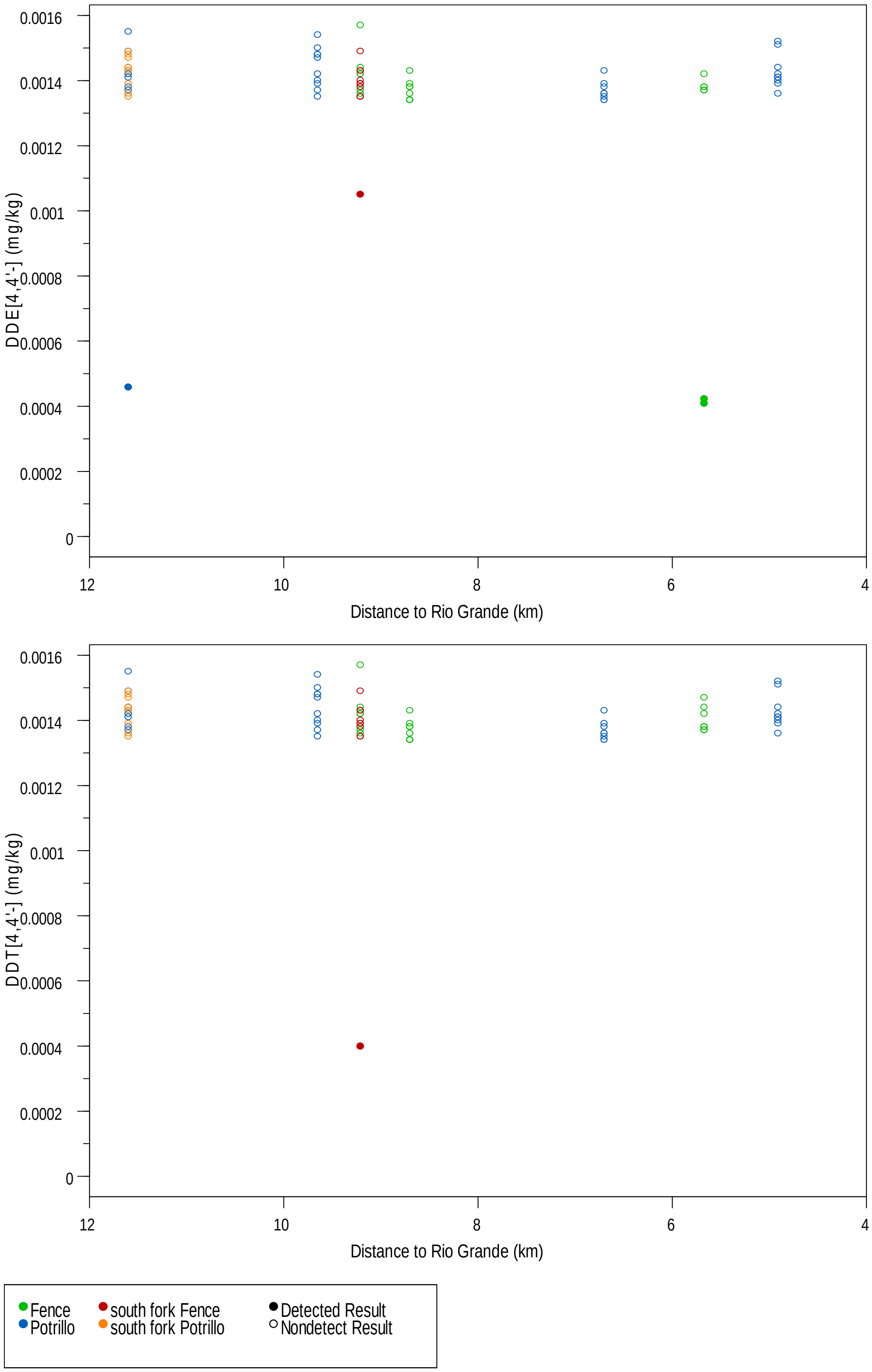


Figure D-1.1-2 (continued) Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons

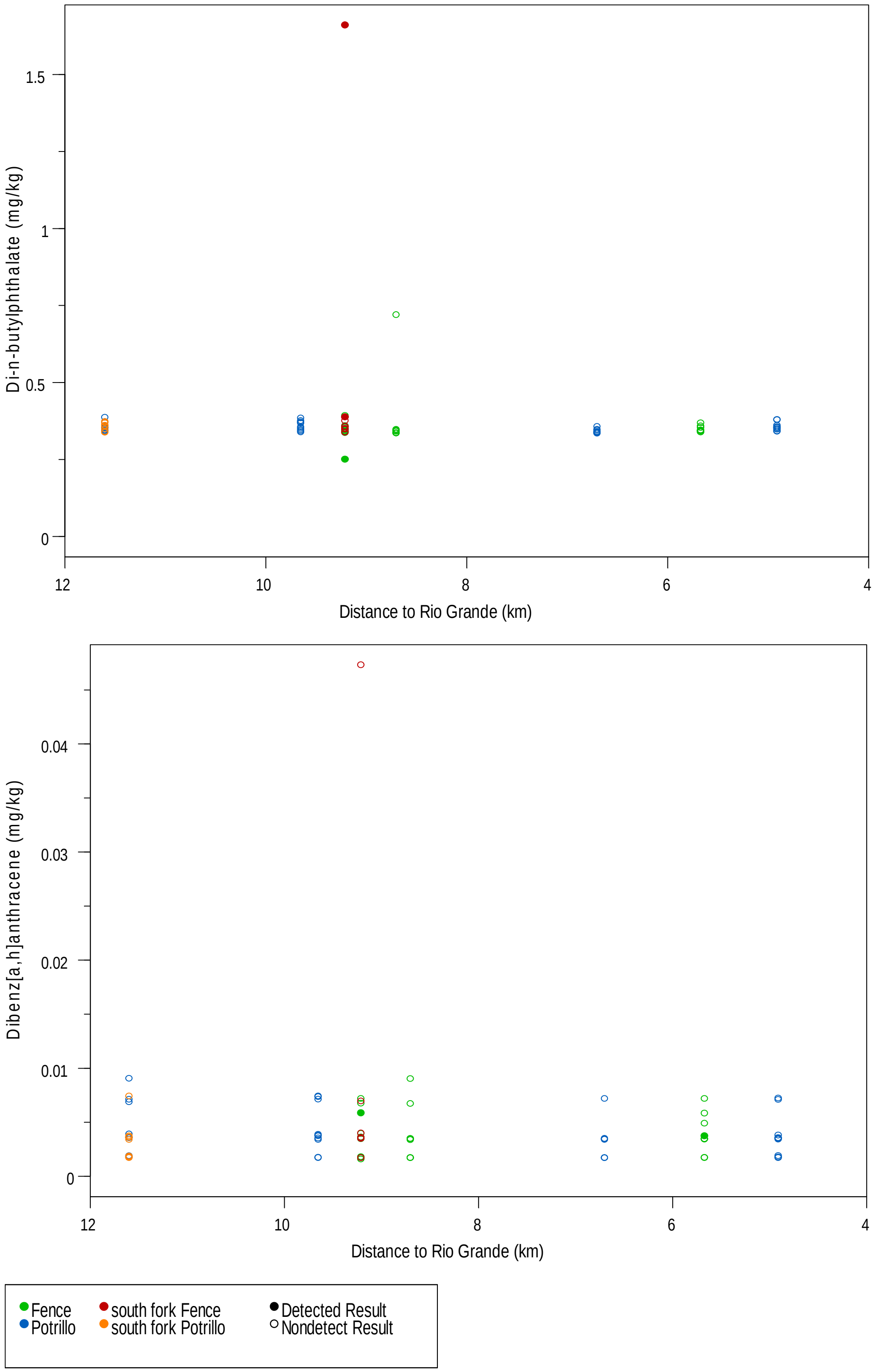


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons**

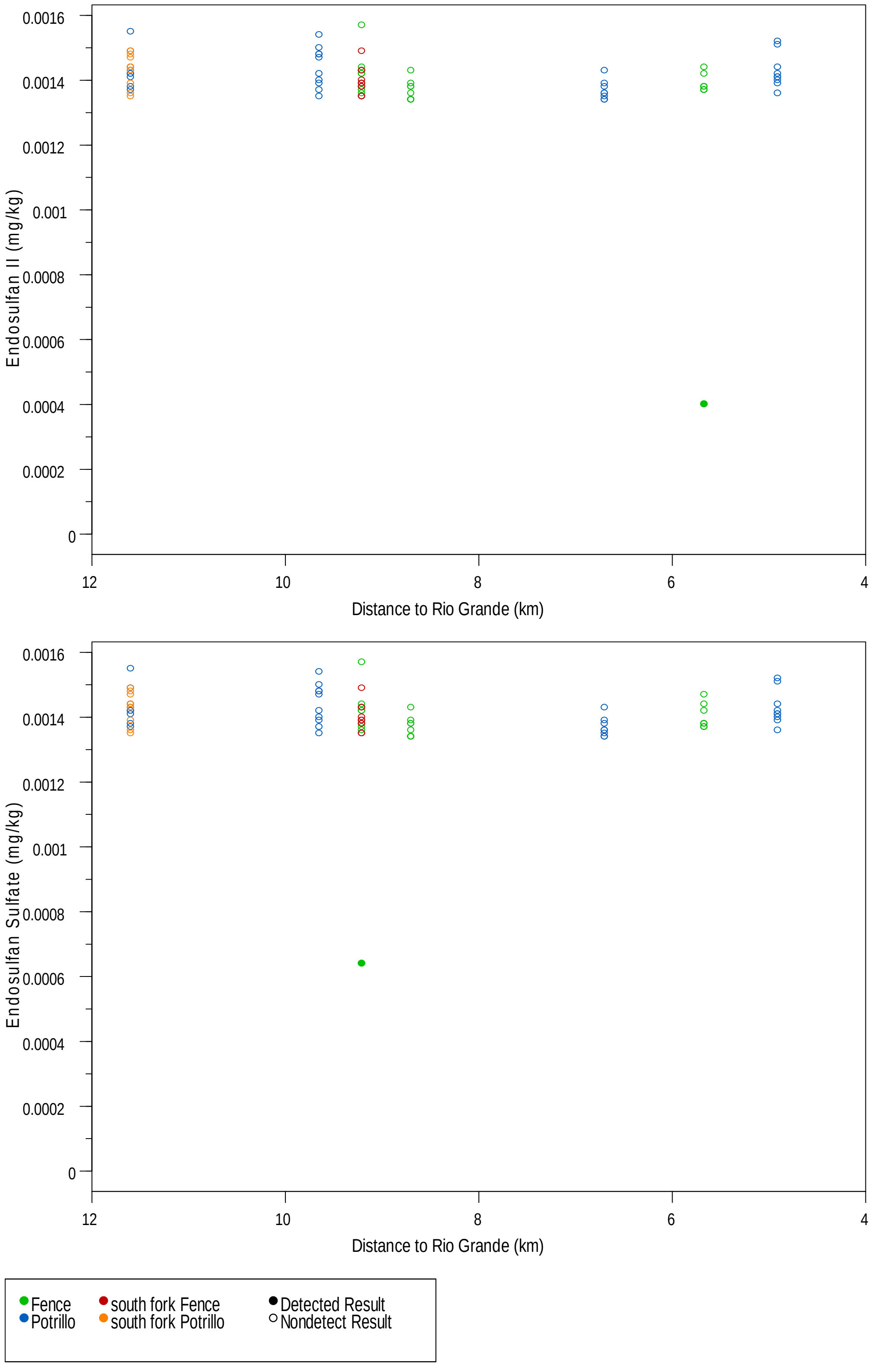


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons**

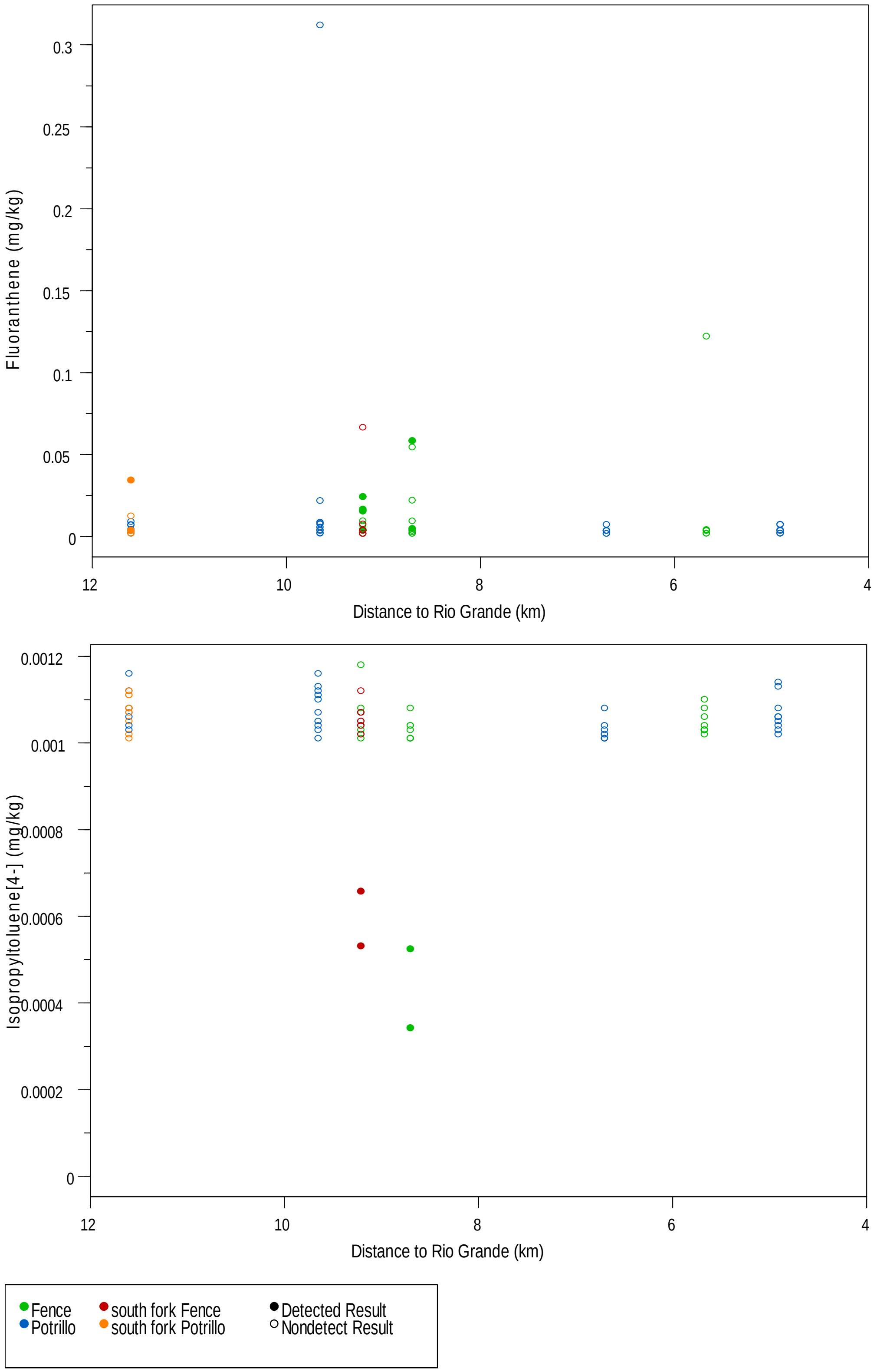


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons**

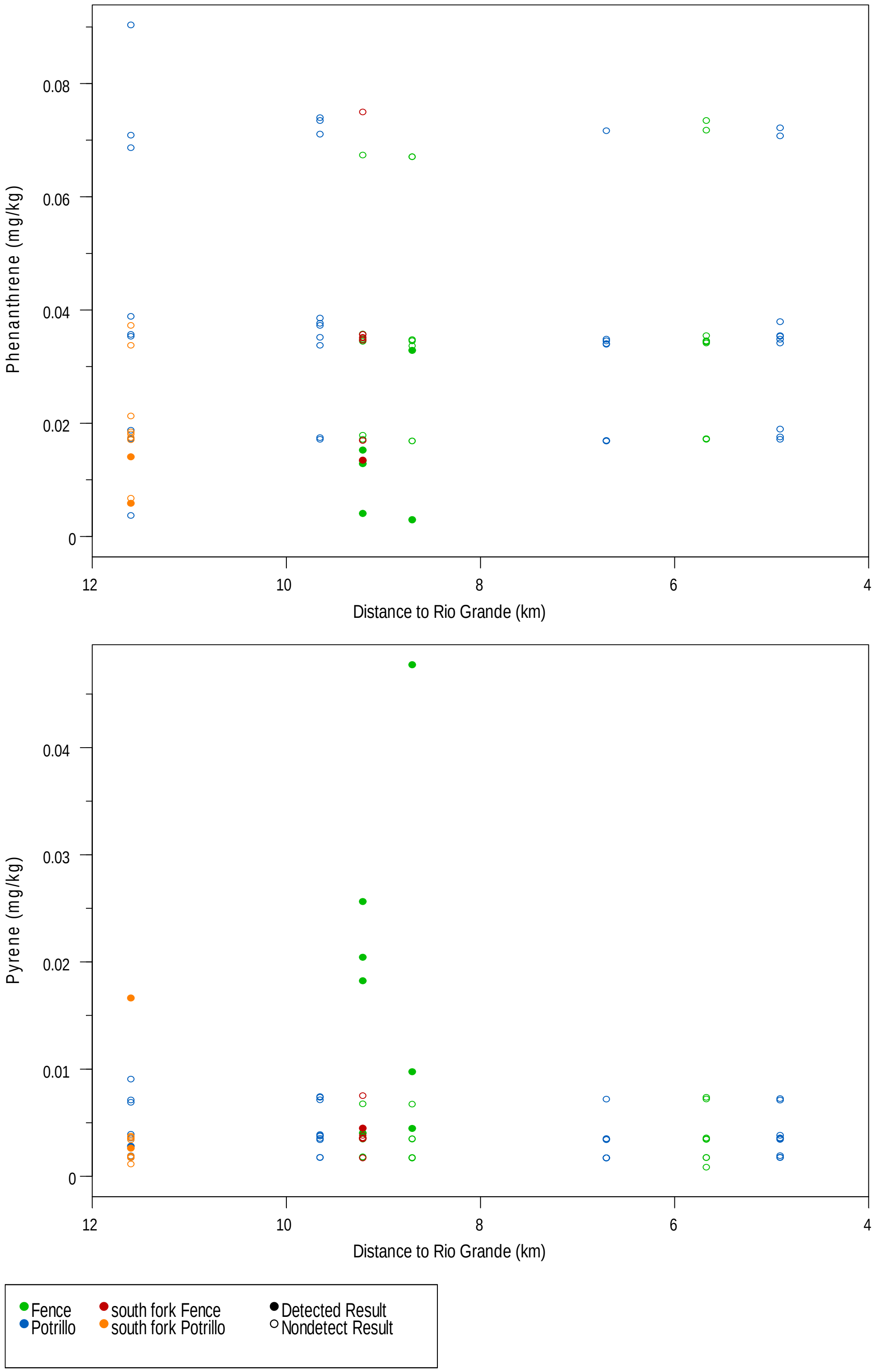


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons**

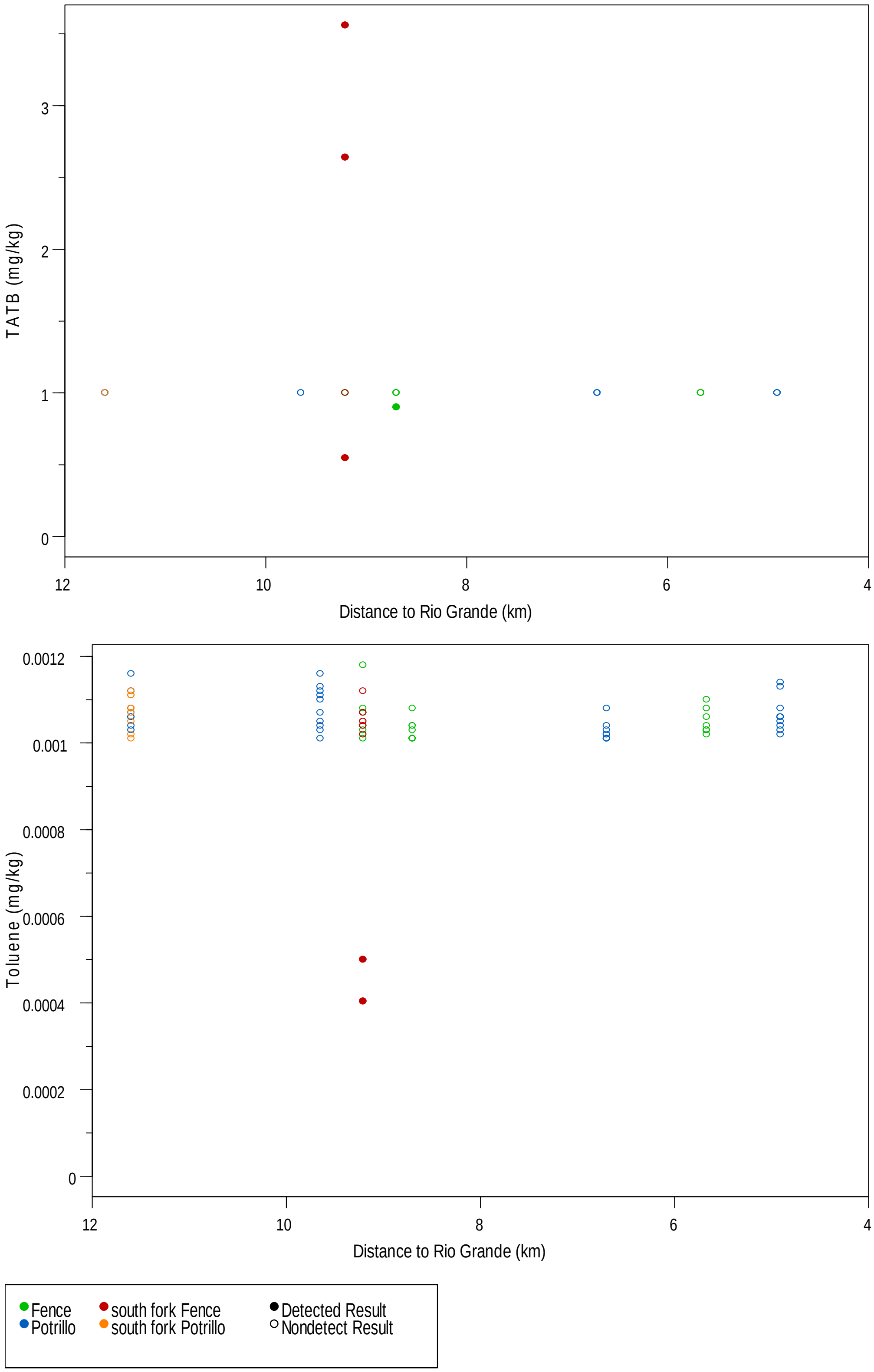


Figure D-1.1-2 (continued) Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in Potrillo and Fence Canyons

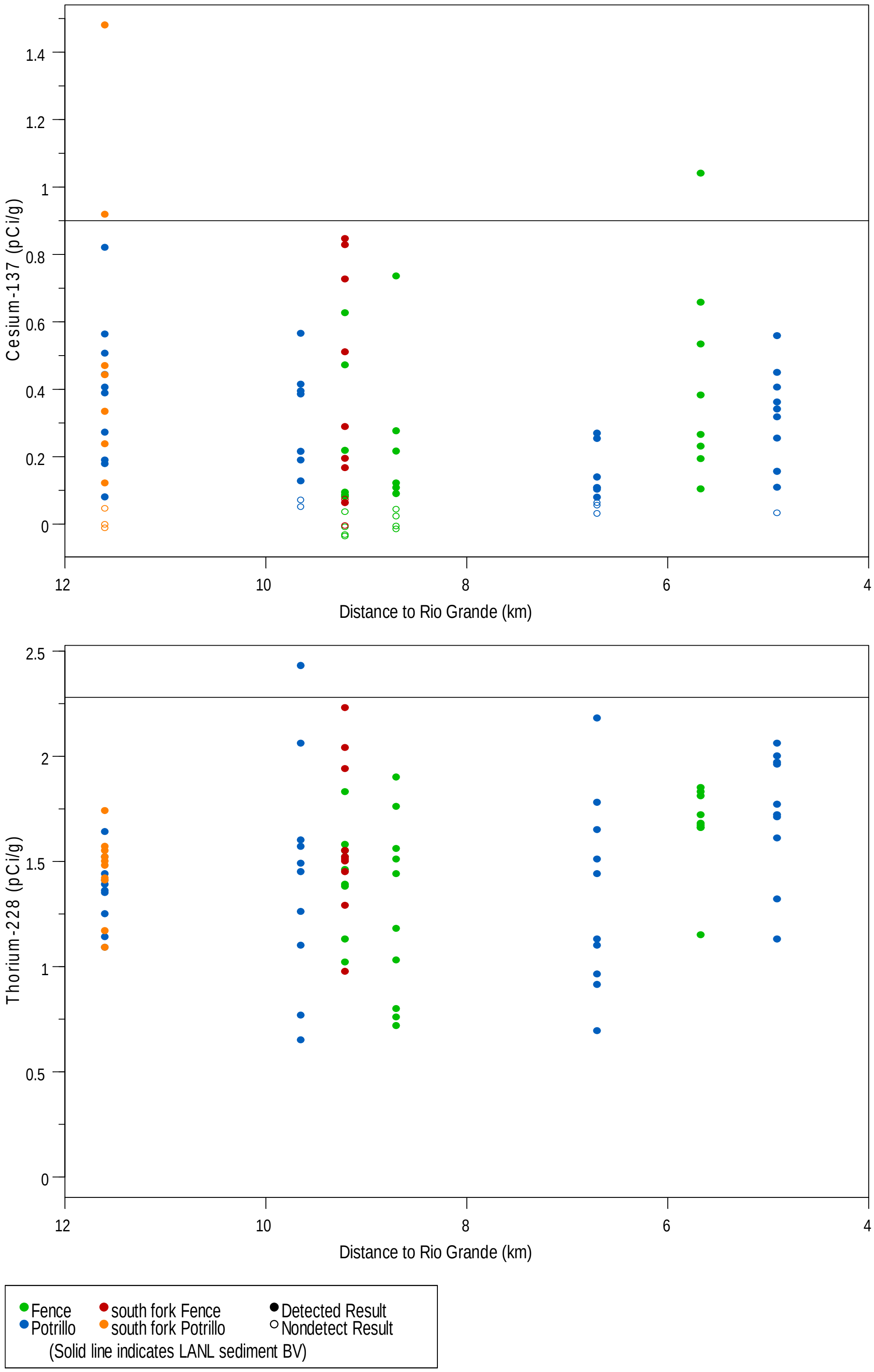


Figure D-1.1-3 Plots of sample results versus distance from the Rio Grande for all radionuclide COPCs identified in sediment in Potrillo and Fence Canyons

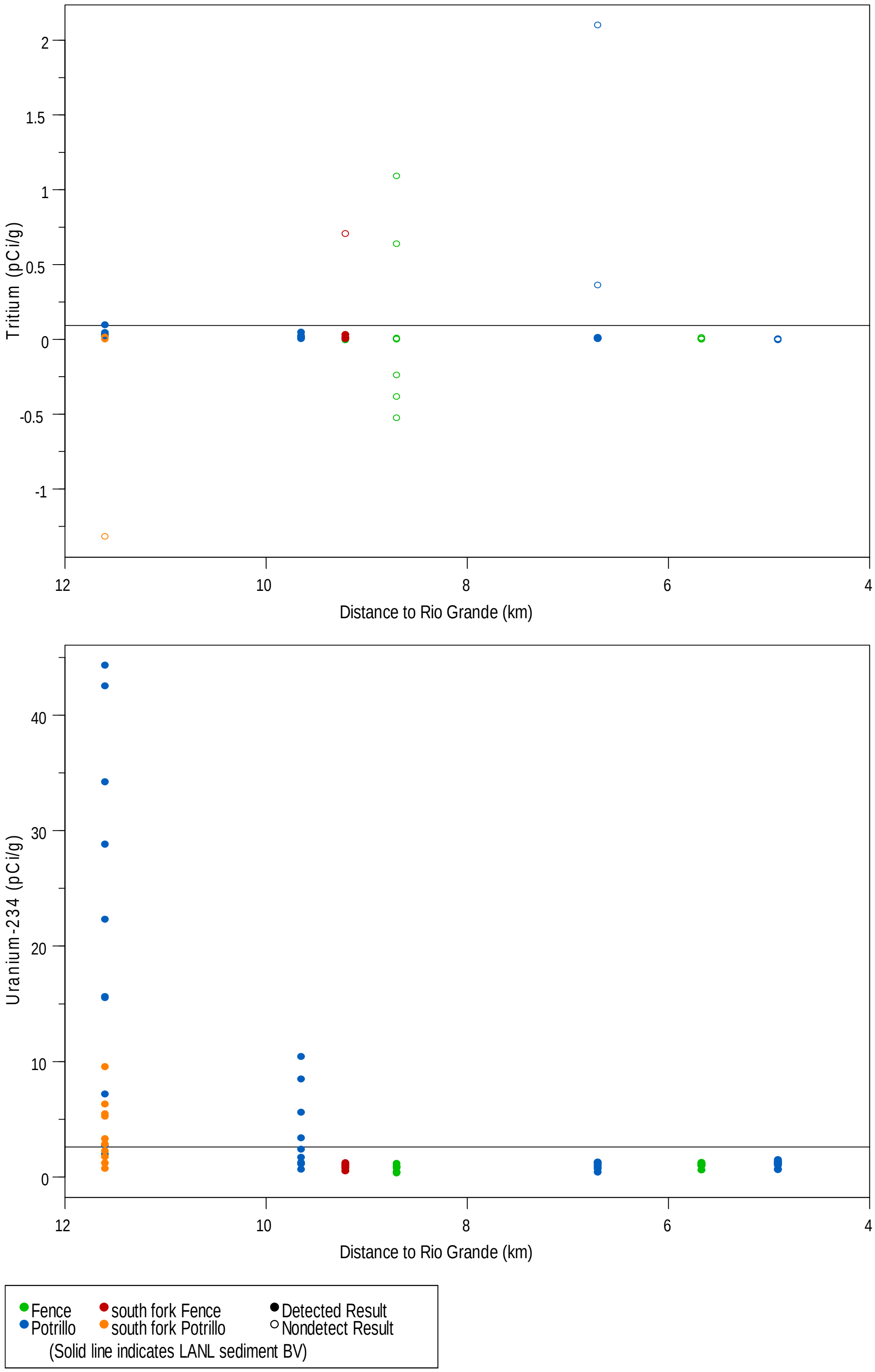


Figure D-1.1-3 (continued) Plots of sample results versus distance from the Rio Grande for all radionuclide COPCs identified in sediment in Potrillo and Fence Canyons

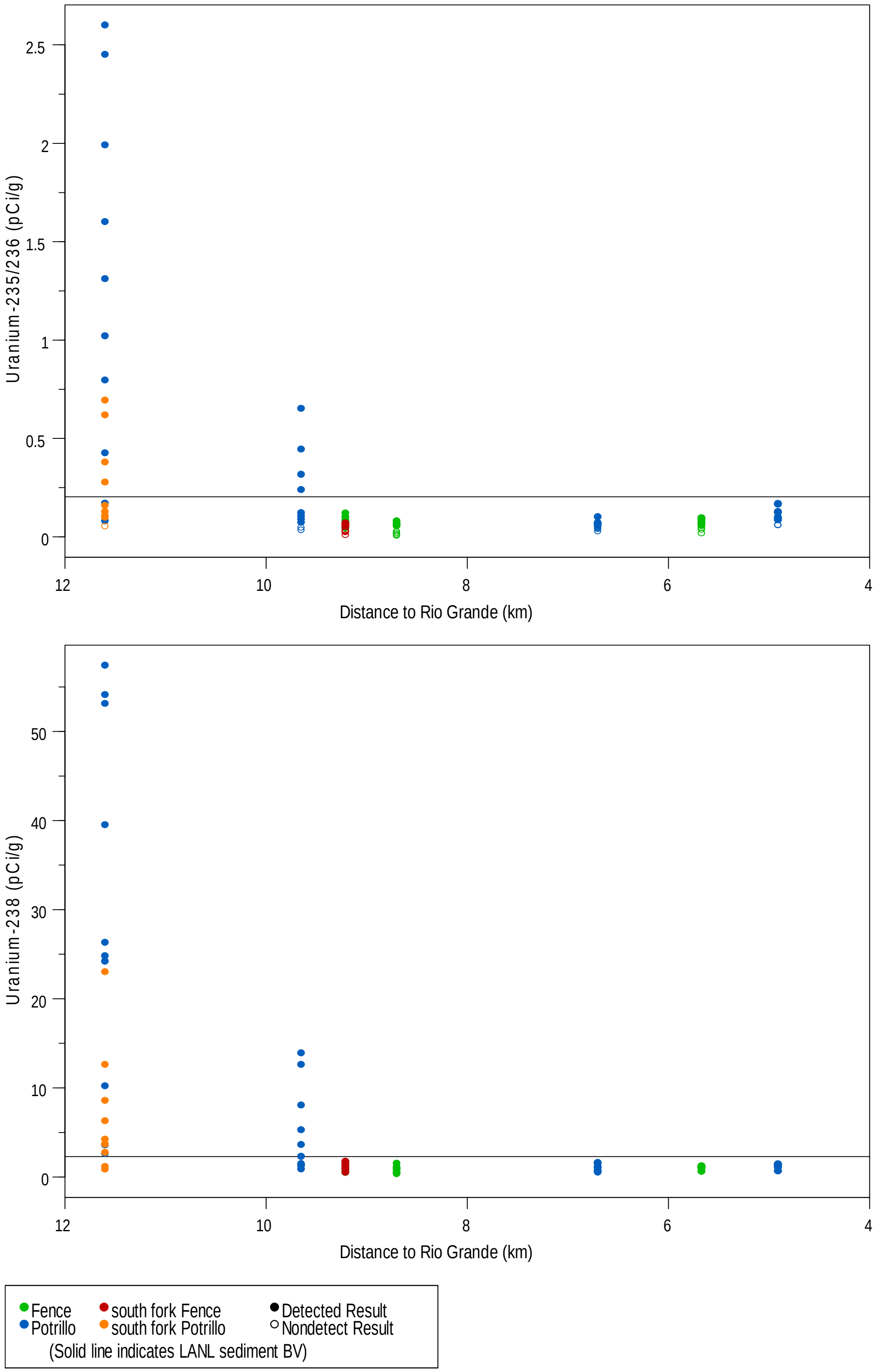


Figure D-1.1-3 (continued) **Plots of sample results versus distance from the Rio Grande for all radionuclide COPCs identified in sediment in Potrillo and Fence Canyons**

Table D-1.2-1
Summary of Average Concentrations of
Select Inorganic Chemicals in Potrillo and Fence Canyon Sediment Samples

	Beryllium		Cadmium						Cobalt		Copper		Selenium						Vanadium		Zinc	
	Fine Facies	Coarse Facies	Fine Facies			Coarse Facies			Fine Facies	Coarse Facies	Fine Facies	Coarse Facies	Fine Facies			Coarse Facies			Fine Facies	Coarse Facies	Fine Facies	Coarse Facies
Reach	Average	Average	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Average	Average	Average	Average	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Average	Average	Average	Average
BV	1.3		0.4						4.73		11.2		0.3						19.7		60.2	
F-1	—*	—	0.36	0.36	0.36	0.26	0.18	0.09	—	—	—	—	0.88	0.58	0.27	0.99	0.49	0.00	—	—	—	—
F-2	—	—	0.51	0.25	0.00	0.49	0.24	0.00	—	—	—	—	1.02	0.25	0.00	0.97	0.25	0.00	17.4	11.2	39.9	35.7
F-3	—	—	0.27	0.19	0.10	0.51	0.26	0.00	—	—	—	—	1.03	0.51	0.00	1.03	0.52	0.00	17.7	8.7	—	—
FS-1	—	—	0.25	0.19	0.12	0.49	0.25	0.00	4.28	1.59	7.8	3.3	0.98	0.59	0.20	0.99	0.50	0.00	17.5	10.2	—	—
PO-1	0.9	0.3	0.31	0.31	0.31	0.39	0.28	0.16	3.90	1.74	30.4	11.8	1.06	0.53	0.00	0.98	0.49	0.00	19.5	12.3	48.3	60.8
PO-2	—	—	0.34	0.34	0.34	0.20	0.20	0.20	2.88	2.92	7.4	3.8	1.06	0.53	0.00	0.99	0.50	0.00	—	—	—	—
PO-3	—	—	0.28	0.28	0.28	0.35	0.35	0.35	—	—	—	—	1.06	0.77	0.47	1.00	0.50	0.00	11.2	13.8	32.5	51.4
PO-4	—	—	0.14	0.14	0.14	0.51	0.25	0.00	—	—	—	—	1.02	0.56	0.09	1.01	0.50	0.00	16.2	11.6	—	—
POS-1	—	—	0.17	0.17	0.17	0.49	0.25	0.00	—	—	—	—	1.06	0.53	0.00	1.02	0.51	0.00	17.5	6.6	—	—

Note: All units are in mg/kg.
* — = Not a COPC in reach (no results above BV).

Table D-1.2-2
Summary of Average Concentrations of Select Organic Chemicals in Fence Canyon Sediment Samples

	Aroclor-1242						Aroclor-1254						Aroclor-1260					
	Fine Facies			Coarse Facies			Fine Facies			Coarse Facies			Fine Facies			Coarse Facies		
Reach	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean
F-1	—*	—	—	—	—	—	0.0036	0.0018	0.0000	0.0032	0.0020	0.0009	0.0034	0.0019	0.0004	0.0034	0.0017	0.0000
F-2	0.0064	0.0032	0.0000	0.0033	0.0020	0.0007	0.0064	0.0032	0.0000	0.0033	0.0020	0.0006	—	—	—	—	—	—
F-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FS-1	—	—	—	—	—	—	—	—	—	—	—	—	0.0041	0.0028	0.0015	0.0034	0.0017	0.0000

Table D-1.2-2 (continued)

	Di-n-butylphthalate						TATB					
	Fine Facies			Coarse Facies			Fine Facies			Coarse Facies		
Reach	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean
F-1	0.343	0.189	0.036	0.340	0.170	0.000	—	—	—	—	—	—
F-2	—	—	—	—	—	—	1.0	0.5	0.0	1.0	0.6	0.2
F-3	—	—	—	—	—	—	—	—	—	—	—	—
FS-1	0.523	0.389	0.256	0.338	0.169	0.000	1.3	0.9	0.5	1.8	0.5	0.0

Note: All units are in mg/kg.

* — = Not a COPC in reach (not detected).

Table D-1.2-3
Summary of Average Concentrations of
Select Radionuclides in Potrillo Canyon Sediment Samples

	Thorium-228		Uranium-234		Uranium-235/236		Uranium-238	
	Fine Facies	Coarse Facies	Fine Facies	Coarse Facies	Fine Facies	Coarse Facies	Fine Facies	Coarse Facies
Reach	Average	Average	Average	Average	Average	Average	Average	Average
BV	2.28		2.59		0.2		2.29	
PO-1	—*	—	22.14	18.95	1.3	1.2	30.66	25.25
PO-2	1.62	1.01	4.71	1.00	0.3	0.1	6.70	1.24
PO-3	—	—	—	—	—	—	—	—
PO-4	—	—	—	—	—	—	—	—
POS-1	—	—	3.88	3.78	0.2	0.3	5.19	10.10

Note: All units are in pCi/g.

* — = Not a COPC in reach (not detected or no detects above BV).

Appendix E

Statistics and Risk Information

E-1.0 ECOLOGICAL SCOPING CHECKLIST

The ecological scoping meeting documentation (section E1-1.0) and the documentation of site visits (section E1-2.0) are included in Attachment E-1.

E-2.0 BIOTA STUDY–RELEVANT EXPOSURE DATA FROM PREVIOUS CANYONS INVESTIGATIONS

As discussed in section 8.1.5, most chemicals of potential ecological concern (COPECs) identified for Potrillo and Fence Canyons have biota study–relevant data from previous canyons investigations. This appendix presents relevant COPEC exposure data for each Potrillo and Fence Canyon assessment endpoint assembled from the Los Alamos and Pueblo Canyons, Mortandad Canyon, Pajarito Canyon, and Sandia Canyon investigation reports (LANL 2004, 087390; LANL 2006, 094161; LANL 2008, 104909; LANL 2009, 107453; LANL 2009, 106939).

Samples with biota-relevant exposure data from the previous canyons investigation reports are tabulated in this appendix. Table E-2.0-1 lists the sediment samples (all sediment, including the active channel) evaluated for terrestrial receptors (plants, earthworms, small mammals, and birds). Table E-2.0-1 is included in Attachment 1 on CD.

E-3.0 SUPPORTING INFORMATION FOR THE HUMAN HEALTH RISK ASSESSMENT

This section provides human health exposure parameters and toxicity information, exposure point concentrations (EPCs) and results for the supplemental human health risk scenario (residential). This information is restricted to radionuclides because no carcinogens or noncarcinogens were identified for further evaluation in section 8.2.

E-3.1 Exposure Parameters and Toxicity Information

Exposure parameters used to calculate soil screening levels (SSLs) and screening action levels (SALs) are provided in Tables E-3.1-1 to E-3.1-3.

E-3.2 Sediment EPCs

This section provides information on the statistical methods used to calculate EPCs for sediment COPCs used in the human health risk assessment. The sample results for radionuclide COPCs are not censored at the detection limit and are reported as the actual measurement value from the instrument with a nondetect qualifier. Therefore, no adjustments are needed for nondetects in the calculation of EPCs. Section E-3.2.1 describes the methods used to analyze these data.

E-3.2.1 Upper Confidence Limit Calculation Methods

The statistical methods used to calculate upper confidence limits (UCLs) are consistent with U.S. Environmental Protection Agency (EPA) guidance (EPA 1989, 008021). ProUCL Version 4.00.05, was used to calculate UCLs to use as EPCs in the human health risk assessment.

The first step in calculating a UCL is to determine whether the data fit a probability distribution. The ProUCL software assesses normal, lognormal, gamma, and nonparametric distributions. The possible outcomes and UCL calculation approaches are as follows.

- The data show a normal distribution; normal distribution methods are used.
- The data show a lognormal distribution; lognormal distribution methods are used.
- The data show a gamma distribution; gamma distribution methods are used.
- The data are not different from either distribution; normal distribution methods are used.
- The data are different from all distributions; the Chebyshev or nonparametric methods are used.
- Insufficient data are available to evaluate the distribution; nonparametric methods (such as bootstrapping) are used.

Generally speaking, the method ProUCL recommends is based upon the sample size, distribution of the data, and sample standard deviation. Details are provided in the “ProUCL Version 4.00.05 User Guide” (EPA 2010, 109944) and “ProUCL Version 4 Technical Guide” (EPA 2009, 110368).

The calculated EPCs based upon the ProUCL UCLs for sediments are provided in Tables 8.2-8 and E-3.2-1. ProUCL data and assorted files are included in Attachment E-2 (on CD).

E-3.3 Supplemental Human Health Risk Scenario

The SALs used in the supplemental human health risk scenario (residential) are provided in Table E-3.3-1. The risk assessment results for the residential scenario are provided in Table E-3.3-2. Sediment EPCs used for this analysis are provided in Tables 8.2-8 and E-3.2-1. Residential radionuclide doses from COPCs are less 15 mrem/yr for both reaches evaluated (Tables E-3.3-2). It should be noted that the doses from radionuclides released or potentially released from Laboratory sites are overestimated because of the presence of naturally occurring radionuclides. For example, the UCL for thorium-228 in reach PO-2 (1.75 pCi/g) is less than the sediment background value (2.28 pCi/g).

E-4.0 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. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate’s Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

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

EPA (U.S. Environmental Protection Agency), December 1989. “Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A), Interim Final,” EPA/540/1-89/002, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1989, 008021)

EPA (U.S. Environmental Protection Agency), August 1997. "Exposure Factors Handbook, Volume I, General Factors," EPA/600/P-95/002Fa, Office of Research and Development, Washington, D.C. (EPA 1997, 066596)

EPA (U.S. Environmental Protection Agency), August 1997. "Exposure Factors Handbook, Volume III, Activity Factors," EPA/600/P-95/002Fc, Office of Research and Development, Washington, D.C. (EPA 1997, 066598)

EPA (U.S. Environmental Protection Agency), February 2009. "ProUCL Version 4.00.04 Technical Guide (Draft)," EPA/600/R-07/041, Office of Research and Development, Washington, D.C. (EPA 2009, 110368)

EPA (U.S. Environmental Protection Agency), May 2010. "ProUCL Version 4.00.05 User Guide (Draft)," EPA/600/R-07/038, Office of Research and Development, Washington, D.C. (EPA 2010, 109944)

LANL (Los Alamos National Laboratory), April 2004. "Los Alamos and Pueblo Canyons Investigation Report," Los Alamos National Laboratory document LA-UR-04-2714, Los Alamos, New Mexico. (LANL 2004, 087390)

LANL (Los Alamos National Laboratory), October 2006. "Mortandad Canyon Investigation Report," Los Alamos National Laboratory document LA-UR-06-6752, Los Alamos, New Mexico. (LANL 2006, 094161)

LANL (Los Alamos National Laboratory), September 2008. "Pajarito Canyon Investigation Report," Los Alamos National Laboratory document LA-UR-08-5852, Los Alamos, New Mexico. (LANL 2008, 104909)

LANL (Los Alamos National Laboratory), August 2009. "Pajarito Canyon Investigation Report, Revision 1," Los Alamos National Laboratory document LA-UR-09-4670, Los Alamos, New Mexico. (LANL 2009, 106939)

LANL (Los Alamos National Laboratory), October 2009. "Investigation Report for Sandia Canyon," Los Alamos National Laboratory document LA-UR-09-6450, Los Alamos, New Mexico. (LANL 2009, 107453)

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

LANL (Los Alamos National Laboratory), February 2010. "Technical Approach for Calculating Recreational Soil Screening Levels for Chemicals, Revision 1," Los Alamos National Laboratory document LA-UR-09-07510, Los Alamos, New Mexico. (LANL 2010, 108613)

NMED (New Mexico Environment Department), December 2009. "Technical Background Document for Development of Soil Screening Levels, Revision 5.0," with revised Table A-1, New Mexico Environment Department, Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2009, 108070)

Table E-3.1-1
Parameters Used to Calculate Chemical Soil Screening Levels

Parameters	Residential Values[a]
Target hazard quotient	1
Target cancer risk	1.00E-05
Averaging time (carcinogen)	70 yr × 365 d
Averaging time (noncarcinogen)	ED[b] × 365 d
Skin absorption factor	Semivolatile organic compound (SVOC) = 0.1
	Chemical-specific
Adherence factor–child	0.2 mg/cm^2
Body weight–child	15 kg (0–6 yr old)
Cancer slope factor–oral (chemical-specific)	mg/kg-d^{-1}
Cancer slope factor–inhalation (chemical-specific)	mg/kg-d^{-1}
Exposure frequency	350 d/yr
Exposure duration–child	6 yr (0–6 yr old)
Age-adjusted ingestion factor	114 mg-yr/kg-d
Age-adjusted inhalation factor	11 m^3-yr/kg-d
Inhalation rate–child	10 m^3/d
Soil ingestion rate–child	200 mg/d
Particulate emission factor	6.61 × 10^9 m^3/kg
Reference dose–oral (chemical-specific)	mg/kg-d
Reference dose–inhalation (chemical-specific)	mg/kg-d
Exposed surface area–child	2800 cm^2/d (head, hands, forearms, lower legs, feet)
Age-adjusted skin contact factor for carcinogens	361 mg-yr/kg-d
Volatilization factor for soil (chemical-specific)	m^3/kg
Body weight–adult	70 kg
Exposure duration	30 yr[c]
Adherence factor–adult	0.07 mg/cm^2
Soil ingestion rate–adult	100 mg/d

Table E-3.1-1 (continued)

Parameters	Residential Values[a]
Exposed surface area–adult	5700 cm^2/d (head, hands, forearms, lower legs)
Inhalation rate–adult	20 m^3/d
Event time	n/a[d]

Note: mg/kg-d^{-1}= milligram per kilogram per day, mg-yr/kg-d = milligram year per kilogram day, m^3/day = cubic meters per day, m^3/kg = cubic meters per kilogram, m^3/h = cubic meters per hour, cm^2/d = centimeters squared per day.

[a] Parameter values from NMED (2009, 108070).

[b] ED = Exposure duration.

[c] Exposure duration for lifetime resident is 30 yr. For carcinogens, the exposures are combined for child (6 yr) and adult (24 yr).

[d] n/a = Not applicable.

Table E-3.1-2
Parameters Used to Calculate Radionuclide SALs, Residential Scenario

Parameters	Residential, Child	Residential, Adult
Inhalation rate (m^3/yr)	3652.5[a]	7305[b]
Mass loading (g/m^3)	1.5×10^{-7}[c]	1.5×10^{-7}[c]
Outdoor time fraction	0.2236[d]	0.0599[e]
Indoor time fraction	0.7347[f]	0.8984[g]
Soil ingestion (g/yr)	73[h]	36.5[i]

[a] Calculated as (10 m^3/d × 350 d/yr) / (indoor + outdoor time fractions), where 10 m^3/d is the daily inhalation rate of a child (NMED 2009, 108070).

[b] Calculated as (20 m^3/d × 350 d/yr) / (indoor + outdoor time fractions), where 20 m^3/d is the daily inhalation rate of an adult (NMED 2009, 108070).

[c] Calculated as (1/6.6 × 10^{+9} m^3/kg) x 1000 g/kg, where 6.6 × 10^{+9} m^3/kg is the particulate emission factor (NMED 2009, 108070).

[d] Calculated as (5.6 h/d × 350 d/yr) / 8766 h/yr, where 5.6 h/d is an estimate of time spent outdoors for a 3- to 11-yr-old child (EPA 1997, 066598, section 15.4-1).

[e] Calculated as (1.5 h/d × 350 d/yr) / 8766 h/yr, where 1.5 h/d is an estimate of time spent outdoors for an adult 12 yr and older (EPA 1997, 066598, section 15.4-1).

[f] Calculated as (24–5.6 h/d × 350 d/yr) / 8766 h/yr.

[g] Calculated as (24–1.5 h/d × 350 d/yr) / 8766 h/yr.

[h] Calculated as (0.2 g/d × 350 d/yr) / (indoor + outdoor time fractions), where 0.2 g/d is the child soil-ingestion rate (NMED 2009, 108070).

[i] Calculated as (0.1 g/d × 350 d/yr) / (indoor + outdoor time fractions), where 0.1 g/d is the adult soil-ingestion rate (NMED 2009, 108070).

Table E-3.1-2
Parameters Used to Calculate Radionuclide SALs, Recreational Scenario

Parameters	Recreational, Child	Recreational, Adult
Inhalation rate (m^3/yr)	10,526[a]	14,035[b]
Mass loading (g/m^3)	1.5 × 10-7[c]	1.5 x 10-7[c]
Outdoor time fraction	0.0228[d]	0.0228[d]
Indoor time fraction	0	0
Soil ingestion (g/yr)	626[e]	225[f]

[a] Calculated as (1.2 m^3/h × 200 h/yr) / (indoor + outdoor time fractions), where 1.2 m^3/h is the child inhalation rate for moderate activity (EPA 1997, 066596, Table 5-23).

[b] Calculated as (1.60 m^3/h × 200 h/yr) / (indoor + outdoor time fractions), where 1.6 m^3/d is the adult inhalation rate for moderate activity (EPA 1997, 066596, Table 5-23).

[c] Calculated as (1/ 6.6 × 10^{+9} m^3/kg) × 1000 g/kg, where 6.6 × 10^{+9} m^3/kg is the particulate emission factor (NMED 2009, 108070).

[d] Calculated as (1 h/d × 200 d/yr) / 8766 h/yr, where 1 h/d is an estimate of the exposure time for a recreational adult or child (LANL 2010, 108613). Calculated as [(0.4 g/d × 5.6 h/day) × 200 h/yr] / (indoor + outdoor time fractions), where 5.6 h/day is the time spent outdoors for a child (EPA 1997, 066598, section 15.4.1), and where 0.4 g/d is the upper bound child soil-ingestion rate (EPA 1997, 066598, Table 4-23).

[f] Calculated as [(0.1 g/d × 3.9 h/day) × 200 h/yr] / (indoor + outdoor time fractions), where 3.9 h/d is the time-weighted average for “doers” ages 12–44 (EPA 1997, 066598, Table 15-10), and where 0.1 g/d is the adult soil-ingestion rate (NMED 2009, 108070).

Table E-3.2-1
EPCs for Sediment COPCs

Reach	Analyte	Number Detects	Number Nondetects	% Number Detects	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Standard Deviation (mg/kg)	Skewness (mg/kg)	Coefficient of Variation	UCL (mg/kg)	UCL Method
PO-1	U-234	10	0	0	1.95	44.3	21.5	19.0	15.6	0.22	0.73	30.5	95% Student’s-t UCL
PO-1	U-235	10	0	0	0.08	2.6	1.24	1.17	0.91	0.23	0.73	1.77	95% Student’s-t UCL
PO-1	U-238	10	0	0	2.61	57.4	29.6	25.6	20.7	0.09	0.70	41.6	95% Student’s-t UCL
PO-2	Th-228	10	0	0	0.65	2.43	1.44	1.47	0.54	0.34	0.38	1.75	95% Student’s-t UCL
PO-2	U-238	10	0	0	0.67	13.9	5.07	2.95	4.86	1.08	0.96	9.48	95% Approximate Gamma UCL

Table E-3.3-1
Screening Levels for the Residential Scenario

COPC	End Point	Target Adverse-Effect Level	Residential SAL (pCi/g)
Thorium-228	Radionuclide	15 mrem/yr	2.3
Uranium-234	Radionuclide	15 mrem/yr	170
Uranium-235	Radionuclide	15 mrem/yr	17
Uranium-238	Radionuclide	15 mrem/yr	87

Note: Residential SALs are from LANL (2009, 107655).

Table E-3.3-2
Dose Based on EPCs for Sediment, Residential Scenario, Radionuclides

Reach	Thorium-228	Uranium-234	Uranium-235	Uranium-238	Sum of Fractions	Total Dose (mrem/yr)
Residential SAL (pCi/g)	**2.3**	**170**	**17**	**87**		
PO-1	—*	0.179	0.104	0.478	0.762	11
PO-2	0.761	—	—	0.109	0.870	13

Note: Residential SALs are from LANL (2009, 107655).
*— = Not a COPC.

Attachment E-1

Ecological Scoping Checklist

E1-1.0 PART A—SCOPING MEETING DOCUMENTATION

Site ID	**Affected Media in Potrillo and Fence Canyon Investigation Reaches**
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.	Sources of potential contamination in the Potrillo and Fence watershed include Technical Area 15 (TA-15) and TA-36. These TAs and their associated areas of concern/solid waste management units (AOCs/SWMUs) are located on mesa tops adjacent to Potrillo and Fence Canyons and in the bottom of Potrillo Canyon. Mechanisms of contaminant release to the Potrillo and Fence watershed include contaminant releases from upgradient mesa-top open-detonation firing sites, septic systems, outfalls, and contaminants mobilized by storm runoff. The nine investigation reaches in the Potrillo and Fence watershed are F-1, F-2, F-3, FS-1, PO-1, PO-2, PO-3, PO-4, and POS-1. Investigation reaches and adjacent AOCs/SWMUs are shown in Figures 2.0-1 and 3.1-1 of the investigation report.
List of primary impacted media **(Indicate all that apply.)**	**Surface soil**—Yes **Sediment**—Yes (c1 geomorphic unit or active channel) **Surface water**—No (stormwater only) **Subsurface**—No **Groundwater**—No **Other,** explain
Vegetation land-cover class **(Indicate all that apply.)**	**Aspen-Riparian-Wetland**—No **Cerro Grande Fire high affected**—Yes **Grassland** —Yes **Mixed conifer**—Yes **Spruce-Fir**—No **Open Water**—No **Ponderosa pine**—Yes **Piñon-juniper**—Yes **Shrub species**—Yes **Urban-Sparse-Bare Rock**—No
Is threatened and endangered species (T&E) habitat present? **list species if applicable**	The Mexican spotted owl is likely to nest, roost, and forage at varying levels in some of the reaches in the Potrillo and Fence watershed (see Nisengard 2010, 111141). The Mexican spotted owl does not currently nest in Potrillo and Fence Canyons but it does nest in other canyons on the Laboratory.
Provide list and description of neighboring/contiguous/ upgradient AOCs/SWMUs **(consider need to aggregate AOCs/SWMUs for screening)**	Appendixes B and C in the South Canyons historical investigation report provide a comprehensive list of SWMUs/AOCs in the watershed (LANL 2006, 093714).
Is there evidence of run-on/runoff, erosion or a terminal point of surface-water transport?	Run-on and runoff are evident in all Potrillo and Fence Canyon reaches. Minor erosion was observed as a result of intermittent stormwater flow. Canyon bottoms serve as the terminal point for surface water transport via runoff from the mesa tops.

Other scoping meeting notes	Three reaches (PO-1, POS-1, PO-2) were selected for the site visit based on the proximity of these locations to contaminant sources and their representativeness of the ecological habitat in Potrillo and Fence Canyons. Thus, this scoping checklist represents ecological receptors and exposure pathways for all reaches in Potrillo and Fence Canyons. All site visits to the reaches occurred in November 2010. Reaches were investigated individually on foot. Aquatic habitat and receptors were not observed in any of the Potrillo Canyon reaches. No perennial surface water is present in the Potrillo and Fence watershed. Surface water is limited to stormwater and short-lived snowmelt runoff. Potrillo and Fence Canyons sediment was sampled in 2010. Although the watershed had been subject to a low-severity burn during the Cerro Grande fire, significant fire-effects were not evident in sediment samples collected in the watershed.

E1-2.0 PART B—SITE VISIT DOCUMENTATION

E1-2.1 Reach PO-1

Site ID	PO-1
Date of Site Visit	11/3/2010
Site Visit Conducted by	R. Ryti, S. Reneau

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = high **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = none
Field notes on the Facility for Information Management, Analysis, and Display Vegetation Class (FIMAD)	Sparse vegetation-bare rock, Cerro Grande fire high-severity burn, piñon-juniper were noted in the geographic information system (GIS) coverage but no piñon-juniper plant cover was noted in the field and generally plant cover was high. Ponderosa pine was also noted in the field. In addition, this is a low-severity fire burn area.
Field notes on T&E habitat, if applicable	Reach PO-1 contains high-quality foraging habitat for the Mexican spotted owl (Nisengard 2010, 111141). Note that Mexican spotted owls do not currently nest in Potrillo and Fence Canyons.
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Terrestrial receptors are present in reach PO-1. No aquatic receptors are present.

Contaminant Transport Information:

Surface-water transport field notes on the terminal point of surface water transport (if applicable)	Surface-water transport in Potrillo Canyon is ephemeral from stormwater runoff. Stormwater may resuspend sediment and associated contaminants.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes, ephemeral surface water from stormwater may serve as a transport pathway. Significant surface-water runoff/erosion was not indicated during the site visit. Because of the high vegetative cover, air is not expected to be a major transport pathway.
Interim action needed to limit off-site transport? **(yes/no/uncertain)** **Provide explanation/recommendation to project lead for interim action (IA) strategic management decision point (SMDP)**	No

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	Reach PO-1 shows minimal recent movement of sediment, although older flood deposits do occur. The area was subject to a low severity burn during the Cerro Grande fire and a power line road crosses the reach.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No
Interim action needed to limit apparent ecological effects? **(yes/no/uncertain)** **Provide explanation and recommendations to mitigate apparent exposure pathways to project lead for IA SMDP.**	No

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 (NFA) recommendation (if needed). At a minimum, the potential for future transport should include likelihood that future construction activities could make contamination more available for exposure or transport. This section does not apply.

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature, rate, and extent of contamination? **(yes/no/uncertain)** **Provide explanation.** **(Consider if the maximum value was captured by existing sample data.)**	Sediment samples provide adequate information to support characterization of the nature and extent of contamination. Sediment samples were collected from representative locations within the mapped geomorphic units. Analytical suites for these samples were adequate to cover the potential contaminant sources.
Do existing or proposed data for the site address potential transport pathways of site contamination? **(yes/no/uncertain)** **Provide explanation.** **(Consider if other sites should aggregated to characterize potential ecological risk.)**	Yes, sediment data are available within the reach.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors. The inactive E-F firing site, which was one of the principal firing sites in the watershed, is located near this reach. A drainage from E-F firing site enters the canyon bottom near the western boundary of the reach. The highest concentrations of uranium isotopes in the watershed were in samples collected from floodplain (f1) sampling locations in the downstream portion of the reach. The habitat is open ponderosa pine forest with some mixed conifers and an understory of shrubs (e.g., oaks). Some soil biological crusts were noted in the reach. Evidence for wildlife use of this area (deer pellets) was noted during the site visit. The steam channel is well developed and there was evidence of past stormwater events. In general the channel and floodplain are fairly narrow—approximately 5 to 10 m in wide at its maximum and more narrow downstream. This part of the watershed was subject to a low-severity burn during the Cerro Grande fire in 2000, but no significant post-fire deposits were noted during sampling.

E1-2.2 Reach POS-1

Site ID	POS-1
Date of Site Visit	11/3/2010
Site Visit Conducted by	R. Ryti, S. Reneau

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = high **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = none
Field notes on the FIMAD	Sparse vegetation-bare rock, piñon-juniper, Cerro Grande fire high-severity burn, mixed conifer were noted in the GIS coverage but no piñon-juniper plant cover was noted in the field and generally plant cover was high. Ponderosa pine was also noted in the field. In addition, this is a low severity fire burn area.
Field notes on T&E habitat, if applicable	Reach POS-1 contains high-quality foraging habitat for the Mexican spotted owl (Nisengard 2010, 111141). Note that Mexican spotted owls do not currently nest in Potrillo and Fence Canyons.
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes, terrestrial receptors are present in reach POS-1. No aquatic receptors are present.

Contaminant Transport Information:

Surface-water transport field notes on the terminal point of surface water transport (if applicable)	Surface water in the Potrillo watershed is ephemeral flow from stormwater runoff. Stormwater may resuspend and transport contaminants present in sediments.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes, ephemeral surface water from stormwater serves as a transport pathway. Because of the high vegetative cover, air is not expected to be a major transport pathway.
Interim action needed to limit off-site transport? **(yes/no/uncertain)** **Provide explanation/recommendation to project lead for IA SMDP**	No

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	The area was subject to a low-severity burn during the Cerro Grande fire, and there is a power line road adjacent to the reach.

Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No
Interim action needed to limit apparent ecological effects? **(yes/no/uncertain)** **Provide explanation and recommendations to mitigate apparent exposure pathways to project lead for IA SMDP.**	No

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 NFA recommendation (if needed). At a minimum, the potential for future transport should include likelihood that future construction activities could make contamination more available for exposure or transport. This section does not apply.

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature, rate, and extent of contamination? **(yes/no/uncertain)** **Provide explanation.** **(Consider if the maximum value was captured by existing sample data.)**	Sediment data provide adequate information to support characterization of the nature and extent of contamination. Sediment samples were collected from representative locations within the mapped geomorphic units. Analytical suites for these samples were adequate to cover the potential contaminant sources.
Do existing or proposed data for the site address potential transport pathways of site contamination? **(yes/no/uncertain)** **Provide explanation.** **(Consider if other sites should aggregated to characterize potential ecological risk.)**	Yes, sediment data are adequate to characterize potential contaminant transport pathways.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Habitat is identical to PO-1. Reach POS-1 is in a tributary drainage directly to the south of main Potrillo Canyon. There is a power line road that separates the habitat between the reaches. The reach was also subject to a low-severity burn during the Cerro Grande fire in 2000. The channel is narrow and typical of a headwater drainage. A damp spot was noted in channel. The highest isotopic uranium sample result for this reach was in an active channel location near the confluence with Potrillo Canyon. Some thick pine-needle litter was noted on the ground under a ponderosa pine and mixed conifer overstory. A mountain chickadee was noted during the site visit.

E1-2.3 Reach PO-2

Site ID	PO-2
Date of Site Visit	11/3/2010
Site Visit Conducted by	R. Ryti , S. Reneau

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = high **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = none
Field notes on the FIMAD	Mixed conifer, ponderosa pine, piñon-juniper were noted in the GIS coverage and in the field.
Field notes on T&E habitat, if applicable	Reach PO-2 contains high-quality nesting, roosting, and foraging habitat for the Mexican spotted owl (Nisengard 2010, 111141). Note that Mexican spotted owls do not currently nest in Potrillo and Fence Canyons.
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes, terrestrial receptors are present in reach PO-2. No aquatic receptors are present.

Contaminant Transport Information:

Surface-water transport field notes on the terminal point of surface water transport (if applicable)	Surface water in Potrillo Canyon is ephemeral flow from stormwater runoff. Stormwater may resuspend and transport contaminants present in sediments.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes, ephemeral surface water from stormwater serves as a transport pathway. Because of the high vegetative cover, air is not expected to be a major transport pathway.
Interim action needed to limit off-site transport? **(yes/no/uncertain)** **Provide explanation/recommendation to project lead for IA SMDP**	No

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	None
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No
Interim action needed to limit apparent ecological effects? **(yes/no/uncertain)** **Provide explanation and recommendations to mitigate apparent exposure pathways to project lead for IA SMDP.**	No

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 NFA recommendation (if needed). At a minimum, the potential for future transport should include likelihood that future construction activities could make contamination more available for exposure or transport. This section does not apply.

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature, rate, and extent of contamination? **(yes/no/uncertain)** **Provide explanation.** **(Consider if the maximum value was captured by existing sample data.)**	Sediment samples provide adequate information to support characterization of the nature and extent of contamination. Sediment samples were collected from representative locations within the mapped geomorphic units. Analytical suites for these samples were adequate to cover the potential contaminant sources.

Do existing or proposed data for the site address potential transport pathways of site contamination? **(yes/no/uncertain)** **Provide explanation.** **(Consider if other sites should aggregated to characterize potential ecological risk.)**	Yes, sediment data are adequate to characterize potential contaminant transport pathways.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Reach PO-2 is located downstream of Eenie firing site. This reach had thorium-228 greater than the background value in one sample.
Many boulders in and next to a fairly narrow incised channel. Damp spots were noted in the channel in areas downstream of side channel, and fine sediments deposited in channel were also noted. Water might temporarily pool after storm events.
Habitat is mixed conifer. Fairly broad floodplain deposits and burrowing activity were noted in these deposits.

E1-3.0 PART C—ECOLOGICAL PATHWAYS CONCEPTUAL EXPOSURE MODEL

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

<u>Question A</u>:

Could soil contaminants reach receptors via 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: There are no known sources of volatile organic compounds (VOCs) in affected media in Potrillo and Fence Canyons. VOCs were detected in only 7 of 5580 results, represented by two analytes. The lack of ubiquitous VOCs in the geomorphically active sediments is consistent with the basic processes of sediment transport, deposition, and remobilization. Thus, with little or no VOC source term in the canyons-affected media, exposure to terrestrial receptors via vapors is unlikely.

<u>Question B</u>:

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: Surface soil is well-vegetated, mitigating fugitive dust carried in air. Burrowing animals are likely to encounter wetted subsurface sediment contamination via ingestion or direct contact rather than as dust in burrow air.

Question C:

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

- **If the SOP-2.01 runoff score* for each AOC/SWMU included in the site is equal to zero, this suggests that erosion at the site is not a transport pathway. (*Note: 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 if aquatic receptors could be affected by contamination from this site.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: No aquatic receptors are present in Potrillo and Fence Canyons. The discontinuous stream channel, ephemeral flow of water, and little or no evidence of ponding in the reaches preclude colonization by aquatic species.

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 via 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 (~1-m depth).**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: No persistent springs or seeps are present in the Potrillo and Fence Canyons.

<u>Question E</u>:

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

- **Suspected ability of contaminants to migrate to groundwater.**
- **The potential for contaminants to migrate via 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 (~1-m depth).**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: There is no known alluvial groundwater in these canyons.

<u>Question F</u>:

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: Not applicable, because these sites are not on or near mesa edges.

<u>Question G</u>:

Could airborne contaminants interact with receptors through respiration of vapors?

- **Contaminants must be present as volatiles in the air.**
- **Consider the importance of inhalation of vapors for burrowing animals.**
- **Foliar uptake of organic 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: VOCs were infrequently detected at low concentrations in Potrillo and Fence Canyon sediment samples.

Question H:

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

- **Contaminants must be present as particulates in the air or as dust for this exposure pathway to be complete.**
- **Exposure via 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: 2

Terrestrial Animals: 2

Provide explanation: Some contamination is expected to be subsurface, and vegetative cover is high in most reaches. In general, little contaminated dust is expected to be generated, limiting the potential importance of this exposure pathway.

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: 2

Provide explanation: Contaminated surface and subsurface sediment may interact with plants through root uptake or rain splash deposition.

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: This is a potentially major pathway because bioaccumulating chemicals of potential concern (COPCs) were detected in Fence Canyon sediment. For example, one high explosive compound was detected in sediment in two Fence Canyon reaches and low concentrations of three polychlorinated biphenyl compounds (Aroclor-1242, Aroclor-1254, and Aroclor-1260) were detected in three Fence Canyon reaches.

Question K:

Could contaminants interact with receptors via 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 while grooming 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: For some animals this will be a minor pathway because of contamination in surface and near surface deposits. However, it could be a major pathway for fossorial animals because they may dig through contaminated sediment and ingest dermal contamination while grooming.

Question L:

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

- **Significant exposure via 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: This is a minor pathway because of the type of COPCs present in the Potrillo and Fence watershed (most are not lipophilic). It is assumed that this pathway is not significant for burrowing mammals because of their specialized pelts. Thus, for burrowing mammals incidental soil ingestion (partly obtained during grooming) is assumed to be a more important exposure pathway.

Question M:

Could contaminants interact with plants or animals through external irradiation?

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

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

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: Gamma-emitting radionuclides (cesium-137 and uranium-235) were detected in sediment samples at concentrations above background.

<u>Question N</u>:

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

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

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

Terrestrial Plants: 0

Provide explanation: There is no persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

<u>Question O</u>:

Could contaminants interact with receptors through aquatic 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: There is no persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

<u>Question P</u>:

Could contaminants interact with receptors via 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 waterborne 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: There is no persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

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 waterborne 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: There is no persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

Question R:

Could contaminants in water or sediment 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: There is no persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

Question S:

Could contaminants in water or sediment bioconcentrate in free-floating aquatic, 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 persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

<u>Question T</u>:

Could contaminants in water or sediment 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 persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

<u>Question U</u>:

Could contaminants bioaccumulate in sedimentary or water column organisms?

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

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

Aquatic Animals: 0

Provide explanation: There is no persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.

Question V:

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

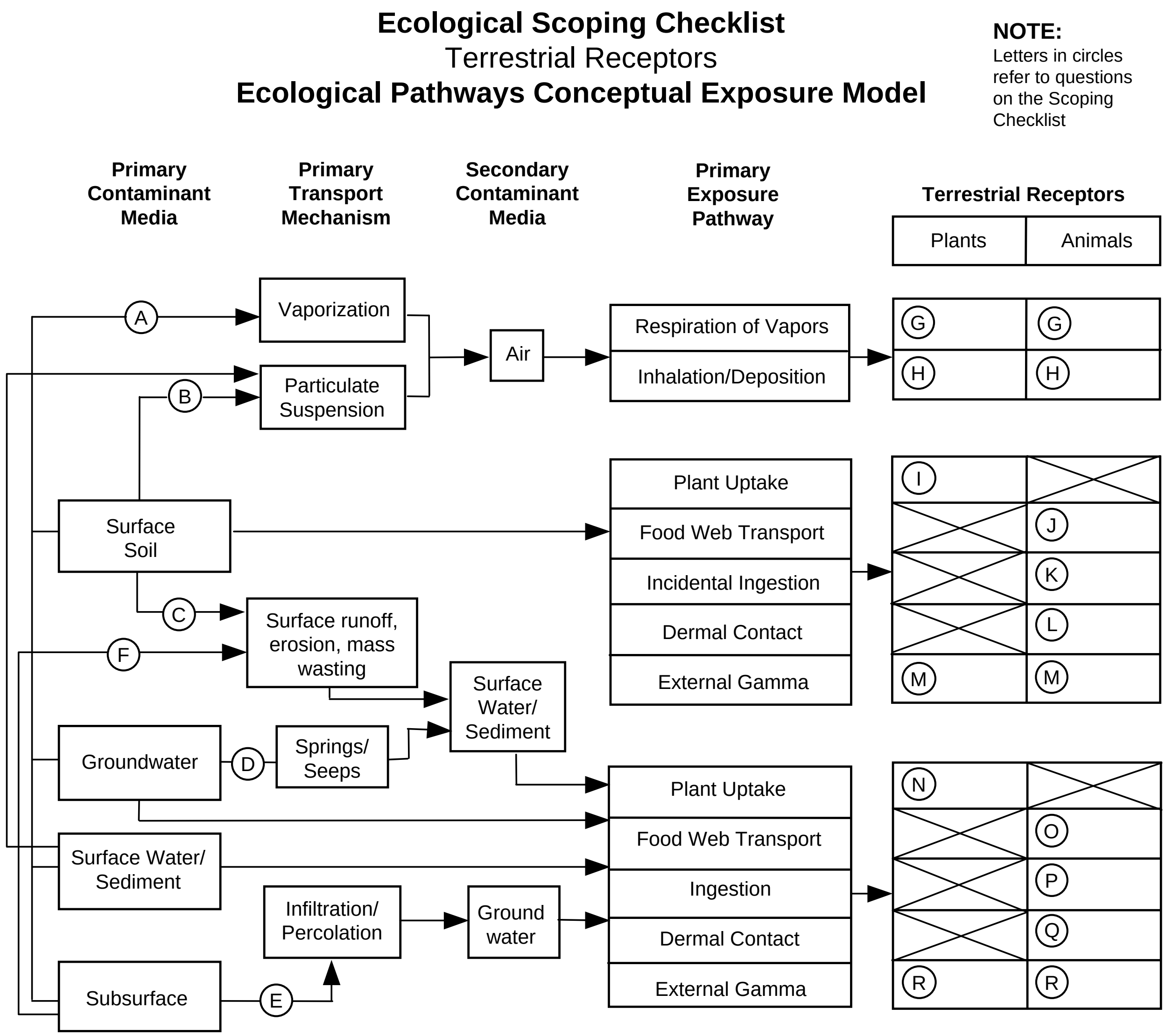
- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **The water column acts to absorb radiation; thus, external irradiation is typically more important for sediment dwelling organisms.**

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

Aquatic Plants: 0

Aquatic Animals: 0

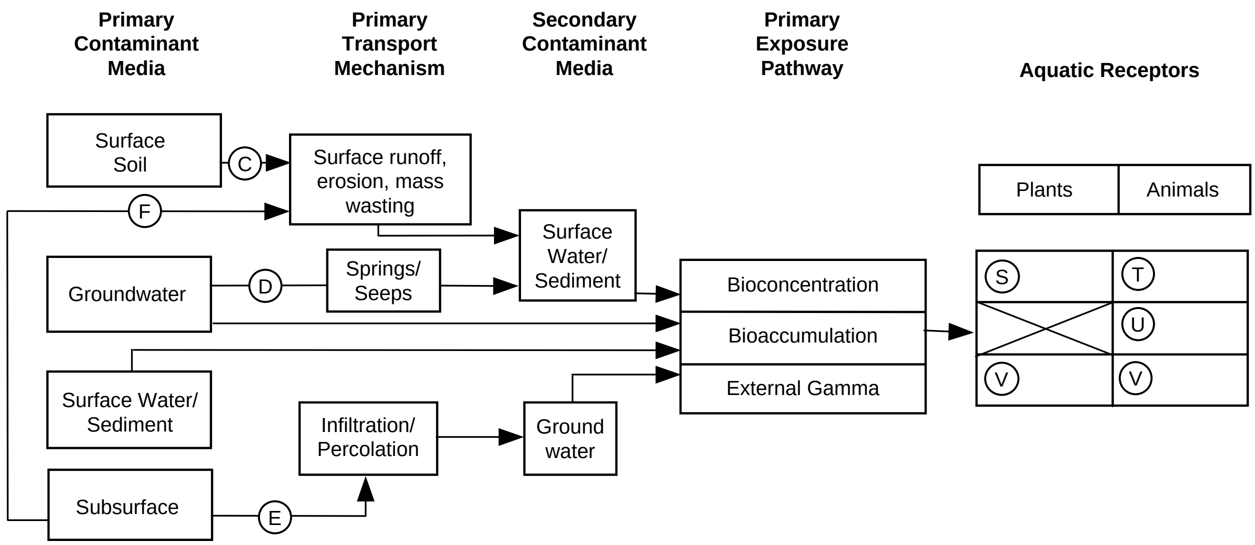
Provide explanation: There is no persistent surface water in Potrillo and Fence Canyons and therefore no pathway to sediment or water. No aquatic community receptors or pathways are present in Potrillo and Fence Canyons.



Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model
NOTE:
Letters in circles refer to questions on the Scoping Checklist
Primary Contaminant Media
Primary Transport Mechanism
Secondary Contaminant Media
Primary Exposure Pathway
Terrestrial Receptors
Plants
Animals
A
B
C
D
E
F
Vaporization
Particulate Suspension
Air
Respiration of Vapors
Inhalation/Deposition
G
G
H
H
Surface Soil
Plant Uptake
Food Web Transport
Incidental Ingestion
Dermal Contact
External Gamma
I
J
K
L
M
M
Surface runoff, erosion, mass wasting
Surface Water/ Sediment
Groundwater
Springs/ Seeps
Plant Uptake
Food Web Transport
Ingestion
Dermal Contact
External Gamma
N
O
P
Q
R
R
Surface Water/ Sediment
Infiltration/ Percolation
Ground water
Subsurface

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 (provide name, organization and phone number)

Name (printed):	Randall Ryti
Name (signature):	Randall Ryti
Organization:	Neptune and Company, Inc.
Phone number:	(505) 662-0707, ext. 37
Date completed:	December 15, 2010

Verification by another party (provide name, organization and phone number)

Name (printed):	Richard J. Mirenda
Name (signature):	Richard J. Mirenda
Organization:	Los Alamos National Laboratory, ET-DO
Phone number:	(505) 665-6953

E-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. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

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

LANL (Los Alamos National Laboratory), September 2006. "South Canyons Historical Investigation Report," Los Alamos National Laboratory document LA-UR-06-6012, Los Alamos, New Mexico. (LANL 2006, 093714)

Nisengard, J.E., November 10, 2010. "Reaches in the Potrillo, Fence, Ancho, Chaquehui, and Indio Canyon Systems for Threatened and Endangered Species Habitat for Ecological Screening/Risk Assessment," Los Alamos National Laboratory memorandum (ENV-ES:10-240) to S.L. Reneau (EES-16) from J.E. Nisengard (ENV-ES), Los Alamos, New Mexico. (Nisengard 2010, 111141)

Attachment E-2

ProUCL Files
(on CD included with this document)

Appendix F

Summary of Stormwater Analytical Results

This appendix presents a summary of the stormwater results collected within Potrillo and Fence Canyons from 2003 to 2010 (Table F-1). This period is representative of current site conditions, as presented in section 6.1 of the investigation report. The only gage in Potrillo and Fence Canyons that produced water samples was gage E267, Potrillo above SR-4. Table F-1 summarizes the stormwater results by field preparation (filtered or nonfiltered) for analytes that exceed the lowest applicable comparison value for that field preparation. The counts of detected concentrations and nondetects are listed. The range and average of the detected concentrations are summarized. The counts of results exceeding comparison values are also presented. All stormwater data are provided in Attachment C-2 on DVD.

The stormwater comparison values are presented in Table F-2; the basis for these values is provided in section 5.4. The classification of the sampling location is ephemeral, consistent with the State of New Mexico Standards for Interstate and Intrastate Surface Waters, New Mexico Administrative Code (NMAC) Section 20.6.4. The stormwater comparison values include values for livestock watering, wildlife habitat, human health persistent, and acute aquatic life from Section 20.6.4 NMAC.

Table F-1
Potrillo and Fence Canyons Stormwater Screen

Location Name	Field Preparation	Type of Analyte	Analyte	Total Number of Analyses	Count of Detected Analytes	Count of Nondetected Analytes	Average Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Count of Detected Analytes with Concentrations Greater than the Lowest Comparison Value*	Lowest Comparison Value*	Units
Potrillo above SR-4	Filtered	Inorganic	Aluminum	8	8	0	1450	597	2910	7	750	µg/L
Potrillo above SR-4	Nonfiltered	Rad	Gross alpha	5	5	0	82.2	31.8	170	5	15	pCi/L

* See Table F-2 for comparison value.

Table F-2
Stormwater Comparison Values

Pollutant	Field Preparation	Analyte Reporting Name	Chemical Abstract Service Number	NMWQCC[a] Livestock Watering (µg/L)	NMWQCC Wildlife Habitat (µg/L)	NMWQCC Human Health Persistent (µg/L)	NMWQCC Acute Aquatic Life (µg/L)
Aluminum	Filtered	Aluminum, dissolved	7429-90-5	—[b]	—	—	750
Antimony	Filtered	Antimony, dissolved	7440-36-0	—	—	640	—
Arsenic	Filtered	Arsenic, dissolved	7440-38-2	200	—	9	340
Boron	Filtered	Boron, dissolved	7440-42-8	5,000	—	—	—
Cadmium[c]	Filtered	Cadmium, dissolved	7440-43-9	50	—	—	0.6
Chromium[c]	Filtered	Chromium, dissolved	18540-29-9	1,000	—	—	213
Cobalt	Filtered	Cobalt, dissolved	7440-48-4	1,000	—	—	—
Copper[c]	Filtered	Copper, dissolved	7440-50-8	500	—	—	4.3
Lead[c]	Filtered	Lead, dissolved	7439-92-1	100	—	—	17
Mercury	Filtered	Mercury, dissolved	7439-97-6	—	—	—	1.4
Mercury	Nonfiltered	Mercury	7439-97-6	10	0.77	—	—
Nickel[c]	Filtered	Nickel, dissolved	7440-02-0	—	—	4,600	169
Selenium	Filtered	Selenium, dissolved	7782-49-2	50	—	4,200	—
Selenium	Nonfiltered	Selenium	7782-49-2	—	5	—	20
Silver[c]	Filtered	Silver, dissolved	7440-22-4	—	—	—	0.4
Thallium	Filtered	Thallium, dissolved	7440-28-0	—	—	0.47	—
Vanadium	Filtered	Vanadium, dissolved	7440-62-2	100	—	—	—
Zinc[c]	Filtered	Zinc, dissolved	7440-66-6	25,000	—	26,000	42
Cyanide, weak acid dissociable	Nonfiltered	Cyanide, weak acid dissociable	57-12-5	—	5.2	—	22
Ra-226 + Ra-228 (pCi/L)	Nonfiltered	Ra-226 + Ra-228	—	30 pCi/L	—	—	—
Gross Alpha (pCi/L)	Nonfiltered	Gross alpha	—	15 pCi/L	—	—	—
Aldrin	Nonfiltered	Aldrin	309-00-2	—	—	0.0005	3

Table F-2 (continued)

Pollutant	Field Preparation	Analyte Reporting Name	Chemical Abstract Service Number	NMWQCC[a] Livestock Watering (µg/L)	NMWQCC Wildlife Habitat (µg/L)	NMWQCC Human Health Persistent (µg/L)	NMWQCC Acute Aquatic Life (µg/L)
Benzo(a)pyrene	Nonfiltered	Benzo(a)pyrene	50-32-8	—	—	0.18	—
Gamma-BHC (Lindane)	Nonfiltered	Gamma-BHC (Lindane)	58-89-9	—	—	—	0.95
Chlordane	Nonfiltered	Chlordane	57-74-9	—	—	0.0081	2.4
4,4'-DDT	Nonfiltered	4,4'-DDT	50-29-3	—	0.001	0.0022	1.1
4,4'-DDD	Nonfiltered	4,4'-DDD	72-54-8	—	0.001	0.0022	1.1
4,4'-DDE	Nonfiltered	4,4'-DDE	72-55-9	—	0.001	0.0022	1.1
Dieldrin	Nonfiltered	Dieldrin	60-57-1	—	—	0.00054	0.24
2,3,7,8-TCDD Dioxin	Nonfiltered	2,3,7,8-TCDD Dioxin	1746-01-6	—	—	5.10E-08	—
alpha-Endosulfan	Nonfiltered	alpha-Endosulfan	959-98-8	—	—	—	0.22
beta-Endosulfan	Nonfiltered	beta-Endosulfan	33213-65-9	—	—	—	0.22
Endrin	Nonfiltered	Endrin	72-20-8	—	—	—	0.086
Heptachlor	Nonfiltered	Heptachlor	76-44-8	—	—	—	0.52
Heptachlor epoxide	Nonfiltered	Heptachlor epoxide	1024-57-3	—	—	—	0.52
Hexachlorobenzene	Nonfiltered	Hexachlorobenzene	118-74-1	—	—	0.0029	—
PCBs	Nonfiltered	PCBs	1336-36-3	—	0.014	0.00064	—
Pentachlorophenol	Nonfiltered	Pentachlorophenol	87-86-5	—	—	—	19
Toxaphene	Nonfiltered	Toxaphene	8001-35-2	—	—	—	0.73

[a] NMWQCC = New Mexico Water Quality Control Commission. NMWQCC comparison values from the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC).

[b] — = None available.

[c] Hardness dependent screening values are based on a hardness value of 30 µg/L.

Attachment 1

Supplemental Tables for Appendixes B, C, and E
(on CD included with this document)