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North Canyons Investigation Report

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EXECUTIVE SUMMARY

This investigation report for Barrancas, Bayo, Guaje, and Rendija Canyons (the “north canyons”) presents the results of studies conducted from 2000 to 2009 by Los Alamos National Laboratory (the Laboratory). These canyons have received inorganic and organic chemicals and radionuclides since the Laboratory was established in 1943, although only limited Laboratory-related activities have occurred in these canyons and the associated watersheds. These watersheds include developed areas within the Los Alamos townsite, which constitute additional sources of contamination. The investigations reported herein address sediment, surface water, and groundwater potentially impacted by solid waste management units (SWMUs) and areas of concern (AOCs) located within the north canyons watersheds. Investigations occurred along 23 km (14 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, surface water, and groundwater and assessing the potential risks to human health and the environment from these COPCs. The investigations also address the sources, fate, and transport of COPCs in the canyons and evaluate the need for additional characterization or remedial actions.

Sediment investigations included geomorphic mapping, associated geomorphic characterization, and sediment sampling in 10 investigation reaches located downcanyon from SWMUs or AOCs. Sediment sampling also occurred in one additional reach downcanyon from SWMUs and AOCs and in one reach located upcanyon from SWMUs and AOCs.

Surface-water investigations included evaluation of analytical data from samples collected at five locations along stream channels and one spring. Three of these are locations where water potentially occurs persistently enough to support an evaluation of human health risks.

Groundwater investigations included evaluation of analytical data from samples at one regional groundwater monitoring well within Bayo Canyon and five municipal supply wells in Rendija and Guaje Canyons. Groundwater investigations also included analyses of core samples and evaluation of analytical data from one spring.

Sediment COPCs in the north canyons include 21 inorganic chemicals, 33 organic chemicals, and 6 radionuclides. These COPCs are derived from a variety of sources, including Laboratory SWMUs and AOCs; runoff from developed areas in the Los Alamos townsite; ash from the area burned in the May 2000 Cerro Grande fire; 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 the evaluation of potential ecological or human health risk. The relative importance of the COPCs was determined by comparing COPC concentrations with human health residential screening action levels and soil screening levels and ecological screening levels.

In groundwater, arsenic is the only analyte that exceeds regulatory drinking water standards in a single detection from water supply well G-1A. This single result most likely reflects naturally occurring arsenic. In surface water, aluminum is the only analyte that exceeds a surface-water standard. Aluminum commonly exceeds this standard in surface water from the Pajarito Plateau, including background locations, and reflects naturally occurring aluminum. The lack of surface water and shallow alluvial groundwater at former Technical Area 10, which is the principal area of subsurface contamination within the north canyons, leads to minimal or no subsurface contaminant transport.

The results of this investigation indicate that human health risks in the north canyons are within acceptable regulatory limits for present-day and reasonably foreseeable future land uses. The site-specific human health risk assessment uses a recreational exposure scenario to represent the present-day and reasonably foreseeable future land use in the north canyons. The assessment results indicate

that for the recreational scenario, there are no unacceptable risks from carcinogens (incremental cancer risk criterion of 1 × 10^{-5}) or radionuclides (target dose limit of 15 millirems per year [mrem/yr] in sediment and 4 mrem/yr in water) due to COPCs in sediment or surface water. However, one location has lead concentrations at 1.3 times greater than levels acceptable for noncarcinogens. The potential for adverse effects from lead, however, is not likely, given the assumed frequency of exposures to surface water.

The conceptual model indicates that conditions for sediments are likely to stay the same or improve; therefore, no further monitoring of sediments is necessary. However, stormwater in the north canyons will be 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.”

Ecological screening of sediment and surface-water data indicates that there is little or no potential for adverse ecological effects to terrestrial or aquatic systems. Therefore, corrective actions are not needed to mitigate unacceptable risks. Chemicals of potential ecological concern (COPECs) identified in the ecological screening were compared with results from other watersheds where more detailed biota investigations were conducted. This comparison indicated that concentrations of COPECs in the north canyons derived from Laboratory SWMUs or AOCs are unlikely to produce adverse ecological impacts, and no additional biota investigations, mitigation, or monitoring are required.

CONTENTS

Figures

Tables

Appendixes

Attachment

Plates

1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility operated by the U.S. Department of Energy (DOE). 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 that 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). 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, in addition to investigations at individual SWMUs and AOCs.

1.1 Purpose and Scope

This investigation report presents the results of studies conducted from 2000 to 2009 in Barrancas, Bayo, Guaje, Rendija Canyons, and their tributaries. This area is collectively referred to in this report as the "north canyons." Figure 1.1-1 shows the north canyons watersheds and the primary subwatersheds or basins, and Plate 1 shows more detail within the primary investigation area. The investigations reported herein address sediment, surface water, and groundwater potentially impacted by SWMUs and AOCs located within the north canyons watersheds. These media are collectively referred to as "canyons media" in this report.

The investigations were conducted to fulfill the requirements of several documents. The "Work Plan for the North Canyons" (hereafter, "the work plan") (e.g., LANL 2001, 071060) describes work scope and regulatory requirements for characterizing the north canyons. It contains a background review of SWMUs and AOCs in the watersheds, the history of releases, and a review of contaminant data collected before the work plan was prepared. The New Mexico Environment Department (NMED) approved the work plan in 2005 following the Laboratory's response to a notice of disapproval (NOD) (LANL 2005, 089412; NMED 2005, 091653; NMED 2005, 088734; LANL 2006, 093250). The requirement to implement the work plan was also included by reference in Section IV.B.6 in the March 1, 2005, Compliance Order on Consent (the Consent Order).

The investigations conducted for 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. In 1998, NMED approved the core document following the Laboratory's response to a request for supplemental information (LANL 1998, 057666; NMED 1998, 058638).

Following submittal of the "Summary of North Canyons Phase 1 Sediment Investigations" (LANL 2007, 097108), NMED requested additional sediment sampling in one reach (NMED 2007, 095863). Results of this Phase 2 sediment investigation are included in this report. Results of groundwater investigations beneath the north canyons watersheds conducted as part of Laboratory's "Hydrogeologic Workplan" (LANL 1998, 059599) are also included in this report.

Data collected during the investigations included in this report are used to (1) define the nature and extent of contamination within the canyon bottoms and in groundwater beneath the north canyons; (2) update the conceptual model for contaminant distribution and transport within the canyons and underlying groundwater; (3) assess potential present-day human health and ecological risk from contaminants within the 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 data collected by the Laboratory since 2000 to evaluate current environmental conditions.

This report addresses characterization and risk assessment on the spatial scale of entire canyon systems, encompassing approximately 23 km (14 mi) of canyon bottom downstream of SWMUs and AOCs. The characterization and assessment approach used in this investigation provides an integrating perspective on historical and current contaminant releases to the canyon floor 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 watersheds and by helping to identify and prioritize remedial activities within the watersheds. 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.

1.2 Organization of Investigation Report

This investigation report has the following sections, following the outline used in the NMED-approved "Mortandad Canyon Investigation Report" (LANL 2006, 094161; NMED 2007, 095109). Section 1 is an introduction to the report and to the north canyons watersheds. 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 watersheds. 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). 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 and human health risk results and assessments. 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.

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. Data packages are included as Attachment C-1 on DVDs. Analytical data from the Environmental Restoration Database 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 through E are provided on CD in Attachment 1. Appendix F presents stormwater analytical results and comparisons to target levels.

1.3 Watershed Descriptions

Barrancas, Bayo, Guaje, and Rendija Canyons are located within the Los Alamos Canyon watershed. Bayo and Guaje Canyons drain directly into Los Alamos Canyon, and Barrancas and Rendija Canyons are tributaries to Guaje Canyon (Figure 1.1-1 and Plate 1).

The Guaje Canyon watershed heads in the Sierra de los Valles (the eastern Jemez Mountains) within the Santa Fe National Forest, has a maximum elevation at Caballo Mountain of 3199 m (10,496 ft) above sea level (asl), and extends approximately 25 km (16 mi) to Los Alamos Canyon at an elevation of approximately 1725 m (5655 ft) asl. The watershed, including Barrancas and Rendija Canyons, has a drainage area of 85 km^2 (33 mi^2), of which 72% is on U.S. Forest Service (USFS) land in the Santa Fe National Forest, 10% is on Pueblo de San Ildefonso land, 4% is on Pueblo de Santa Clara land, 4% is on General Services Administration (GSA) land administered by DOE, 5% is on private land or land owned by Los Alamos County, and a small area (<1%) is within the Valles Caldera National Preserve. Barrancas Canyon heads on Barranca Mesa in the Los Alamos townsite and has a length of approximately 9.1 km (5.7 mi) and a drainage area of 13 km^2 (5 mi^2), of which 49% is on USFS land, 28% is on Pueblo de San Ildefonso land, and 23% is on private land or land owned by Los Alamos County. Rendija Canyon heads in the Sierra de los Valles within the Santa Fe National Forest and has a length of approximately 16 km (10 mi) and a drainage area of 25 km^2 (10 mi^2), of which 77% is on USFS land, 15% is on GSA land, and 8% is on private land or land owned by Los Alamos County. Bayo Canyon heads on the Pajarito Plateau within the Los Alamos townsite and has a length of approximately 13 km (8 mi) and a drainage area of 10 km^2 (4 mi^2), of which 57% is on Pueblo de San Ildefonso land, 42% is on private land or land owned by Los Alamos County, and a small part (<1%) is within the current boundary of the Laboratory.

Bedrock geologic units exposed within the watersheds of the north canyons consist largely of volcanic and sedimentary rocks of the Jemez volcanic field, including dacitic rocks of the Miocene and Pliocene Tschicoma Formation, fanglomerates of the Pliocene Puye Formation, Quaternary ignimbrites of the Otowi and Tshirege Members of the Bandelier Tuff, and Quaternary tephras and sediments of the Cerro Toledo interval. Sedimentary rocks of the Miocene Santa Fe Group also occur in the eastern part of Bayo and Guaje Canyons (Griggs and Hem 1964, 092516; Smith et al. 1970, 009752). Geologic units within these watersheds are discussed in more detail in Section 7 of this report.

A comprehensive overview of the biological setting of the north canyons is provided in the work plan (LANL 2001, 071060). Details about the hydrology are provided in Section 7 of this report.

1.4 Current Land Use

The portions of the north canyons downcanyon from SWMUs and AOCs are either open to the public or are part of Pueblo de San Ildefonso. The Pueblo land is used for various traditional uses, including hunting. The remaining land is used largely for recreation, including hiking, horseback riding, and bike riding. Recreational target shooting occurs at the Sportsman’s Club in Rendija Canyon and also is dispersed elsewhere in the canyons, particularly at the “poor man’s shooting range” in Rendija Canyon east of the Sportsman’s Club. The County of Los Alamos maintains water supply wells in Guaje Canyon and lower Rendija Canyon, pump stations and other parts of a water distribution system in Guaje and Rendija Canyons, and sanitary wastewater lines in Bayo Canyon. Private residences are present near the canyon bottom in Rendija Canyon (North Community and Ponderosa Estates developments within the Los Alamos townsite), and on mesas above Barrancas, Bayo, and Rendija Canyons (Barranca Mesa and North Mesa developments). A small part of Bayo Canyon on Los Alamos County land, at the site of former Technical Area 10 (TA-10), is currently fenced, pending completion of environmental investigations and remediation. Most of the GSA land in Rendija Canyon is planned for conveyance and transfer to the County of Los Alamos (DOE 1998, 058671) by November 26, 2012 (U.S. Senate Armed Services Committee report [S. Rpt. 109-254] on Defense Authorization [S. 2766], Sec. 3116, Extension of Deadline for Transfer of Lands to Los Alamos County, New Mexico, and of Lands in Trust for the Pueblo de San Ildefonso). The Sportsman’s Club and the poor man’s shooting range are not planned to be transferred to the County of Los Alamos because of known contamination resulting from recreational target shooting.

2.0 BACKGROUND

Contaminants consisting of inorganic chemicals, organic chemicals, and radionuclides have been released into the north canyons watersheds from a variety of sources, including both Laboratory and non-Laboratory-related activities, since the Laboratory was established in 1943. The primary Laboratory contaminant source was former TA-10 in the bottom of Bayo Canyon. Other contaminant sources related to the Laboratory include former firing sites and mortar impact areas in Bayo and Rendija Canyons and an asphalt batch plant in Rendija Canyon. Non-Laboratory sources of contaminants include urban runoff from the Los Alamos townsite and recreational shooting in Rendija Canyon. 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 the canyon bottoms or in source areas are also discussed.

2.1 Sources and History of Contaminant Releases and Remediation Activities

2.1.1 TA-00

TA-00 refers to areas outside the current and former Laboratory boundaries where activities related to the Laboratory were conducted. Known sources of contaminants in TA-00 within the north canyons watersheds are discussed in Chapter 2 of the work plan (LANL 2001, 071060) and are summarized below. Additional work at some of these sites was reported in the “Investigation Report for Guaje/Barrancas/Rendija Canyons Aggregate Area at Technical Area 00, Revision 1” (LANL 2007, 099954).

The only confirmed Laboratory-related contaminant source in TA-00 within the Bayo Canyon watershed is SWMU 00-011(d) at the head of the canyon below Barranca Mesa. The U.S. Army fired various types of ordnance in this area between 1944 and 1948, and the Laboratory performed an extensive cleanup of ordnance fragments in 1994. Additional cleanup occurred in 2006. Soil sampling indicated that barium, lead, and selenium were above background levels, and perchlorate was also detected. No high explosives (HE) were detected (LANL 2001, 071060, p. 2-10; LANL 2007, 099954, pp. 9, 19). Stormwater sampling and biennial visual surveys to identify and remove any munitions and explosives of concern (MEC) or munitions debris (MD) will be conducted, starting in October 2009 (NMED 2007, 099632).

An asphalt batch plant, AOC C-00-041, was located in the area of the Guaje Pines Cemetery in Rendija Canyon from the late 1940s to about 1958. This was the source for a layer of asphalt that extended down the stream channel of the east fork of Rendija Canyon. Cleanups of this asphalt occurred in 1995, 1999, and 2007 (LANL 2001, 071060, pp. 2-28, 2-29; LANL 2007, 099954, p. 12) and continued biyearly; stormwater sampling and continued inspections to look for and remove tar and asphalt exposed by runoff and erosion will be conducted in the fall of each odd numbered year (LANL 2008, 102726; NMED 2008, 102289).

SWMU 00-011(a) is a former mortar impact area in Rendija Canyon east of the Sportsman’s Club. The U.S. Army fired various types of ordnance in this area between 1944 and 1948; in 1993, the Laboratory performed an extensive cleanup of ordnance fragments and of some live HE mortar rounds. Additional cleanup occurred in 2006. Soil sampling indicated that cadmium, cobalt, lead, manganese, and selenium were above background levels, and perchlorate was also detected. No HE was detected (LANL 2001, 071060, pp. 2-29, 2-30; LANL 2007, 099954, pp. 9, 18). Stormwater sampling and biennial visual surveys to identify and remove any MEC or MD will be conducted, starting in October 2009 (NMED 2007, 099632).

SWMU 00-011(e) is a former mortar impact area in Rendija Canyon north of the Sportsman's Club, in a short tributary referred to as "37-millimeter Canyon." The U.S. Army fired 37-mm rounds from tanks into this area between 1944 and 1948, and the Laboratory performed an extensive cleanup of ordnance fragments and of some live HE mortar rounds in 1993. Additional cleanup occurred in 2006. Soil sampling indicated that lead, mercury, nickel, and selenium were above background levels, and perchlorate was also detected. No HE was detected in soil samples from this area (LANL 2001, 071060, pp. 2-29, 2-30; LANL 2007, 099954, pp. 9, 18). Stormwater sampling and biennial visual surveys to identify and remove any MEC or MD will be conducted, starting in October 2009 (NMED 2007, 099632).

AOC 00-015 is the Sportsman's Club, an active firing range in Rendija Canyon on GSA land that is operated by a private club and has been in operation since 1966. Lead is present in earthen berms and on the surface, but there are no documented releases from the site (LANL 2001, 071060, p. 2-31). The site will not be remediated until the range is decommissioned.

SWMU 00-016 is a former small-arms firing range in Rendija Canyon northwest of the Guaje Pines Cemetery that the Laboratory security force used from 1947 to the early 1960s. The public subsequently used the site for recreational target practice until 1992. Voluntary corrective action (VCA) work was conducted at this site from 1993 to 1997 to remove lead and other metals from the soil (LANL 2001, 071060, pp. 2-31–2-33). The site was approved for no further action (NFA), and it was removed from the Resource Conservation and Recovery Act (RCRA) permit (Class III modification) in October 2001 (NMED 2001, 070236).

AOC 00-029(c), located in Guaje Canyon near former water supply well G-1, is the site of a potential transformer leak of PCB-containing oil. The transformer was removed on April 19, 1986 (Aldrich 1991, 071265). In November 2002, 44 soil samples were collected from 21 locations at AOC 00-029(c) and analyzed for polychloride biphenyls (PCBs) and pesticides (LANL 2003, 087625). Low concentrations of PCBs and DDT and the metabolites of DDT (DDE and DDD) were detected, but these presented no unacceptable risk to human health and no unacceptable potential for adverse ecological effects (LANL 2003, 087625). NMED made a determination of "Corrective Action Complete without Controls" in 2006 for this AOC (NMED 2006, 091517).

2.1.2 Former TA-10

Former TA-10, now known as the Bayo Canyon Aggregate Area, is located in the bottom of Bayo Canyon. During its operational history, the site included facilities that supported the development of nuclear weapons. Between 1943 and 1961, TA-10 was used primarily as a firing site to test assemblies containing conventional HE, including components made from depleted or natural uranium, and radiochemistry and liquid-processing facilities used in the production of lanthanum-140. Dispersal of material from the firing sites in Bayo Canyon over the watershed divide to the north and is a potential source of contamination for Barrancas Canyon, which otherwise has no identified source of contamination. Between 1960 and 1963, TA-10 underwent decontamination and decommissioning (D&D), including the razing of all structures. Several field investigations have been conducted at the site since the D&D, including field campaigns in 1994 (LANL 1996, 054332; LANL 1996, 054617) and in 2007 (LANL 2008, 102424). A 2007 geophysical survey indicated that all subsurface structures at former TA-10 have been removed, including drainlines and pipes (LANL 2008, 102424).

The Bayo Canyon Aggregate Area includes Consolidated Units 10-001(a)-99 and 10-002(a)-99, SWMUs 10-004(a) and 10-006, and AOCs C-10-001 and 10-009. The principal COPC for the Bayo Canyon Aggregate Area is strontium-90; however, a total of 24 inorganic, 42 organic, and 6 radionuclide COPCS were identified in solid media during the 2007 investigations. The nature and extent of site contamination are defined (LANL 2008, 102424). In general, the concentrations of inorganic and organic COPCs at all former TA-10 sites are low and do not exhibit marked concentration trends or strong correlation that would indicate a release. The 2007 data confirm the extent of the strontium-90 contamination associated with historical operations. Much of the former TA-10 area has been proposed as corrective actions complete without controls. However, pending DOE and Los Alamos County approval, further actions are proposed for Consolidated Unit 10-002(a)-99 because of concerns related to strontium-90, including continued institutional controls to limit site access to the Central Area and removing two isolated area of elevated strontium-90 activity identified outside the Central Area as a good stewardship practice (LANL 2008, 102424).

2.1.3 Runoff from Developed Areas

The north canyons watersheds include urbanized areas within the Los Alamos townsite, and runoff from developed areas can transport various contaminants into the canyons. Contaminants commonly found below developed areas include constituents in motor oil, gasoline, diesel fuel, asphalt, road salt, PCBs, heavy metals, and pesticides. Polycyclic aromatic hydrocarbons (PAHs), suspected carcinogens that are frequently associated with vehicle usage and asphalt, are a common class of contaminants associated with developed areas (Edwards 1983, 082302; Lopes and Dionne 1998, 082309; Van Metre et al. 2000, 082262). Metals associated with runoff from roads include cadmium, chromium, copper, lead, nickel, and zinc (Walker et al. 1999, 082308; Breault and Granato 2000, 082310, p. 49). Consistent with studies in other regions, investigations in other canyons in and near the Laboratory have identified various inorganic and organic COPCs as being associated with runoff from developed areas (LANL 2004, 087390, pp. 7-14, 7-16).

2.1.4 Cerro Grande Fire

In May 2000, the Cerro Grande fire burned a large part of the Guaje Canyon watershed, including much of the Rendija Canyon watershed. Approximately 46 km^2 (18 mi^2) of the Guaje watershed was within the burn perimeter (BAER 2000, 072659), comprising 54% of its area. Roughly half of the area within the burn perimeter was classified as low burn severity or not burned and half as high or moderate burn severity. 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 sediment before the fire, and the transport of ash has resulted in elevated levels of these analytes in post-fire sediment deposits in some canyons, including Guaje and Rendija Canyons (Katzman et al. 2001, 072660; Kraig et al. 2002, 085536; LANL 2004, 087390). Elevated levels of inorganic chemicals and radionuclides attributed to the transport of ash have also been found in stormwater samples in some canyons (Gallaher and Koch 2004, 088747, pp. 44-46).

2.2 Potential Contamination in Canyons Media

Potential contamination in sediment, surface water, and groundwater in the north canyons has been evaluated in several studies before this report, dating back to 1965 (Purtymun 1971, 004795). 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 (ESP) and related programs (e.g., the Formerly Utilized Sites Remedial Action Program) have sampled and analyzed sediments, surface water, and groundwater in the north canyons since 1965. This work, reported in annual environmental surveillance reports (e.g., LANL 2008, 105241) and in other reports (e.g., Purtymun 1971, 004795; Purtymun 1975, 011787; Mayfield et al. 1979, 011717; Gallaher and Koch 2004, 088747), supports the evaluation of long-term trends in contamination in different media and an understanding of the role of stormwater transport. A summary of all results from active channel sediment sampling in the north canyons from 1978 to 1999 is presented in the work plan (LANL 2001, 071060, pp. 3-11–3-22).

2.2.2 Ecology Group

The Laboratory's Ecology Group has conducted a study on the potential uptake of strontium-90 and uranium into vegetation in Bayo Canyon at former TA-10 (Fresquez et al. 1995, 068471).

2.2.3 RCRA and Consent Order Investigations

Since 1993, detailed studies of canyons media in the north canyons watersheds have been conducted by the Laboratory as part of RCRA and Consent Order investigations. Results of these investigations have been presented in several reports (e.g., LANL 1994, 059427; LANL 1995, 049974; LANL 1996, 054332; LANL 1996, 054617; LANL 1997, 056358; LANL 1998, 059996; LANL 2007, 097108; LANL 2007, 099954; LANL 2008, 102424). The work presented in this investigation report builds on these previous studies.

2.2.4 NMED and the U.S. Environmental Protection Agency

NMED and the U.S. Environmental Protection Agency (EPA) or their subcontractors have collected and analyzed samples from canyons media in the north canyons as part of oversight activities (e.g., Dale et al. 1996, 057014; NMED 1997, 057582; Yanicak 1998, 057583; EPA 2001, 070669). These data provide supplemental information about potential contamination in these watersheds.

3.0 SCOPE OF ACTIVITIES

The scope of activities in this report includes investigations of sediment, surface water, and groundwater in the north canyons watersheds, as presented in the work plan and subsequent documents (LANL 2001, 071060; LANL 2005, 089412; LANL 2006, 093250). 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 potential contaminants in post-1942 sediment deposits in a series of reaches in the north canyons. Data from these reaches are used to evaluate potential human health and ecological risks and to identify spatial trends in COPCs at a watershed scale, including variations in COPC concentration 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 work plan (LANL 2001, 071060); and in the canyons core document (LANL 1997, 055622; LANL 1998, 057666).

The scope of this investigation included characterization of the 10 reaches identified as priority reaches in the work plan (LANL 2001, 071060, p. 7-8). One of these reaches (R-3) and two additional areas (designated reaches G-Background [G-BKG] and R-3 East [R-3E]) were sampled in 2000 or 2001 to directly characterize post-fire sediment deposits that included ash from the Cerro Grande burn area. Table 3.1-1 lists the sediment investigation reaches and the years in which samples were collected in each reach. Table 3.1-1 also provides abbreviations for reach names included in this report and 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 and in Plate 1. One reach specified in the work plan, "R-1 North" (LANL 2001, 071060, p. 7-12), was renamed during this investigation to R-1 Middle (R-1M) to be consistent with the subsequent designations of the "middle fork" and the "north fork" for two tributary drainages to Rendija Canyon.

An additional task was conducting a walkover survey downcanyon from former TA-10 to search for shrapnel fragments that may have been transported by floods, as specified in the work plan (LANL 2001, 071060, p. 7-11).

3.2 Surface-Water and Groundwater Investigations

The water investigations presented in this report focus on watershed-scale characterization of surface water and groundwater within and beneath the north canyons watersheds. Data from these components of the hydrogeologic system are used to evaluate potential human health and ecological risk as well as to identify spatial trends in contamination at a watershed scale. This work involved sampling snowmelt runoff, stormwater, a spring and associated surface flow, and regional groundwater in wells. Additionally, one new regional groundwater monitoring well was installed. Water levels were measured at regional aquifer wells.

Persistent surface-water flow occurs west of the Rendija Canyon fault in upper Guaje Canyon. However, there is no persistent surface-water flow in the portions of the north canyons included in this investigation except for the lower end of Guaje Canyon below NM 502 where water emerges from the stream bed (GU-0.01 Spring). Intermittent surface-water flow occurs during snowmelt runoff, and ephemeral flow occurs as short-duration stormwater runoff. Figure 3.2-1 shows the locations of surface-water and groundwater sites sampled as part of this investigation. The investigation methods are discussed in Section 4.2. The scope of the investigation is described in the work plan (LANL 2001, 071060) and in NMED's approval with modifications (2005, 091288).

3.2.1 Monitoring Well Installation

Well R-24 was installed in Bayo Canyon in 2005 to fulfill the requirement of Section IV.C.5.c.v in the Consent Order to monitor regional groundwater in the vicinity of former TA-10. Well R-24 is located about 3670 ft east-southeast of Consolidated Unit 10-001(a)-99 and 830 ft north-northwest of the former Los Alamos County Bayo Wastewater Treatment Plant (WWTP) (Figure 3.2-1 and Plate 1). Well R-24 was drilled to a depth of 881 ft, and a single-completion well was installed with a well screen placed between depths of 825 and 848 ft. A separate core hole was drilled on the same well pad to a depth of 213 ft to determine if contaminants are present in pore water of rocks in the upper vadose zone. Well completion diagrams and geologic logs for R-24 are provided in the report, "Final Completion Report, Characterization Well R-24" (Kleinfelder 2006, 092489).

3.2.2 Surface-Water and Groundwater Sampling

Sampling activities included collection of snowmelt runoff or persistent surface water at two locations (gages E089 and E099), stormwater at five locations, spring water at GU-0.01 Spring near the confluence of Guaje Canyon with Los Alamos Canyon, and groundwater at monitoring well R-24 and at five municipal supply wells in Rendija and Guaje Canyons. Stormwater samples (see Appendix F) collected at three stream gages (E089, E090, and E099) are augmented by data collected at two site monitoring area (SMA) stormwater-sampling locations in upper Bayo Canyon (B-SMA-1) and upper Rendija Canyon (R-SMA-1). Sampling of stormwater was required under the Federal Facilities Compliance Agreement–Administrative Order (replaced on April 1, 2009, by an individual permit [IP] with EPA). The locations and analyte suites for groundwater samples in the watershed are specified in the annual “Interim Facility-Wide Groundwater Monitoring Plan” (IFGMP), in accordance with requirements in the Consent Order. Historical monitoring data from the Laboratory’s ESP were used to supplement this investigation. The list of surface-water sites and groundwater monitoring wells used to prepare this investigation report are presented in Table 3.2-1. Figure 3.2-1 and Plate 1 show the locations of the sampling sites listed in Table 3.2-1.

3.2.3 Water-Level Measurements

Both manual and automated water-level data have been collected from R-24 and from municipal supply wells in Guaje Canyon. A summary of water-level measurements for wells at the Laboratory, including those in the north canyons watersheds, is given in the annual report, “Groundwater Level Status Report for Fiscal Year 2000, Los Alamos National Laboratory” (Koch and Schmeer 2009, 105181). Some interpretation of these data is presented in Section 7.2 of this report.

3.3 Deviations from Planned Activities

In its NOD to the work plan, NMED required that the Laboratory install one alluvial well in lower Rendija Canyon on Santa Fe National Forest land (NMED 2005, 088734). The specified location is planned for transfer to the County of Los Alamos, and the U.S. Department of Agriculture (USDA) Forest Service denied the Laboratory’s request to install this well due to conditions in the pending land transfer (USDA 2009, 105313). The Laboratory was therefore unable to fulfill this requirement before preparation of this investigation report. Once land transfer to Los Alamos County is complete, the Laboratory will request access to drill the well from the county.

4.0 FIELD INVESTIGATIONS

Field investigations in the north canyons watersheds included investigations of sediment, surface water, and groundwater. The approaches and methods of these investigations are briefly discussed in the following sections. A more detailed discussion of the methods and of the sediment investigation results is presented in Appendix B.

4.1 Sediment

Sediment investigations in the north canyons 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 1997, 055622; LANL 1998, 057666; LANL 2001, 071060; LANL 2005, 089412; LANL 2006, 093250). The geomorphic characterization in most reaches included preparing a detailed geomorphic map and delineating the horizontal extent of geomorphic units with varying physical characteristics and/or age. These maps are presented in Plates 2, 3, and 4. The geomorphic characterization also included measuring the thicknesses 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).

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. In one reach, samples were collected in multiple phases, and analytical results from the initial sampling phase were used to help guide subsequent sampling. Section B-1.0 of Appendix B includes more detailed discussion of the investigation methods. All analytical results of the sediment sampling incorporated in this investigation report are presented in Attachment C-2 in Appendix C.

Plates 2 to 4 present geomorphic maps for reaches in the north canyons and 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 field investigation results, including sediment thickness measurements.

4.2 Surface Water and Groundwater

The surface-water and groundwater field investigations in the north canyons watersheds are designed to define the nature and extent of contamination, to identify the physical and chemical processes controlling contaminant distributions, and to identify the transport pathways that could result in potential human health and ecological exposure and risk. This work includes sampling surface water and a spring, installing a regional monitoring well, sampling municipal water supply wells, and measuring water-level variations in regional wells. In addition, core samples were collected at well R-24 to characterize the distribution of contaminants and moisture in rocks of the upper vadose zone.

4.2.1 Monitoring Well Installation

Well R-24 was installed in Bayo Canyon to monitor regional groundwater in the vicinity of former TA-10. The location of R-24 is shown in Figure 3.2-1 and in Plate 1. A separate core hole was drilled at the same location to determine if contaminants are present in pore water of rocks in the upper vadose zone. Well completion diagrams and geologic logs for R-24 are provided in the report, “Final Completion Report, Characterization Well R-24” (Kleinfelder 2006, 092489). Pore moisture and concentration data for nitrate and perchlorate in the upper vadose zone are presented in the “Los Alamos and Pueblo Canyons Groundwater Monitoring Well Network Evaluation and Recommendations” report (LANL 2008, 101330).

4.2.2 Surface-Water and Groundwater Sampling

Analytical results for surface-water and groundwater sampling are discussed in Section 7.2, and the data are provided as Attachment C-2 in Appendix C. Water-quality field parameters, including pH, specific conductance, temperature, and turbidity, were measured for each surface-water and groundwater sample collected. Sampling of nonstorm-related surface-water conditions, springs, and regional groundwater is conducted as part of the IFGMP (e.g., LANL 2009, 106115), and field and analytical procedures are described in that document.

4.2.3 Water-Level Measurements

Historical and new water-level data were compiled for regional wells in the investigation watersheds. These data, which included both manual and automated measurements, allow hydraulic interconnections between wells to be assessed by comparing water-level responses with pumping records at municipal supply wells. Water-level data were also collected to determine hydraulic gradients within groundwater bodies and to assess hydraulic conductivity. Details of the field methodology and results are presented in Koch and Schmeer (2009, 105181) and in Section 7.2.

5.0 REGULATORY CRITERIA

This section provides information on the regulatory context, human health screening levels, ecological screening values, applicable water-quality standards, and screening levels.

5.1 Regulatory Context

Regulatory requirements governing the canyons investigations are discussed in Section 1.4 of the NMED-approved canyons core document (LANL 1997, 055622; LANL 1998, 057666; NMED 1998, 058638; LANL 2007, 096665). In particular, these investigations address requirements of the Laboratory’s Hazardous Waste Facility Permit (Module VIII) under RCRA, including “the existence of contamination and the potential for movement or transport to or within Canyon watershed” (EPA 1990, 001585; EPA 1994, 044146). RCRA and the New Mexico Hazardous Waste Act (NMHWA) regulate releases of hazardous wastes and hazardous waste constituents. DOE Order 5400.1, “General Environmental Protection Program,” establishes requirements for managing residual radioactivity at DOE facilities.

As a result of the operational history of sites in the north canyons, this investigation addresses both radioactive and hazardous components. NMED has authority under the NMHWA over the cleanup of hazardous wastes and hazardous constituents, while DOE has authority over the cleanup of radioactive contamination. Radionuclides are regulated under DOE Order 5400.5, “Radiation Protection of the Public and the Environment,” and DOE Order 435.1, “Radioactive Waste Management.”

The regulatory requirements for conducting investigations in the north canyons are incorporated into Module VIII through work plans approved by NMED. The approved work plans include the “Work Plan for North Canyons” (LANL 2001, 071060) and the Laboratory’s “Hydrogeologic Workplan” (LANL 1998, 059599). Corrective actions at the Laboratory are subject to the Consent Order, which contains general requirements and those specific to the north canyons (Section IV.B.6, “Other Canyons: Ancho, Chaquehui, Indio, Potrillo, Fence, and North Canyons [Bayo, Guaje, Barrancas, and Rendija]”). The Consent Order was issued pursuant to NMHWA, New Mexico Statutes Annotated (NMSA) 1978 § 74-4-10 and the New Mexico Solid Waste Act (NMSWA) 1978, § 74-9-36(D). The requirements of the Consent Order now supersede those of Module VIII.

Surface-water discharges are subject to a permit under Section 402 of the federal Clean Water Act (CWA), including stormwater discharges, and are not regulated under the Consent Order. Stormwater discharges from certain SWMUs and AOCs are regulated by an IP issued by EPA Region 6, 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, February 13, 2009). The Laboratory’s IP became effective on April 1, 2009, and 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. Surface-water and groundwater standards are used to support the assessment of nature and extent of contamination in canyons media. Concentrations of chemicals and radionuclides are compared with various risk-based screening levels, which are described in Sections 5.2 and 5.3. Applicable water-quality standards are discussed in Section 5.4. Stormwater comparison values are discussed in Section 5.5.

5.2 Human Health Screening Levels

In Section 6, soil screening levels (SSLs) for inorganic and organic chemicals and screening action levels (SALs) for radionuclides are media-specific concentrations derived for residential exposures. If environmental concentrations of contaminants are below SALs or SSLs, then the potential for adverse human health effects is highly unlikely. For sediment chemical COPCs with carcinogen or noncarcinogen endpoints, SSLs from NMED guidance (NMED 2006, 092513) were used, if available. If values were not available from NMED, then the residential screening value from the EPA regional SL tables http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm was used as the SSL. 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} (E-5). For nonradionuclide COPCs without NMED SSLs, approved surrogate chemicals were used (NMED 2003, 081172). SALs for radionuclides were obtained from Laboratory guidance (LANL 2005, 088493). The radionuclide SALs have a target dose limit of 15 millirem per year (mrem/yr), which is consistent with guidance from DOE (2000, 067489).

Human health SLs for nonstorm-related surface water are EPA regional tap water screening levels for carcinogens and noncarcinogens (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and DOE Derived Concentration Guidelines (DCGs) for radionuclides. Comparisons to these screening values are provided in Section 8.2. The SLs for carcinogens and noncarcinogens in water are based on the same HQ and cancer risk levels as the SSLs. The SLs for radionuclides in nonstorm-related surface water were calculated based on a target dose limit of 4 mrem/yr, which is the radiation dose limit for a public drinking water supply in DOE Order 5400.5, “Radiation Protection of the Public and the Environment.”

Comparisons of sediment data to residential SLs are provided in Section 6. Additional information regarding the potential for human health risks from COPCs in affected media, including the assessment of nonstorm-related surface water, in the north canyons is provided in Section 8.2.

5.3 Ecological Screening Levels

Ecological screening levels (ESLs) are used to determine chemicals of potential ecological concern (COPECs) for water and 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 and surface water were compared with ESLs from the ECORISK Database Version 2.3 (LANL 2008, 103352); these comparisons are provided in Section 6. Additional information regarding the potential for ecological risks from COPCs in affected media in the north canyons is provided in Section 8.1.

5.4 Water-Quality Standards

COPCs are identified by comparing concentrations in water with applicable water-quality standards and screening values. The New Mexico Water Quality Control Commission (NMWQCC) establishes surface-water standards in the State of New Mexico Standards for Interstate and Intrastate Surface Waters

(20.6.4 New Mexico Administrative Code [NMAC]). Certain watercourses may be “classified” and have segment-specific designated uses. A designated use may be an attainable or an existing use (e.g., livestock watering) for surface water. Nonclassified surface waters are described as ephemeral, intermittent, or perennial, each of which also has corresponding designated uses described in 20.6.4.97–99 NMAC. The designated uses for surface water are associated with use-specific water-quality criteria (WQC), including numeric criteria.

Except for a short segment of Bayo Canyon, none of the north canyons lie within the current Laboratory boundary; surface waters are not classified with segment-specific designated uses. Guaje Canyon upcanyon from SWMUs and AOCs has perennial flow (20.6.4.99 NMAC), with designated uses of coldwater aquatic life, livestock watering, wildlife habitat, and secondary contact. No sampling locations from perennial segments are included in Section 6. The remaining segments in the north canyons are ephemeral (20.6.4.97 NMAC), with designated uses of limited aquatic life, livestock watering, wildlife habitat, and secondary contact.

The numeric WQC for livestock watering (20.6.4.900[F] and 20.4.6.900[J] NMAC); wildlife habitat (20.4.6.900[G] and 20.4.6.900[J] NMAC); acute aquatic life (20.6.4.900[H], 20.4.6.900[I], and 20.4.6.900[J] NMAC); human health (persistent) (20.6.4.11[G] and 20.4.6.900[J] NMAC); and secondary contact (20.6.4.900[E] NMAC) apply to nonstorm-related surface water for all of the watercourse classifications. For classified ephemeral/intermittent segments, the WQC for acute total ammonia (20.6.4.900[K] NMAC) also applies. The New Mexico Environment Improvement Board (NMEIB) Standards for Protection Against Radiation (20.3.4.461 [D], 20.3.4.461 [E] NMAC) are applicable to nonstorm-related surface water.

Concentrations of radionuclides in nonstorm-related surface water were compared with the lowest of the following values to identify COPCs:

- NMEIB Standards for Protection Against Radiation (20.3.4.461 [D], 20.3.4.461 [E] NMAC)
- DOE Biota Concentration Guides (BCGs) for protection of ecological receptors (DOE 2002, 085637)

If none of the above standards exist for an analyte, the following values were compared with concentrations in nonstorm-related surface water to identify COPCs:

- DCGs based on 4 mrem/yr

To identify COPCs in groundwater, comparisons to the lowest of the following standards were performed:

- Human Health (20.6.2.3103[A] NMAC: Human health standards)
- Other Standards for Domestic Water (20.6.2.3103[B] NMAC: Other standards for domestic water supply)
- EPA maximum contaminant levels (MCLs)
- NMEIB Standards for Protection Against Radiation (20.3.4.461 [D], 20.3.4.461 [E] NMAC)

If none of the above standards exist for an analyte, the following values were compared with concentrations in groundwater to identify COPCs:

- DCGs based on 4 mrem/yr
- EPA regional tap water SLs

Comparisons of nonstorm-related surface water and groundwater concentrations to applicable standards are summarized in Section 6.

5.5 Stormwater Comparison Values

Stormwater discharges are regulated under the CWA, and no applicable standards for stormwater are provided in the Consent Order. For informational purposes, available stormwater monitoring data for the north canyons are tabulated relative to the following comparison values:

- Livestock watering (20.6.4.900[F] and 20.4.6.900[J] NMAC)
- Wildlife habitat (20.4.6.900[G] and 20.4.6.900[J] NMAC)
- Acute aquatic life (20.6.4.900[H], 20.4.6.900[I], and 20.4.6.900[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 analytical data-screening assessments for samples collected in the north canyons to identify COPCs in sediment, nonstorm-related surface water, and groundwater samples. 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 evaluated in the human health risk assessment in Section 8.2 and have been considered in developing the measures evaluated in the baseline ecological risk assessment in Section 8.1. 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 screens for sediment and Section 6.3 presents the screens for nonstorm-related surface water and groundwater. Section 6.4 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 analytical data for all media are presented in Attachment C-1 in Appendix C. The data used in the assessments were obtained from the Sample Management Database and the WQDB and are presented in Attachment C-2 in Appendix C. Samples collected, analytical methods used, and data qualifiers are summarized in Appendix C.

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), PAH, or 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 primary characterization data.

- Results from water samples collected before 2003—Results from samples collected in 2003 and later are used in the COPC screens because these data are most representative of current site conditions.

6.2 Sediment COPCs

This section presents the process for screening analytical results obtained from sediment samples collected in the north canyons. Samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-1 in Appendix C. Sample locations are presented in Plates 2 to 4. 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 there is at least one detected result in the reach.

A total of 21 inorganic chemicals, 33 organic chemicals, and 6 radionuclides were retained as COPCs in sediment in the north 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. 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 are most important for understanding potential human health risk. Two inorganic COPCs (arsenic and iron), no organic COPCs, and one radionuclide COPC (cesium-137) have maximum concentrations exceeding residential SSLs or SALs in the north canyons, and these are included in the conceptual model for sediment in Section 7.1. These COPCs are highlighted in gray in Tables 6.2-1 and 6.2-3.

6.3 Surface-Water and Groundwater COPCs

This section presents the process for screening nonstorm-related surface-water and groundwater sample results from the north canyons. Water samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-2 in Appendix C. Sample locations are presented in Table 3.2-1, Figure 3.2-1, and Plate 1. Analytical results from nonstorm-related surface-water and groundwater samples were screened to develop a list of COPCs, as presented in Section 6.3.1. Spring samples were screened both as nonstorm-related surface water and as groundwater.

6.3.1 Identification of Surface-Water and Groundwater COPCs

There are no BVs for surface water, and retaining an analyte as a COPC is based on detection status. This process is performed for groups of data defined by field preparation (filtered or nonfiltered samples) and analyte type (inorganic chemicals, organic chemicals, and radionuclides). An analyte is retained as a COPC for a location if there is at least one detected result at that location.

Groundwater COPCs are identified by a screening process that includes comparing the maximum concentrations with Laboratory groundwater BVs (LANL 2007, 096665).

For inorganic chemicals and radionuclides, an analyte is retained as a COPC for a location if

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

There are no groundwater 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 for a location if there is at least one detected result at that location.

A total of 43 inorganic chemicals, 11 organic chemicals, and 16 radionuclides were retained as COPCs in water in the north canyons. Maximum sample results for nonstorm-related surface water and groundwater are presented in Tables 6.3-1 to 6.3-21.

6.3.2 Comparison of Water COPC Concentrations to Standards

Maximum detected concentrations of water COPCs were compared with applicable water-quality standards, as discussed in Section 5, to identify which are most important from a regulatory perspective. Two inorganic COPCs in the north canyons, aluminum and arsenic, have maximum concentrations exceeding a water-quality standard. These COPCs are highlighted in gray in Tables 6.3-2 and 6.3-15.

6.4 Stormwater

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

6.4.1 Stormwater Screen against Comparison Values

The first step in the stormwater screen (Table F-1.0-1) is an evaluation of detected analyte concentrations in filtered and nonfiltered stormwater against the lowest comparison value from the State of New Mexico Standards for Interstate and Intrastate Surface Waters (§ 20.6.4 NMAC), as described in Section 5.4.

These stormwater comparison values are presented in Table F-1.0-2 and include values for livestock watering, wildlife habitat, human health persistent, and acute aquatic life. Table F-1.0-1 presents the results of the stormwater screen for analytes with concentrations exceeding a comparison value grouped by location, field preparation, and analyte type.

The stormwater comparison values were exceeded by six inorganic chemicals (aluminum, cadmium, copper, lead, mercury, and zinc), one organic chemical (Aroclor-1260), and two radionuclides (radium-226 and radium-228). The stormwater comparison value for gross-alpha radiation was also exceeded. Table 6.4-1 summarizes the number of stormwater results by analyte exceeding the lowest comparison value and the basis for the comparison value.

6.4.2 Comparison of Stormwater Concentrations to Acute Exposure Benchmarks

Water uses consistent with existing, designated, or reasonable anticipated attainable uses of stormwater in the north canyons are those for acute ecological and human exposures. The maximum detected concentrations of the analytes exceeding stormwater comparison values based on acute aquatic life or persistent human health were compared with acute exposure benchmarks to identify which were most important, based on acute ecological or human exposures. Stormwater comparison values based on water uses inconsistent with existing, designated, or reasonable anticipated attainable uses of stormwater in the north canyons are those for livestock watering and wildlife habitat. Analytes exceeding these values (mercury, gross-alpha radiation, radium-226, and radium-228) are not evaluated further.

6.4.2.1 Acute Ecological Comparisons

The maximum detected concentrations of five analytes (aluminum, cadmium, copper, lead, and zinc) exceeded stormwater comparison values based on acute aquatic life. 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 6.4-2 summarizes the maximum detected concentrations of the analytes exceeding an acute benchmark, and these exceedances are discussed in Section 8.1.

6.4.2.2 Acute Human Health Comparisons

The maximum detected concentration of one analyte, Aroclor-1260, exceeded a stormwater comparison value based on persistent human health. Because persistent human health does not represent an acute exposure, a human health acute exposure benchmark was developed for Aroclor-1260. The method for calculating the acute human health exposure benchmark is described in Section 6.4.2.3. As shown in Table 6.4-3, the maximum detected value for Aroclor-1260 (0.066 µg/L) does not exceed the benchmark (4.65 µg/L), so Aroclor-1260 in stormwater is not discussed further.

6.4.2.3 Acute Human Health Stormwater SLs

Data on concentrations of contaminants are not typically evaluated for acute toxicity in human health risk assessments. Consequently, compilations of acute toxicity values are not typically available nor are media-specific screening values based upon acute toxicity data. To evaluate the acute oral toxicity due to short-term exposure to stormwater in the north canyons, the following hierarchy of acute oral toxicity values was used (in order of descending priority):

1. Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (MRLs) for hazardous substances)(http://www.atsdr.cdc.gov/mrls/)
    a. acute
    b. subchronic or intermediate
2. The Risk Assessment Information System (RAIS) Chemical Specific Toxicity Values (http://rais.ornl.gov/tox/tox_values.shtml)
    a. acute
    b. short-term
    c. subchronic
3. ATSDR oral toxicity values from chemical specific toxicity profiles modified by uncertainty and modifying factors (http://www.atsdr.cdc.gov/toxpro2.html)
    a. lowest acute nonlethal dose
    b. lowest acute lethal dose
    c. lowest subchronic dose

The selected dose (in mg/kg-d) from the above hierarchy of sources is then converted to a stormwater SL according to the following equation:

SL (µg/L) = [Dose (mg/kg-d) × body weight (BW) (31 kg)/water ingested (0.2 L/d)] × (1000 µg/mg)

In these calculations it is assumed that the most sensitive receptor will be the recreational child (BW = 31 kg) ingesting 0.2 L of water per day during an exposure event. This is consistent with the derivation of surface-water SLs in Section 8.2.

For example, the MRL for Aroclor-1260 is 3E-05 mg/kg-d (no value for Aroclor-1260 was available, so the ATSDR intermediate oral MRL for Aroclor-1254 is used); therefore, the SL for Aroclor-1260 is

SL Aroclor-1260 (µg/L) = (3E-05 × 31/0.2) × 1000 = 4.65 µg/L.

6.5 Summary

Table 6.5-1 presents a summary of the COPCs in sediment, nonstorm-related surface water, groundwater, and detected analytes in stormwater in the north canyons. Table 6.5-1 indicates which COPCs have maximum results that exceed residential SSLs and SALs for sediment and water-quality standards for nonstorm-related surface water and groundwater. Table 6.5-1 also indicates stormwater analytes with detected concentrations that exceed acute exposure benchmark values.

7.0 PHYSICAL SYSTEM CONCEPTUAL MODEL

This section discusses aspects of the physical system conceptual model that are relevant for understanding the nature, sources, extent, fate, and transport of contaminants in the north canyons watersheds. The discussion includes COPCs that are included in evaluations of potential human health risk in Section 8.2 or that exceed water-quality standards for surface water or groundwater. This section also includes discussion of 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 of contaminants. Section 7.2 describes the hydrology of the watersheds, including descriptions of surface water and regional groundwater, and summarizes spatial trends for contaminants in these media.

7.1 COPCs in Sediments

The following sections first use spatial variations in concentrations of sediment COPCs in the north canyons to identify sources, in part distinguishing COPCs that are present because of releases from Laboratory SWMUs or AOCs from COPCs derived from other sources, such as ash from the Cerro Grande burn area, runoff from roads or other developed areas, or 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). Therefore, the spatial distribution of contaminants can directly indicate their source or sources. In most reaches in Guaje and Rendija Canyons, pre- and post-fire sediment layers can be distinguished based on the presence of in situ or reworked ash at varying depths. COPCs that are elevated above BVs in post-fire sediment in the burn area and downcanyon but not in pre-fire sediment near potential Laboratory sources record the effects of redistribution of ash from the burn area. In contrast, COPCs that are elevated because of natural variations in background concentration generally show no distinct spatial trends and may have no significant differences in concentration between pre-fire and post-fire sediment. 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 revealing the presence or absence of contamination.

7.1.1 Inorganic Chemicals in Sediments

Two inorganic COPCs in north canyons sediment have maximum detected concentrations greater than residential SSLs and are most important for assessing potential human health risk: arsenic and iron. Five other inorganic COPCs are also included in the human health risk assessment in Section 8.2: aluminum, chromium, lead, manganese, and vanadium. Additional inorganic chemicals detected in sediment samples are also important for assessing potential ecological risk, as discussed in Section 8.1 (antimony, cyanide, selenium, and zinc). The spatial distribution of these inorganic chemicals (discussed below) indicates that they are derived from a variety of sources, including Laboratory SWMUs or AOCs, ash from the Cerro Grande burn area, roads and other developed areas, 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.

This section focuses on spatial variations in inorganic chemicals in the north canyons. Supporting information 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 2008, 104909). 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. For three inorganic chemicals that are elevated in Cerro Grande ash (antimony, cyanide, and manganese), Table D-1.2-1 distinguishes concentrations in pre- and post-fire sediment in each reach.

The plots in Figure 7.1-1 include both the 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 north canyons 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 that are indicative of natural background variations.

Aluminum is an important COPC for evaluating potential human health and ecological risk in the north canyons and is also important for evaluating water quality, as surface-water samples on the Pajarito Plateau are commonly above the NMWQCC acute aquatic life standard for dissolved aluminum (e.g., LANL 2008, 105241, p. 220). Three of the investigation reaches have maximum concentrations of aluminum above the sediment BV of 15,400 mg/kg (R-1E, R-1S, and R-3; Table 6.2-1), although none are above the residential SSL of 77,800 mg/kg. The highest concentration, 23,500 mg/kg, was measured in reach R-3, east of the Sportsman's Club (AOC 00-015), SWMU 00-001(a), and the poor man's shooting range in an active channel sample with elevated results for several other metals (sample CARE-06-72925). Aluminum concentrations in six other active channel samples from R-3 are below the BV, indicating that this sample was anomalous. None of these three reaches have average aluminum concentrations in fine facies sediment above the BV, as shown in Figure 7.1-1 and Table D-1.2-1. The highest average concentrations are in R-1E where the sediment has the highest silt and clay content in fine facies sediment (71%). Figure 7.1-2 shows the generally positive correlations that exist between aluminum concentration and silt and clay content for both north canyons and background sediment samples (background data from McDonald et al. 2003, 076084). With two exceptions, all north canyons samples fall on the same trend as background samples, and the higher aluminum in R-1E is consistent with the higher silt and clay content there than in the background samples. The two exceptions are both in R-3, one in the active channel sample mentioned previously (c1 unit) and one in a floodplain sample (f1 unit). These data indicate limited releases of aluminum upcanyon from R-3, perhaps at SWMU 00-001(a), AOC 00-015, or at the poor man's shooting range. Elsewhere, the combined aluminum and particle size data indicate that the aluminum above BVs represents natural background variations.

Antimony was indicated to be an important COPC for evaluating potential ecological risk in the north canyons, based on comparison of maximum sample results to ESLs and sediment data from other watersheds, as discussed in Section 8.1. However, it has only three detected results above the sediment BV of 0.83, 0.92, 1.2 mg/kg in ash-rich post-fire samples collected in 2000 and 2001 in reaches G-BKG and R-3. The average concentration in fine facies post-fire sediment in R-3 is above the BV (Table D-1.2-1). These results indicate that the elevated antimony is associated with ash from the Cerro Grande burn area and not Laboratory releases.

Arsenic is an important inorganic chemical for evaluating potential human risk in the north canyons with maximum concentrations being greater than the sediment BV of 3.98 mg/kg and the residential SSL of 3.9 mg/kg in four investigation reaches (G-BKG, R-1E, R-1S, and R-3; Table 6.2-1). (Note: Because of an elevated local background for arsenic on the Pajarito Plateau, the sediment BV is above the residential SSL.) Average concentrations of arsenic in fine facies sediment are greater than the sediment BV in one reach, R-1E, about 15% higher (4.59 mg/kg, Figure 7.1-1, Table D-1.2-1). As discussed for aluminum, this appears to represent an effect of particle-size variations because of a general positive correlation between arsenic concentration and silt and clay content and the finer average particle size in R-1E (Figure 7.1-2). With one exception, all north canyons samples fall in the same trend as background samples, and the higher arsenic in R-1E is consistent with the higher silt and clay content there than in the background samples. The one exception is in R-3 in the active channel sample mentioned previously (c1 unit). These data indicate a limited release of arsenic upcanyon from R-3, perhaps at SWMU 00-001(a), AOC 00-015, or at the poor man's shooting range. Elsewhere, the combined arsenic and particle-size data indicate that the arsenic above BVs represents natural background variations.

Chromium is an important inorganic chemical for evaluating potential human risk in the north canyons, and maximum concentrations are greater than the sediment BV of 10.5 mg/kg in most of the investigation reaches (BY-1, BY-2, G-1, R-1E, R-1M, R-1S, and R-3; Table 6.2-1). Average chromium concentrations in fine facies sediment in all reaches are less than the BV (Figure 7.1-1 and Table D-1.2-1), and no spatial pattern is present that would indicate a significant anthropogenic source. The highest average concentrations in fine facies sediment are in G-1 and R-1E and appear to represent background variations. Generally positive correlations between chromium concentration and silt and clay content are present in this data set, and higher averages in R-1E are consistent with the finer particle size there (Figure 7.1-2). In contrast, the higher average concentrations in G-1 appear to be associated with differing source rocks because the G-1 samples form a distinct population in the chromium-silt and clay plot (Figure 7.1-2), and chromium is not similarly elevated in upcanyon reaches in Rendija Canyon. Two distinct outliers are present in Figure 7.1-2, which are also the two highest results in this data set, and indicate isolated releases of chromium. One sample is the active channel sample from R-3 discussed previously, and the other is a coarse subsurface sample (50–75 cm deep) from the c2 unit of BY-2 (sample CABY-06-72833). The latter result suggests a source at former TA-10, immediately upcanyon.

Cyanide is an important COPC for evaluating potential ecological risk in the north canyons and has maximum concentrations above the sediment BV of 0.82 mg/kg in three samples in two of the investigation reaches, G-BKG and R-3E (Table 6.2-1). All three samples are ash-rich sediment deposited in 2000 and indicate a source in ash from the Cerro Grande burn area. Cyanide is also elevated in post-fire sediment samples and in stormwater collected from other burned watersheds not affected by Laboratory activities (Gallaher and Koch 2004, 088747, pp. 44-46; LANL 2008, 104909, p. 26). Average concentrations of cyanide in post-fire sediment in G-BKG and R-3E are presented in Table D-1.2-1.

Iron is an important inorganic chemical for evaluating potential human health and ecological risk in the north canyons. Maximum concentrations are greater than the sediment BV of 13,800 mg/kg in three investigation reaches (G-1, R-1E, and R-3; Table 6.2-1) and greater than the residential SSL of 23,500 mg/kg in one reach (R-3). Average concentrations of iron in fine facies sediment are below the BV in these three reaches (Figure 7.1-1 and Table D-1.2-1). The relation of iron concentration to silt and clay content is shown in Figure 7.1-2, and, with one exception, indicates the same general positive correlations discussed previously. This one exception is the same active channel (c1 unit) sample in R-3 discussed above. The slightly elevated iron in G-1 is consistent with differing source area geology, as seen for chromium, and the elevated iron in R-1E is consistent with the finer average particle size in R-1E and not anthropogenic releases.

Lead is an important COPC for evaluating potential human health and ecological risk in the north canyons and has maximum concentrations exceeding the sediment BV of 19.7 mg/kg in half of the investigation reaches (BY-1, BY-2, G-BKG, R-1E, R-3, and R-3E; Table 6.2-1). Average lead concentrations in fine facies sediment exceed the BV in two reaches (BY-1 and R-3) and are close to the BV in three other reaches (G-BKG, R-1E, and R-3E), as shown in Figure 7.1-1 and Table D-1-2-1, and indicate multiple sources. A plot of lead concentration versus silt and clay content (Figure 7.1-2) shows both a general correlation between lead and particle size and also a scattering of samples with higher lead than expected from this relation. The two highest lead concentrations are in ash-rich sediment in R-3 deposited by a large flood on July 2, 2001, that was derived from runoff from the Cerro Grande burn area and the Los Alamos townsite in an exceptionally intense rainstorm (Reneau et al. 2003, 105242). The occurrence of higher lead in these two samples than in other ash-rich samples indicates a source in the townsite. Lead is elevated in single coarse-grained samples from BY-2 and R-3 that have been discussed previously and from four finer-grained samples from BY-1. BY-1 is immediately downcanyon from SWMU 00-011(d), a site used for firing ordnance, which indicates it may have been a source. However, BY-1 also receives runoff from major paved roads, and lead in this reach may also be derived from road runoff. Lead is a common contaminant found below roads and other developed areas, and one source is leaded gasoline (Walker et al. 1999, 082308, p. 364; Breault and Granato 2000, 082310, p. 48; Callender and Rice 2000, 082307, p. 232). Lead is also apparently elevated in ash-rich samples collected from R-3E and G-BKG in 2000 in sediment deposited from the first runoff events after the Cerro Grande fire. The occurrence of the elevated lead in a background reach (G-BKG), upcanyon from paved roads, suggests it was concentrated in ash.

Manganese is an important COPC for evaluating potential human health risk and has maximum concentrations above the sediment BV of 543 mg/kg in three investigation reaches in the north canyons (G-BKG, R-3, and R-3E; Table 6.2-1). Manganese is only above the BV in ash-rich post-fire sediment samples, including a background reach in Guaje Canyon (G-BKG), as shown in Figure 7.1-1 and Table D-1-2-1, indicating a source in the Cerro Grande burn area. These relations are consistent with previous studies that also identified manganese as being elevated in ash-rich sediment in comparison to pre-fire background (Katzman et al. 2001, 072660; Kraig et al. 2002, 085536; LANL 2004, 087390; LANL 2008, 104909).

Selenium is an important COPC for evaluating potential ecological risk in the north canyons and has maximum detected concentrations above the sediment BV of 0.3 mg/kg in five investigation reaches (G-BKG, R-1E, R-1M, R-3, and R-3E; Table 6.2-1). It is also a COPC in the other reaches because of detection limits that are greater than the BV. Evaluating the distribution of selenium is difficult because of a high frequency of nondetects (81%) and elevated detection limits, such that the average detection limit for nondetects (1.77 mg/kg) is greater than the average detected concentration (1.10 mg/kg). Average selenium concentrations are presented in Table D-1.2-1 and also indicate the uncertainty in average concentrations associated with elevated detection limits. The maximum detected concentration, 2.4 mg/kg, was obtained from fine-grained sediment samples from R-1E that are also elevated in other metals, as discussed previously. Excluding R-1E, the next highest detected selenium concentrations are from the background reach G-BKG. Considering the uncertainties imposed by elevated detection limits and the occurrence of selenium above the BV in a background reach, no spatial trends are apparent that indicate significant Laboratory releases, and the sediment data instead indicate that selenium in the north canyons is largely or entirely naturally derived. The pervasive occurrence of selenium above the BV also suggests a difference in the analytical method between the background data set and the north canyons data set, which is supported by widespread detected selenium above BVs in other watersheds (e.g., LANL 2008, 104909).

Vanadium is an important COPC for evaluating potential human health and ecological risk in the north canyons. It has maximum concentrations above the sediment BV of 19.7 mg/kg in most of the investigation reaches (BY-1, BY-2, BY-3, G-1, R-1E, R-1M, R-1S, and R-3; Table 6.2-1), and average concentrations in fine facies sediment are greater than the BV in one reach (G-1) (Figure 7.1-1 and Table D-1.2-1). No clear spatial trends in vanadium concentration are evident that would indicate significant releases from SWMUs or AOCs, and instead, with one exception, the sediment data indicate natural background variability in vanadium. Figure 7.1-2 plots vanadium concentration versus silt and clay content, indicating the generally positive correlation that also exists for other metals. The one exception is the coarse active channel (c1) sample from R-3 discussed previously. The G-1 data plot above the general trend from other reaches, suggesting locally elevated background as also seen for chromium and iron. Vanadium has also been identified as having a locally elevated background elsewhere on the Pajarito Plateau (Cañada del Buey reach CDB-4, Drakos et al. 2000, 068739).

Zinc is an important COPC for evaluating potential ecological risk in the north canyons, and maximum concentrations are greater than the sediment BV of 60.2 mg/kg in three investigation reaches (BY-2, G-BKG, and R-3; Table 6.2-1). Average zinc concentrations in fine facies sediment are not above the BV in any reaches and are highest in the background reach G-BKG (Figure 7.1-1 and Table D-1.2.1). A comparison of zinc concentration and silt and clay content show the same general positive correlations seen for other metals, with two outliers in coarse-grained samples from BY-2 and R-3 that have been discussed previously (Figure 7.1-2). The spatial distribution of zinc therefore indicates that its primary source is natural background, with small releases into Bayo and Rendija Canyons indicated by the outliers from BY-2 and R-3.

7.1.2 Organic Chemicals in Sediments

This section focuses on spatial variations in select organic chemicals in the north canyons. No organic chemicals detected in sediments in the north canyons have maximum detected concentrations greater than residential SSLs, and none are included in the human health risk assessment in Section 8.2. Several organic chemicals detected in sediment samples are important for assessing potential ecological risk (Aroclor-1242, benzoic acid, and phenol). One class of detected organic chemicals, PCBs, is also of concern for impacts on the Rio Grande, which prompted fish advisories by the New Mexico Department of Game and Fish both upriver and downriver of the Laboratory (http://www.wildlife.state.nm.us/publications/documents/rib/2009/09FishRIB.pdf). Other classes of organic chemicals are important for identifying potential releases from SWMUs or AOCs, including former TA-10 in Bayo Canyon, an asphalt batch plant in Rendija Canyon, and mortar impact sites in Bayo and Rendija Canyons. These organic chemicals are derived from a variety of sources, including runoff from the Los Alamos townsite and possibly Laboratory SWMUs or AOCs, as indicated by their spatial distribution (discussed below). Once in the canyon bottoms, most of these organic chemicals will adsorb to sediment particles and organic matter, and their subsequent fate and transport by fluvial processes are expected to be similar to that for inorganic chemicals. Some of the organic chemicals discussed in this section have relatively short environmental half-lives associated with biodegradation and/or volatilization in the environment. Therefore, the concentrations will decrease over time unless additional amounts are added to the canyon bottoms (such as from road runoff). However, the degradation rates are not well constrained and vary with local environmental conditions.

7.1.2.1 Explosive Compounds

Explosive compounds were not detected in any of the north canyons sediment samples, indicating that SWMUs and AOCs in the north canyons are not significant sources for these organic chemicals.

7.1.2.2 PCBs

PCBs were detected in six reaches in the north canyons (BR-1, BY-1, BY-2, BY-3, R-1E, and R-1S; Table 6.2-2), at concentrations well below residential SALs (maximum of 0.0585 mg/kg for Aroclor-1242 versus the SSL of 1.12 mg/kg). Notably, PCBs were not detected in reach G-1, which is downcanyon from a former transformer site with reported detects of Aroclor-1260 [AOC 00-029(c)]. 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 (e.g., Walker et al. 1999, 082308, pp. 364-365), and their widespread use is consistent with their spatial distribution in sediments in the north canyons. The sediment data indicate that PCBs were derived from multiple sources in the watershed and that concentrations generally decrease downcanyon from these sources, as discussed below.

Average PCB concentrations in coarse and fine facies samples in each reach are shown in Table D-1.2-2, presenting average concentrations in each and 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. This table indicates that average concentrations of PCBs are generally lower in coarse facies sediment than in fine facies sediment, and the discussions and figures in the following sections focus on data from fine facies sediment. Table-D-1.2-2 also indicates the uncertainty that exists in the average concentration of PCBs in some reaches because of elevated detection limits and/or a high frequency of nondetects.

Aroclor-1242 was detected in seven samples, including all six reaches with detected PCBs (Table 6.2-2). The maximum concentration, 0.0585 mg/kg, was measured in BY-1, near the head of Bayo Canyon, which is also the highest detected PCB concentration in this data set. BY-1 also had the second highest detected result and was the only reach with two detects (20% detection frequency). The only upcanyon SWMU or AOC is SWMU 00-011(d), a site used by the U.S. Army for firing ordnance. The most likely source for the detected PCBs in this reach is runoff from roads or developed areas in the Los Alamos townsite. Aroclor-1242 was also detected at lower concentrations downcanyon in Bayo Canyon, in Rendija Canyon near the Guaje Pines Cemetery, and in Barrancas Canyon. A non-Laboratory source is inferred for the single Barrancas Canyon detect because it receives runoff from part of the Los Alamos townsite and because there were no Laboratory facilities in this watershed. The two Rendija Canyon detects, with similar low concentrations, are also in areas receiving runoff from the townsite and are similarly inferred to represent non-Laboratory sources.

Aroclor-1254 was detected in seven samples from four reaches (BY-1, BY-2, BY-3, and R-1E; Table 6.2-2). BY-2, immediately east of former TA-10, had a single detect (10% detection frequency), and the other reaches had two detects each (20% detection frequency). As with Aroclor-1242, the two highest detected results for Aroclor-1254 were in BY-1 (0.0368 and 0.0333 mg/kg), indicating a probable non-Laboratory source at the head of the watershed. Detected results in other reaches are much lower.

Aroclor-1260 is the most frequently detected PCB in the north canyons, being detected in 15 samples from five reaches (BY-1, BY-2, BY-3, R-1E, and R-1S; Table 6.2-2) but at lower concentrations than the other Aroclors. The maximum concentration (0.0169 mg/kg) and the highest frequency of detects (60%)

was from BY-2, immediately east of former TA-10, indicating a possible source for this PCB. Runoff from developed areas in Los Alamos (e.g., Barranca Mesa), between BY-1 and BY-2, may also be the source for this Aroclor-1260. The second and third highest concentrations (0.0139 and 0.0119 mg/kg) were from BY-1, indicating a non-Laboratory source in the Bayo Canyon watershed.

The maximum concentrations of all Aroclors were measured in fine facies sediment samples, as found for many other contaminants. Average concentrations in fine facies sediment are shown in Figure 7.1-3 and show the higher concentrations that occur in BY-1 for Aroclor-1242 and Aroclor-1254 than in the other reaches. Aroclor-1260 has similar but lower concentrations in BY-1 and BY-2, decreasing downcanyon in BY-3. Relatively low concentrations are present in R-1E and R-1S near the Los Alamos townsite but not farther downcanyon in Rendija or Guaje Canyons. The low concentrations of Aroclor-1242 in Barrancas Canyon (BR-1) also indicate the dispersed occurrence of PCBs in areas without Laboratory facilities.

7.1.2.3 Pesticides

Six pesticides were detected in sediment samples from the north canyons: chlordane (alpha-), chlordane (gamma-), DDE (4,4'-), DDT (4,4'-), dieldrin, and endosulfan II (Table 6.2-2). The highest frequency of detects was from reach BY-1 at the head of Bayo Canyon, which drains residential areas in Los Alamos. Only three pesticides were detected in BY-1 (chlordane [alpha-], chlordane [gamma-], and dieldrin). The next highest detection frequencies were from reaches R-1E and R-1M, which also drain residential areas as well as receive runoff from the Guaje Pines Cemetery. Only DDE (4,4'-) and DDT (4,4'-) were detected in these reaches. Reach R-1E had the highest measured concentrations of these pesticides in the north canyons, 0.00236 and 0.00359 mg/kg, respectively. Pesticides were also detected in reach BR-1 in Barrancas Canyon and reaches R-2 and R-3 in Rendija Canyon. No pesticides were detected in Bayo Canyon below former TA-10 (reaches BY-2 and BY-3) or in Guaje Canyon. These data indicate that the Los Alamos townsite is the most important source of pesticides in the north canyons.

7.1.2.4 SVOCs

Two SVOCs are important in the north canyons for assessing potential ecological risk, benzoic acid and phenol, as discussed in Section 8.1. Other SVOCs, including PAHs, are important for evaluating the potential effects from a former asphalt batch plant in Rendija Canyon, AOC C-00-041, and former TA-10 in Bayo Canyon. Sources and average concentrations of these SVOCs are typically uncertain, as discussed below.

Benzoic acid was reported as detected in four sediment samples from one investigation reach in the north canyons, R-3 (Table 6.2-2). All detects were from fine-grained samples—two from ash-rich sediment deposited by the large flood of July 2, 2001, and two from older pre-fire sediment. The highest concentrations were measured in the ash-rich sediment, 2 and 3.4 mg/kg, which also had high concentrations of lead, as discussed in Section 7.1.1. The July 2, 2001, storm produced significant runoff from the Los Alamos townsite, and the occurrence of benzoic acid in these two samples but not other ash-rich samples indicates a source in the townsite. Concentrations in the other two samples, 0.659 and 0.679 mg/kg, are below the average detection limit for other samples (0.778 mg/kg), preventing reliable conclusions concerning average concentrations or sources, although the Los Alamos townsite is also a possible source for them.

Phenol was reported as detected in two sediment samples from one investigation reach in the north canyons, R-3 (Table 6.2-2). Both detects were from the fine-grained ash-rich sediment deposited by the large flood of July 2, 2001, that also contained elevated benzoic acid and lead. This indicates that runoff from the Los Alamos townsite is the source of this phenol.

Two SVOCs were detected in reach R-1E immediately below the former asphalt batch plant, AOC C-0-041, di-n-butylphthalate and pyrene. Di-n-butylphthalate was detected only in R-1E, with a detection frequency of 30%, suggesting a possible source at this AOC. However, measured concentrations, 0.0504 to 0.0549 mg/kg, were much lower than the average detection limit for di-n-butylphthalate in the north canyons sediment samples, 0.394 mg/kg, preventing reliable conclusions concerning average concentrations or sources. The PAH pyrene was detected in both R-1M (30% detection frequency) and R-1E (40% detection frequency), and the detected concentrations were higher in R-1M (0.0202 to 0.146 mg/kg in R-1M versus 0.00375 to 0.00578 mg/kg in R-1E). Pyrene was also detected at similar concentrations in BY-1 and G-1 (0.00446 to 0.0506 mg/kg). These data indicate that the most important source for pyrene in the north canyons is a non-Laboratory source in the middle fork of Rendija Canyon above reach R-1M, an area which includes a residential development, and that AOC C-0-041 is not an important source for SVOCs.

No SVOCs were detected in sediment samples in Bayo Canyon downcanyon of former TA-10 (reaches BY-2 and BY-3), indicating that this TA was not a significant source of SVOCs.

7.1.2.5 VOCs

VOC data were obtained only from the three Bayo Canyon reaches to evaluate if former TA-10 was a source for these constituents. Five VOCs were detected in Bayo Canyon (chloroform, isopropylbenzene, isopropyltoluene[4-], toluene, and trichloro-1,2,2-trifluoroethane[1,1,2-]), and two of these (isopropylbenzene and isopropyltoluene[4-]) in BY-2 immediately east of former TA-10 (Table 6.2-2). There were only single detects for each of these VOCs from BY-2 (10% detection frequency), and both of the detected values (0.000524 and 0.000439 mg/kg) were lower than the average detection limit (0.00116 and 0.00115 mg/kg). These data indicate that former TA-10 was not a significant source for VOCs in Bayo Canyon sediment samples.

7.1.3 Radionuclides in Sediments

Two radionuclides in sediments in the north canyons are identified as being important for the evaluation of potential human health risk in Section 8.2, cesium-137 and strontium-90. No radionuclide COPCs have been identified as important for evaluating ecological risk. Table D-1.2-3 in Appendix D shows average concentrations of these two radionuclides in fine and coarse facies sediment in each reach where they are COPCs, distinguishing concentrations in pre- and post-fire sediment. Figure 7.1-4 shows the spatial variations in average cesium-137 and strontium-90 concentration in fine facies sediment in these reaches, separated into pre-fire and post-fire samples.

Cesium-137 was detected at concentrations above the sediment BV of 0.9 pCi/g in four reaches: BR-1, G-BKG, R-3, and R-3E (Table 6.2-3). With the exception of the single result from BR-1 exceeding the BV (1.11 pCi/g), all other results are from ash-rich post-fire sediment from reaches downcanyon from the Cerro Grande burn area. Average concentrations are above the BV in fine facies post-fire sediment from G-BKG, R-3, and R-3E but not in pre-fire sediment in any reach (Figure 7.1-4 and Table D-1.2-3). These results are consistent with other studies that have shown cesium-137 to be elevated in Cerro Grande ash and post-fire ash-bearing sediment relative to pre-fire background (Katzman et al. 2001, 072660; Kraig et al. 2002, 085536; LANL 2004, 087390).

Strontium-90 was detected at concentrations above the sediment BV of 1.04 pCi/g in two reaches: G-BKG and R-3 (Table 6.2-3). All results exceeding the BV are from ash-rich post-fire sediment from reaches downcanyon from the Cerro Grande burn area, although average concentrations in fine facies sediment are below the BV these reaches (Figure 7.1-4). These results are consistent with other studies that have shown strontium-90 to be elevated in Cerro Grande ash and post-fire ash-bearing sediment relative to pre-fire background (Katzman et al. 2001, 072660; Kraig et al. 2002, 085536; LANL 2004, 087390). Notably, even though strontium-90 is a widespread contaminant at former TA-10 in Bayo Canyon (LANL 2001, 071060), it was not detected above the BV in downcanyon reaches (BY-2 and BY-3), indicating minimal surface transport.

7.1.4 Shrapnel in Sediments

A walkover survey was conducted in Bayo Canyon downcanyon of former TA-10 in September 2007 to look for shrapnel fragments that had been transported by floods and to perform field radiation measurements on them (LANL 2007, 099656). Three pieces of deformed metal were found during the survey. One was located approximately 0.8 km (0.5 mi) east of the TA-10 fence outside the active channel and may have been within the dispersal range of debris from the TA-10 firing sites and not transported by floods. The other two were located within the active channel approximately 2.9 km (1.8 mi) east of the TA-10 fence and record dispersal by floods. None of these pieces had measurable radioactivity above background levels. This survey indicates a small amount of flood transport of nonradioactive shrapnel from former TA-10.

7.1.5 Summary of Sources and Distribution of Key Sediment COPCs

The data discussed in the previous sections indicate that the sediment COPCs in the north canyons have a variety of sources, including runoff from roads and other developed areas in the Los Alamos townsite, ash from the Cerro Grande burn area, natural background, and possibly Laboratory SWMUs or AOCs. Table 7.1-1 summarizes the inferred primary sources of the sediment COPCs discussed above and also the inferred downcanyon extent of COPCs that may be derived from Laboratory sources. Sources and downcanyon extent for these COPCs are discussed further below.

7.1.5.1 Cerro Grande Ash

Various inorganic chemicals and radionuclides are elevated above BVs in ash from the Cerro Grande burn area, and downcanyon transport of ash in post-fire floods has affected the chemistry of sediment deposits in many canyons in and near the Laboratory (Katzman et al. 2001, 072660; Kraig et al. 2002, 085536; LANL 2004, 087390; LANL 2008, 104909). As discussed in previous sections, the occurrence of several COPCs in the north canyons is dominated by the redistribution of ash, including antimony, cyanide, manganese, cesium-137, and strontium-90 (Sections 7.1.1 and 7.1.3; Figures 7.1-1 and 7.1-3). At least one COPC, lead, shows a combination of sources, including runoff from the Los Alamos townsite, redistribution of Cerro Grande ash, and possible releases from Laboratory sites (Section 7.1.1 and Figure 7.1-1). These COPCs were derived from the upper watersheds of Guaje and Rendija Canyons, and post-fire floods transported them the full length of these canyons, into lower Los Alamos Canyon, and into the Rio Grande.

7.1.5.2 Los Alamos Townsite Sources

Roads, parking lots, and other developed areas are the primary sources for several COPCs in sediment in the north canyons, including the PCBs, Aroclor-1242 and Aroclor-1254, and the SVOCs, benzoic acid and phenol, as discussed in previous sections. The highest concentrations of these PCBs were measured in reach BY-1 at the head of Bayo Canyon in an area draining part of the townsite but not including any former Laboratory facilities that may have released PCBs. The distribution of another PCB, Aroclor-1260, suggests sources at both the townsite and former TA-10. Lead, benzoic acid, and phenol are notably elevated in two fine-grained ash-rich samples collected from reach R-3 in Rendija Canyon following the large flood of July 2, 2001. This was the largest post-fire flood in Rendija Canyon at that time and involved heavy rainfall and runoff from both the Cerro Grande burn area and the townsite. The occurrence of these COPCs in those two samples but not other ash-rich samples indicates a source from the townsite, perhaps from areas where residences had burned during the fire.

7.1.5.3 Natural Background Variability

Sediment data from different canyons indicate that natural background concentrations for many inorganic chemicals and radionuclides are more variable than 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 there are no Laboratory releases. For example, in Cañada del Buey above White Rock, sampling of sediment in local drainages not affected by Laboratory operations identified a series of inorganic chemicals as being elevated above BVs in that area (barium, cobalt, iron, selenium, and vanadium; Drakos et al. 2000, 068739). In the north canyons sediment data set, concentrations of many COPCs are generally positively correlated with silt and clay content (Figure 7.1-2), and higher concentrations in some north canyons samples than in the background samples are consistent with their higher silt and clay content. For example, the maximum silt and clay content in the background samples was 54%, whereas silt and clay content exceeds this in 19% of the north canyons samples. The highest average silt and clay content in fine facies sediment in the north canyons reaches is 71% in R-1E, where results for several inorganic chemicals are also elevated (e.g., aluminum, arsenic, chromium, iron, and vanadium). Additional background variability is indicated in reach G-1 in Guaje Canyon, which drains an area of differing bedrock geology from other reaches. Chromium, iron, and vanadium are elevated in G-1 relative to other reaches, although the only SWMU between it and upcanyon reaches is the site of PCB spills from a former transformer [AOC 00-029(c)].

7.1.5.4 Former TA-10

Former TA-10 in Bayo Canyon was the largest Laboratory facility in the north canyons watersheds, and the sediment data indicate some downcanyon transport of COPCs from this site. The PCB Aroclor-1260 has the highest detection frequency and the highest sample results in reach BY-2, immediately downcanyon from former TA-10, although concentrations are low and well below the residential SSL. Aroclor-1260 was also detected in the next downcanyon reach, BY-3. These data indicate the release of some Aroclor-1260 from this site, although Aroclor-1260 is also present farther upcanyon in reach BY-1, and the Los Alamos townsite is another source for this PCB. Aroclor-1260 was not detected farther downcanyon in lower Los Alamos Canyon (reach LA-5), above the Rio Grande (LANL 2004, 087390), constraining the downcanyon extent of measurable Aroclor-1260 derived from Bayo Canyon.

Several inorganic chemicals are elevated in a single coarse-grained sample from the c2 unit in reach BY-2, collected at a depth of 50 to 74 cm (1.6 to 2.4 ft), including chromium, lead, and zinc. The results from this sample indicate minor releases from former TA-10. These metals were also identified as COPCs at former TA-10 (LANL 2008, 102424). However, they were not identified as COPCs downcanyon in reach BY-3, indicating limited spatial distribution. They are also not above background levels in previous environmental surveillance sediment samples from lower Bayo Canyon above NM 502 (e.g., LANL 2001, 071060, p. 3-12).

Strontium-90 is a widespread contaminant at former TA-10 (LANL 2001, 071060), but it was not detected above the BV in downcanyon reaches (BY-2 and BY-3). This indicates minimal surface transport. The sediment data also indicate that former TA-10 was not a recognizable source for explosive compounds, pesticides, SVOCs, or VOCs in Bayo Canyon. These data are consistent with previous environmental surveillance sediment samples from lower Bayo Canyon above NM 502 (e.g., LANL 2001, 071060, p. 3-12). In addition, a walkover survey conducted the length of Bayo Canyon downcanyon from former TA-10 found no radioactive shrapnel that had been transported by floods (LANL 2007, 099656).

Dispersal of material from firing sites at former TA-10 over the watershed divide to the north is the only possible source of Laboratory contaminants into the Barrancas Canyon watershed. However, no COPCs that can be traced to former TA-10 were identified in reach BR-1 in Barrancas Canyon immediately downgradient from the closest tributary drainage to the firing sites.

7.1.5.5 SWMU 00-011(a), AOC 00-015, and the Poor Man's Shooting Range

Several potential contaminant sources exist in Rendija Canyon east of the Guaje Pines Cemetery, particularly SWMU 00-011(a) (a former mortar impact area), AOC 00-015 (the Sportsman's Club), and the poor man's shooting range. The highest concentrations of several inorganic COPCs were measured in one of two coarse-grained samples collected in 2006 from the active stream channel (c1 unit) in reach R-3, downcanyon from these sites. These COPCs include antimony, arsenic, chromium, iron, lead, vanadium, and zinc. To evaluate if these COPCs were widespread in this reach, an additional 10 samples were collected from R-3 in 2007, including five new c1 locations. These COPCs were not above BVs in any of the samples from 2007, indicating that releases from upcanyon were minor.

7.1.5.6 SWMU 00-011(d)

SWMU 00-011(d) is a site at the head of Bayo Canyon where the U.S. Army fired ordnance between 1944 and 1948. Lead is present above the sediment BV in reach BY-1, immediately downcanyon, which indicates SWMU 00-011(d) may have been a source. However, BY-1 receives runoff from major paved roads, and lead in this reach may also be derived from road runoff. Lead is a common contaminant found below roads and other developed areas, and one source is the past use of leaded gasoline (Walker et al. 1999, 082308, p. 364; Breault and Granato 2000, 082310, p. 48; Callender and Rice 2000, 082307, p. 232).

7.1.5.7 Other SWMUs and AOCs

The sediment data collected in this investigation indicate that other SWMUs and AOCs have had little or no impact on sediments in the north canyons.

AOC C-00-041 is a former asphalt batch plant at the current site of the Guaje Pines Cemetery that released asphalt into the east fork of Rendija Canyon. However, SVOCs or VOCs are not elevated in reach R-1E immediately downgradient from the AOC.

SWMU 00-011(e), a former mortar impact area in Rendija Canyon north of the Sportsman's Club, is a potential source of contaminants to Rendija Canyon east of the Guaje Pines Cemetery. However, no inorganic COPCs or explosive compounds that might be related to the firing activities were detected in reach R-2, immediately downgradient from SWMU 00-011(e).

SWMU 00-016, a former small-arms firing range northwest of the Guaje Pines Cemetery, is a potential source of contaminants for the middle and south forks of Rendija Canyon. Lead is a primary contaminant derived from firing ranges, but it was not detected above the sediment BV in reaches R-1M or R-1S immediately downcanyon, indicating no recognizable impacts from this SWMU on canyon bottom sediments.

AOC 00-029(c) is a former transformer site in Guaje Canyon. No PCBs were detected in reach G-1, immediately downgradient, indicating no recognizable impacts from this AOC.

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 Rendija and Bayo Canyons where Laboratory operations were conducted. Guaje Canyon is also discussed because it contains a small AOC, and it receives snowmelt and stormwater runoff from Rendija Canyon. Barrancas Canyon is not directly affected by Laboratory operations and is not discussed further. Figure 7.2-1 shows the locations of three conceptual hydrogeologic cross-sections discussed below, along with several water supply wells and monitoring wells R-4, R-24, and G-3. Figures 7.2-2 and 7.2-3 are conceptual hydrogeologic cross-sections that follow the canyon floors for Bayo Canyon and Guaje Canyon, respectively. Figure 7.2-4 is a north-northeast trending conceptual cross-section that cuts across the north canyons area.

7.2.1 Bayo Canyon

The hydrologic conditions of Bayo Canyon are such that the canyon can be classified as a dry canyon as described by Birdsell et al. (2005, 092048). Dry canyons 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 in their floors. If anthropogenic water sources are present, they are small volume sources. These hydrologic factors yield little lateral near-surface contaminant migration and slow unsaturated flow and transport from the surface to the regional aquifer. Because surface-water flow is infrequent and alluvial water is uncommon, 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 (similar to dry mesas). Finally, transport times to the aquifer beneath dry canyons are expected to be from hundreds to several thousands of years.

Bayo Canyon has a relatively small drainage area of 10.4 km^2 (4.0 mi^2) and heads on the Pajarito Plateau in a residential area of Los Alamos at an elevation of approximately 2256 m (7400 ft) (LANL 2001, 071060). Surface-water flow in the canyon is ephemeral, with flow occurring primarily following infrequent, intense thunderstorms; flow generally lasts a few hours and is confined to the upper canyon (LANL 2008, 102424). Only five surface-water flow events were measured at gage E070 (Plate 1) in Bayo Canyon for the period from January 2002 to December 2005. There are no outfalls that release to the canyon. Former TA-10 SWMUs and AOCs are located within alluvium on the floor of middle Bayo Canyon. Alluvium is underlain by a thin sequence (10–15 m) of nonwelded ash-flow tuffs of the Otowi Member and fall deposits of the Guaje Pumice Bed (Figure 7.2-2). These tuffs overlie fanglomerate deposits of the Puye Formation.

Extensive drilling in and around former TA-10 has shown that alluvial groundwater is absent in this area. For example, during a 1994 RCRA facility investigation (RFI), 93 boreholes were drilled to a minimum depth of 50 ft in the former TA-10 area, and none of them encountered saturated conditions in the alluvium (LANL 1996, 054332). In addition, drilling campaigns conducted during 1961, 1973–1974, 1980, and 2007 encountered no saturated conditions (LANL 1996, 054332; LANL 2008, 102424). Subsurface moisture content was measured on three alluvial core samples collected near SWMU 10-007 in 2007; low moisture contents ranging from 4.7% to 14.8% were reported (LANL 2008, 102424, Table 4.3-4). Moisture content was also measured on one core sample from the Guaje Pumice Bed at this same location; that sample was unsaturated with a moisture content of 23.3%, which is quite dry given the high porosity (65.8%) of the sample (LANL 2008, 102424; Table 4.3-4). Test holes drilled into the top of the

Puye Formation (e.g., BCO-1 and BCM-1 [Plate 1] drilled in 1994 and BCTH-1 through BCTH-4 [Plate 1] drilled in 1961) also encountered unsaturated conditions (LANL 2001, 071060). BCO-1 is completed as an observation well at the interface between the Guaje Pumice Bed and the Puye Formation and was noted to be dry through 1995 (LANL 2001, 071060). The well was sounded for water on June 2, 2009, for this investigation and was found to be dry.

Migration of contaminants to deeper zones is inhibited by a lack of surface water and alluvial groundwater in Bayo Canyon. No alluvial or perched-intermediate groundwater was identified when regional aquifer well R-24 was drilled downcanyon of the former TA-10 site. Core collected over the 65-m (213-ft) length of the separate core hole drilled adjacent to R-24 was unsaturated. The regional water table lies approximately 253 m (830 ft) below the surface at R-24 (Koch and Schmeer 2009, 105181). Contaminant profiles for strontium-90 from core holes drilled in the former TA-10 area indicate that the maximum subsurface concentrations, and most of the mass, occur at depths of less than 10 m (30 ft) in the central area of Consolidated Unit 10-002(a) beneath SWMU 10-007 (Figure 7.2-2) (LANL 1996, 054617; LANL 2008, 102424). Strontium-90 was not detected in core samples collected to a depth of 65 m (213 ft) or in regional groundwater at R-24 (Plate 1).

7.2.2 Rendija and Guaje Canyons

The hydrologic conditions of Rendija and Guaje Canyons are such that the canyons are most closely classified as naturally wet canyons, as described by Birdsell et al. (2005, 092048). Several features characterize the large, deep naturally wet canyons on the Pajarito Plateau. Their headwaters are in the mountains, they have large catchment areas (>13 km^2), surface flow occurs frequently, and perched-alluvial groundwaters exist beneath portions of the canyon floors. Often, deeper perched-intermediate zones are associated with wet canyons, but no deep perched-intermediate groundwater was identified when the municipal supply wells were drilled in the Guaje well field. The geometry of wet canyons promotes hydrologic conditions that can yield relatively fast, unsaturated flow, especially in areas with persistent alluvial groundwater.

Both Rendija Canyon and Guaje Canyon head on the flanks of the Sierra de los Valle, at elevations of 2311 m (9825 ft) and 3199 m (10,497 ft), respectively. Rendija Canyon has a drainage area of 24.6 km^2 (9.5 mi^2), and Guaje Canyon (including Barrancas and Rendija Canyons) has a drainage area of 85.0 km^2 (32.8 mi^2). Although surface-water flow is perennial in upper Guaje Canyon and may be fairly persistent in upper Rendija Canyon, the SWMUs and AOCs in these canyons are located in lower reaches where surface flow is ephemeral or intermittent (Figure 7.2-3). Surface flow in these lower reaches is largely controlled by large precipitation events and snowmelt during years with heavy snow fall. To illustrate the range in the frequency of runoff events, runoff data from 2006 (a light snow year) and 2007 (a heavy snow year) are contrasted. At gages E089 (Guaje above Rendija) and E099 (Guaje at SR-502) (Plate 1), infrequent stormwater runoff was observed in 2006 (7 d and 7 d, respectively), and much more frequent runoff was observed in 2007 (83 d and 60 d, respectively).

Thick packets of canyon-floor alluvium are less common beneath Rendija Canyon than beneath other large canyons on the plateau, and they occur predominantly near the confluence with Guaje Canyon. In the western part of the Rendija drainage, the suballuvial lavas are relatively nonporous rocks; the fractures in these rocks may allow some infiltration, particularly near faults that tend to shatter these brittle rocks. In Guaje Canyon below the confluence with Rendija Canyon, alluvium is somewhat thicker 10–40 ft), based on drill logs for the replacement municipal supply wells installed in 1998 (Shomaker 1999, 092525)**.** In years with sufficient stormwater runoff, the alluvial packet near the confluence of the two canyons is likely recharged by surface water and represents a zone of deep infiltration. In addition, infiltration likely occurs into the porous and permeable Puye and Chamita Formations where those are present near the surface.

At three AOCs near the Guaje Pines Cemetery (00-016, C-00-20, and C-00-041), canyon-floor alluvium in Rendija Canyon is underlain by a thin sequence of Tshirege ash-flow tuffs underlain by thick Tschicoma dacitic lavas (Figure 7.2-3). The north-trending Rendija Canyon fault zone lies near the eastern extent of the AOCs. Surface-water flow in this part of the watershed is intermittent to ephemeral, occurring primarily during snowmelt and storm runoff. Some infiltration of surface water may occur along fractured lavas within the Rendija Canyon fault zone, but the likelihood of measurable contaminants in perched or regional groundwater beneath the canyon floor is minimal because of the low inventory of potential contaminants available for mobilization. AOCs 00-016 and C-00-041 were remediated and are no longer potential contaminant sources. An RFI found that the third AOC (C-00-20) showed no evidence of Laboratory use, and it was recommended for NFA. The three AOCs contained low or no soluble contaminants that could be mobilized during infiltration.

Groundwater flow in alluvium is expected to be limited downcanyon of the cemetery because the canyon is narrow, and alluvium is thin where the stream cuts through dacitic lavas on the footwall of the Rendija Canyon fault. Exposures of lava bedrock in the stream channel indicate the alluvium is discontinuous in areas.

Canyon-floor alluvium in Rendija Canyon thickens near the Sportsman's Club where the canyon floor widens in a broad area underlain by Cerro Toledo volcaniclastic sediment and Otowi Member ash-flow tuffs and fall deposits (Figure 7.2-3). The porous sediment and tuff overlie coarse Puye fanglomerate and Tschicoma dacitic lavas. The north-trending Guaje Mountain fault zone cuts through the area just west of the Sportsman's Club. The presence of thicker alluvium, highly porous sediment and tuff bedrock, and fractures associated with the fault zone may enhance infiltration in this area. However, the intermittent to ephemeral nature of surface-water flow indicates that the amount of water available for infiltration is limited. The AOCs near the Sportsman's Club include a shooting range (00-015) and firing sites (00-011) that contain low inventories of contaminants that could be mobilized during infiltration.

East of the Sportsman's Club, Rendija Canyon is deeply incised into coarse fanglomerate deposits of the Puye Formation. The canyon floor narrows, and the stream gradient increases toward the confluence with Guaje Canyon, 4.7 km (2.9 mi) downcanyon of the Sportsman's Club. The stream channel contains coarse poorly sorted alluvial deposits that are lithologically similar to the Puye fanglomerate. During storm runoff, surface water generally flows to Guaje Canyon; however, some infiltration may occur beneath lower Rendija Canyon.

The Puye Formation pinches out as the suballuvium bedrock unit in Guaje Canyon about a kilometer downstream of its confluence with Rendija Canyon (Figure 7.2-3). Farther east, alluvium overlies Chamita Formation sands, silts, and gravels. Surface-water flow in this portion of Guaje Canyon is intermittent and ephemeral. Purtymun (1995, 045344, Table XXVII-B) showed that surface flow rarely extended east of the Guaje Mountain fault in Guaje Canyon during low flow stream measurements made during 1958, 1959, 1960, and 1967. The thickness of alluvium and occurrence of alluvial groundwater in lower Guaje Canyon is not well defined, but municipal well G-5A (Plate 1), located 750 m west of the Rendija Canyon confluence, encountered alluvial groundwater during drilling operations (Shomaker 1999, 092525, p. 10).

The only AOC in Guaje Canyon is the former PCB transformer site [AOC 029(c)] located near former municipal well G-1 at the Pueblo de San Ildefonso boundary, for which NMED made a determination of "Corrective Action Complete without Controls" in 2006 (NMED 2006, 091517).

7.2.3 Regional Aquifer

The regional aquifer beneath the Pajarito Plateau is a complex hydrogeological system. The top of the aquifer is predominantly under phreatic (water-table) conditions. However, there are also areas of local confinement caused by local hydrogeological conditions. In general, the top of the regional aquifer is defined by the elevation of the regional water table. In the areas of local confinement, there is a regional piezometric surface that represents the elevation of hydraulic heads in the confined zones. The regional aquifer flow is generally from west to east, controlled by the regional zones of aquifer recharge (near the Jemez Mountains) and discharge (near the Rio Grande). Maps of the regional aquifer water table are discussed in various reports (e.g., LANL 2007, 095364; LANL 2008, 101932).

The flow directions in the regional aquifer beneath the north canyons are uncertain because there are a limited number of regional aquifer wells in this area. The flow occurs predominantly in sediments of the Santa Fe Group (Figures 7.2-2 and 7.2-3, in the figures for the Santa Fe Group, are represented by Chamita Formation and Miocene basalts). It is important to note that the aquifer is predominantly under confined conditions that appear to become artesian close to the Rio Grande (near the Los Alamos well field; Figure 7.2-3). The artesian conditions may allow some groundwater to flow upward into the shallower zones of saturation. For example, elevated uranium, as well as major anions and cations in alluvial wells in Los Alamos Canyon (LLAO-4 and LLAO-5), may indicate mixing of deep regional aquifer water in the alluvial aquifer (see also Section 7.2.4 below). The elevated uranium may indicate that the groundwater in the deep regional aquifer beneath the Rio Grande originated predominantly east of the Rio Grande. The westward groundwater flow in the subsurface beneath the Rio Grande may be controlled by the pronounced western dip and anisotropic hydraulic properties of the stratified sediment deposits in the Santa Fe Formation in this area (Koning et al. 2007, 106122). Additional information about the potential artesian aquifer conditions near the Rio Grande has been discussed by Vesselinov (2004, 090040).

In the north canyons, there is one regional aquifer monitoring well, R-24 (Figure 7.2-1). The well has a single, 23-ft long screen between the depths of 825 and 848 ft below ground surface (bgs) (Figures 7.2-2 and 7.2-4). Figure 7.2-4 presents a hydrogeologic cross-section intersecting well R-4 in Pueblo Canyon, well R-24 in Bayo Canyon, and well G-2A in Guaje Canyon (Figure 7.2-1). The well R-24 screen partially penetrates a 60-ft-thick interval of Santa Fe Group sediments spanning depths of 810 to 870 ft bgs. The screened zone of saturation is sandwiched between relatively tighter Miocene basalts (Figure 7.2-4). The piezometric water level is observed to be above the screen within the basalts, thus confining the Santa Fe sediments in which the well was completed. The average hydraulic conductivity of the 60-ft-thick Santa Fe sediments penetrated by well R-24 is estimated, based on a single-hole pumping test (Kleinfelder 2006, 092489); it is approximately 0.1 m/d. Long-term observations of water-level transients (Koch and Schmeer 2009, 105181) suggest that well R-24 is influenced by the pumping of water supply well PM-3 (Figure 7.2-5). More detailed analysis of well R-24 transients is performed using a modeling approach previously described in the “Pajarito Canyon Investigation Report” (LANL 2008, 104909, Appendix I). Pumping records of various water supply wells on the Pajarito Plateau (Pajarito, Otowi, and Guaje well fields; Figure 7.2-1) indicate that well R-24 water levels respond predominantly to pumping of supply wells PM-3 (distance = 2.5 km) and O-4 (distance = 2.4 km) (Figures 7.2-5). The model-predicted and observed water levels (and drawdown) at well R-24 are compared in Figure 7.2-6. Contributions to the total drawdown at well R-24 due to pumping of supply wells PM-3 and O-4 are also plotted in Figure 7.2-6 along with their respective pumping records. The figure demonstrates the ability of the model to represent observed water-level transients. Other water supply wells may slightly influence water level at well R-24 (less than 10 cm), but those influences are difficult to identify because of the existing data. The Guaje well field is located about 3.2 km to the northeast of well R-24. The analysis indicates that pumping of the Guaje well field has limited effect on the R-24 water levels; this indicates that the aquifer is heterogeneous and anisotropic, potentially because of the southwest to south dipping of the basalt flows and the layering in the Santa Fe Group, which may diminish the propagation of the Guaje well field pumping effects in the shallow aquifer zone where the R-24 screen is located (Figure 7.2-4). R-4 in Pueblo Canyon to the southwest of well R-24 (Figures 7.2-1 and 7.2-4) also responds to pumping of supply wells O-4 and PM-3 but not to the Guaje well field pumping. Based on pumping responses, estimated effective properties of the aquifer between wells PM-3 and R-24 are transmissivity 890 m^2/d and storativity 0.001. Between wells O-4 and R-24, they are transmissivity 560 m^2/d and storativity 0.002. Storativity estimates are consistent with those obtained during other tests conducted on the Pajarito Plateau (McLin 2006, 093670). Transmissivity estimates are relatively high. Assuming an effective aquifer thickness on the order of 100–200 m, the effective permeability of the Santa Fe Group is on the order of 2 to 8 m/d. This indicates that the low permeability observed during the pumping test at R-24 characterizes a local low-conductive zone in the Santa Fe Formation, while the rest of the formation is expected to have higher permeability. This demonstrates substantial aquifer heterogeneity.

In 1998, the former production well G-3 was converted to an observation well because of damaged well screens. The well is used to monitor water-levels near the Guaje well field (Figure 7.2-1). Figure 7.2-5 summarizes the daily production history of the Guaje well field and the water levels observed at G-3. Supply well G-2A has a daily drawdown of about 40 ft when cycled on and off (Koch and Schmeer 2009, 105181), while monitoring well G-3 shows a daily water-level fluctuation of about 5 ft in response to operation of G-2A and potentially other Guaje supply wells. A summary of the available information about the Guaje well field and an evaluation of aquifer characteristics are provided by McLin (2006, 093672). The Guaje well field pumps water from the Santa Fe Group. Spinner logs were conducted in all new supply wells (G-1A, G-2A, G-3A, G-4A, and G-5A). The spinner-log data indicate that a dominant portion of the water is produced from the top 70–140 m (230–460 ft) of the formation within the screened intervals. Overall, the screens are placed about 70 m (230 ft) below the regional piezometric surface. The analysis of pumping tests performed indicates that the aquifer pumped by the Guaje well field is confined and impacted by barrier effects potentially caused by the faults in the area (McLin 2006, 093672). McLin (2006, 093672) also estimates that the aquifer transmissivity ranges between 200 and 400 m^2/d.

The water level at G-3 is used to identify the pumping wells that cause the observed transients. Taking into account the pumping records of various water supply wells on the Pajarito Plateau (Pajarito, Otowi, and Guaje well fields), it has been identified that G-3 water levels vary most in response to pumping of G-2A (distance = 91 m [300 ft]) and G-3A (distance = 628 m [2060 ft]), the nearest surrounding supply wells (Figure 7.2-5). The model-predicted and observed water levels and drawdown at G-3 are compared in Figure 7.2-7. Individual contributions to drawdown at G-3 due to pumping of supply wells G-2A and G-3A are also plotted in Figure 7.2-7. The figure demonstrates the model's ability to represent observed water-level transients. Pumping at other water supply wells may also have small influences on water levels at monitoring well G-3, but those wells are difficult to indentify, based on the existing data. Based on pumping responses, estimated effective properties of the aquifer between G-3 and G-2A are transmissivity of 40 m^2/d and storativity of 0.01. Between G-3 and G-3A, they are transmissivity of 80 m^2/d and storativity of 0.002. These estimates are potentially more reliable than the previous estimates because they are based on longer observation records that take into account the influence of pumping transients before the observation period associated with the G-3 water-level data. By correlating water-level responses to longer-term pumping records, there is no need for the aquifer to be at steady state before collecting the water-level data. McLin pointed out that the previous pumping-test analyses had limitations because they were based on an assumption that the aquifer was at a steady state (McLin 2006, 093672). If the new estimates are accurate, they suggest that the effective transmissivity of the aquifer is substantially lower in the Guaje well field area than near the Pajarito and Otowi well fields. This demonstrates substantial hydrogeological heterogeneity of the Santa Fe Group sediments and associated interbedded volcanic rock. The new analysis also indicates that the postulated faults in the area may have a limited effect on the groundwater flow. McLin (2006, 093672) concluded that there is a fault between G-3A and G-2A that influences the propagation of the G-3A pumping effects to the east and the G-2A pumping effects to the west (Figure 23 in McLin 2006, 093672). The new analysis proposes that transmissivity between G-3A and G-3 is higher than the transmissivity between G-2A and G-3, even though G-3 is located much closer to G-2A (Figure 7.2-1).

7.2.4 COPCs in Surface Water and Groundwater

Inorganic chemicals, organic chemicals and radionuclides have been identified as COPCs in surface water and groundwater within and beneath the north canyons watersheds, as presented in Section 6.3. The surface waters represent nonstorm-related samples collected at gaging stations E089 and E099. Groundwater is represented by samples from GU-0.01 Spring, well R-24, and the active Guaje municipal supply wells (G-1A through G-5A). Appendix D provides screening tables of chemicals detected in the north canyons area (major ions [Tables D-2.0-4, D-2.0-8, and D-2.0-12]; trace metals [Tables D-2.0-1, D-2.0-5, and D-2.0-9]; radionuclides [Tables D-2.0-2, D-2.0-6, and D-2.0-10]; and organic compounds [Tables D-2.0-3, D-2.0-7, and D-2.0-11]) compared with applicable standards (if available).

7.2.4.1 Inorganic Chemicals in Water

Arsenic

No inorganic chemicals exceed established NMWQCC groundwater standards or EPA groundwater MCLs in regional groundwater, except for one detection of arsenic at supply well Guaje (G-1A) (Figure 3.2-1). The concentration of arsenic in the groundwater sample was 16.3 μg/L, and the EPA MCL for this trace element is 10 μg/L. Detectable dissolved concentrations of arsenic measured using inductively coupled plasma mass spectrometry (ICPMS) ranged from 1.6 to 8.1 μg/L at R-24; background mean, median, minimum, and maximum concentrations of this trace element are 2.37, 2.50, 0.80, and 12.0 μg/L, respectively, within the regional aquifer (LANL 2007, 094856). Detected arsenic is thought to be naturally occurring in the north canyons watersheds.

Aluminum

Elevated concentrations of aluminum occur in surface-water samples collected at gaging stations E089 and E099 (Figure 3.2-1). The aluminum is thought to be naturally occurring and may be caused by natural colloidal clay minerals and other silicates. Aluminum detected in pore water (0.08 to 19.4 ppm or μg/g) from unsaturated core collected at R-24 and leached with deionized water correlates very well with iron ($r^2 = 0.95$). Both metals detected in pore water probably are from natural sources consisting of colloidal clay minerals and/or ferric (oxy)hydroxide. Dissolved aluminum is less than detection (2 and 68 μg/L) in groundwater samples collected from regional aquifer well R-24. Aluminum detected in the north canyons watersheds is thought to be naturally occurring.

Nitrate

Nitrate concentrations do not exceed water-quality standards. However, nitrate is discussed here because it is useful for identifying potential surface water and groundwater pathways in the canyons. Under oxidizing conditions, nitrate is mobile as an oxyanion in groundwater and does not significantly adsorb onto clay minerals, ferric (oxy)hydroxide, solid organic matter, and other naturally occurring adsorbents. In the presence of denitrifying bacteria and reactive solid and dissolved organic carbon, nitrate becomes reduced to nitrogen gas. Other types of nitrate-reducing bacteria are capable of reducing nitrate to ammonium under oxygen-depleted conditions below pH 9. Results for nitrate and nitrate plus nitrite are combined because nitrite is generally a very small part of the measured concentration, unless unique redox conditions occur, such as groundwater impacted by residual drilling fluid effects. Filtered and nonfiltered results are also combined because filtration has little to no effect on nitrate concentration. Nitrate concentrations in the discussions that follow are reported in the units "Nitrate (as N, mg/L)," unless otherwise noted.

Nitrate in Surface Water and at GU-0.01 Spring

A statistical summary of nitrate plus nitrite concentrations in surface water at gages E089 and E099 and at GU-0.01 Spring from 2000 to early 2009 are provided in Appendix D (Tables D-2.0-8 and D-2.0-12). Concentrations of nitrate plus nitrite(N) range from 0.0561 to 3.06 mg/L with a median value of 1.66 mg/L. Nitrate has been detected in surface water at E099 and is elevated above background values at GU-0.01 Spring. There are anthropogenic sources of nitrate initially released to surface water within the Pueblo watershed that is connected to both the lower Los Alamos watershed (surface water and alluvial groundwater) and the lower section of the Guaje watershed (alluvial groundwater). Nitrate released from the Los Alamos County Bayo WWTP into Pueblo Canyon most likely is the dominant source of this constituent at GU-0.01 Spring. Nitrate concentrations in treated sewage effluent are typically less than 5 mg/L because of denitrification. Concentrations of nitrate and nitrate plus nitrite at surface and groundwater sampling stations within the Guaje watershed are less than 10 mg/L as N, the NMWQCC groundwater standard. Cattle grazing in upper Guaje Canyon may contribute nitrate to groundwater discharging at GU-0.01 Spring. Natural nitrate at concentrations less than 0.50 mg/L is common on the Pajarito Plateau and in the American Southwest (Walvoord et al. 2003, 093787). Thus, detection of low concentrations of nitrate (<0.5 mg/L as nitrogen) does not mean that contamination is present.

Nitrate in the Regional Aquifer

A statistical summary of nitrate plus nitrite(N) and other general inorganic chemicals is provided in Table D-2.0-4. Background mean and median concentrations and the BV (upper tolerance limit) for dissolved nitrate plus nitrite are 0.33, 0.31, and 0.89 mg/L, respectively, within the regional aquifer (LANL 2007, 095817). Concentrations of nitrate plus nitrite range from 0.21 to 0.40 mg/L at well R-24 from 2005 to early-2009, which reflect background conditions at the well.

Lead in Surface Water and Alluvial Groundwater

A statistical summary of lead concentrations in surface water (gaging stations E089 and E099) is provided in Appendix D (Table D-2.0-9). Concentrations of lead in nonfiltered samples range from 0.6 to 85.5 μg/L and concentrations of this metal are less than analytical detection (0.077 μg/L) in filtered water samples. Lead adsorbs strongly onto clay minerals and ferric (oxy)hydroxide, which is consistent with the analytical results for both filtered (nondetections) and nonfiltered water samples. Concentrations of lead in filtered and nonfiltered water samples collected from GU-0.01 Spring are less than analytical detection (0.5 and 2 μg/L) using ICPMS. The highest concentrations of lead in nonfiltered samples collected at gaging station E099 were in snowmelt runoff samples. These may be caused by historical emissions of leaded gasoline, which are commonly detected in sediments near roadways (Walker et al. 1999, 082308, p. 364; Breault and Granato 2000, 082310, p. 48; Callender and Rice 2000, 082307, p. 232) from vehicles traveling on the adjacent highway (NM 502). Sediment data indicate that another source of lead in the north canyons is runoff from burned areas in the Los Alamos townsite, as discussed in Section 7.1.1.

7.2.4.2 Organic Chemicals in Water

The organic chemicals 1,2-dichloroethane (1.69 µg/L) and toluene (1.62 µg/L) were detected at GU-0.01 Spring during one of four sample events (Table D-2.0-11) along with 4-methyl-2-pentanone (3.68 µg/L). These results are all below groundwater screening levels (5, 750, and 1990 µg/L for 1,2-dichloroethane, toluene, and 4-methyl-2-pentanone, respectively). Several organic compounds, including acetone, bis(2 ethylhexyl)phthalate, 2-butanone, chloromethane, endrin aldehyde, methylene chloride, and toluene were infrequently detected (1 to 4 detections out of 24 to 36 samples) at regional monitoring well R-24. However, no organic chemicals exceed established NMWQCC groundwater standards or EPA groundwater MCLs in regional groundwater. The infrequent detections and the absence of sources of these organic chemicals in the north canyons suggest that these contaminants are either random analytical detections or are from sources other than SWMUs and AOCs, such as road runoff in the case of GU-0.01 Spring.

7.2.4.3 Radionuclides in Water

Cosmogenic- and/or Laboratory-derived tritium is present in surface water and at GU-0.01 Spring at concentrations ranging from 13.39 to 48.85 pCi/L, with a median concentration of 19.06. The background concentration of tritium in regional precipitation currently is 19 pCi/L (Longmire et al. 2007, 096660). Tritium is a radioactive isotope of hydrogen with a relatively short half-life of 12.32 yr, which decays to helium-3 with the emission of a beta particle (Clark and Fritz 1997, 059168). It is extremely mobile because it can replace hydrogen within a water molecule and travel as groundwater. Tritium has not been detected above 1 pCi/L in the regional aquifer at R-24 and the Guaje supply wells (Table D-2.0-2). Strontium-90, a COPC at former TA-10, has not been detected at R-24 and GU-0.01 Spring. One detect of strontium-90 at a concentration of 0.171 ± 0.044 pCi/L and an MDA of 0.13 pCi/L was not confirmed in a reanalysis of the sample collected from supply well G-3A on June 20, 2000. No other detections of this radionuclide have been detected at G-1A, G-2A, G-4A, and G-4A.

7.2.5 Major Ion Chemistries of Surface Water, Alluvial and Perched-Intermediate Groundwater and the Regional Aquifer in Lower Los Alamos and Guaje Canyons

Figure 7.2-8 provides Stiff diagrams of major cation (calcium, magnesium, sodium, and potassium) and anion (chloride, bicarbonate, bromide and sulfate) compositions (milliequivalent per liter) for several surface-water and groundwater-sampling stations within lower Los Alamos Canyon and Guaje Canyon. Samples collected from Basalt Spring, GU-0.01 Spring, and alluvial well LLAO-1b have similar major ion compositions (sodium-calcium-bicarbonate and calcium-sodium-bicarbonate). Groundwater samples collected from GU-0.01 Spring, however, have less sodium compared with LLAO-1b and Basalt Spring. Basalt Spring and GU-0.01 Spring are likely to be related to each other through surface-water recharging alluvial groundwater within lower Los Alamos Canyon. Because of its location and chemistry, GU-0.01 Spring may represent discharge of alluvial groundwater derived from both Guaje and Los Alamos Canyons (Plate 1).

LA Spring discharges from a perched-intermediate zone within the Puye Formation and provides a component of groundwater to the alluvium within lower Los Alamos Canyon. Alluvial well LLAO-4 located west of the Rio Grande probably represents a groundwater mixing zone within the alluvium and contains a significant component of regional aquifer groundwater characterized by higher concentrations of major ions, most notably calcium and bicarbonate. The regional aquifer supply wells LA-1, LA-1b, and LA-2 are characterized by a sodium-bicarbonate composition, whereas LA-5 is characterized by a calcium-bicarbonate composition. Variations in major ion chemistries in groundwater samples collected from the

LA-designated water supply wells represent mixing zones of groundwater from beneath the Pajarito Plateau and sources to the east and possibly north.

8.0 RISK ASSESSMENTS

This section presents the methods used to evaluate the potential for adverse ecological and human health risks from contaminants in sediment and surface water in the north canyons. Risk characterization results, uncertainty analyses, and risk assessment summaries are also provided for each assessment.

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) that identifies COPECs and ecological receptors potentially at risk. This section presents ecological screening results based on the comparison of ESLs with available sediment and nonstorm-related surface-water data. Additional information on the SL methodology and development of ESLs is provided in the SLERA methods document (LANL 2004, 087630). The ESLs used for screening soil, sediment, and nonstorm-related surface-water data in this report are from ECORISK Database, Version 2.3 (LANL 2008, 103352). This section also includes a comparison of available data with DOE BCGs for radionuclides (DOE 2002, 085637; DOE 2004, 085639). These SL 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 brief summary, as applied to canyon bottoms in the north canyons, is presented below.

Historical contaminant releases into the north canyons have potentially occurred from multiple SWMUs and AOCs, as discussed in Section 2.1. Mechanisms of contaminant release to the north canyons from SWMUs and AOCs include airborne releases from firing sites, liquid releases, and contaminants mobilized by storm runoff. The primary Laboratory contaminant source was former TA-10 in the bottom of Bayo Canyon. Other contaminant sources related to the Laboratory include former firing sites and mortar impact areas in Bayo and Rendija Canyons and an asphalt batch plant in Rendija Canyon. Non-Laboratory sources of contaminants include urban runoff from roads and other developed areas in the Los Alamos townsite and recreational shooting in Rendija Canyon. For ecological receptors, the primary impacted media in the canyons are sediment deposits and nonstorm-related surface water in the canyon bottom. The active channel sediment (c1 geomorphic unit) may have persistent water in some locations; the channel sediment is evaluated using the sediment ESLs in the screening. For the north canyons, assuming that active channel sediment has aquatic community pathways and receptors is a protective assumption because water is ephemeral in most stream channels in these watersheds. Sediment in other geomorphic units, such as abandoned channels and floodplains (e.g., c2, c3, f1, and f2 units), is not exposed to persistent water. Sediment in geomorphic units other than c1 (abandoned channels and floodplains) is evaluated as soil by comparing concentrations with the soil ESLs. The active channel sediment in the north canyons was also evaluated as soil in the terrestrial ecological screening as all sediments in the investigation reaches are dry for most of the year. During this period, terrestrial receptors could be exposed to this sediment. Contaminants present in persistent nonstorm-related surface water may also interact with receptors in the aquatic food web. Therefore, contaminant concentrations in persistent surface water, snowmelt runoff, and spring water (collectively referred to as nonstorm-related surface water) were also evaluated by comparing detected concentrations with surface-water ESLs.

An ecological scoping checklist was completed for sediment investigation reaches within the north canyons; the completed ecological scoping checklist is provided in Appendix E of this document. A separate Part B, 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 the north 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. Reaches within the canyons 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. Parts of the watershed were burned during the 2000 Cerro Grande fire; vegetation has regenerated to some extent in these areas. Reaches within and downcanyon from the burn area contain sediment layers with reworked ash deposited by post-fire flood events. 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 any of the terrestrial receptors for a particular chemical or radionuclide. The ESLs for soil developed for each of these 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 adverse observed effect levels 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. The development of TRVs and the values for TRVs and ESLs are documented in the ECORISK Database, Version 2.3 (LANL 2008, 103352).

Aquatic habitat and receptors were not observed in any of the north canyons reaches. However, the timing of the site visit, which was in December 2008, between periods of significant precipitation, may have precluded observation of aquatic habitat and receptors. Perennial and intermittent reaches of flowing water and springs exist in Guaje Canyon within the north canyons. Water from snowmelt runoff in some years can extend the full length of Rendija Canyon, including the middle and south forks, and in Guaje Canyon as far east as somewhere between Rendija Canyon and NM 4 (near the Los Alamos Canyon confluence). Intermittent flow is possible in reaches R-1M, R-1S, R-3, and G-1. The presence of a spring downstream of reach G-1 (GU-0.01 Spring) indicates the presence of alluvial groundwater in this part of the canyon.

Persistent surface-water data are available at three locations in Guaje Canyon. Persistent surface water is present above reach G-1 at the background location "Guaje above Rendija" (reach G-BKG, which was not visited during scoping). Snowmelt runoff data are available for location "Guaje at SR-502." Spring water is present in Guaje Canyon at location GU-0.01 Spring near the confluence with Los Alamos Canyon. The other reaches only have ephemeral flow and therefore have no pathway for chronic exposure to water. To ensure that contaminants in water have not been overlooked relative to acute exposures, the results of the screening of stormwater samples versus comparison values from the State of New Mexico standards for acute aquatic life (20.6.4.900[H], 20.4.6.900[I], and 20.4.6.900[J] NMAC) are considered.

ESLs for sediment from the ECORISK Database, Version 2.3 (LANL 2008, 103352) were used to screen sediment in areas of the canyons that could potentially contain water. The sediment ESLs are developed based on potential toxicity to aquatic community organisms and two species of aerial insectivores (the little brown myotis bat and the violet-green swallow) that may be exposed to sediment contamination through ingestion of sediment-dwelling insects. Because persistent surface water exists in some areas of the north canyons, nonstorm-related surface-water data were screened against the limiting water ESLs from the ECORISK Database, Version 2.3, which are protective of both aquatic community organisms and drinking of water by wildlife receptors (LANL 2008, 103352). Stormwater, a transient medium, was not screened using surface-water ESLs; however, stormwater COPEC concentrations were compared with NMWQCC standards for acute aquatic life as a relative measurement of potential acute effects.

8.1.2 Ecological Screening Approach for the North Canyons

Extensive sampling of sediment has been done within the north canyons, and some data are also available on the concentrations of chemicals and radionuclides in nonstorm-related surface water and in stormwater. 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 or water-sampling location was compared with the appropriate screening concentrations. Maximum concentrations in both sediment and soil (as defined in Section 8.1.1) were first compared with the applicable sediment BVs (LANL 1998, 059730) (see Section 6.2). Maximum concentrations in all sediment samples (representing all sampled geomorphic units) were compared with the soil ESLs for terrestrial receptors (Tables 8.1-1 through 8.1-3). The active channel sediments (c1 geomorphic unit) were also evaluated as “sediment” and screened against sediment ESLs (Tables 8.1-4 through 8.1-6). Results for detected essential nutrients (i.e., calcium, magnesium, potassium, and sodium) are presented but not evaluated as COPECs.

Maximum detected radionuclide concentrations for each reach were also evaluated against the Level 1 soil, sediment and water BCG values for terrestrial, riparian, and aquatic animals, respectively. Radionuclide BCG comparisons are provided for the limiting receptors. Limiting receptors for soil and sediment BCGs are the terrestrial and riparian animal, respectively. The limiting receptors for water BCGs are nuclide-dependent and are either aquatic or riparian animals. The dose rate limits differ between terrestrial and riparian animals (0.1 rad/d) compared with terrestrial plants and aquatic animals (1 rad/d). Terrestrial plants are not a limiting receptor for BCGs from any media.

A sum of fractions (SOF) approach is used in comparing measured radionuclide concentrations in each environmental media with the BCGs. For soil, the SOF is represented by the summed BCG HQs for the terrestrial animal. For sediment, the SOF is the sum of BCG HQs for the riparian animal receptor. The SOF for water is the sum of the BCG HQs for the limiting receptor. It should be noted that the limiting receptor for water BCGs varies by radionuclide and that the water SOFs are calculated irrespective of receptor type (i.e., aquatic or riparian animal). Comparisons to BCGs and computation of the SOF are presented in Tables 8.1-7 and 8.1-8, for soil and sediment, respectively.

Surface water occurs within the north canyons as the result of runoff from rainfall and snowmelt in some reaches combined with discharge from springs. Also, after runoff events, persistent pools of water can be present for some time. Surface-water sampling stations from which nonstorm-related surface-water samples have been collected are shown in Figure 3.2-1. Stations from which temporary surface water has also been collected are shown in Figure 3.2-1. Water-sampling results from all nonstorm-related surface-water locations in the north canyons are compared with the minimum water ESLs and BCGs that are protective of both aquatic receptors and drinking water by terrestrial wildlife. COPCs for ecologically relevant nonstorm-related surface water are identified in Tables 6.3-8 through 6.3-21.

Stormwater represents a transient exposure that is not well suited for comparison to water ESLs. Filtered and unfiltered stormwater samples collected throughout the watershed were screened using the surface-water comparison values (see Section 6.4 and Appendix F for more information). The results of stormwater screening versus NMAC water-quality standards will be used to ensure that the potential for acute effects has been adequately addressed with the ESL water screening for chronic effects.

8.1.3 Data Evaluation for Screening of Sediment and 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 21 inorganic chemicals, 33 organic chemicals, and 6 radionuclides were retained as COPCs in sediment in the north canyons watersheds. Maximum detected 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), "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 089308, pp. B-4–B-7), and "Pajarito Canyon Biota Investigation Work Plan" (LANL 2006, 093553). All COPCs are compared with minimum ESLs to identify COPECs, as presented in Section 8.1.4.

8.1.4 Results of the Screening Comparison for Sediment and 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 3. This HQ is calculated based on dividing the maximum detected concentration of a chemical or radionuclide by the minimum ESL applicable to that media (i.e., soil, c1 sediment, or nonstorm-related surface water). This criterion of an HQ greater than 3 is based on the geometric mean of the ratio between the no observed adverse effect level (NOAEL) and the lowest observed adverse effect level (LOAEL) (Dourson and Stara 1983, 073474). An HQ greater than 3 represents levels that may impact receptors and is therefore appropriate for determining which COPECs should be included in site-specific biota studies in the north canyons reaches. Concentrations corresponding to LOAELs represent levels where impacts to individuals or populations may occur, and these levels represent a more appropriate criterion for determining which COPECs should be included in site-specific biota analyses to assess if impacts to ecological receptors have actually occurred. The same criterion of an HQ greater than 3 was used to refine the list of COPECs for the baseline studies conducted in Pajarito Canyon (LANL 2008, 104909, p. 8-2), Los Alamos and Pueblo Canyons (LANL 2004, 087390, p. 8-2), and Mortandad Canyon (LANL 2006, 094161, p. 96). Receptors representing threatened and endangered (T&E) species are evaluated versus an HQ greater than 1 to ensure protection of each individual within the population.

The COPECs based on an HQ greater than 3 are highlighted in the HQ screening tables in this section. Table 8.1-1 provides the HQ for the maximum detected concentration of each inorganic COPC in soil (active channel and other sediments combined). Table 8.1-2 shows the same HQ evaluation for radionuclide COPCs, and Table 8.1-3 shows the HQ evaluation for organic COPCs. Tables 8.1-4 through 8.1-6 present the same HQ comparisons for the maximum detected concentrations seen in geomorphic unit c1 sediment (active channel sediment). The HQs in these three tables are based on a comparison to the minimum sediment ESLs, which are designed for the protection of aquatic receptors and aerial insectivores (bats and swallows). COPECs with an HQ greater than 3 are shaded in black. Sediment and soil COPECs without ESLs are noted as uncertainties and are listed in Table 8.1-31.

To further refine the COPEC process, north canyons radionuclide concentrations were compared with soil and sediment BCGs, and SOFs were computed using maximum detected concentrations in each reach. BCGs are more restrictive than ESLs for two radionuclides in soil (cesium-137 and strontium-90) and one radionuclide in sediment (tritium). BCG HQs and the computed SOFs for each reach are presented for soil in Table 8.1-7. BCG HQs and the computed SOFs for each reach for c1 unit sediment are presented in Table 8.1-13.

Soil Screening Results. Sediment COPECs identified with maximum soil ESL HQs >3 included 10 metals and 2 organic COPECs in five reaches. No maximum detected radionuclide concentrations exceeded an HQ of 3. Maximum soil HQs are reported for inorganic, radionuclide, and organic COPCs in Tables 8.1-1, 8.1-2, and 8.1-3, respectively. All radionuclide results for soil were less than soil BCGs. The SOFs for maximum detected concentrations in each reach were less than 1.0, indicating that the 0.1 rad/d threshold for the protection of the limiting receptor (terrestrial animals) was not exceeded.

Sediment (c1 Geomorphic Unit) Screening Results. Sediment (c1 geomorphic unit) COPECs identified with sediment minimum ESL HQs >3 included five inorganic and three organic chemicals. No maximum detected radionuclide concentrations exceeded an HQ of 3 in c1 sediment. Maximum soil HQs are reported for inorganic, radionuclide, and organic COPCs in Tables 8.1-4, 8.1-5, and 8.1-6, respectively. All radionuclide results for c1 sediment were less than sediment BCGs. The SOFs for maximum detected concentrations by reach were less than 1.0, indicating that the 0.1 rad/d threshold for the protection of the limiting receptor (riparian animals) was not exceeded.

8.1.5 Data Evaluation for Screening of Nonstorm-Related Surface Water

Evaluation of the sample data for nonstorm-related surface water follows the same approach to that used in the “Pajarito Canyon Biota Investigation Work Plan” (LANL 2006, 093553) and the “Mortandad Canyon Biota Investigation Work Plan” (LANL 2005, 089308). The data evaluation in Section 6 (see Section 6.3.1, Tables 6.3-8 through 6.3-21) determined which nonstorm-related surface-water chemicals and radionuclides were retained as COPCs. All detected COPCs are compared with minimum surface-water ESLs to identify COPECs, as presented in Section 8.1.6. Concentrations detected in nonstorm-related surface water at sampling stations that have been sampled routinely represent the most appropriate water concentrations for assessing chronic exposure. Nonstorm-related surface water was compared with minimum surface-water ESLs and BCGs.

Filtered and unfiltered stormwater samples measured at other points throughout the watershed were also screened using NMAC surface-water comparison values in Section 6.4 to provide a more complete picture of the potential for adverse, acute effects from stormwater in the north canyons. Stormwater concentrations are not compared with ESLs or BCGs.

8.1.6 Results of the Screening Comparison against Minimum ESLs and Limiting Receptor BCGs for Nonstorm-Related Surface Water

Nonfiltered nonstorm-related surface water was compared with minimum ESLs for sample locations within the north canyons. HQs calculated using maximum detected concentrations of each COPC in unfiltered nonstorm-related surface water at each sample location are presented in Tables 8.1-9 through 8.1-11. Nonstorm-related surface water COPECs without ESLs are noted as uncertainties and are listed in Table 8.1-31.

Maximum radionuclide concentrations in unfiltered nonstorm-related surface water were compared with water BCGs for the protection of limiting receptors. Limiting receptors for the aquatic analysis are radionuclide-dependent, consisting of either aquatic or riparian animals. The SOF computation was applied to account for water exposure where multiple radionuclides are detected. It should be noted that the SOF was calculated based on BCG HQs for limiting receptors, irrespective of receptor type (i.e., aquatic or riparian animal). For nonfiltered nonstorm-related surface water, the SOF comprises the BCG ratios for both aquatic and riparian animals as limiting receptors (Table 8.1-12).

Nonfiltered Nonstorm-Related Surface-Water Minimum ESL Comparison Results Summary. Surface-water minimum ESLs were exceeded by at least one COPC at each of the locations sampled. Maximum concentrations of 10 inorganic COPCs exceeded surface-water HQs of 3 in north canyons reaches. HQs for remaining COPC concentrations were less than 3. Four radionuclides exceeded surface-water HQ thresholds of 3 in the north canyons. The maximum detected concentrations of radium-226, radium-228, thorium-228, and thorium-232 resulted in HQs >3. No maximum detected concentrations of organic chemicals resulted in HQs greater than 3 in nonfiltered nonstorm-related surface water.

Only one maximum radionuclide concentration (radium-226 at Guaje at SR-502) exceeded the water BCG for the aquatic animal receptor. The radiological SOF for Guaje at SR-502 was 2.5, indicating potential radiological risk to the aquatic animal receptor. Maximum concentrations of all other detected radionuclides were less than BCGs for all locations. The SOFs for the other two nonstorm-related surface-water locations, GU-0.01 Spring and Guaje above Rendija, were less than 1, indicating there is no radiological risk to the aquatic community at these locations.

Summary of Stormwater Standards Comparisons. As discussed in Section 6.4, north canyons stormwater was evaluated against comparison values from the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC). Maximum concentrations for five COPCs exceeded the acute aquatic life comparison values (20.6.4.900[H], 20.4.6.900[I], and 20.4.6.900[J] NMAC) (see Section 6.4 and Table 6.4-2). The results of stormwater screening versus acute exposure comparison values are used to assess the potential for acute effects from nonstorm-related surface-water COPECs that may or may not have been identified as COPECs with the ESL water screening for chronic effects. All five of the stormwater COPCs that exceeded acute aquatic life criteria (aluminum, cadmium, copper, lead, and zinc) were also identified as aquatic community chronic exposure COPECs for nonstorm-related surface water.

8.1.7 Evaluation of North Canyons COPEC Concentrations for Biota Studies

The COPECs, exposure pathways, and receptors in the north canyons are similar to those previously investigated in the Los Alamos and Pueblo, Mortandad, and Pajarito watersheds (LANL 2004, 087390; LANL 2005, 089308; LANL 2006, 093553; LANL 2006, 094161; LANL 2008, 104909). Aspects of the study designs and conclusions from biological investigations performed in these watersheds are therefore complementary to the ecological risk assessment process in the north 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 the north canyons to interpret potential risks.

This section describes the methods and results for evaluating COPEC concentrations in the north canyons with media 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), “Mortandad Canyon Investigation Report” (LANL 2006, 094161), “Pajarito Canyon Biota Investigation Work Plan” (LANL 2006, 093553), and “Pajarito Canyon Investigation Report” (LANL 2008, 104909). 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 COPC concentrations in north canyons sample media are less than concentrations in the exposure media evaluated in previous canyons investigation reports and these reports concluded there was no unacceptable ecological risk to this assessment endpoint, then north canyons biota studies are not necessary.

Maximum detected concentrations of chemical and radionuclide COPCs in north canyons sediment and nonstorm-related surface water were compared with sediment BVs and receptor-specific ESLs for soil, sediment, and surface water to identify COPECs. COPECs were identified for north canyons media where media-specific maximum detected concentrations of chemical or radionuclide COPCs exceeded one or more receptor-specific ESLs with HQs >3 (or HQ >1 for the American kestrel, which represents the Mexican spotted owl). Soil COPECs, the minimum soil ESLs, and potentially affected receptors are presented in Table 8.1-13. Sediment (c1 geomorphic unit) COPECs, minimum sediment ESLs, and potentially affected receptors are presented in Table 8.1-14. Nonfiltered nonstorm-related surface-water COPECs, minimum surface-water ESLs, and potentially affected receptors are presented in Table 8.1-15.

Ecologically relevant media, COPECs, and potentially affected receptors are identified where north canyons data exceeded one or more receptor-specific ESLs. Relevant COPEC exposure data for each assessment endpoint were assembled from the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon investigation reports (LANL 2004, 087390; LANL 2006, 094161; LANL 2008, 104909). The types of data are summarized below along with rationale for including these previous studies.

Most COPECs identified for the north canyons have biota-relevant soil, sediment, and/or surface-water data from these previous investigations. Samples with biota-relevant exposure data from the previous canyons investigation reports are tabulated in Appendix E, Tables E-2.0-1 through E-2.0-3 (included on CD as Attachment 1). 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-2.0-2 lists the sediment samples (a mixture of all sediment and active channel sediment) evaluated for riparian and aquatic receptors (bats, swallow, and the aquatic community) in the north canyons and biota investigation reaches in other watersheds. Table E-2.0-3 lists the water samples evaluated for the aquatic community in the north canyons and biota investigation reaches in other watersheds.

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, and Pajarito Canyons biota investigations are relevant to the north canyons assessment process. Toxicity tests performed for these previous investigations are particularly relevant as 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 north canyons sediment that are less than concentrations correlated to effects (or no effects) observed in previous studies. All plant-relevant COPECs identified for the north canyons have plant-relevant sediment data from these previous investigations, and samples with plant-relevant exposure data from the previous canyons investigation reports are tabulated in Appendix E, Table E-2.0-1.

Table 8.1-16 shows the maximum detected concentrations of COPECs with HQs greater than 3 for plants in the north canyons, and compares these with maximum detected concentrations in reaches used for plant toxicity tests in the Los Alamos and Pueblo, Mortandad, and Pajarito watersheds. COPECs where north canyons maximum detected concentrations are lower than previous investigations include barium, chromium, manganese, and selenium. Maximum concentrations of antimony and vanadium exceeded maximum values reported from the previous investigations. Average concentrations of antimony in the north canyons also exceeded average concentrations of antimony in sediment from the Los Alamos and Pueblo Canyons and Pajarito Canyon investigations. However, average concentrations of vanadium in the north canyons are bounded by the average concentrations observed in the Mortandad Canyon and Pajarito Canyon investigations.

Soil Invertebrates (Earthworm). Earthworm toxicity tests were performed for the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon biota investigations. Toxicity tests performed for these previous investigations are particularly relevant as they measured earthworm survival and growth across a gradient of COPEC concentrations collected from discrete locations in these watersheds. In addition, collocated soils and earthworm tissues are valuable for establishing uptake relationships and dietary transfer to upper trophic species. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in north canyons soil that are less than toxicity test concentrations correlated to effects or no effects observed in previous studies. All earthworm-relevant COPECs identified for the north canyons have worm-relevant soil data from these previous investigations, and sample IDs with earthworm-relevant exposure data from the canyons investigation reports are tabulated in Appendix E, Table E-2.0-1.

Maximum earthworm-relevant COPEC concentrations for the north canyons and previous studies are listed in Table 8.1-17. All earthworm-relevant maximum COPEC concentrations are bounded by results from 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 and Mortandad 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 for a reach scale (composite samples were collected from trapping arrays) and therefore are not directly comparable to the discrete samples from north canyons 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 the north canyons that are less than concentrations observed in previous studies collected from discrete locations or composite samples representing reaches in these watersheds. All small mammal-relevant COPECs identified for the north canyons have corresponding small mammal-relevant location soil data (corresponding to the trapping arrays or dietary sources) from these previous investigations, and samples with ground-dwelling mammal-relevant exposure data from previous canyons investigations are tabulated in Appendix E, Table E-2.0-1. Sediment data from those investigations are compared with maximum detected north canyons sediment concentrations in Table 8.1-18.

Although sediment data from the other investigations represent both mouse and shrew-relevant data, maximum detected sediment results were compared with the ESLs for shrews because ESLs for shrews are more conservative. COPECs where north canyons maximum detected sediment concentrations are higher than in previous investigations include antimony, selenium, and benzoic acid. Average concentrations of antimony, selenium, and benzoic acid in the north canyons are not bounded by average concentrations observed in the Los Alamos and Pueblo Canyons or Mortandad Canyon investigations.

Aluminum in nonstorm-related surface water was also identified as a drinking water COPEC for the shrew and deer mouse. North canyons maximum aluminum concentration in nonstorm-related surface water exceed surface-water concentrations from previous studies, and aluminum will be evaluated to determine if additional biota studies are warranted.

Terrestrial Avian Consumer (Robin). Avian consumers (insectivorous, omnivorous, and herbivorous robins) were previously evaluated in the Mortandad and Pajarito Canyon investigations using nest box studies and the collection of eggs and insects. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in north canyons that are less than the soil concentrations observed in previous studies. All bird-relevant COPECs identified for the north canyons have corresponding bird-relevant location soil data (corresponding to reaches where nest box data, eggs or insects were collected) from these previous investigations, and samples with avian consumer-relevant exposure data from the canyons investigation reports are tabulated in Appendix E, Table E-2.0-1. Sediment data from bird-relevant reach locations from the previous studies were then summarized and maximum COPEC concentrations are compared with maximum north canyons sediment concentrations in Table 8.1-19. The American robin is modeled as the representative for invertivorous 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.

COPECs where north canyons maximum detected concentrations are less than those from previous investigations include total cyanide, mercury, selenium, vanadium, and di-n-butylphthalate. COPECs where north canyons maximum detected concentrations are greater than in previous investigations include lead and zinc. However, average north canyons concentrations of both lead and zinc are bounded by average concentrations observed in the Pajarito Canyon investigation.

Avian Predator (Kestrel). Avian carnivores (represented by the kestrel) were previously evaluated in the Mortandad and Pajarito Canyon investigations using dietary exposure modeling from small mammal tissues. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in north canyons that are less than soil concentrations observed in previous studies. All kestrel-relevant COPECs identified for the north canyons have corresponding kestrel-relevant location soil data (corresponding to reaches where dietary exposure to small mammals was assessed) from these previous investigations, and samples with avian predator-relevant exposure data from the previous canyons investigations are tabulated in Appendix E, 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 a HQ greater than 3) was used to evaluate COPECs for potential ecological risk. Sediment data from bird-relevant reach locations from the previous studies are summarized compared with maximum north canyons sediment concentrations in Table 8.1-20. North canyons maximum detected concentrations of mercury and total cyanide are less than those observed from previous studies.

Aquatic Community. Chironomid toxicity tests were used to evaluate growth and survival of the aquatic community using sediment in the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon biota investigations. Toxicity tests performed for these previous investigations are particularly relevant as they measured survival and growth across a gradient of COPEC concentrations. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in north canyons sediment that are less than those concentrations correlated to effects or no effects observed in previous studies. All aquatic community-relevant COPECs identified for the north canyons have aquatic community-relevant sediment and water data for comparison from these previous investigations, and samples with aquatic community-relevant exposure data from the previous canyons investigations are tabulated in Appendix E, Tables E-2.0-2 and E-2.0-3. Maximum aquatic community-relevant sediment and nonstorm-related surface-water COPEC concentrations for the north canyons and previous canyons studies are presented in Tables 8.1-21 and 8.1-22, respectively. COPECs where north canyons maximum detected sediment concentrations are less than those from previous investigations include barium, mercury, anthracene, alpha-chlordane, and gamma-chlordane. COPECs where north canyons maximum detected sediment concentrations are greater than in previous investigations include iron and zinc.

Nonfiltered nonstorm-related surface-water COPECs for the aquatic community that are greater than in the previous studies include aluminum, barium, cadmium, cobalt, copper, iron, lead, manganese, vanadium, and zinc (Table 8.1-22). Of these analytes, aluminum, cadmium, copper, lead, and zinc were also identified in stormwater as exceeding acute aquatic community criteria (see Section 6.4) and therefore have the potential for adverse effect from acute exposure to stormwater.

An algal toxicity test was performed using surface water as part of the Mortandad Canyon investigation. Only one Mortandad Canyon algal toxicity COPEC, radium-226, overlapped with nonfiltered nonstorm-related surface-water COPECs for north canyons algal receptors. Radium-228, thorium-228, and thorium-232, which exceeded surface water ESLs in north canyons nonfiltered nonstorm-related surface water, were not analyzed in the Mortandad Canyon study. Maximum north canyons results for radium-226 in nonfiltered nonstorm-related surface water were greater than (or “unbounded”) by maximum results from the Mortandad Canyon study. These unbounded results, as well as the analytes not evaluated in the Mortandad Canyon study, represent potential data gaps (Table 8.1-23).

Mammalian Aerial Insectivore (Bat). Dietary exposure modeling has been the primary assessment method for the mammalian aerial insectivore (bat) for the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon biota investigations. In these studies, dietary dose from prey items was assessed to determine potential exposure. For comparison to north canyons sediment COPECs, bat-relevant sediment data from previous studies include soils collocated with earthworm tissues used in dietary exposure modeling. While bats do not consume ground-dwelling invertebrates, earthworm samples provide a reasonable surrogate measure of exposure. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in north canyons c1 sediment that are less than those concentrations correlated to effects or no effects observed in previous studies. All bat-relevant COPECs identified for the north canyons have corresponding prey-relevant sediment data for comparison from these previous investigations, and samples with mammalian aerial insectivore-relevant exposure data from the previous canyons investigations are tabulated in Appendix E, Table E-2.0-2. Maximum COPEC concentrations from these investigations are compared with maximum bat-relevant COPEC concentrations and ESLs in the north canyons in Table 8.1-24. Aluminum is the only sediment COPEC where north canyons maximum detected sediment concentrations are greater than in previous investigations. However, average concentrations of aluminum in north canyons sediment are less than average concentrations of aluminum in the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon investigations.

Aluminum in nonstorm-related surface water was also identified as a drinking water COPEC for the bat. North canyons maximum aluminum concentration in nonstorm-related surface water exceed surface-water concentrations from previous studies, and aluminum will be evaluated to determine if additional biota studies are warranted.

Avian Aerial Insectivore (Violet-Green Swallow). Dietary exposure modeling has been the primary assessment method for avian aerial insectivores, represented by the violet-green swallow, for the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon biota investigations. In these studies, dietary dose from prey items was assessed to determine potential exposure. While swallows do not consume ground-dwelling invertebrates, earthworm samples provide a reasonable surrogate measure of exposure. For comparison to north canyons sediment COPECs, swallow-relevant sediment data from previous studies include soils collocated with earthworm toxicity tests. Inferences can be drawn concerning potential ecological effects from COPEC concentrations in north canyons c1 sediment that are less than those concentrations correlated to effects or no effects in previous studies. All swallow-relevant COPECs identified for the north canyons have corresponding prey-relevant sediment data for comparison from these previous investigations, and samples with avian aerial insectivore-relevant exposure data from the previous investigations are tabulated in Appendix E, Table E-2.0-2.

The violet-green swallow represents the avian aerial insectivore feeding guild. Maximum COPEC concentrations from previous studies are compared with maximum swallow-relevant COPEC concentrations and ESLs in the north canyons in Table 8.1-25. North canyons maximum detected concentrations of mercury are less than those in previous studies and therefore not considered to pose ecological risk. North canyons maximum detected concentrations of zinc are greater than in previous studies. However, average north canyons concentrations of zinc in sediment are bounded by bird-relevant average concentrations of zinc in the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon sediment investigations.

Other Mammals. Aluminum was identified as a drinking water COPEC for five mammal receptors based on maximum north canyons concentrations in nonfiltered nonstorm-related surface water. As previously discussed, aluminum in nonfiltered nonstorm-related surface water was identified as a drinking water COPEC for the shrew (limiting receptor), deer mouse, and myotis bat (Tables 8.1-18 and 8.1-24). The maximum north canyons nonstorm-related surface-water concentration of aluminum also exceeded the drinking water ESLs for the cottontail rabbit and fox. No soil or sediment COPECs were identified for the rabbit or fox. The ESLs and comparison of maximum detected concentrations of aluminum in nonfiltered nonstorm-related surface water for all receptors is presented in Table 8.1-26.

Unbounded Soil (All Sediment) COPECs. Maximum concentrations in north canyons sediment samples that are greater than in previous canyons investigations (“unbounded COPECs”) for terrestrial receptors for which they were COPECs included antimony, lead, selenium, vanadium, zinc, and benzoic acid. All other maximum COPEC concentrations are less than those from previous biota investigations that evaluated ecological exposures and the potential for adverse effects. Table 8.1-27 summarizes concentrations of all unbounded sediment COPECs in the north canyons.

As discussed in Section 7.1, the inferred primary source of antimony in the north canyons is the Cerro Grande burn area. All detected antimony results exceeding the ESL are from fire-affected soil samples, and therefore antimony is not recommended as a COPEC for additional study.

Only the two highest lead concentrations in reach R-3 (110 and 78 mg/kg) are unbounded by previous studies relevant to the robin. Because only two results were greater than concentrations observed in previous studies which did not indicate ecological risk, lead is not recommended as a COPEC for additional terrestrial biota studies.

Selenium concentrations in soil were unbounded by previous concentrations relevant to the shrew in 6 of 20 detected results for the north canyons. Five of the six results were from reach R-1E, and the sixth result was from reach R-3E. However, as discussed in Section 7.1, the selenium in the north canyons represents natural background variability, and therefore it is not recommended as a COPEC for additional terrestrial biota studies.

Only one result for vanadium (76.8 mg/kg in reach R-3) was greater than previous concentrations relevant to plants or robins from previous studies. Because only one result was greater than concentrations observed in previous studies, which did not indicate ecological risk, vanadium is not recommended as a COPEC for additional terrestrial biota studies.

The maximum north canyons concentration of zinc was unbounded for robins from previous studies. The inferred primary sources of zinc in the north canyons include natural background, releases from former TA-10 in Bayo Canyon, and SMWU 00-001(a), SWMU 00-015, or the poor man’s shooting range in Rendija Canyon. However, only one detected concentration of zinc (267 mg/kg in reach R-3) was greater than found in previous studies. Because only one result exceeded the bounding concentrations observed in previous studies, which did not indicate ecological risk, zinc is not recommended as a COPEC for additional terrestrial biota studies.

As discussed in Section 7.1, the Los Alamos townsite is the inferred primary source of benzoic acid. Benzoic acid was infrequently detected, and given its non-Laboratory origin, benzoic acid is not recommended as COPEC for additional terrestrial biota studies.

Unbounded Sediment (c1 Unit) COPECs. Maximum concentrations in north canyons active channel (c1) sediments that exceeded those of previous ecological studies include aluminum, iron and zinc. All other maximum detected sediment COPEC concentrations are less than in previous canyon biota investigations that evaluated ecological exposures and the potential for adverse effects. Table 8.1-28 summarizes sediment COPEC concentrations that are greater than concentrations observed in other canyons biota studies.

As discussed in Section 7.1, the three unbounded sediment COPECs have inferred sources related to natural background and/or minor releases from SWMUs, AOCs, or other anthropogenic sources in the north canyons. Primary sources of aluminum, iron, and zinc are related to natural background and minor releases from SWMU 00-001(a), SWMU 00-015, or the poor man’s shooting range in Rendija Canyon, and former TA-10 in Bayo Canyon.

Only single concentrations of aluminum (23,500 mg/kg), iron (67,700 mg/kg) and zinc (267 mg/kg) in one sediment sample from reach R-3 exceeded concentrations observed in previous studies relevant to the bat, aquatic community, or swallow (Table 8.1-28). Because only one result for each COPEC was greater than concentrations observed in previous studies, which concluded no ecological risk, aluminum, iron, and zinc are not recommended as COPECs for additional aquatic biota studies.

Unbounded Water COPECs. Water ESLs for the aquatic community and algal toxicity were exceeded by samples results from nonfiltered nonstorm-related surface water in the north canyons. The maximum detected concentrations of north canyons nonfiltered nonstorm-related surface water that exceeded ESLs were evaluated against findings from two previous biota studies (Table 8.1-29). The Los Alamos and Pueblo Canyons and Mortandad Canyon biota investigations conducted aquatic toxicity tests using sediment and water with a gradient of COPEC concentrations to determine the growth and mortality of *Chironomus tentans*. Additionally, for Mortandad Canyon, an algal test was performed to measure the toxicity of radionuclides in water from reaches with elevated radium concentrations. The algal test results corresponded to direct-measured radionuclide COPC concentrations and would be relevant to radionuclide COPEC exposures from nonstorm-related surface waters from the north canyons.

A comparison of maximum nonfiltered nonstorm-related surface-water concentrations from north canyons to maximum surface-water concentrations from previous investigations is presented in Table 8.1-29. While nonfiltered nonstorm-related surface-water concentrations of 10 inorganic COPECs exceeded concentrations observed by the previous biota investigations, these unbounded results originated from only five nonfiltered nonstorm-related surface-water samples. With the exception of one spring water sample, all unbounded nonstorm-related surface-water COPEC results are from unfiltered snowmelt runoff samples.

Table 8.1-29 presents results for all north canyons nonstorm-related surface-water COPECs where maximum concentrations are unbounded by previous studies. Radium-228, thorium-228, thorium-230 and thorium-232 were not analyzed in previous investigations and represent an uncertainty. North canyons reach average concentrations of aluminum, cobalt, copper, iron, manganese, vanadium, and zinc are bounded by maximum concentrations from previous studies which concluded no ecological risk. Maximum and average north canyons concentrations of barium, cadmium, and lead are not bounded by previous investigations.

To better understand the relatively elevated concentrations of metals in north canyons snowmelt, the suspended sediment concentrations of nonstorm-related surface-water COPECs were used to estimate COPEC concentrations that would result from sediment background. In unfiltered snowmelt runoff, the measured COPEC concentrations are well correlated with suspended sediment concentrations and natural sediment background concentrations, as shown in Figure 8.1-1. Table 8.1-30 shows the values used to predict COPEC concentrations in water based on measured suspended sediment concentrations. To predict the concentration of COPECs in water based on the contribution from sediment background, the BV of each COPEC was multiplied by the suspended sediment concentration physically measured in Guaje Canyon snowmelt runoff samples. Predicted water concentrations based on contributions from sediment at background concentrations were generally greater than or similar to those measured in Guaje Canyon snowmelt runoff (Figure 8.1-1). Therefore, the COPEC concentrations present in nonfiltered snowmelt are consistent with background sediment concentrations and not Laboratory activities.

8.1.8 Ecological Risk Assessment Uncertainties

There are several ecological risk assessment uncertainties related to the north canyons. Uncertainties associated with established soil ESLs fall into two main categories. The first group is associated with COPCs, 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 represent worst-case conditions. For several 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 the north canyons but have no ESLs include 6 inorganic chemicals (including potassium and sodium, which are generally considered to be essential nutrients) and 10 organic chemicals. Five inorganic COPCs (including calcium, magnesium, potassium, and sodium, which are generally considered to be essential nutrients) and four organic COPCs detected in c1 sediment had no ESL for comparison. No surface-water ESLs were available for seven inorganic COPCs, including the essential nutrients calcium, magnesium, potassium, and sodium. Analytes for which no screening value is available are listed by media in Table 8.1-31.

Another source of uncertainty is COPECs identified in the north canyons screening process that were either not previously investigated in other biota studies or those with concentrations that were greater than in previous studies. However, as discussed in Section 8.1.7, these COPCs were either infrequently detected above concentrations from other watersheds where previous studies indicated no ecological risk or represent non-Laboratory sources (e.g., natural background or ash from the Cerro Grande burn area). Therefore, no further investigation of potential ecological risk is indicated.

8.1.9 Summary of the SLERA

COPECs were identified for north canyons sediment based on the comparison of maximum detected concentrations against applicable soil and sediment ESLs. Where COPEC concentrations in north canyons sediment samples resulted in an ESL HQ >3, they were compared with a range of exposure concentrations observed in previous biota studies where associated effects information indicated no unacceptable ecological risks. Where north canyons sediment concentrations were greater than in previous investigations, the number of these results were generally limited and/or have non-Laboratory sources (e.g., natural background or Cerro Grande burn area). Based on this information, no COPECs in sediment are recommended for additional biota studies.

All nonstorm-related surface-water COPECs in the north canyons exceeded those observed in previous studies. Based on exceedances of both chronic and acute screening levels by maximum detected concentrations of aluminum, cadmium, copper, lead, and zinc in surface water and stormwater, concentrations of these analytes suggest potential risk to ecological receptors. However, concentrations of these metals in nonfiltered water are consistent with measured suspended sediment concentrations and background sediment concentrations, and do not represent releases from Laboratory activities. Therefore, no further investigation is required.

Three surface-water COPECs, radium-228, thorium-228, and thorium-232, were not reported in previous algal toxicity studies. However, nonstorm-related surface-water concentrations of these COPECs in north canyons are lower than the concentrations predicted as a result of background suspended sediment loading in surface water. Therefore, no further investigation is required.

8.2 Human Health Risk Assessment

The human health risk assessment evaluates the potential for adverse effect on human health in the north canyons from COPCs identified in Section 6 of this report. The risk assessment approach used in this report follows guidance from NMED (2006, 092513), and is organized in seven major subsections. The approach utilizes media- and scenario-specific SLs to evaluate the potential for human health risks separately from sediment and surface water and cumulative risks from sediment and surface water in the north canyons. Section 8.2.1 provides the basis for selecting 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. The exposure assessment (Section 8.2.3) provides information used in quantifying human exposure to COPCs in sediments and water. The toxicity assessment (Section 8.2.4) provides information on potential human health effects from chemicals and radionuclides evaluated in the risk assessment. Section 8.2.4 provides the sources for the media- and scenario-specific SLs. Risk characterization (Section 8.2.5) is based on the 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 the north canyons to assess potential impacts under reasonable maximum exposure (RME) conditions. The canyon bottoms in the north canyons include a mixture of land ownership, as discussed in Section 1.3, potentially supporting a variety of land uses.

The assessment employs the recreational user exposure scenario, which combines both adult trail user and child-extended backyard exposures, to represent the current and reasonably foreseeable future exposure activities for contaminated sediment and surface water in the watersheds. The trail user scenario describes an adult individual who contacts contaminated sediment and surface water 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 the canyon as an extension of the play areas immediately surrounding the home. These uses are inclusive of realistic present-day potential exposure activities in canyon bottoms in areas of the watersheds where COPCs are at levels requiring a human health risk assessment. One supplemental exposure scenario, residential, is evaluated in the human health risk assessment for comparison purposes only. A description of this supplemental exposure scenario is provided in Section 8.2.3.2. Unlike the recreational scenario, residential use is not currently applicable across the north canyons. A residential scenario does not represent current or reasonably foreseeable future land uses within the parts of the canyons subject to flooding, although residences occur near the stream channel in part of Rendija Canyon. In contrast to the recreational scenario, residential exposure is limited to canyons sediment and does not consider exposures to water.

8.2.2 Data Collection and Evaluation

The approach to sampling design, data collection, and characterization is described in Sections 3 and 4 and Appendix B. Sample locations, sample results, and data quality for data employed in the human health risk assessment are presented in Appendix C. Section 6 describes how sediment data within reaches were combined for the comparison of contaminant data with BVs. Water data were evaluated at each surface-water sampling location.

Identifying COPCs for the Human Health Risk Assessment

COPCs for the human health risk assessment are identified based on SL risk calculations using a residential scenario based on the "Los Alamos and Pueblo Canyon Investigation Report" (LANL 2004, 087390, p. E-33) and the "Mortandad Canyon Investigation Report" (LANL 2006, 094161, p. 126). This process includes calculating a ratio, which is the maximum concentration of an analyte in a specific media in a reach or at a water-sampling station divided by the SL. This is analogous to the HQ as used in Section 8.1 for assessing potential ecological risk. An SOF is the sum of these ratios for each risk type, i.e., carcinogens (SOF_{ca}), noncarcinogens (SOF_{nc}), and radionuclides (SOF_{rad}). These are analogous to HIs calculated in Section 8.1. Ratios based on maximum detected concentrations for all COPCs within a reach or water location are summed to calculate the SOF for the risk class of those analytes (carcinogen, noncarcinogen, or radionuclide). For all reaches or water locations with an SOF >1.0 for a risk class within a reach or surface-water sampling location, all COPCs within that risk class with ratios greater than 0.10 are retained as COPCs for the site-specific risk assessment. COPCs with a ratio ≤0.10 based on maximum sample results are excluded because they are unlikely to significantly contribute to risk. If the risk ratio for an individual analyte was greater than 0.10 but the SOF for the reach the analyte was detected in was less than 1.0, the analyte was not carried through to the human health risk assessment.

Sediment COPCs: The human health SLs for nonradionuclides in sediment used in this screening assessment are the NMED residential SSLs from Revision 4 of NMED guidance (2006, 092513). For analytes for which NMED does not provide a value, the residential screening value from the current EPA 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 and are based on the soil guidelines for unrestricted release of property (DOE Order 5400.5, "Radiation Protection of the Public and the Environment"). SALs are derived using RESRAD Version 6.21 (LANL 2005, 088493).

Tables 8.2-1 to 8.2-3 present the residential SSLs and SALs used to calculate ratios; these tables also provide the SOFs for each reach for each risk class for all sediment COPCs, based on the maximum detected concentrations for each analyte. COPCs and reaches shaded gray are those retained for the risk assessment. Table 8.2-1 provides the results for noncarcinogens, Table 8.2-2 provides the results for carcinogens, and Table 8.2-3 provides the results for radionuclides.

Surface-Water COPCs. SLs for surface water for organic and inorganic COPCs are the tap water values from the EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm). The

EPA regional values were supplemented by screening values from drinking water standards (MCLs) issued under the Safe Drinking Water Act (http://www.epa.gov/safewater/contaminants/index.html), or 20.6.4 NMAC “Standards for Interstate and Intrastate Surface Waters.” Radionuclide SLs are based on a dose of 4 mrem/yr and are from the DOE DCG (DOE Order 5400.5, “Radiation Protection of the Public and the Environment”) or based on EPA preliminary remediation goals (PRGs) (adjusted to a target risk level of 10^{-5}) (http://epa-prgs.ornl.gov/radionuclides/).

In evaluating surface water associated with sediment reaches in the north canyons, only data for nonstorm-related surface-water samples were evaluated (e.g., perennial springs or snowmelt runoff). For many of the surface-water samples, chemical analysis was performed on both the unfiltered and filtered samples (all samples, unfiltered, were analyzed, a portion of which were filtered and then analyzed). However, since the analyses on the filtered samples were aliquots from the unfiltered samples, the filtered samples are essentially duplicate results. Consequently, only the unfiltered sample results were used for the surface-water COPC evaluation. In addition, since the primary exposure pathway for the recreational exposure scenario is ingestion of surface waters, the unfiltered sample results will be more representative of the actual intake. Unfiltered samples will generally have higher COPC concentrations (due to contaminants absorbed on the unfiltered particulate material suspended in the surface water), so the evaluation of the health effects based upon these unfiltered samples will be more protective than if the evaluation was based upon filtered samples.

Tables 8.2-4 to 8.2-6 present the human health water SLs used to calculate ratios; these tables also provide the SOFs for each risk class for all surface-water COPCs. COPCs and water locations shaded gray are those retained for the further assessment. Table 8.2-4 provides the results for noncarcinogens; Table 8.2-5 provides the results for carcinogens; Table 8.2-6 provides the results for radionuclides. Because the use of any given water source within a reach by a human receptor is random (i.e., the receptor is capable of using one or both sources for drinking water within the confines of the defined exposure scenario), results for both surface-water sources associated with reach G-1 are provided in Tables 8.2-4, 8.2-5, and 8.2-6.

COPC Summary. Table 8.2-7 presents a summary of endpoints and reaches considered in the human health risk assessment for the north canyons. For each reach and endpoint combination with both sediment and water COPCs retained, a multimedia assessment would also be performed for this reach to assess potential cumulative risks. There were no reaches where effects due to multimedia exposures needed to be evaluated.

Calculating Exposure Point Concentrations

According to 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) on the mean. Different methods are available to estimate the 95% UCL, depending upon the underlying distribution of the data set.

Sediment. 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 95% UCLs on the means for COPCs retained for the human health risk assessment in each reach. The EPA software, ProUCL Version 4.00.04 (http://www.epa.gov/esd/tsc/software.htm), 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 for the EPC. However, if the calculated UCL on the mean suggested by ProUCL was greater than the maximum detected value for a COPC within a reach, then an alternative UCL was selected per the ProUCL logic. If the number of samples was small (<3) and an appropriate UCL was not recommended by ProUCL, then the maximum detected value was used for the EPC. Further details on the calculation of the UCLs used in this risk assessment are provided in Appendix E, Section E-3.0, and in the ProUCL guidance (EPA 2007, 102895). The EPA statistical software package ProUCL Version 4.00.02 (http://www.epa.gov/esd/tsc/software.htm) was used for this assessment. 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 for the EPC. However, if the calculated UCL on the mean suggested by ProUCL was greater than the maximum detected value for a COPC within a reach, then an alternative UCL was selected per the ProUCL logic. If the number of samples was small (<3) and an appropriate UCL not suggested by ProUCL, then the maximum detected value was used for the EPC. Further details on the calculation of the UCLs used in this risk assessment are provided in Appendix E, Section E-3.0 and in the ProUCL guidance (EPA 2007, 102895).

Many of the data sets for COPCs include nondetect values. The approach to estimating averages and UCLs with data that include nondetects is also described in Section E-3.0 (Appendix E).

Surface Water: Surface-water COPC concentrations are evaluated for each sampling location, unlike sediments where multiple sample locations are combined to generate an EPC concentration for a reach (see Section 8.2-2). The only exception is for locations that are basically collocated within a few meters of each other. For reach G-1, there were two associated surface-water locations: Guaje at SR-502 and GU-0-01 Spring. As discussed in the previous section, because it cannot be assumed that a receptor is only limited to accessing and using one water source, contamination in both surface-water sources in reach G-1 is used in calculating EPCs and the human health risk assessment. Only a limited number of COPCs were detected at GU-0.01 Spring, most of which were not selected as COPCs using the previously described screening process (see previous section). The exception is for PCDFs, which were detected only at GU-0.01 Spring. Because of limited numbers of samples, all of the surface-water EPCs are based on maximum detected values. The surface-water EPC concentrations for the recreational user scenario are presented in Section 8.2.5, Table 8.2-14.

8.2.3 Exposure Assessment

The recreational user scenario applies to all reaches identified in Table 8.2-7. Additionally, potential risk associated with the residential scenario is provided as a point of comparison (see Appendix E, Section E-3.0). The two exposure scenarios employed in the human health risk assessment have been described in other documents (LANL 2007, 094496; LANL 2007, 095115). Exposures from surface-water ingestion are evaluated based on the trail user and extended backyard scenarios (collectively, the “recreational” exposure scenario) described in the “Los Alamos and Pueblo Canyon Investigation Report” (LANL 2004, 087390, p. 8-37) and the “Mortandad Canyon Investigation Report” (LANL 2006, 094161, p. 128), which also provide risk-based concentrations for trail user surface-water exposures (LANL 2004, 087390, p. E-317). Residential SSLs are from NMED guidance (NMED 2006, 092513), and residential SALs are from Laboratory guidance (LANL 2005, 088493). Sediment SLs for the recreational scenario are provided in (LANL 2007, 094496). However this document does not address surface-water exposures for the recreational exposure scenario. The basic approach outlined in the Laboratory guidance for recreational sediment exposure was used to calculate the recreational surface-water SLs used to calculate the risk ratios presented in this report (Section 8.2.4).

8.2.3.1 Exposure Scenario Description

The human health risk assessment focuses on potential risks and doses resulting from direct exposure to contaminants in sediments through ingestion, inhalation, external irradiation (radionuclides only), and dermal contact (chemicals only). The water pathways for the recreational user consist of ingestion and dermal contact (chemicals only) using persistent surface-water data. If necessary, cumulative risks resulting from the exposures to sediments and persistent surface water are evaluated. Stormwater data in comparison to applicable standards are summarized in Section 6, and no analytes have potential for acute human health effects based on exposure to stormwater. 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. Exposure to groundwater (other than that emanating from perennial springs) is not evaluated because no groundwater in the north canyons is available for human uses under current conditions or the reasonably foreseeable future for a recreational user. Exposures to the recreational user are evaluated at the scale of sediment investigation reaches or water location. This local-scale evaluation is protective compared with an assessment based on a more realistic scale encompassing numerous reaches and areas between reaches. A summary of potentially complete exposure pathways, by scenario, is provided in Table 8.2-8.

Exposure scenario parameters were selected to provide an RME estimate of potential exposures. As discussed in EPA (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–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 at a residence near the canyon, using the canyon over an extended period of time. Therefore, receptors for the recreational user 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 2004, 087390, p. 8-37). Exposure parameters for the recreational scenario are provided in Appendix E, Section E-3.0.

8.2.3.2 Supplemental Exposure Scenario

Risk estimates are provided for a resident as a supplemental exposure scenario. A more detailed discussion of the basis and parameterization of this scenario is provided in NMED guidance (2006, 092513) and Laboratory guidance (2005, 088493). Exposure parameters and results for the resident are provided in Appendix E, Section E-3.0.

8.2.3.3 Spatial Scales of Application for the Exposure Scenarios

Each exposure scenario is evaluated at the scale of a reach for sediments and at the scale of individual sampling locations for water. The investigations evaluated in this report have multiple investigation reaches and water-sampling locations. The risk assessment does not attempt to integrate exposure across multiple reaches for sediment or across water-sampling locations for surface water. By assessing each reach and associated water-sampling locations separately, the impacts of local variability in COPC concentrations upon the risk assessment 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) and from specific water-sampling locations. Risks for more realistic exposures from multiple reaches or water locations within the north canyons are therefore expected to be lower.

8.2.4 Toxicity Assessment

This section of the human health risk assessment provides information related to the basis for distinguishing among the three classes of chemicals that are evaluated in this assessment: systemic toxicants (noncarcinogens), chemical carcinogens, and radionuclides. This information provides a context for interpreting the results of the risk assessment, which employs COPC-specific values of toxicity and radiation dose to evaluate potential health impacts.

Using SLs simplifies aspects of the risk assessment in that exposure and toxicity information has been compiled in available guidance documents and reports. The sources for toxicity data used for this risk assessment include NMED, Laboratory, and EPA guidance documents and databases (NMED 2006, 092513; LANL 2007, 094496, http://cfpub.epa.gov/ncea/iris/index.cfm). The Laboratory's "Technical Approach for Calculating Recreational Soil Screening Levels for Chemicals" (LANL 2007, 094496) is used as the basis for calculating surface-water screening values. Toxicity information used to develop surface-water screening values is also generally consistent with values used in NMED, Laboratory, and EPA guidance documents (as discussed below).

SLs are from several sources based on COPC type and exposure medium.

- Recreational scenario for carcinogens and noncarcinogens:
  - Sediment: used the recreational SSLs developed in Laboratory guidance (LANL 2004, 087800)
  - Surface water: calculated based upon method in "Technical Approach for Calculating Recreational Soil Screening Levels for Chemicals" (LANL 2007, 094496)
- Recreational scenario for radionuclides:
  - Sediment: used the recreational SALs developed in Laboratory guidance (LANL 2005, 088493)
  - Surface water: calculated based upon method in "Derivation and Use of Radionuclide Screening Action Levels, Revision 1" (LANL 2005, 088493) and cancer slope factors from EPA PRGs for radionuclides: (http://epa-prgs.ornl.gov/radionuclides/)
- Residential scenario for carcinogens and noncarcinogens:
  - Sediment: used the SSLs from NMED guidance (2006, 092513), except for certain values from EPA regional values: (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm)
  - Surface water (screening only): tap water screening values from EPA regional values: (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm), U.S. primary drinking water standards issued under the Safe Drinking Water Act: (http://www.epa.gov/safewater/contaminants/index.html.), and 20.6.4 NMAC, "Standards for Interstate and Intrastate Surface Waters"

- Residential scenario for radionuclides:
    - ❖ Sediment: used the residential SALs developed in Laboratory guidance (LANL 2005, 088493)
    - ❖ Surface water (screening only): DOE DCG (DOE Order 5400.5, "Radiation Protection of the Public and the Environment") and the EPA PRGs for radionuclides: (http://epa-prgs.ornl.gov/radionuclides/)

Table 8.2-9 summarizes recreational sediment and surface-water SLs and target adverse effect levels. Comparing the screening values with COPCs for a given risk endpoint provides some information of the relative toxicity of these analytes. Because these risk-based screening values are obtained from references prepared from 2004 to 2008, there is potential for differences in the toxicity values used in the SL calculations. The toxicity values in the EPA's Integrated Risk Information System (IRIS) database (http://cfpub.epa.gov/ncea/iris/index.cfm) or the analytes listed in Tables 8.2-1, 8.2-2, 8.2-4, and 8.2-5 (for sediment and surface water, noncarcinogens and carcinogens) were reviewed. None of the IRIS toxicity values for any of the COPCs listed have been updated since 2006; hence, the SLs (see Appendix E, Section E-3.0) used to calculate risk ratios are based upon the most current toxicological data available.

8.2.5 Risk Characterization

In this section of the human health risk assessment, information provided in the exposure and toxicity assessments (Sections 8.2.3 and 8.2.4, respectively) is integrated to characterize potential risk and dose. The risk characterization is conducted on the basis of the general principles described in Section 8.0 of the risk assessment guidance for Superfund (EPA 1989, 008021). Potential adverse effects related to noncarcinogens, chemical carcinogens, and radionuclides are discussed in Sections 8.2.5.1, 8.2.5.2, and 8.2.5.3, respectively. The presentation of potential adverse effects focuses on the quantitative expressions of potential impacts. In the uncertainty analysis (Section 8.2.6), the confidence associated with the quantitative risk estimates is discussed through an evaluation of the uncertainties pertaining to each step of the risk assessment process.

This risk assessment employs SLs to evaluate COPCs for potential adverse health effects. COPC intake and toxicity are combined within the screening value calculations; therefore, separate calculations of intake and health effects (cancer risk, hazard, and dose) were not generated. Potential human health effects were assessed using the ratios of EPCs to SLs for each COPC retained in this assessment for each of the exposure scenarios. These ratios were summed for an investigation reach and (when applicable) a water-sampling location within the COPC classes of chemical carcinogens, noncarcinogens, and radionuclides (SOFs). A sum of less than 1.0 indicates that exposure is unlikely to result in an unacceptable cancer risk, hazard, or radiation dose. SOF values are then multiplied by the target effect level (i.e., HI = 1, risk = 1×10^{-5}, or dose = 15 mrem/yr sediment, 4 mrem/yr water) to provide risk and dose estimates for each COPC class.

For the recreational scenario, there were no reaches where cumulative exposure to sediment and surface water needed to be evaluated through a multimedia sum. For COPCs with a common target effect level (e.g., all carcinogens are based on 1×10^{-5} incremental cancer risk [ICR]), the multimedia sum can be converted into an approximate effect level. Carcinogen and noncarcinogen SLs are based on a common adverse effect level across sediment and surface water, but the radionuclide adverse effect levels are not the same for sediment (15 mrem/yr) and surface water (4 mrem/yr).

The recreational user scenario cumulative, multimedia sums, and the risk values for noncarcinogens, carcinogens, and radionuclides based on EPCs were not calculated. No reaches qualified for multimedia exposures, noncarcinogens, carcinogens, or radionuclides (see Tables 8.2-7 and 8.2-10).

Table 8.2-11 presents the COPC and reach-specific recreational risk values for sediment, and Table 8.2 12 presents the COPC and reach-specific recreational risk values for surface water. The EPCs for sediment are presented in Table 8.2-13, and the EPCs for surface water are presented in Table 8.2 14. Results for the supplemental exposure scenario (residential) are provided in Tables E-3.4-2 and E-3.4-3.

8.2.5.1 Noncarcinogenic Effects

Chemical hazard for an individual chemical is commonly defined by the HQ, which is calculated as the ratio of the chemical intake to the reference dose for that chemical. An HQ greater than 1.0 is indicative of the potential for adverse effects; therefore, an HQ of 1.0 was used in the calculation of screening values for noncarcinogenic effects. When the potentially additive effects of two or more chemicals are considered, HQs are summed to generate an HI. However, summing of chemical HQs to create an HI assumes that the target organs and mechanisms of toxicity are similar. The SOF_{nc} values in this human health risk assessment are functionally equivalent to generating an HI. The protective approach of summing these ratios does not warrant refinement because the HI values are in all cases well below 1.0.

Potential noncarcinogenic effects for contaminants in sediment were calculated (Table 8.2-7) for reaches G-1, R-1E, and R-3 and for contaminants in surface water in reach G-1 (primarily surface-water sampling location Guaje at SR-502). None of reaches were evaluated for multimedia exposure for noncarcinogens. The calculated sediment HIs for all reaches were significantly less than 1 (Tables 8.2-10 and 8.2-11). The surface water HI for reach G-1 was 1.6 (Tables 8.2-10 and 8.2-12); driven primarily by lead (HQ=1.3). This is based on a recreational water-screening value of 65 µg/L that was developed as part of the “Los Alamos and Pueblo Canyons Supplemental Investigation Report” (LANL 2005, 091818). This screening value was calculated using the EPA Integrated Exposure Uptake Biokinetic lead model.

The lead EPC is based on the maximum detected value for three unfiltered snow melt samples from location Guaje at SR-502. Two of these samples were also filtered and analyzed. Lead was detected in one filtered sample at a concentration of 0.62 µg/L. It was not detected in the second filtered sample (detection limit 0.5 µg/L). Because the soluble lead is 100 times lower than the lead in the unfiltered sample, this indicates that most of the lead is associated with suspended sediment. Lead was not detected above the sediment BV in the sediment samples collected from reach G-1 (Table 8.2-1). The surface-water samples collected from location Guaje at SR-502 were evaluated for suspended sediment concentration in the three unfiltered samples. The average of the reported suspended sediment values was 5,970,000 µg/L. The BV for lead in sediment is 19.7 mg/kg, which is equivalent to 1.97E-5 µg lead per microgram of sediment. If the sediment in these three samples contained lead at the BV, then the concentration of lead in unfiltered water samples would be 117 µg/L ([1.97E-5 µg lead/µg sediment] × [5,970,000 µg/L sediment]). The maximum detected lead concentration was 77.5 µg/L, lower than the calculated water concentration based on the BV. This comparison, plus the 100 times lower soluble lead concentration, indicates that the lead in the surface-water sample is caused by lead present at background concentrations in suspended sediment and not by Laboratory activities.

8.2.5.2 Carcinogenic Effects

Cancer risk for an individual chemical is defined by the ICR, which is calculated as the product of exposure to a single chemical and the cancer slope factor (SF) for that chemical. ICRs for each exposure route and chemical are then summed to calculate the total ICR to an individual. A target risk level of 1×10^{-5} was used in this human health risk assessment to calculate risk-based concentrations for carcinogenic effects (NMED 2006, 092513). Lifetime cancer risk is considered to be additive over time; childhood and adulthood exposures are summed to calculate the ICR.

Potential risks due to carcinogens in sediment were evaluated for reaches G-BKG, R-1E, R-1S, and R-3 and in surface water for reach G-1 (Table 8.2-7). None of the reaches were evaluated for multimedia exposure to carcinogens. All of the ICRs were less than or equal to 2×10^{-6} (Tables 8.2-10, 8.2-11, and 8.2-12), indicating that risk due to carcinogens in sediment and surface water in the north canyons is not a concern for the recreational scenario.

8.2.5.3 Radiation Dose

The radiation dose associated with the EPA dose conversion factors (DCFs) used in the human health risk assessment is the annual committed effective dose equivalent (internal) or annual effective dose equivalent (external), expressed in units of millirems per year. The target dose limit used for calculating SLs related to soil pathways is 15 mrem/yr, which is consistent with guidance from DOE (2000, 067489). For water-based exposure pathways, SLs were calculated using a target dose limit of 4 mrem/yr. Use of this more protective dose limit for water pathways is based on the radiation dose limit for a public drinking water supply in DOE Order 5400.5, “Radiation Protection of the Public and the Environment.” Consistent with EPA guidance (1989, 008021), dose through dermal absorption is not quantified because it is probably negligible compared with the other exposure pathways.

Exposure to radionuclides was evaluated for sediment in reaches G-BKG and R-3 and surface water in reach G-1 (Table 8.2-7). None of the reaches were evaluated for multimedia exposure to radionuclides. The radionuclide dose for each of these three reaches was less than 1 mrem/yr (Tables 8.2-10, 8.2-11, and 8.2-12).

The Laboratory’s Environmental ALARA (as low as reasonably achievable) Program (LANL Program Description PD410, p. 7) states that “…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 0.4 mrem/yr for exposure to sediment in reach G-BKG. Consequently, no further quantitative evaluation of radiation exposure and dose is required.

8.2.6 Uncertainty Analysis

The uncertainty analysis uses qualitative and semiquantitative information to evaluate the uncertainty associated with the risk, hazard, and dose estimates described in Section 8.2.5. This uncertainty analysis pertains to the results of the recreational scenario. 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

COPCs identified in Section 6 were retained for evaluation in the human health risk assessment. COPCs that were retained for calculation of EPCs were those that had ratios greater than 0.10 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.

Some of the COPCs retained for the human health risk assessment, manganese, cesium-137, and strontium-90 have their main inferred source from ash contained in post-Cerro Grande fire deposits (see Section 7.1, Table 7.1-1). Other COPCs have a combination of sources, including the Cerro Grande fire and variations in natural background. The assessment is protective by including all of these COPCs in the assessment of the potential for human health effects.

No BVs are available for surface water. The inability to distinguish COPCs in surface water based on comparisons with background concentrations is a substantial source of uncertainty in the results of the human health risk assessment for this media. For example, concentrations of arsenic (contributes to carcinogenic risk) and iron (contributes to noncarcinogenic HI) in surface water could be associated with local background and not with releases from Laboratory SWMUs or AOCs.

The possibility of underestimating EPCs for investigation reaches is another potential source of uncertainty. Four 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 areas, 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 Section B-1.0 of Appendix B. Second, 95% UCLs on the average sediment concentrations were employed 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. Fourth, for radionuclides, no correction was made for radioactive decay since the time of sampling, although present-day concentrations are lower than at the time of sampling for cesium-137 or strontium-90.

Uncertainty also exists for estimating EPCs for water-sampling locations. COPC concentrations often change with hydrologic conditions, particularly suspended sediment concentrations. The data evaluated in this assessment represent a snapshot of the current hydrological conditions and generally reflect a range of hydrologic conditions at each sampling location. As discussed in Section 7.2.1 and Appendix B, Section B-2.0, sampling occurred during a range of water-level conditions and field parameters, so the EPCs calculated from these data represent the range of COPC concentrations at the sampling locations. For Guaje at SR-502, associated with reach G-1, only three snowmelt samples were collected. Because of this small number of samples, UCLs were not calculated and the maximum detected value was used for the EPC. Using the maximum detected value for the human health risk assessment minimizes the chance of underestimating the exposure and hence the risk, hazard, or dose for a sampling location when there are only a limited number of sample results available.

As discussed in Section 8.2.2, only unfiltered samples were used to evaluate intake and exposure for this risk assessment. For the water ingestion pathway, the use of unfiltered water samples for calculation of EPCs generally results in a conservative (protective) exposure estimate because although suspended particulate matter in the surface water could be ingested, stormwater sampling is biased to the sediment-laden leading edges of flood bores, and it is unlikely that trail users would drink this water. For the dermal exposure pathway, EPCs based on unfiltered samples also likely results in overestimation of exposure. Because the dermal pathway represents only a small proportion of the total intake of the COPCs evaluated as part of this risk assessment for the recreational exposure scenario, this overestimation is small and unlikely to affect the overall quantitative outcome and consequently the final risk assessment conclusions.

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-3.0). 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 a description of 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 sediments across hazard, ICR, and dose for the recreational scenario include dermal absorption, incidental soil ingestion, 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. 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) and from specific water-sampling locations. Risks for more realistic exposures from multiple reaches or water locations within the north 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 both carcinogens and radionuclides, the exposure assessment should be evaluating incremental exposures that are greater than background. EPCs are calculated that include background concentrations. For the most part, background exposures are likely negligible, with the exception of some metals in sediment and surface water (e.g., arsenic) and do not lead to overestimating risk or dose.

Dermal contact with sediments and incidental soil ingestion have a second exposure characteristic in addition to time spent on-site that was biased in a protective manner. The soil adherence factors used to define soil loading on skin for children and adults are both protectively biased. The adult adherence factor is based on a high-exposure activity (gardening) that would result in greater exposure than would be the case during trail use. Adult soil ingestion was assumed to be 100 mg/d, which is twice the EPA-recommended value for adults (EPA 1997, 066596).

Because external gamma radiation is the main contributor to radionuclide dose, the assessment should also be protective of child exposures because behaviors that increase child exposure through some pathways (incidental soil ingestion and dermal contact) play basically no role in external gamma dose. Exposure related to external irradiation from soil is primarily a function of time spent on-site. However, the external DCFs used in the calculation of external dose protectively assume an effectively infinite area and depth of contamination.

An important aspect of uncertainty in exposure to COPCs in surface water relates to exposure intensity. Dermal contact and surface-water ingestion were assumed to occur 20 times per year for 30 yr (recreational user). This assumption was developed to bound a high-end exposure condition. Potential contact by adults with surface water in the north canyons are highly intermittent at some locations based on the limited availability of water.

8.2.6.3 Toxicity Assessment

SLs compiled by NMED (dated 2006) and EPA (regional screening levels dated 2008, Medium-Specific Screening Levels dated 2007 from EPA Region 6, and PRGs dated 2004 from EPA Region 9) were utilized. These data compilations are infrequently updated (greater than yearly) and therefore it is possible that SLs used in this risk assessment may not be reflective of the latest toxicity factors available from the EPA IRIS database for any given analyte. Review of the IRIS database (http://cfpub.epa.gov/ncea/iris/index.cfm) revealed that for the analytes evaluated in Tables 8.2-1 and 8.2-2, none of the toxicity values have been updated since 2006. Consequently, all of the screening values used are based upon the most up-to-date toxicity data available.

8.2.7 Summary of the Human Health Risk Assessment

The health effects associated with COPCs in the north canyons were assessed relative to a radiological dose criterion of 15 mrem/yr for sediment and 4 mrem/yr for water, a chemical cancer risk criterion of 1.0×10^{-5}, and a chemical hazard criterion of 1.0. The risk assessment results for sediment are below these thresholds for the recreational scenario. For the surface waters evaluated in the north canyons, only the chemical hazard in reach G-1 exceeded these criteria; chemical carcinogenic risk and radiological dose were below target levels. The exceedance of the HQ of 1.0 in G-1 was caused by lead detected in the three samples evaluated for this assessment. As discussed in Section 8.2.5.1, the lead in G-1 surface water was likely caused by the presence of naturally occurring lead in suspended sediments.

For the three reaches evaluated for radionuclide COPCs (G-BKG, R-3, and G-1), the radionuclide doses were all less than 1 mrem/yr, and the equivalent risks were all less than 1.0×10^{-5} (Tables 8.2-11 and 8.2-12). Because the calculated doses are all less than the 3-mrem ALARA guidance (Section 8.2.5.3), NFA is required with respect to radionuclides.

9.0 CONCLUSIONS AND RECOMMENDATIONS

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

The site-specific human health risk assessment uses a recreational exposure scenario to represent the present-day and reasonably foreseeable future land use in the north canyons. The assessment results indicate that for the recreational scenario, there are no unacceptable risks from carcinogens (incremental cancer risk criterion of 1×10^{-5}) or radionuclides (target dose limit of 15 mrem/yr in sediment and 4 mrem/yr in water) due to COPCs in sediment or surface water. However, one location has lead concentrations at 1.3 times greater than levels acceptable for noncarcinogens. The potential for adverse effects from lead, however, is not likely, given the assumed frequency of exposures to surface water.

COPECs identified in the initial ecological screening were compared with results from other watersheds where more detailed biota investigations were conducted. This comparison indicated that concentrations of COPECs in the north canyons derived from Laboratory SWMUs or AOCs are unlikely to produce adverse ecological impacts, and no additional biota investigations, mitigation, or monitoring is required.

Investigations of sediment, surface water, and groundwater in the north canyons indicate that inorganic, organic, and radionuclide COPCs are present in these media at concentrations above screening levels and/or standards. These COPCs are derived from several sources, including Laboratory SWMUs and AOCs; runoff from developed areas in the Los Alamos townsite; ash from the Cerro Grande burn area; and natural sources, such as noncontaminated soils, sediments, and bedrock. The risk assessments and screening assessments discussed above show that human health risks are within acceptable regulatory limits and there are no adverse ecological effects under current conditions. The conceptual model indicates that these conditions for sediments are likely to stay the same or improve; therefore, no further monitoring of sediments is necessary. However, stormwater in the north canyons will be 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.”

The spatial distribution of sediment COPCs in the north canyons indicates that contaminants have been or may have been released and transported downcanyon from former TA-10 in Bayo Canyon and several additional SWMUs or AOCs in Bayo and Rendija Canyons. Contaminants in sediment that were or may have been released from these sources are identifiable as COPCs for varying distances downcanyon. Most are COPCs only in reaches close to the sources, whereas at least one COPC that was apparently released from former TA-10 (Aroclor-1260) remains detected in the farthest downcanyon reach in Bayo Canyon, BY-3 above NM 501, approximately 6 km (4 mi) from the sources. However, this COPC has not been detected farther downcanyon in lower Los Alamos Canyon. The presence of these constituents does not pose an unacceptable risk.

In groundwater, arsenic is the only analyte that exceeds regulatory drinking water standards in a single detection from water supply well G-1A. This single result most likely reflects naturally occurring arsenic. In surface water, aluminum is the only analyte that exceeds a surface-water standard. Aluminum commonly exceeds the standard in surface water on the Pajarito Plateau, including background locations, and therefore likely reflects naturally occurring aluminum. The lack of surface water and shallow alluvial groundwater at former TA-10, which is the principal area of subsurface contamination within the north canyons, leads to minimal or no subsurface contaminant transport. Continued monitoring at well R-24 is, however, appropriate at this time because of its location downgradient of former TA-10.

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- Project Leaders: Danny Katzman and Steven Reneau
- Risk Assessments: Jenifer Linville, David Brenner, and Randall Ryti
- Sediment Investigations: Steven Reneau
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- Regional Water-Level Analysis: Velimir Vesselinov, Rich Koch, and Dylan Harp
- Geologic Setting: David Broxton and David Vaniman
- Contaminant Sources: Steven Reneau and Kay Birdsell
- Conceptual Model: David Broxton, Velimir Vesselinov, Kay Birdsell, and Patrick Longmire

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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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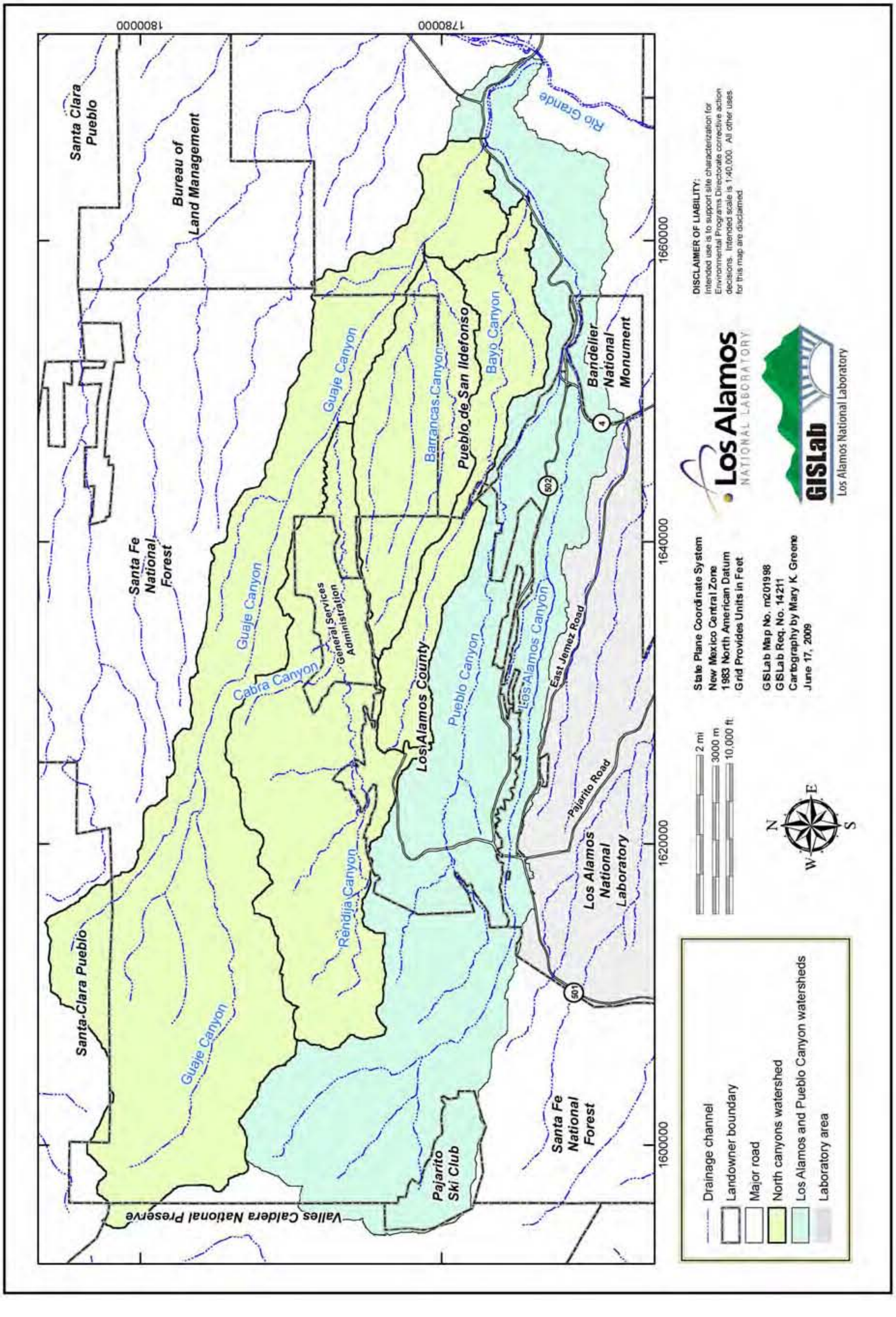


Figure 1.1-1 Locations of the north canyons watersheds showing major subbasins

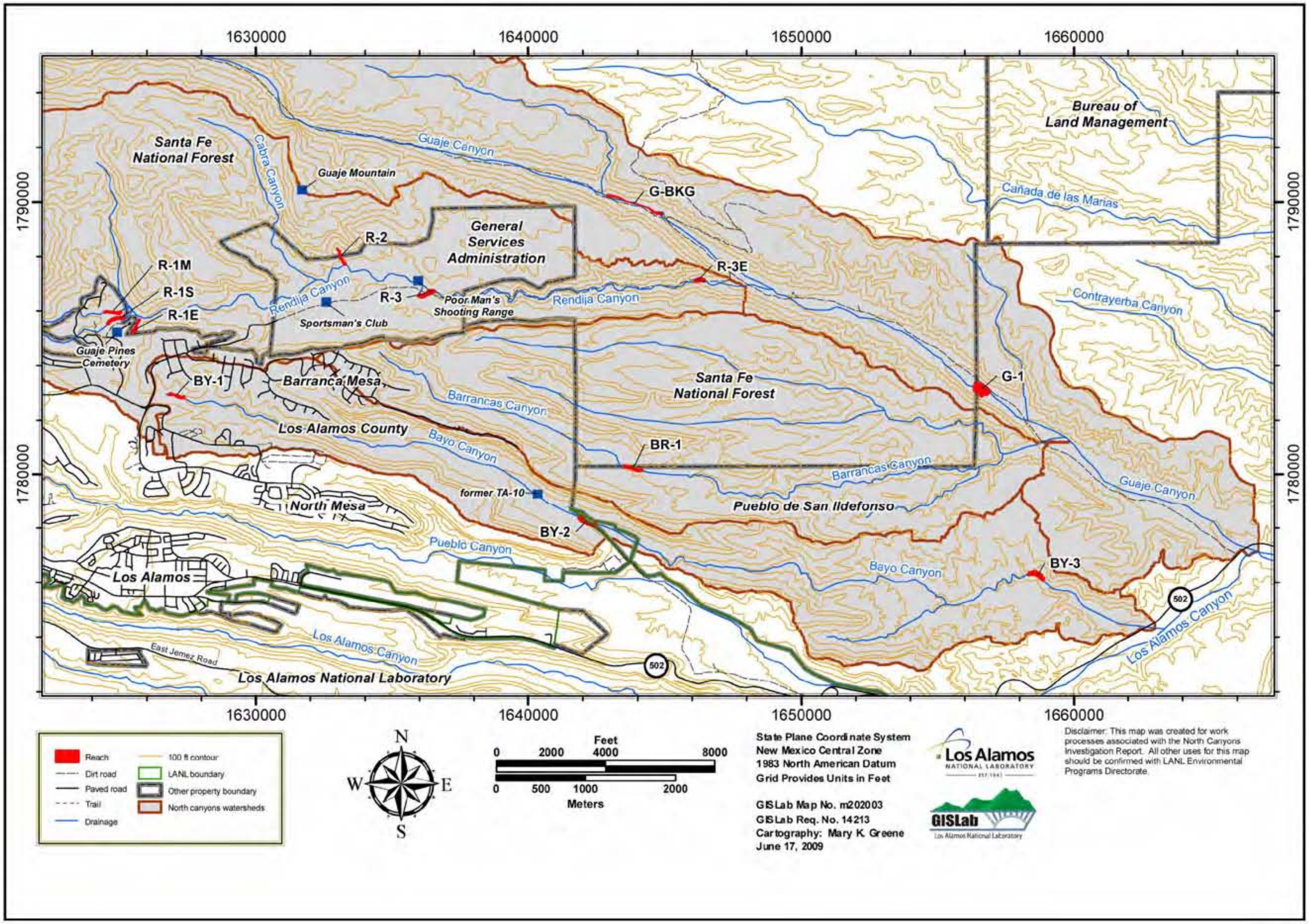


Figure 3.1-1 Sediment investigation reaches in the north canyons watersheds

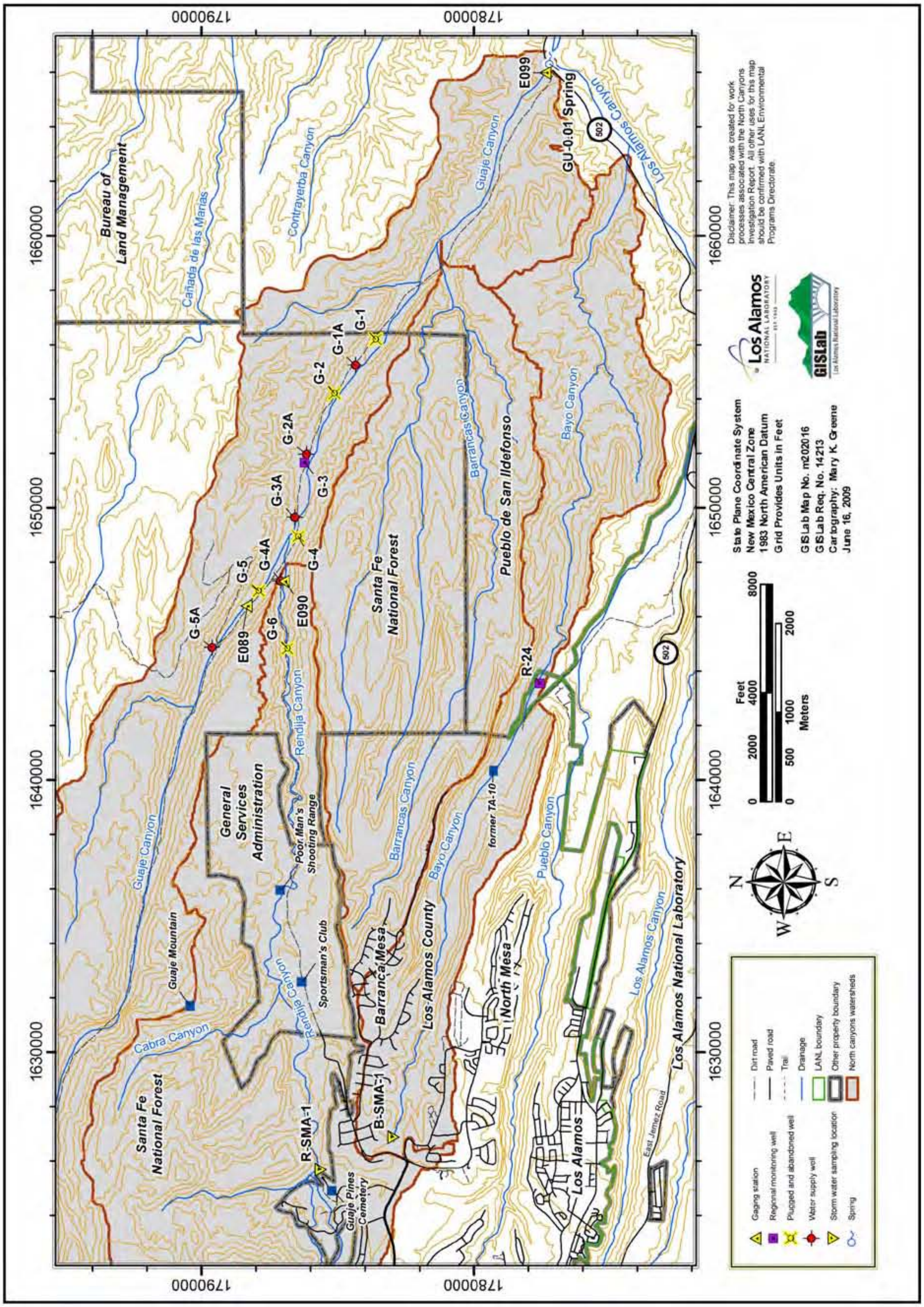
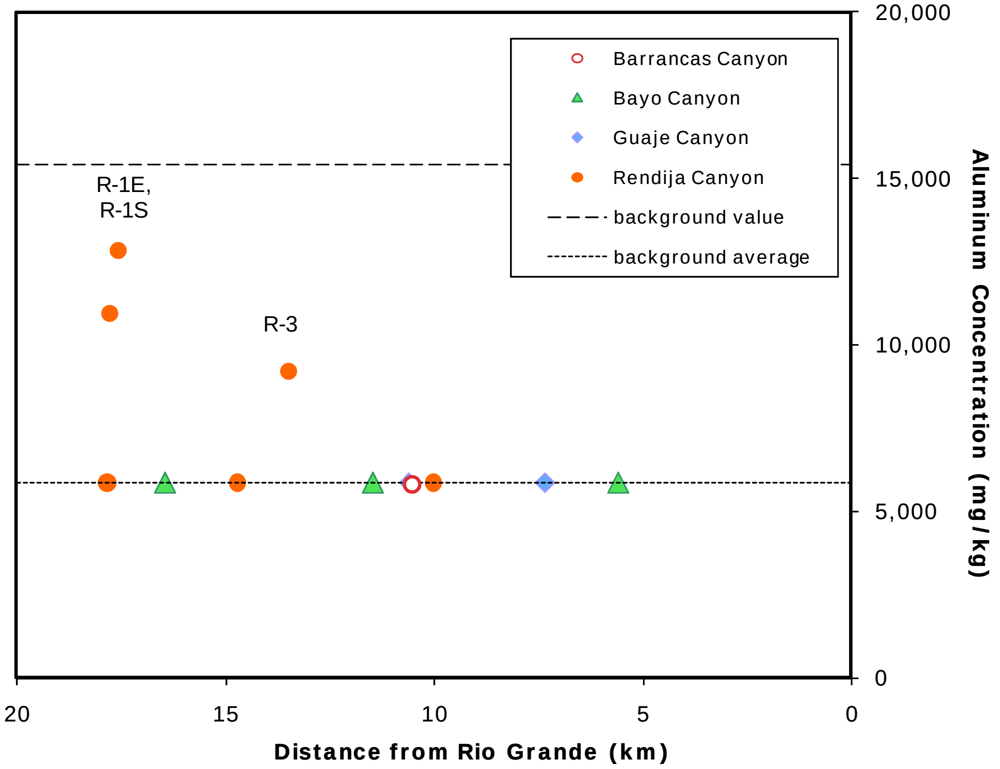
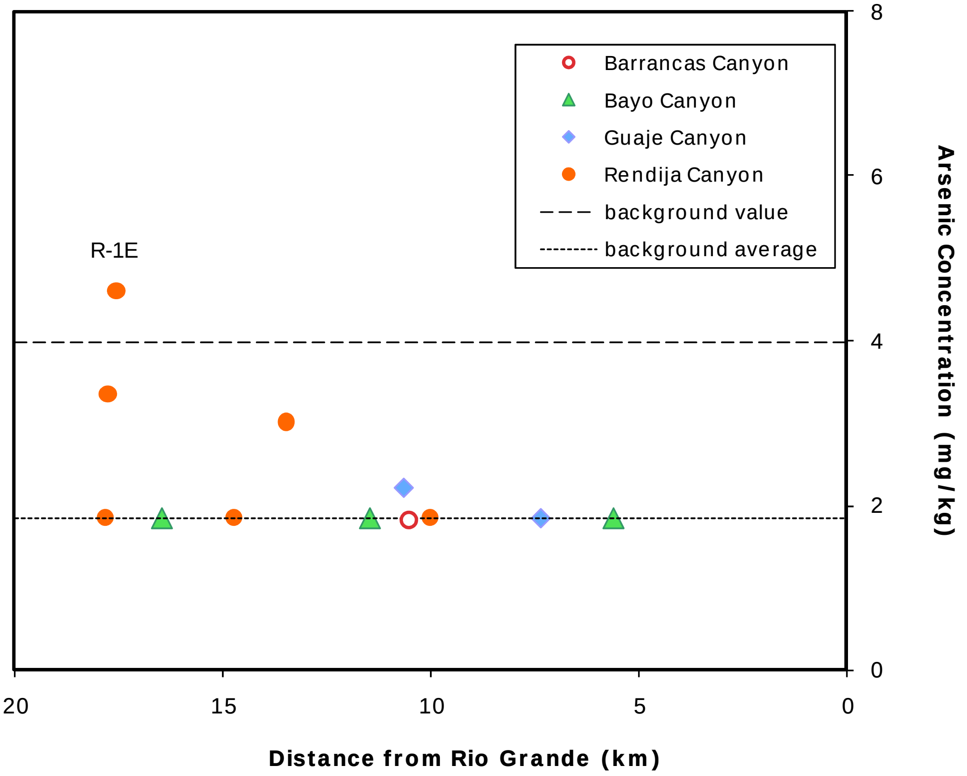


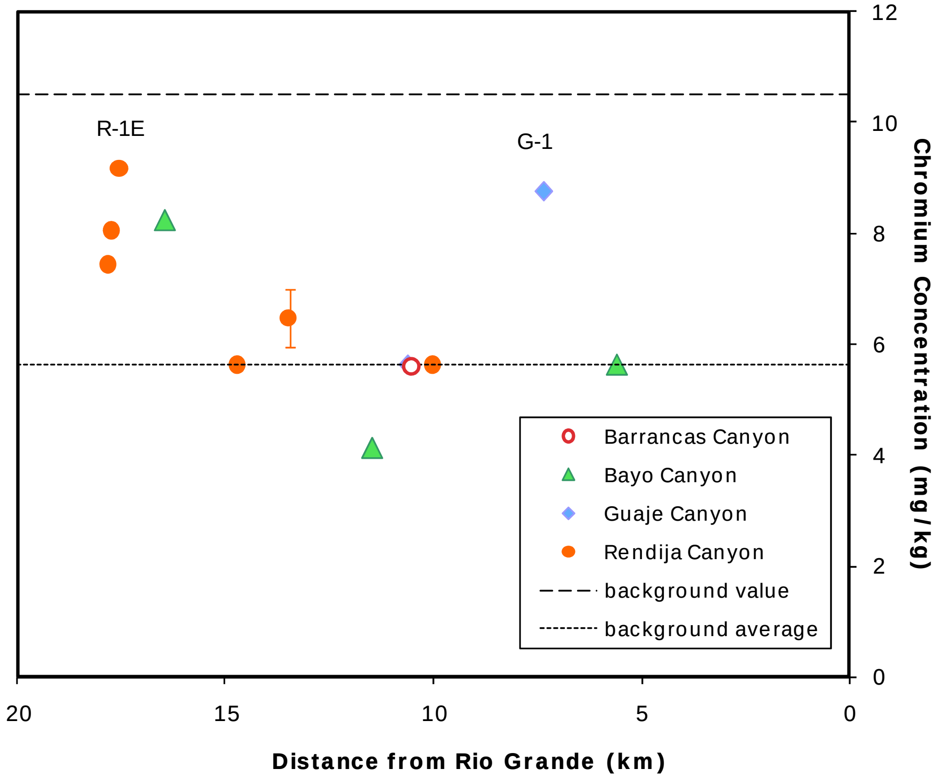
Figure 3.2-1 Water sampling locations in the north canyons watersheds

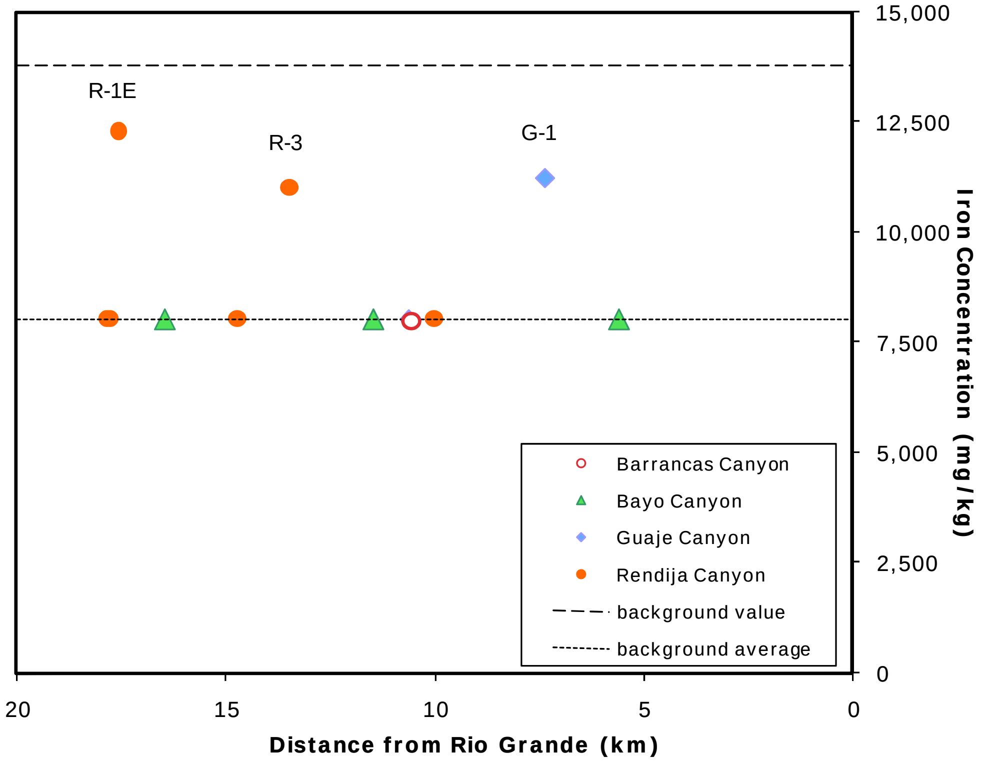




Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero, and the background average is plotted where an analyte is not a COPC in a reach.

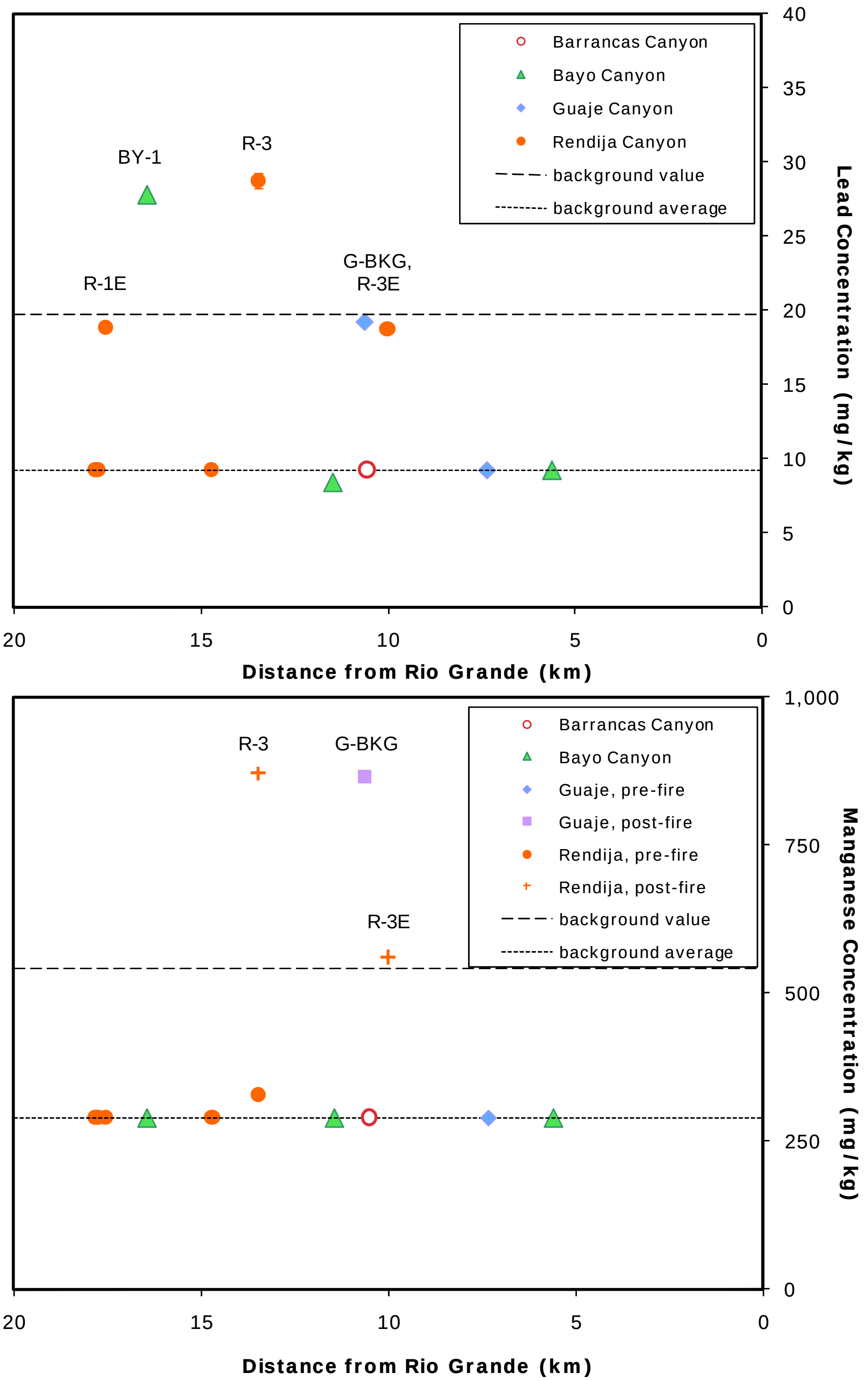
Figure 7.1-1 Estimated average concentrations of select inorganic chemicals in fine facies sediment in the north canyons





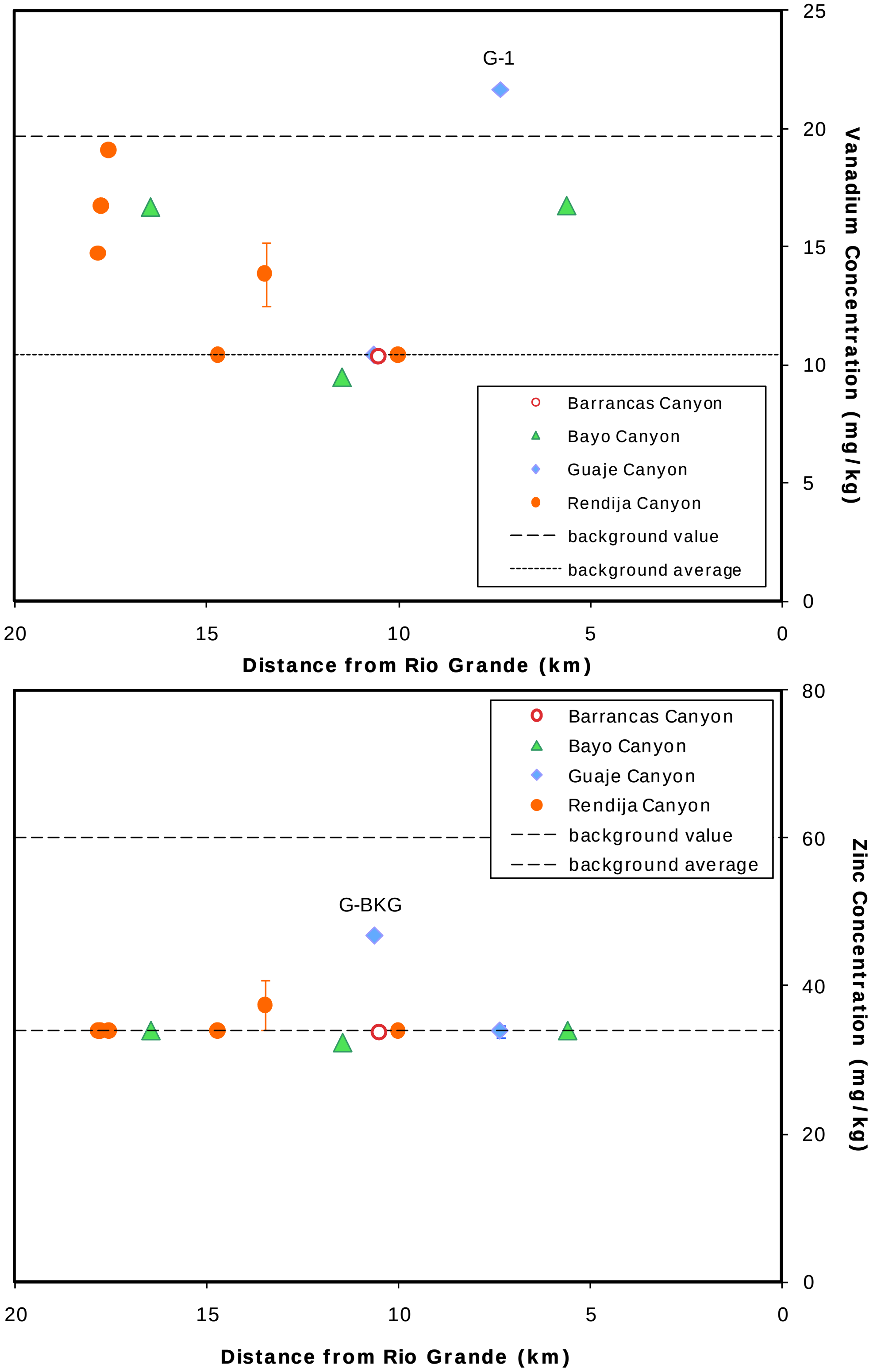
Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero, and the background average is plotted where an analyte is not a COPC in a reach.

Figure 7.1-1 (continued) Estimated average concentrations of select inorganic chemicals in fine facies sediment in the north canyons



Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero, and the background average is plotted where an analyte is not a COPC in a reach.

Figure 7.1-1 (continued) Estimated average concentrations of select inorganic chemicals in fine facies sediment in the north canyons



Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero, and the background average is plotted where an analyte is not a COPC in a reach.

Figure 7.1-1 (continued) Estimated average concentrations of select inorganic chemicals in fine facies sediment in the north canyons

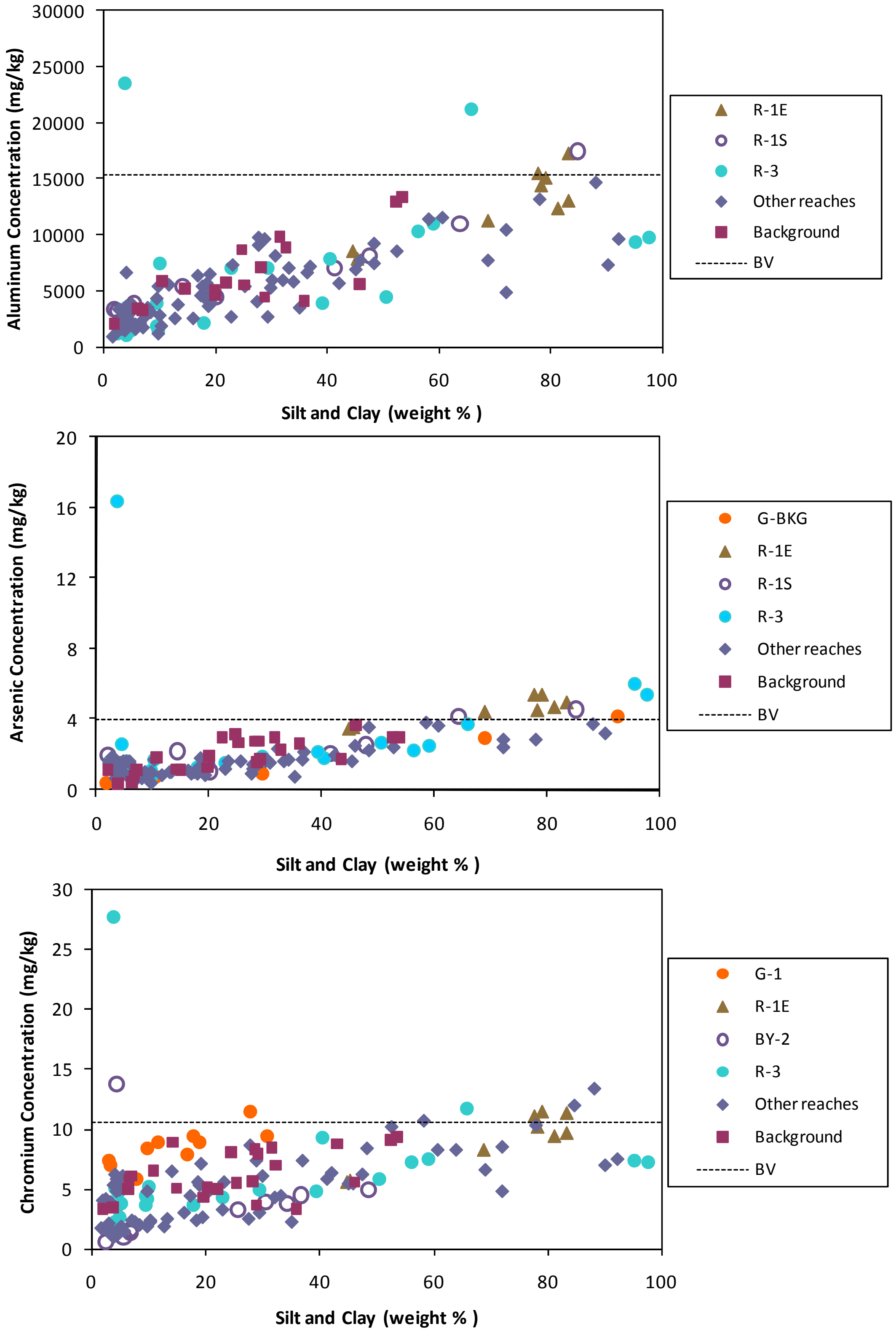


Figure 7.1-2 **Concentrations of select inorganic chemicals in north canyons and background sediment samples versus silt and clay content**

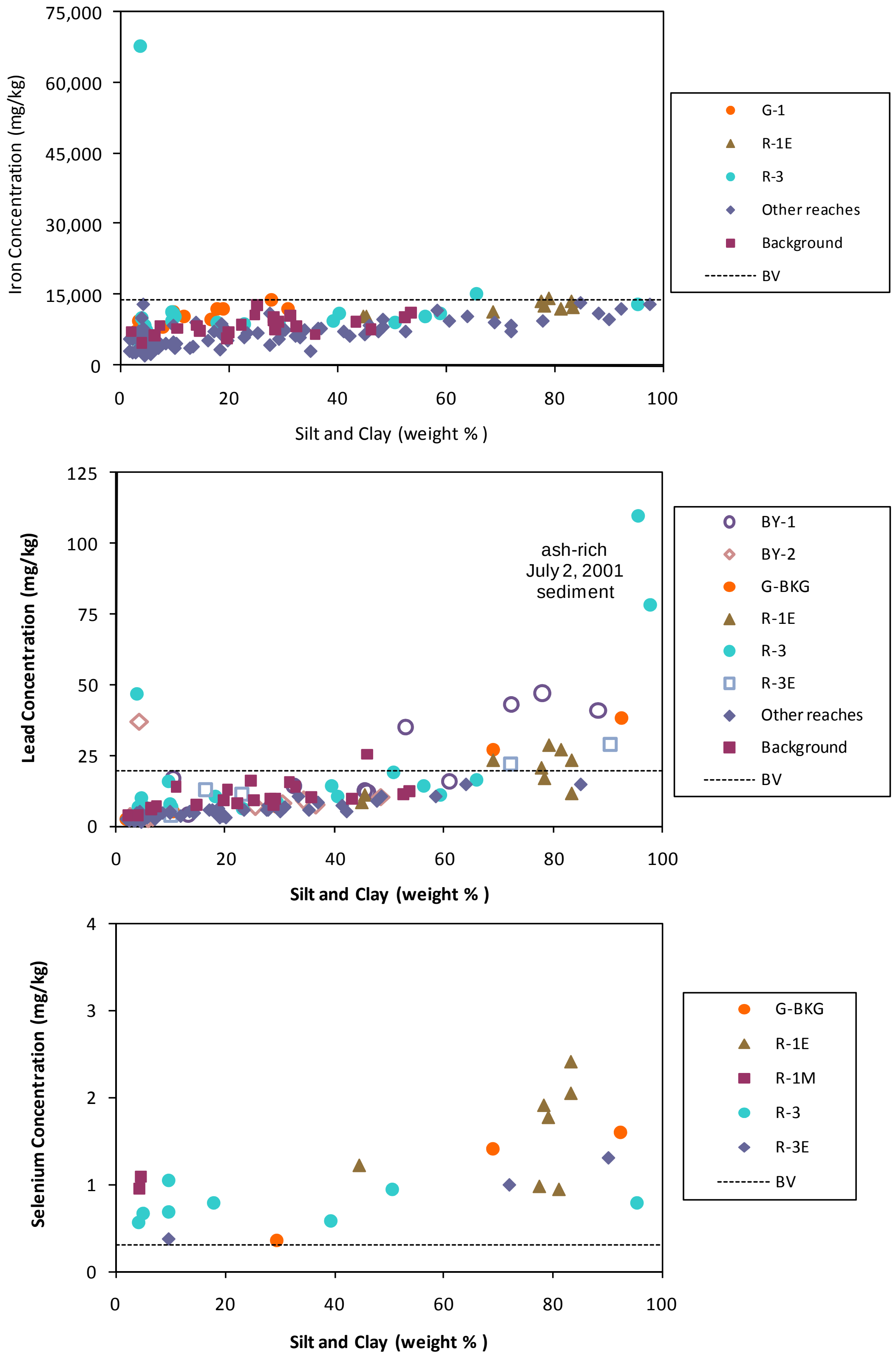


Figure 7.1-2 (continued) **Concentrations of select inorganic chemicals in north canyons and background sediment samples versus silt and clay content**

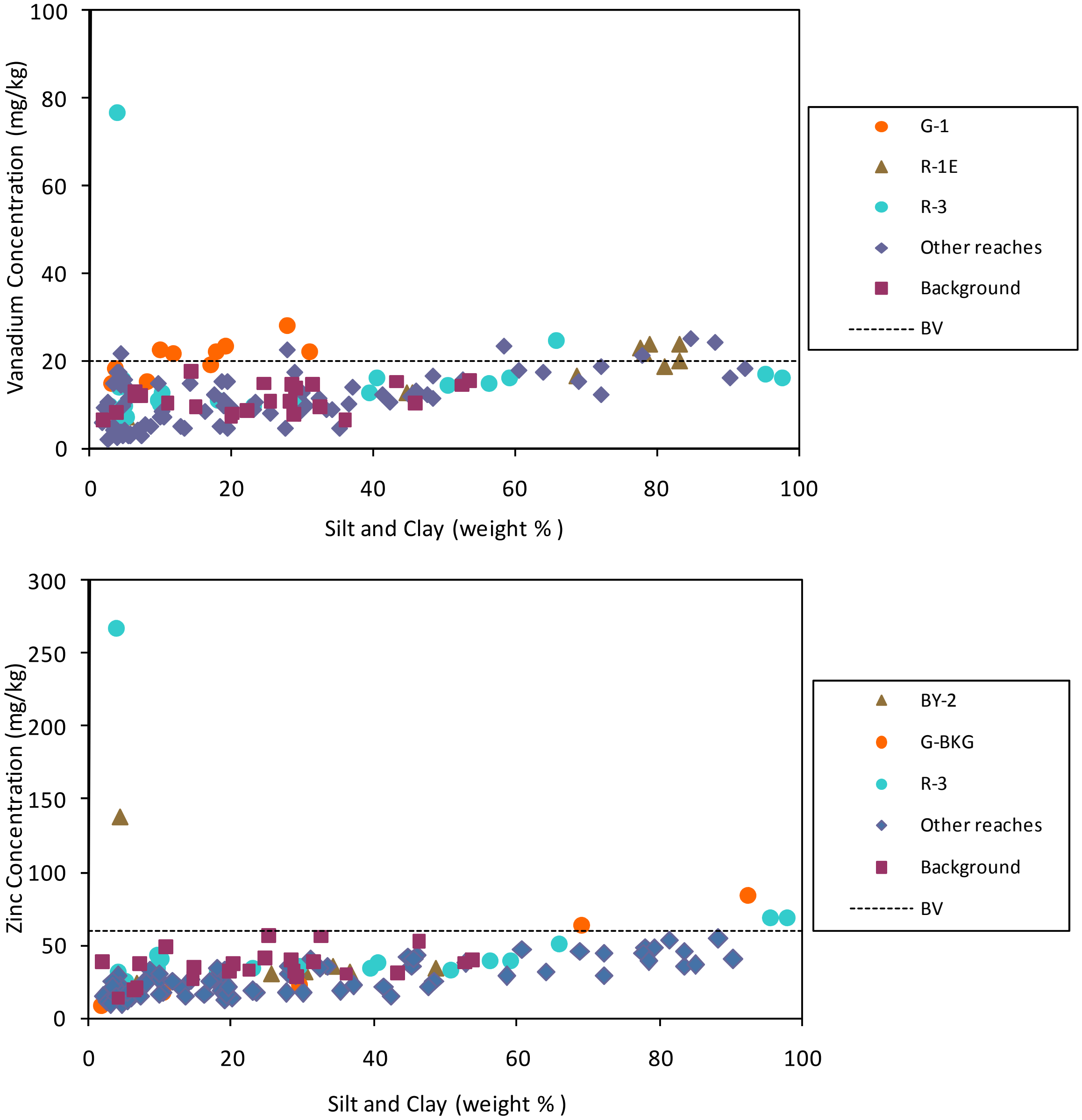
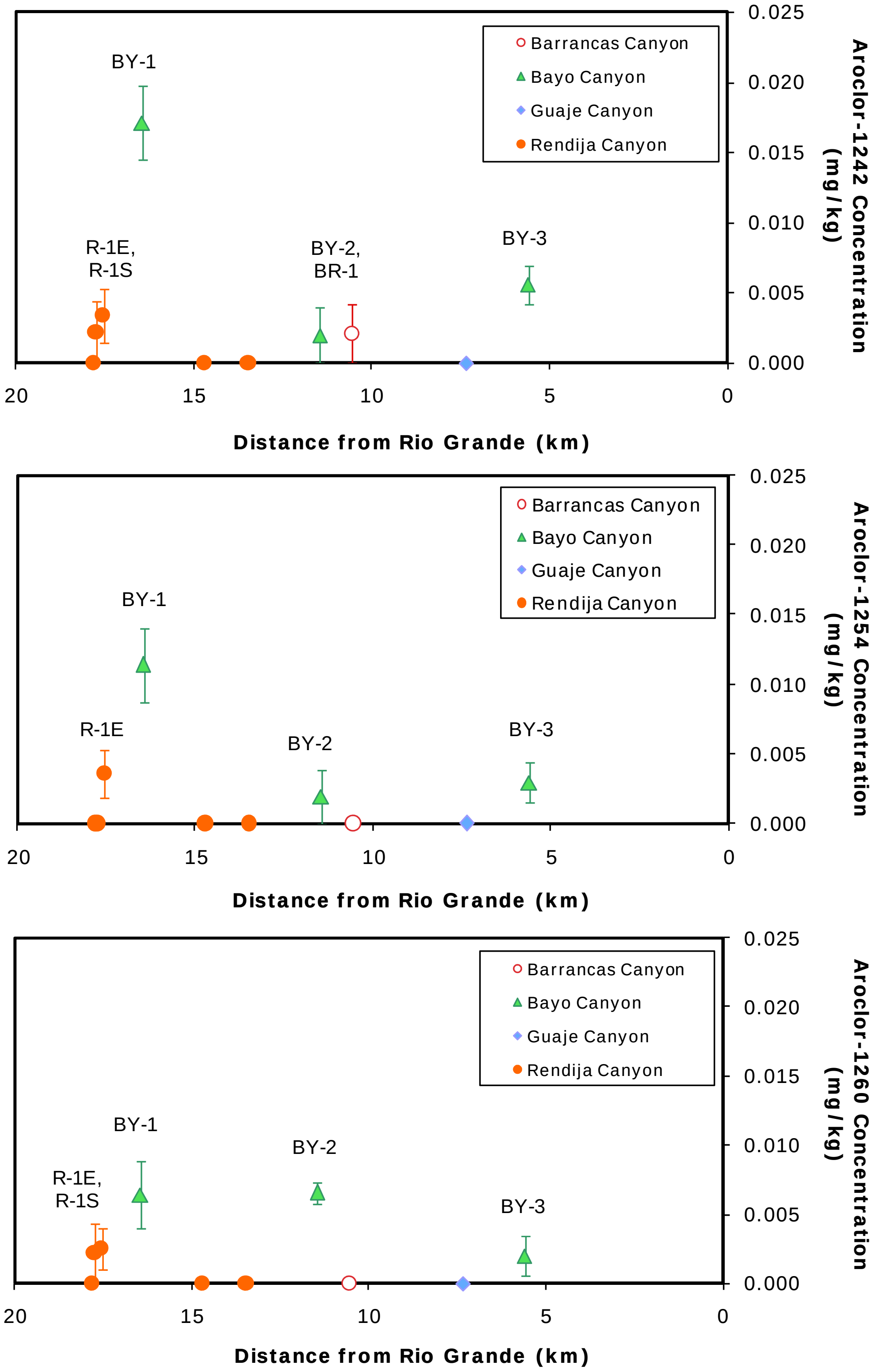
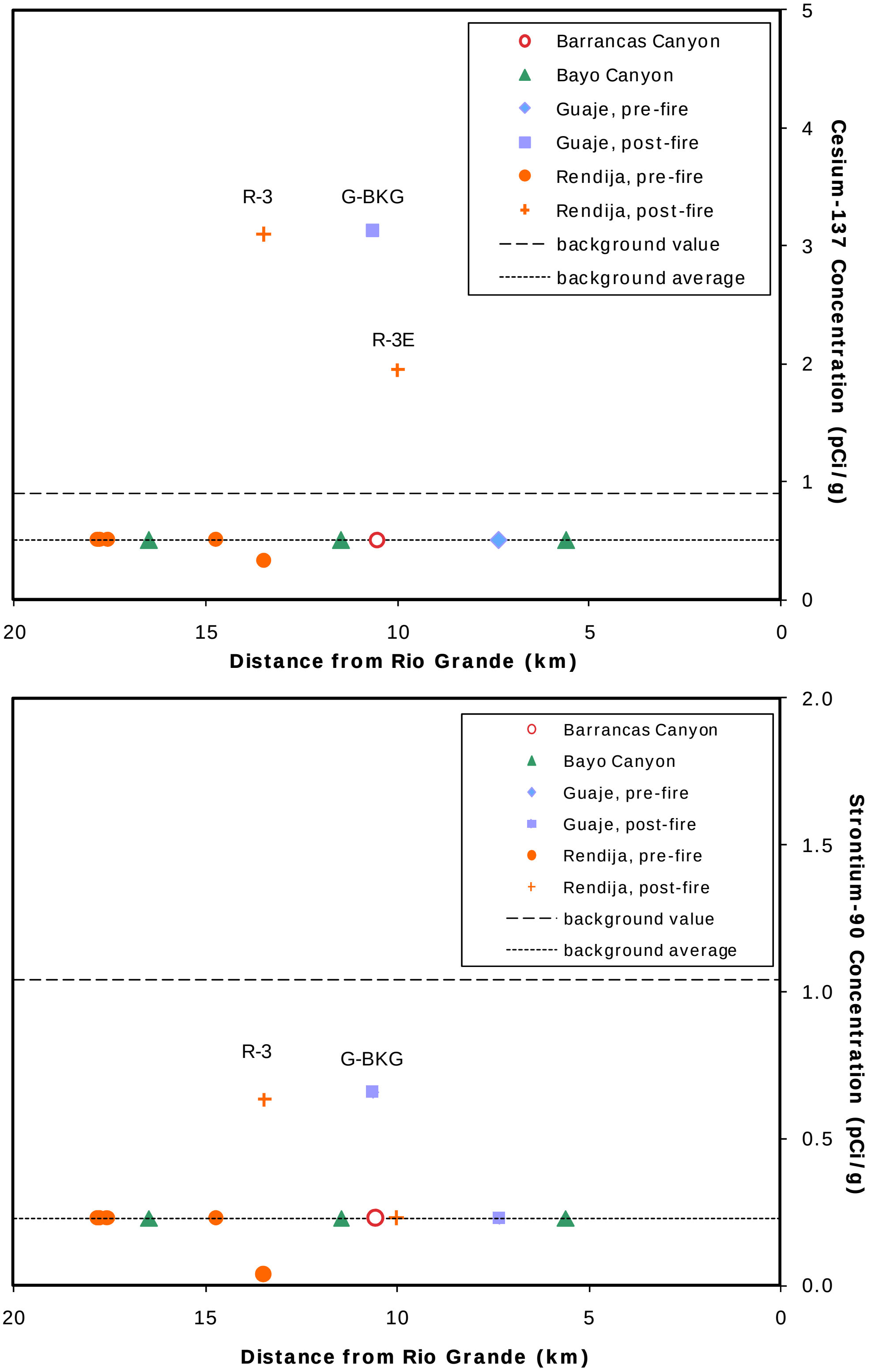


Figure 7.1-2 (continued) **Concentrations of select inorganic chemicals in north canyons and background sediment samples versus silt and clay content**



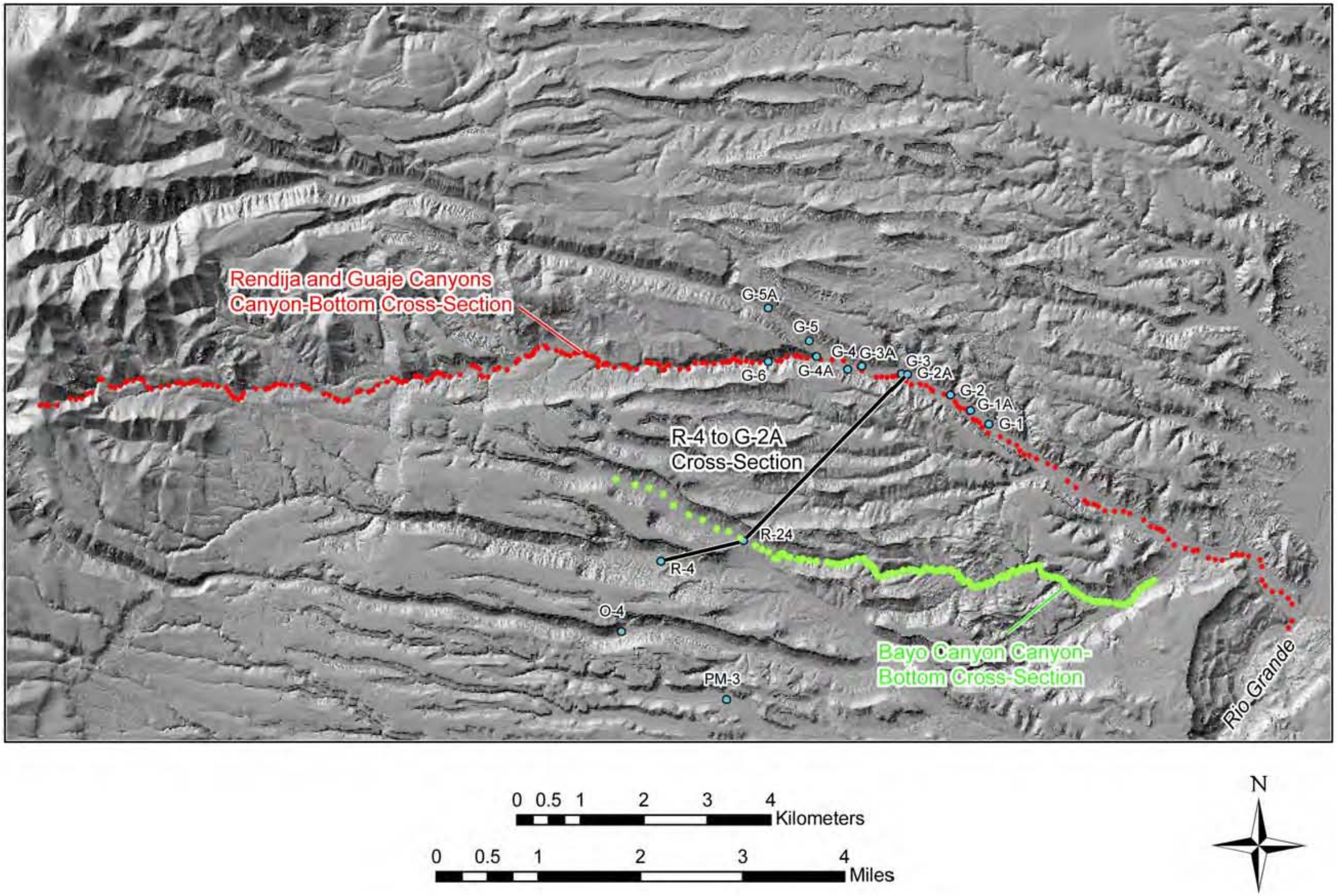
Note: Error bars indicate upper and lower bounds based on replacing nondetect values with either the detection limit or zero, and the background average is plotted where an analyte is not a COPC in a reach.

Figure 7.1-3 Estimated average concentrations of PCBs in fine facies sediment in the north canyons



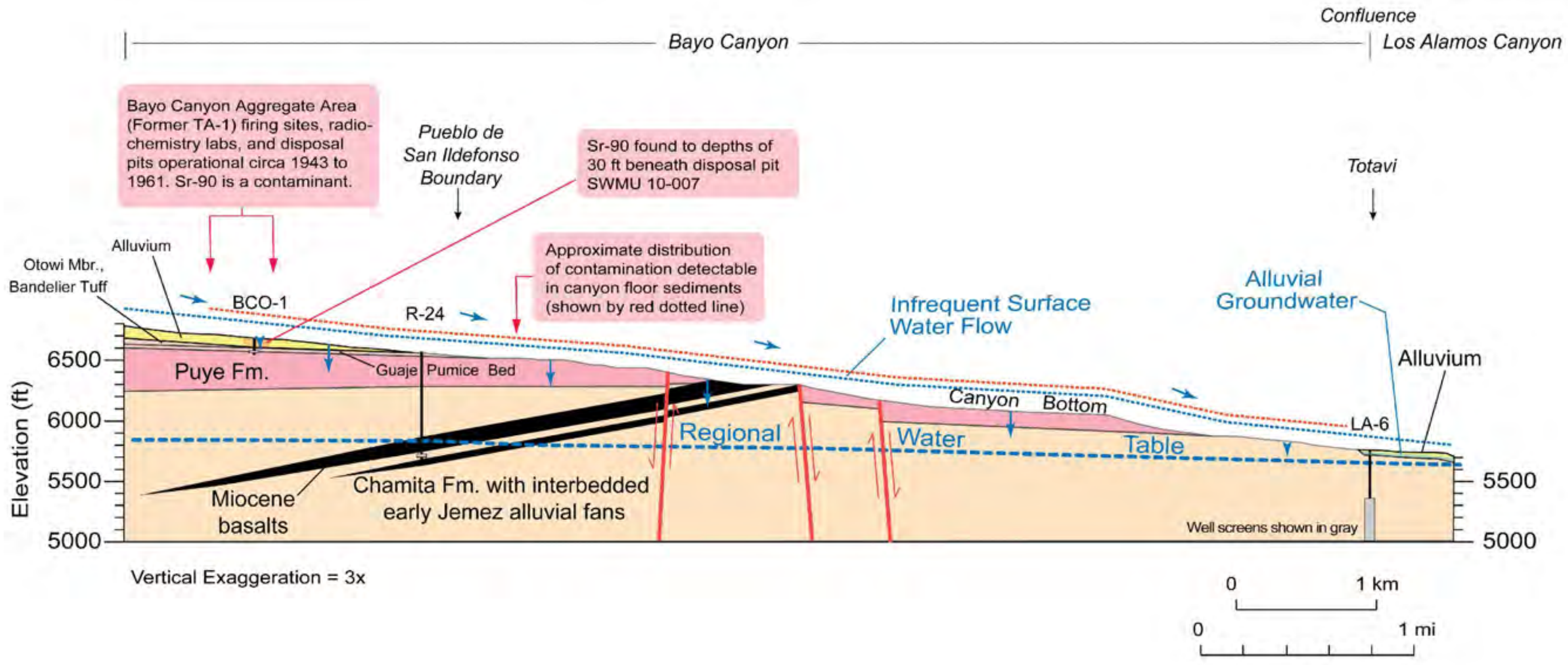
Note: Value shown is the average background concentration in reaches where these radionuclides are not COPCs.

Figure 7.1-4 **Estimated average concentrations of cesium-137 and strontium-90 in fine facies sediment in the north canyons**



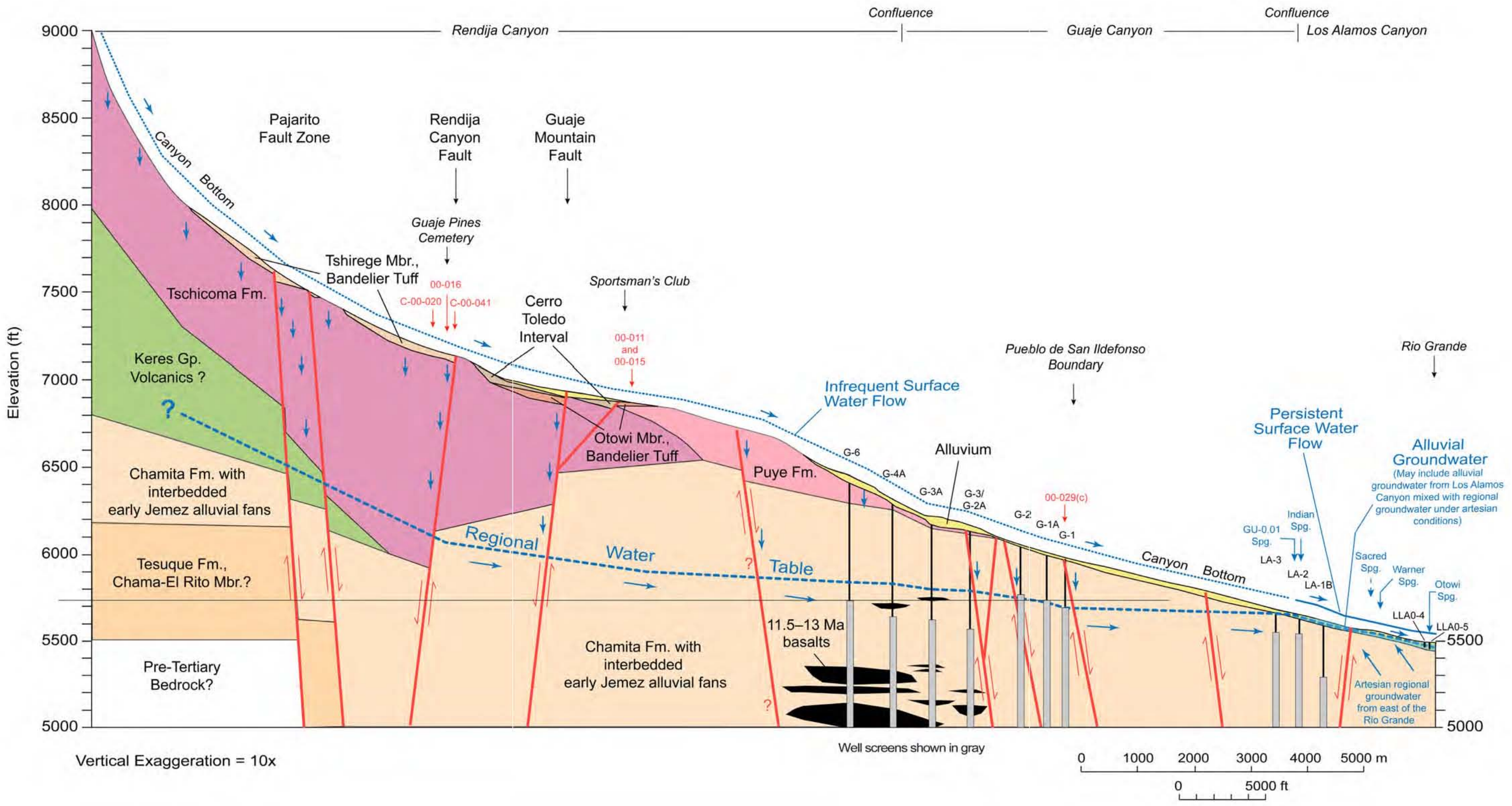
Notes: The cross-section line through wells R-4, R-24, and G-2A is shown in black (see Figure 7.2-4). Blue dots show the locations of municipal supply wells and monitoring wells R-4 and R-24.

Figure 7.2-1 Locations of conceptual geologic cross-sections along the stream channels in Bayo Canyon (see Figure 7.2-2) and in Rendija and Guaje Canyons (see Figure 7.2-3)



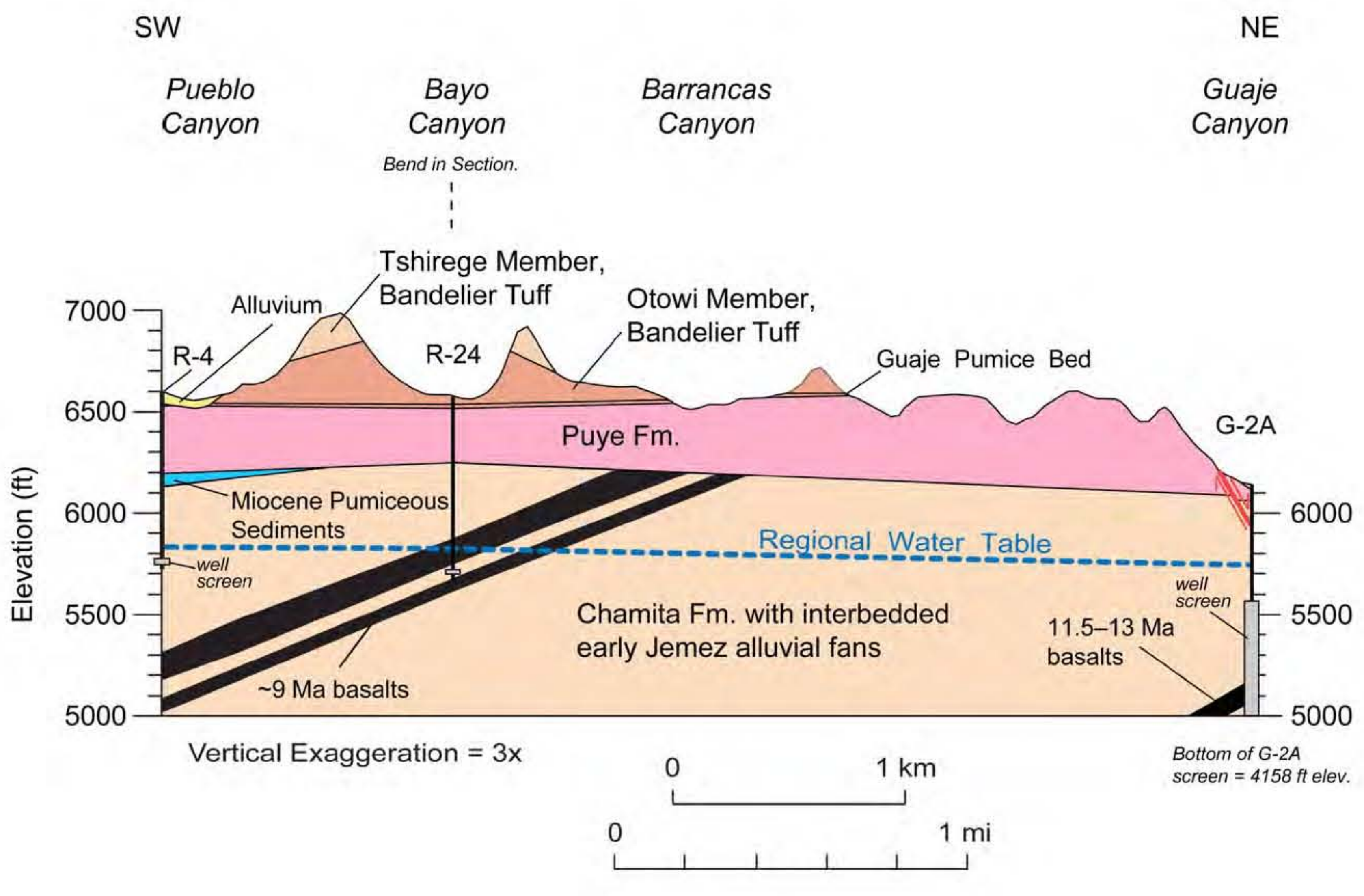
Notes: The cross-section line follows the stream channel in Bayo Canyon to a point just beyond its confluence with Los Alamos Canyon. See Figure 7.2-1 for the location of the cross-section. Potential contaminant release sites are labeled in red.

Figure 7.2-2 Conceptual hydrogeologic cross-section showing potential surface and groundwater pathways for Bayo Canyon



Notes: The cross-section line follows the stream channel in Rendija Canyon to its confluence with Guaje Canyon, continues down the channel in Guaje Canyon to its confluence with los Alamos Canyon, and continues down Los Alamos Canyon to its confluence with the Rio Grande. See Figure 7.2-1 for the location of the cross-section. Potential contaminant release sites are labeled in red.

Figure 7.2-3 Conceptual hydrogeologic cross-section showing potential surface and groundwater pathways for Rendija and Guaje Canyons



Note: See Figure 7.2-1 for the location of the cross-section.

Figure 7.2-4 North-northeast trending conceptual hydrogeologic cross-section showing the distribution for rock units in the regional aquifer along a line connecting wells R-4, R-24, and G-2A

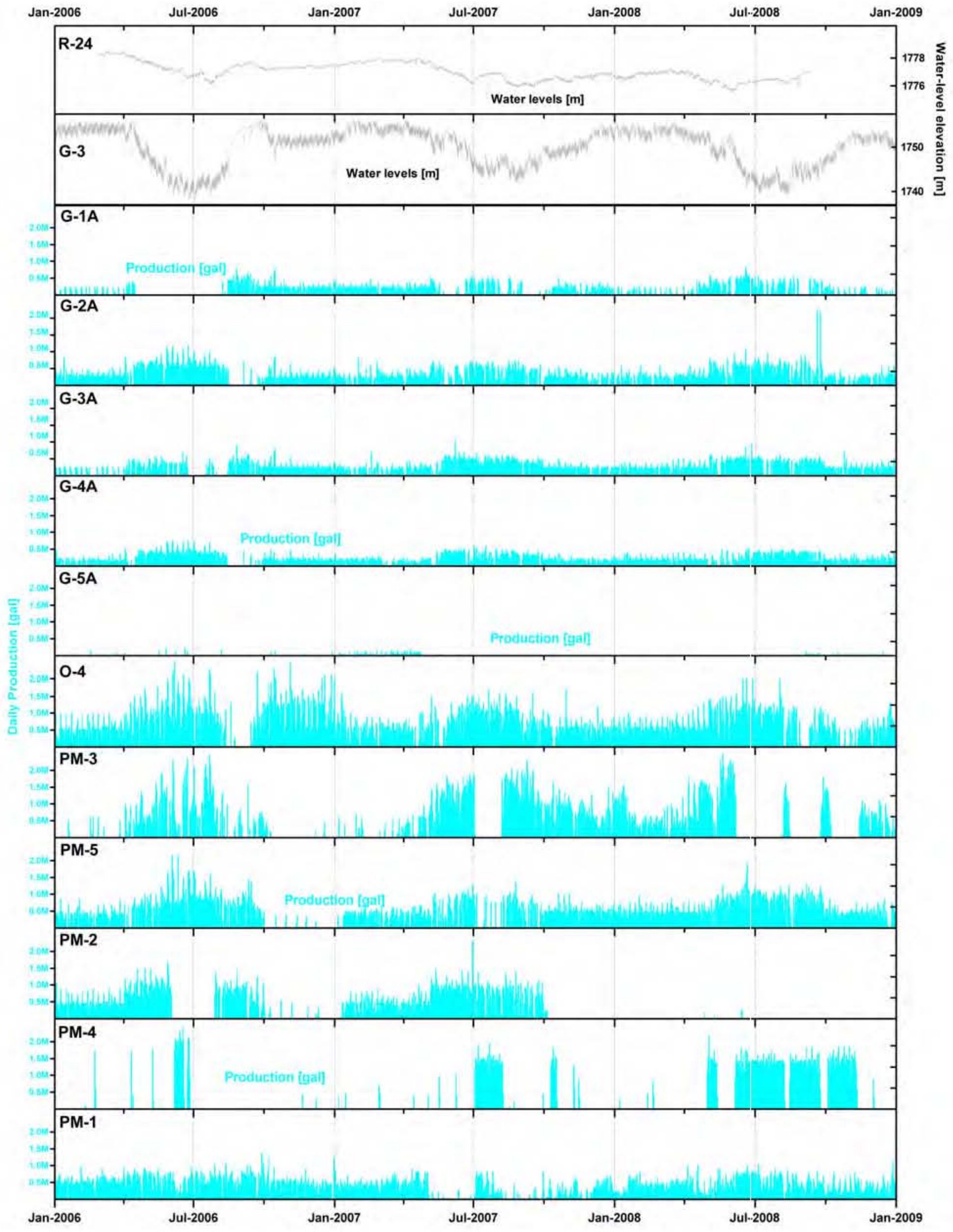
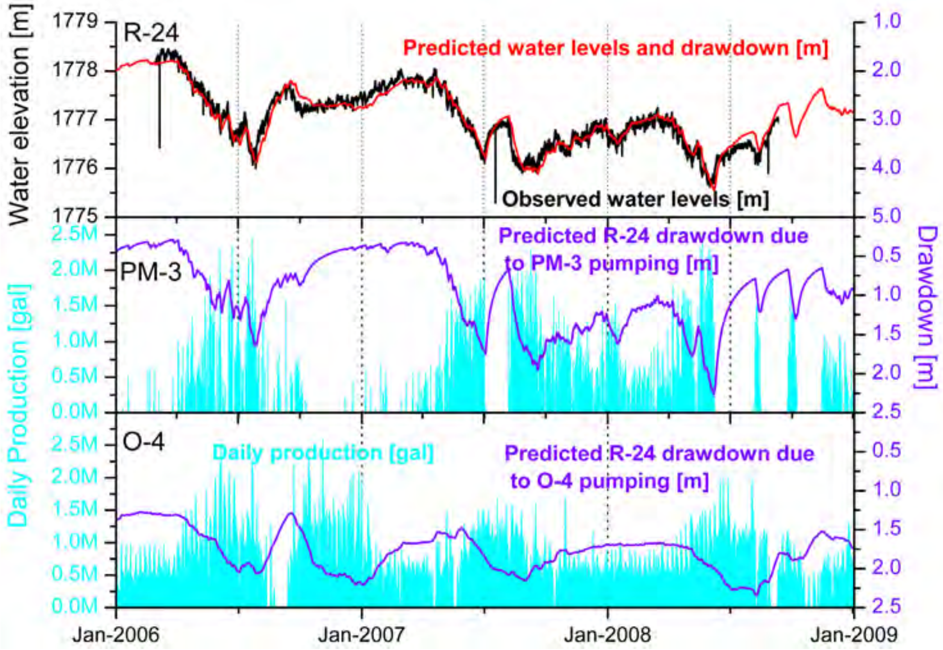
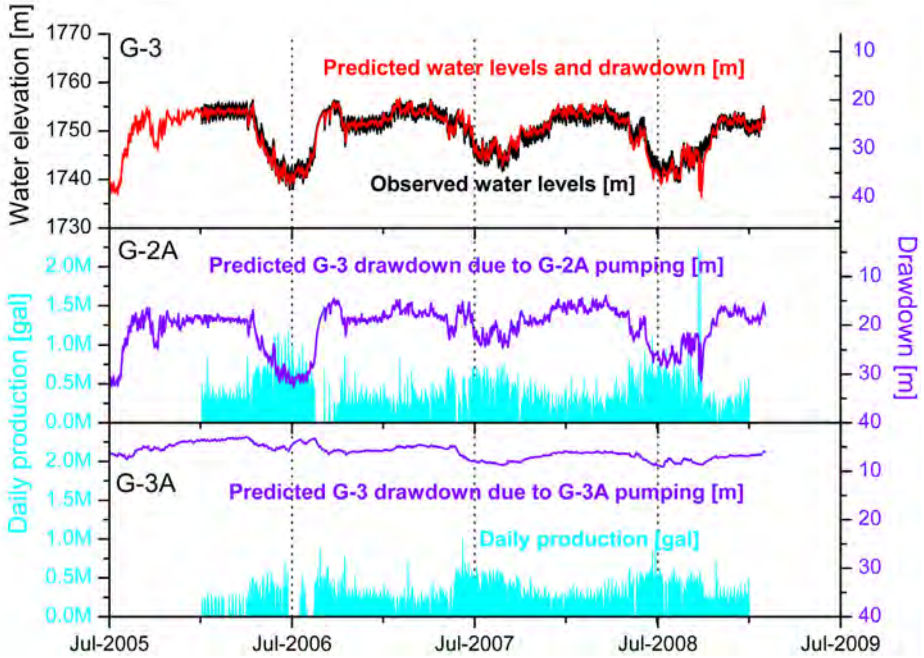


Figure 7.2-5 Groundwater-level elevations [m] at observation wells R-24 and G-3 and supply-well daily pumping volumes [gal.] for production wells in the north canyons area



Notes: The individual components of the total predicted drawdown at R-24 (red line) due to pumping of PM-3 and O-4 (purple lines) are also shown. Note that the predicted drawdown axes (right side of figure) increase downwards to facilitate comparison with the predicted water elevation.

Figure 7.2-6 Observed (black line) and model-predicted (red line) water-level elevations [m] and drawdown [m] at monitoring well R-24 due to daily production [gal.] at supply wells PM-3 and O-4 (turquoise bars)



Notes: The individual components of the total predicted drawdown at G-3 (red line) due to pumping of G-2A and G-3A (purple lines) are also shown. Note that the predicted drawdown axes (right side of figure) increase downwards to facilitate comparison with the predicted water elevation.

Figure 7.2-7 Observed (black line) and model-predicted (red line) water-level elevations [m] at monitoring well G-3 due to daily production [gal.] at supply wells G-2A and G-3A and model-predicted (purple lines) drawdown at those wells

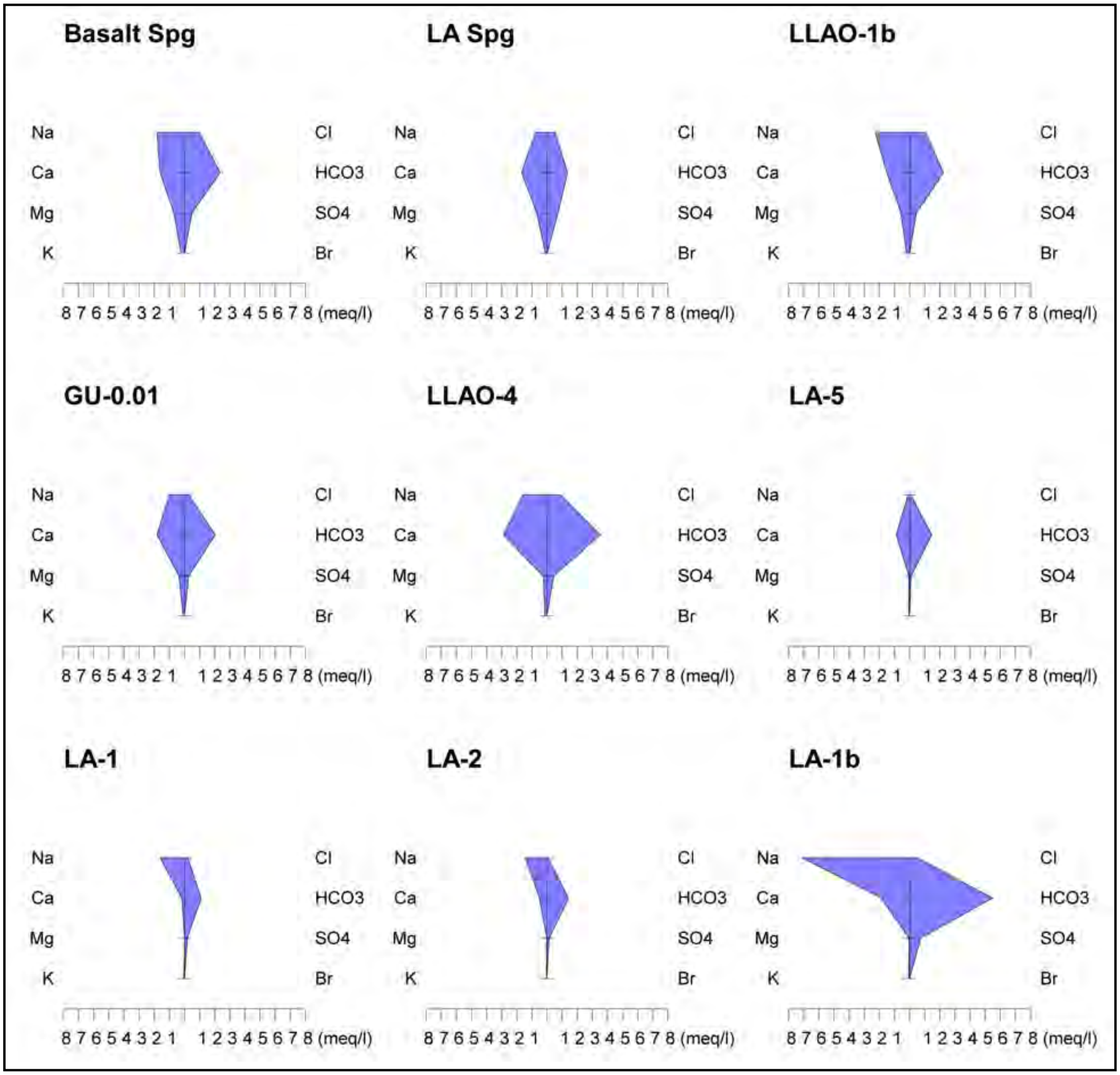


Figure 7.2-8 Stiff diagrams for selected wells and springs in lower Los Alamos Canyon

Table 3.1-1
Sediment Investigation Reaches in the North Canyons

Subwatershed	Investigation Reach	Reach Abbreviation	Approximate Distance from Rio Grande to Midpoint of Reach (km)	Reach Length (km)[a]	Year(s) of Sample Collection (Canyons Investigations)	Notes
Barrancas	BR-1	BR-1	10.55	0.20	2006	West end of San Ildefonso Pueblo land; downcanyon of tributary north of former TA-10
Bayo	BY-1	BY-1	16.46	0.21	2006	Upper Bayo Canyon watershed; downcanyon of SWMU 01-011(d)
	BY-2	BY-2	11.46	0.23	2006	Downcanyon of former TA-10
	BY-3	BY-3	5.60	0.20	2006	Upcanyon of NM 502 and Los Alamos Canyon confluence; San Ildefonso Pueblo land
Guaje	G-Background	G-BKG	10.63	[b]	2000	Upcanyon of Rendija Canyon; background reach
	G-1	G-1	7.35	0.20	2006	West end of San Ildefonso Pueblo land; downcanyon of SWMU 00-029(c)
Rendija	R-1 East	R-1E	17.55	0.20	2006	Lower east fork of Rendija Canyon, below former asphalt batch plant (AOC C-00-041)
	R-1 Middle	R-1M	17.82	0.20	2006	Middle fork of Rendija Canyon, below SWMU 00-016
	R-1 South	R-1S	17.75	0.20	2006	South fork of Rendija Canyon, below SWMU 00-016
	R-2	R-2	14.71	0.20	2006	“37-millimeter Canyon,” SWMU 00-011(e)
	R-3	R-3	13.47	0.22	2001, 2006, 2007	Rendija Canyon east of Sportsman's Club
	R-3 East	R-3E	10.01	[b]	2000	Lower Rendija Canyon

[a] Length refers to area mapped and characterized.

[b] Reach not mapped; post-fire sediment samples collected from reach.

Table 3.2-1
North Canyons Surface-Water and Groundwater-Sampling Locations and Rationale

Location Name	Location and Rationale
Surface Water (west to east)	
R-SMA-1	Stormwater-sampling location in east fork of Rendija Canyon (reach R-1E). Location selected to monitor potential impacts of contaminant releases from AOC C-00-041) near Guaje Pines Cemetery.
B-SMA-1	Stormwater-sampling location in upper Bayo Canyon (reach BY-1). Location selected to monitor potential impacts of contaminant releases from SWMU 00-011(d). Provides a basis for comparison to data from downstream locations.
E089	Background location in Guaje Canyon. Gaging station located above the confluence with Rendija Canyon. Provides a basis for comparison to data from downstream locations.
E090	Gaging station in lower Rendija Canyon. Located above the confluence with Guaje Canyon. Location selected to monitor potential cumulative impacts in Rendija watershed.
E099	Gaging station located in Guaje Canyon at NM 502. Location selected to monitor potential cumulative impacts in the Guaje watershed (including Barrancas and Rendija Canyons).
Spring	
GU-0.01 Spring	Guaje Canyon at NM 502. Location selected to monitor potential cumulative impacts in Guaje watershed.
Regional Groundwater (west to east)	
R-24	TA-74 in Bayo Canyon near the former Los Alamos County Bayo WWTP. Provides water-quality and water-level data for regional groundwater downgradient of inactive firing sites and Laboratory buildings at former TA-10. Well installed with one screen from 825 to 848 ft bgs. Core collected for contaminant characterization in adjacent borehole to a total depth of 213 ft.
G-6	Rendija Canyon 4200 ft west of confluence with Guaje Canyon. Municipal supply well installed in 1964. Drilled to a depth of 2005 ft and completed with louvers from 700 to 1510 ft. Plugged and abandoned in 1999.
G-4A	Rendija Canyon 1625 ft west of confluence with Guaje Canyon. Municipal supply well installed in 1998. Drilled to a depth of 2000 ft and completed with perforated well casing from 655 to 1980 ft. Operated by Los Alamos County.
G-5A	Guaje Canyon 5000 ft west of confluence with Rendija Canyon. Municipal supply well installed in 1998. Drilled to a depth of 2000 ft and completed with perforated well casing from 765 to 1980 ft. Operated by Los Alamos County.
G-5	Guaje Canyon 2300 ft west of confluence with Rendija Canyon. Municipal supply well installed in 1951. Drilled to a depth of 1997 ft and completed with a 400 ft of slotted casing between 462 and 1830 ft. Plugged and abandoned in 1999.
G-4	Guaje Canyon 230 ft east of confluence with Rendija Canyon. Municipal supply well installed in 1951. Drilled to a depth of 2002 ft and completed with a 360 ft of slotted casing between 426 and 1925 ft. Plugged and abandoned in 1999.
G-3A	Guaje Canyon 750 ft east of confluence with Rendija Canyon. Municipal supply well installed in 1998. Drilled to a depth of 2000 ft and completed with perforated well casing from 590 to 1980 ft. Operated by Los Alamos County.
G-3	Guaje Canyon 2725 ft east of confluence with Rendija Canyon. Municipal supply well installed in 1951. Drilled to a depth of 1997 ft and completed with a 400 ft of slotted casing between 441 and 1785 ft. Plugged back to 1103 ft and converted to a monitoring well in 1998. Operated by Los Alamos County.

Table 3.2-1 (continued)

Location Name	Location and Rationale
G-2A	Guaje Canyon 3100 ft east of confluence with Rendija Canyon. Municipal supply well installed in 1998. Drilled to a depth of 2000 ft and completed with perforated well casing from 565 to 1980 ft. Operated by Los Alamos County.
G-2	Guaje Canyon 5500 ft east of confluence with Rendija Canyon. Municipal supply well installed in 1951. Drilled to a depth of 2006 ft and completed with a 425 ft of slotted casing between 281 and 1960 ft. Plugged and abandoned in 1999.
G-1A	Guaje Canyon 6730 ft east of confluence with Rendija Canyon. Municipal supply well installed in 1954. Drilled to a depth of 2071 ft and completed with slotted casing from 272 to 1513 ft. Operated by Los Alamos County.
G-1	Guaje Canyon 7565 ft east of confluence with Rendija Canyon. Municipal supply well installed in 1950. Drilled to a depth of 2020 ft and completed with a 490 ft of slotted casing between 282 and 1980 ft. Plugged and abandoned in 1999.

Table 6.2-1
North Canyons Sediment Inorganic COPCs

Reach	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Perchlorate	Potassium	Selenium	Vanadium	Zinc
Sediment BV[a]	**15400**	**0.83**	**3.98**	**127**	**1.31**	**0.4**	**4420**	**10.5**	**4.73**	**11.2**	**13,800**	**19.7**	**2370**	**543**	**0.1**	**9.38**	**na[b]**	**2690**	**0.3**	**19.7**	**60.2**
Soil ESL[c]	**pH dependent**	**0.05**	**6.8**	**110**	**2.5**	**0.27**	**na**	**2.3**	**13**	**15**	**na**	**14**	**na**	**220**	**0.013**	**9.7**	**na**	**na**	**0.52**	**0.025**	**48**
Residential SSL[d]	**77800**	**31.3**	**3.9**	**15600**	**156**	**39**	**na**	**2800[e]**	**1520**	**3130**	**23,500**	**400**	**na**	**3590**	**23[e]**	**1560**	**55[e]**	**na**	**391**	**78.2**	**23,500**
BR-1	—[f]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.85(U)	—	—
BY-1	—	—	—	—	—	0.52 (J)	—	13.4 (J)	—	—	—	46.9	2420 (J)	—	—	—	0.000655 (J)	—	2.05(U)	24.2	—
BY-2	—	—	—	—	—	—	—	13.8	—	—	—	37.1	4200	—	—	—	0.00106 (J)	2730 (J+)	1.74(U)	21.4	138
BY-3	—	—	—	178 (J-)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.65(U)	22.3 (J)	—
G-1	—	—	—	—	—	—	—	11.4	—	—	14,000 (J+)	—	—	—	—	—	—	—	1.86(U)	28	—
G-BKG	—	0.92 (J)	4.2	360	—	0.46 (J)	18,000	—	6.6	18	—	38	2500	1800	—	9.8	—	—	1.6	—	84
R-1E	17300	—	5.36	—	—	0.67 (UJ)	—	11.4 (J-)	—	—	14,300	28.4 (J-)	2510 (J+)	—	0.174	—	—	—	2.4	23.9 (J-)	—
R-1M	—	—	—	—	—	0.679(U)	—	10.7 (J)	5.49	—	—	—	—	—	—	14.5	—	—	1.08 (J)	23.2	—
R-1S	17400	—	4.52	134	—	0.686(U)	—	11.9	5.01	—	—	—	2730 (J+)	—	—	—	—	—	2.06(U)	25	—
R-2	—	—	—	—	—	0.574(U)	—	—	—	—	—	—	—	—	—	—	—	—	1.72(U)	—	—
R-3	23500 (J+)	1.2 (J)	6	210	2	—	6800	27.7	9.75	19	67,700	110	4160	1540	—	9.8	—	4010	1.05 (J)	76.8	267
R-3E	—	—	—	200	—	—	9100	—	6.6	12 (J)	—	29	—	970 (J)	—	10	—	—	1.3	—	—

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. Shading indicates the residential SSL was exceeded. Residential SSLs are adjusted to a target risk of 10^{-5}.

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

[b] na = Not available.

[c] ESLs are from the ECORISK Database, Version 2.3 (LANL 2008, 103352).

[d] SSLs are from NMED (2006, 092513) unless otherwise noted.

[e] SSL from http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm.

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

Table 6.2-2
North Canyons Sediment Organic COPCs

Reach	Acenaphthene	Anthracene	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	Benzyl Alcohol	Chlordane[alpha-]	Chlordane[gamma-]	Chloroform	Chrysene	DDE[4,4*-]	DDT[4,4*-]	Dieldrin	Di-n-butylphthalate	Endosulfan II	Fluoranthene	Isopropylbenzene	Isopropyltoluene[4-]	Methylphenol[4-]	Naphthalene	Phenanthrene	Phenol	Pyrene	Toluene	Total Petroleum Hydrocarbons Diesel Range Organics	Total Petroleum Hydrocarbons Gasoline Range Organics	Trichloro-1,2,2-trifluoroethane[1,1,2-]
Soil ESL[a]	**0.25**	**6.8**	**0.041**	**0.041**	**0.14**	**3**	**53**	**18**	**na[b]**	**62**	**1**	**na**	**0.27**	**2.2**	**8**	**2.4**	**0.11**	**0.044**	**0.0045**	**0.011**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**0.79**	**10**	**23**	**na**	**na**	**na**
Residential SSL[c]	**3730**	**22,000**	**1.12**	**1.12**	**1.12**	**6.21**	**0.621**	**6.21**	**22,000**	**62.1**	**24,0000[d]**	**31000[d]**	**16.2[e]**	**16.2[e]**	**4**	**615**	**17.2**	**17.2**	**0.304**	**6110**	**367**	**2290**	**271**	**271[f]**	**310[g]**	**79.5**	**1830**	**18300**	**2290**	**252**	**na**	**na**	**3280**
BR-1	—[h]	—	0.0042	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00102 (J)	0.000929 (J)	—	—	—	—	—	—	—	—	—	—	—	—	7.64	—	—
BY-1	0.012 (J)	0.00764 (J)	0.0585	0.037	0.0139	0.037	0.0279	—	—	—	—	—	0.003	0.00191 (J)	0.000609 (J)	0.0274	0.000988 (J)	0.00352 (J)	0.000698 (J)	—	—	0.0608	—	0.000519 (J)	—	—	0.0569	—	0.0526	0.000514 (J)	9.45	—	—
BY-2	—	—	0.0242	0.015	0.0169	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.000524 (J)	0.000439 (J)	—	—	—	—	—	—	42.1	0.0402 (J)	—
BY-3	—	—	0.0165	0.006	0.0023 (J)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00192	8.32	—	0.0011 (J)
G-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0174 (J-)	—	84.3	—	—
R-1E	—	—	0.013	0.014	0.0047	—	—	—	—	—	—	—	—	—	—	—	0.00236	0.00359 (J)	—	0.0549 (J)	—	—	—	—	—	—	—	—	0.00578	—	6.41	—	—
R-1M	—	—	—	—	—	0.0691 (J-)	0.0862 (J-)	0.0793 (J-)	0.055 (J-)	0.0432 (J-)	—	—	—	—	—	0.0451 (J-)	0.0021 (J)	0.000867 (J)	—	—	—	0.0882 (J-)	—	—	—	—	0.0455 (J-)	—	0.147 (J-)	—	4.9 (J-)	—	—
R-1S	—	—	0.0025 (J)	—	0.003 (J)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8.65 (J-)	—	—
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.000785 (J-)	—	—	—	0.00253 (J-)	—	—	—	—	—	—	—	—	—	9.83	—	—
R-3	—	—	—	—	—	—	—	—	—	—	3.4 (J)	0.13 (J)	—	—	—	—	0.000908 (J)	—	—	—	—	—	—	—	7.9	0.13 (J)	0.072 (J)	0.79	—	—	7.53	—	—

Notes: Values are in mg/kg. Values are maximum detected values. No screening values were exceeded. Residential SSLs are adjusted to a target risk of 10^{-5}.

[a] ESLs are from the ECORISK Database, Version 2.3 LANL (2008, 103352).

[b] na = Not available.

[c] SSLs are from NMED (2006, 092513) unless otherwise noted.

[d] SSL from http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm.

[e] Chlordane from NMED (2006, 092513) used as surrogate.

[f] Isopropylbenzene SSL from NMED (2006, 092513) used as surrogate.

[g] SSL from USEPA Region 6 HHMSSLs (EPA 2005, 091002).

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

Table 6.2-3
North Canyons Sediment Radionuclide COPCs

Reach	Americium-241	Cesium-137	Plutonium-238	Plutonium-239/240	Strontium-90	Tritium
Sediment BV[a]	**0.04**	**0.9**	**0.006**	**0.068**	**1.04**	**0.093**
Soil ESL[b]	**44**	**680**	**44**	**47**	**560**	**36,000**
Residential SAL[c]	**30**	**5.6**	**37**	**33**	**5.7**	**750**
BR-1	—[d]	1.11	—	—	—	—
BY-1	0.0778	—	—	—	—	0.117
BY-2	—	—	—	—	—	—
BY-3	—	—	—	—	—	—
G-1	—	—	—	—	—	0.119
G-BKG	—	6.22	—	0.245	1.25	—
R-1E	—	—	—	—	—	—
R-1M	—	—	—	—	—	0.105
R-1S	—	—	—	—	—	0.157
R-2	—	—	—	—	—	—
R-3	—	4.69	0.0887	0.34	1.08	—
R-3E	—	3.58	—	0.135	—	—

Notes: Values are in pCi/g. Values are maximum detected values greater than the sediment BV. Shading indicates the residential SAL was exceeded.

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

[b] ESLs are from the ECORISK Database, Version 2.3 (LANL 2008, 103352).

[c] SALs are from LANL (2005, 088493).

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

Table 6.3-1
Inorganic COPCs in Filtered Regional Groundwater Samples

Well	Barium	Boron	Chromium	Chromium Hexavalent Ion	Copper	Lead	Molybdenum	Uranium	Vanadium
LANL Regional GW BV[a]	**56.83**	**38.77**	**5.75**	**na**[b]	**5**	**2.9**	**4.4**	**1.9**	**13.41**
Standard Level	**1000**	**750**	**50**	**50**	**1000**	**15**	**1000**	**30**	**182.5**
Standard Type	**NMGSF**[c]	**NMGSF**	**NMGSF**	**NMGSF**	**NMGSF**	**MCL**[d]	**NMGSF**	**NMGSF**	**Reg**[e]
G-1A	—[f]	—	15.4	4.8	5	2.9	—	—	29.7
G-2A	—	—	6.9	5.8	—	—	—	—	—
G-3A	—	—	6.6	4.5	—	—	—	—	—
G-4A	—	—	—	3.1	—	—	—	—	—
G-5A	—	—	—	3	—	—	—	—	—
R-24	163	64	—	—	5.1	—	7.4	3.4	22.9

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV; if no BV, value is maximum detected value.

[a] Regional groundwater BVs are from LANL (2007, 096665).

[b] na = Not available.

[c] NMGSF = NMAC 20.6.2, Groundwater Standards (Filtered).

[d] MCL = EPA maximum contaminant level.

[e] Reg = EPA regional tap water screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[f] — = Analyte is not a COPC at that location (not detected, not analyzed, or maximum detect <BV).

Table 6.3-2
Inorganic COPCs in Nonfiltered Regional Groundwater Samples

Well	Aluminum	Arsenic	Barium	Boron	Chromium	Chromium hexavalent ion	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Mercury	Molybdenum	Nickel	Strontium	Thallium	Uranium	Vanadium	Zinc
LANL Regional GW BV[a]	**na[b]**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**0.24**	**na**	**na**	**na**	**na**	**na**	**na**	**na**
Standard Level	**36500**	**10**	**2000**	**7300**	**100**	**100**	**730**	**1300**	**25,550**	**15**	**730**	**1700**	**2**	**183**	**100**	**21,900**	**2**	**30**	**182.5**	**10,950**
Standard Name	**Reg[c]**	**MCL[d]**	**MCL**	**Reg**	**MCL**	**MCL**	**Reg**	**MCL**	**Reg**	**Reg**	**Reg**	**Reg**	**NMGSU[e]**	**Reg**	**MCL**	**Reg**	**MCL**	**MCL**	**Reg**	**Reg**
G-1A	21.7	8.3	73	33	16	4.8	—[f]	62.2	915	4.6	17	220	—	5.8	0.77	110	0.544	0.48	37.6	7.27
G-2A	16	16.3	15	24.3	5.9	5.8	—	—	216	—	—	—	—	3.04	0.223	61.2	0.6	0.6	62.7	7.17
G-3A	—	3.4	4.2	21.4	7.6	4.5	—	—	—	—	—	—	—	3.01	0.238	66.4	—	0.858	21.8	7.15
G-4A	—	2.1	7.85	22.6	6.8	3.1	—	—	152	—	—	1.87	—	2.66	1.1	70.9	0.36	0.83	16	8.99
G-5A	21.1	3.5	10.1	22.4	5.8	3	—	5.1	—	2.3	—	2.3	—	2.86	0.305	73.3	—	1	19.1	15.1
R-24	8	6.2	150	72	7.1	—	3.5	7.2	60	0.2	47	129	0.38	8.9	5.1	150	—	3.5	26	460

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV; if no BV, value is maximum detected value. Shading indicates a standard screening value was exceeded.

[a] Regional groundwater BVs are from LANL (2007, 096665).

[b] na = Not available.

[c] Reg = EPA regional tap water screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[d] MCL = EPA maximum contaminant level.

[e] NMGSU = NMAC 20.6.2, Groundwater Standards (Unfiltered).

[f] — = Analyte is not a COPC at that location (not detected, not analyzed, or maximum detect <BV).

Table 6.3-3
Radionuclide COPCs in
Filtered Regional Groundwater Samples

Well	Uranium-235/236
Standard Level	**300**
Standard Type	**NMRPS***
R-24	0.084

Notes: Values are in pCi/L. Values are maximum detected value.

*NMRPS, NMEIB Radiation Protection Standards (http://www.nmcpr.state.nm.us/nmac/parts/title20/20.003.0004.htm).

Table 6.3-4
Radionuclide COPCs in Nonfiltered Regional Groundwater Samples

Well	Gross Alpha	Gross Beta	Potassium-40	Radium-226	Radium-228	Thorium-230	Uranium-234	Uranium-235/236	Uranium-238
Standard Level	**15**	**50**	**4000**	**5**	**5**	**na**[a]	**300**	**300**	**300**
Standard Name	**MCL**[b]	**SMCL**[c]	**NMRPS**[d]	**MCL**	**MCL**	**na**	**NMRPS**	**NMRPS**	**NMRPS**
G-1A	—[e]	3.49	40.6	0.608	—	—	0.464	0.0575	0.244
G-2A	—	2.27	40.2	0.692	—	—	0.338	0.0684	0.225
G-3A	—	3.32	—	0.727	—	—	0.532	0.0477	0.302
G-4A	—	3.06	—	—	—	0.202	0.494	0.0501	0.281
G-5A	—	5.36	47.3	0.479	—	0.298	0.627	0.0595	0.347
R-24	4.94	6.06	—	—	0.553	—	1.97	0.109	1.1

Notes: Values are in pCi/L. Values are maximum detected value.

[a] na = Not available.

[b] MCL = EPA maximum contaminant level (4 mrem).

[c] SMCL = EPA secondary maximum contaminant level.

[d] NMRPS, NMEIB Radiation Protection Standards (http://www.nmcpr.state.nm.us/nmac/parts/title20/20.003.0004.htm).

[e] — = Analyte is not a COPC at that location (not detected or not analyzed).

Table 6.3-5
Organic COPCs in Nonfiltered Regional Groundwater Samples

Well	Acetone	Bis[2-ethylhexyl]phthalate	Butanone[2-]	Chloromethane	Endrin Aldehyde	Methylene Chloride	Toluene
Standard Level	**5475**	**6**	**7060**	**21.3**	**2**	**5**	**750**
Standard Type	**Reg**[a]	**MCL**[b]	**Reg**	**Reg**	**MCL**	**MCL**	**NMGSU**[c]
G-1A	3	—[d]	—	—	—	2.4	—
G-2A	1.47	—	—	—	—	—	—
G-3A	—	—	—	0.51	0.0128	—	—
G-4A	—	—	—	—	—	—	—
G-5A	—	—	—	—	—	—	—
R-24	2.27	2.14	1.73	—	—	—	1.49

Notes: Values are in µg/L. Values are maximum detected value.

[a] Reg = EPA regional tap water screening level (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) adjusted to a target risk of 10^{-5}.

[b] MCL = EPA maximum contaminant level.

[c] NMGSU = NMAC 20.6.2, Groundwater Standards (Unfiltered).

[d] — = Analyte is not a COPC at that location (not detected or not analyzed).

Table 6.3-6
General Inorganic COPCs in Filtered Regional Groundwater Samples

Well	Carbonate	Chloride	Nitrate as Nitrogen	Nitrite as Nitrogen	Potassium	Sodium	Sulfate
LANL Regional GW BV[a]	**7200**	**3570**	**530**	**0**	**2630**	**24,500**	**7200**
Standard Level	**na[b]**	**250,000**	**10,000**	**1000**	**na**	**na**	**600,000**
Standard Type	**na**	**NMGSF[c]**	**MCL[d]**	**MCL**	**na**	**na**	**NMGSF**
G-1A	7200	—[e]	530	—	2810	26,800	—
G-2A	—	—	—	—	—	—	—
G-3A	—	—	—	—	—	—	—
G-4A	—	—	—	—	—	—	—
G-5A	—	—	—	—	—	—	—
R-24	—	7590	—	22	3660	37,900	12,500

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV; if no BV, value is maximum detected value.

[a] Regional groundwater BVs are from LANL (2007, 096665).

[b] na = Not available.

[c] NMGSF = NMAC 20.6.2, Groundwater Standards (Filtered).

[d] MCL = EPA maximum contaminant level.

[e] — = Analyte is not a COPC at that location (not detected, not analyzed, or maximum detect <BV).

Table 6.3-7
General Inorganic COPCs in Nonfiltered Regional Groundwater Samples

Well	Bromide	Calcium	Carbonate	Chloride	Cyanide [Total]	Fluoride	Magnesium	Nitrate as Nitrogen	Nitrate-Nitrite as Nitrogen	Nitrite as Nitrogen	Oxalate	Perchlorate	Potassium	Silicon Dioxide	Sodium	Sulfate	Total Kjeldahl Nitrogen	Total Phosphate as Phosphorus
LANL Regional GW BV[a]	**na[b]**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**0.44**	**na**	**na**	**na**	**na**	**na**	**na**
Standard Level	**na**	**na**	**na**	**na**	**200**	**4000**	**na**	**10,000**	**10,000**	**1000**	**na**	**24.5**	**na**	**na**	**na**	**na**	**na**	**na**
Standard Name	**na**	**na**	**na**	**na**	**MCL[c]**	**MCL**	**na**	**Reg[d]**	**MCL**	**Reg**	**na**	**Reg**	**na**	**na**	**na**	**na**	**na**	**na**
G-1A	40	16400	7100	7560	—[e]	572	592	540	510	—	—	—	2880	75,600	28,800	5470	—	299
G-2A	—	12200	—	2390	2.89	498	1120	—	450	—	—	—	2080	60,900	27,900	3510	—	22
G-3A	—	15600	—	2580	65.1	366	2630	—	600	—	—	0.451	1910	50,700	17,100	3350	57	20
G-4A	—	16300	—	2550	—	326	3160	—	560	—	—	0.442	2020	53,700	14,600	3270	41	17
G-5A	—	15100	—	2890	—	377	3150	—	570	—	—	—	2060	52,600	20,000	3930	35	39
R-24	120	27200	—	10,700	2.21	470	7230	400	305	6	20	—	4390	59,600	39,300	17,300	—	22.82

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV; if no BV, value is maximum detected value.

[a] Regional groundwater BVs are from LANL (2007, 096665).

[b] na = Not available.

[c] MCL = EPA maximum contaminant level.

[d] Reg = EPA regional tap water screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[e] — = Analyte is not a COPC at that location (not detected, not analyzed, or maximum detect <BV).

Table 6.3-8
Inorganic COPCs in Filtered Springs Samples

Location	Barium	Strontium	Uranium	Vanadium	Zinc
LANL Alluvial Groundwater BV[a]	**68.57**	**120**	**1.03**	**5**	**10**
Standard Level	**1000**	**21,900**	**30**	**182.5**	**10,000**
Standard Type	**NMGSF[b]**	**Reg[c]**	**NMGSF**	**Reg**	**NMGSF**
GU-0.01 Spring	128	301	1.9	9	32.8

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV.

[a] Alluvial groundwater BVs are from LANL (2007, 096665).

[b] NMGSF = NMAC 20.6.2, Groundwater Standards (Filtered).

[c] Reg = EPA regional tap water screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table 6.3-9
Inorganic COPCs in Nonfiltered Springs Samples

Location	Barium	Boron	Chromium	Iron	Manganese	Nickel	Strontium	Uranium	Vanadium	Zinc
Standard Level	**2000**	**7300**	**100**	**25,550**	**1700**	**100**	**21,900**	**30**	**183**	**11,000**
Standard Type	**MCL**[a]	**Reg**[b]	**MCL**	**Reg**	**Reg**	**MCL**	**Reg**	**MCL**	**Reg**	**Reg**
GU-0.01 Spring	130	31.2	4.1	27.5	20.3	1.8	304	2	9.7	34.3

Notes: Values are in µg/L. Values are maximum detected value.

[a] MCL = EPA maximum contaminant level.

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

Table 6.3-10
Radionuclide COPCs in Filtered Springs Samples

Location	Gross Alpha	Gross Beta	Uranium-234	Uranium-238
LANL Alluvial GW BV[a]	**na**[b]	**na**	**0.16**	**0.12**
Standard Level	**15**	**50**	**300**	**300**
Standard Type	**MCL**[c]	**SMCL**[d]	**NMRPS**[e]	**NMRPS**
GU-0.01 Spring	2.14	2.21	0.734	0.431

Notes: Values are in pCi/L. Values are maximum values greater than the LANL BV; if no BV, value is maximum detected value.

[a] Alluvial groundwater BVs are from LANL (2007, 096665).

[b] na = Not available.

[c] MCL = EPA maximum contaminant level.

[d] SMCL = EPA Secondary Maximum Contaminant Level.

[e] NMRPS = NMEIB Radiation Protection Standards (http://www.nmcpr.state.nm.us/nmac/parts/title20/20.003.0004.htm).

Table 6.3-11
Radionuclide COPCs in Nonfiltered Springs Samples

Location	Gross Beta	Radium-226	Radium-228	Uranium-234	Uranium-238
Standard Level	**50**	**5**	**5**	**300**	**300**
Standard Type	**SMCL**[a]	**MCL**[b]	**MCL**	**NMRPS**[c]	**NMRPS**
GU-0.01 Spring	3.89	0.443	0.917	0.758	0.513

Notes: Values are in pCi/L. Values are maximum detected values.

[a] SMCL = EPA Secondary Maximum Contaminant Level.

[b] MCL = EPA maximum contaminant level.

[c] NMRPS = NMEIB Radiation Protection Standards (http://www.nmcpr.state.nm.us/nmac/parts/title20/20.003.0004.htm).

Table 6.3-12
Organic COPCs in Nonfiltered Springs Samples

Location	Dichloroethane[1,2-]	Methyl-2-pentanone[4-]	Pentachlorodibenzofuran[2,3,4,7,8-]	Pentachlorodibenzofurans [Totals]	Toluene
Standard Level	**5**	**1990**	**na**[a]	**na**	**750**
Standard Type	**MCL**[b]	**Reg**[c]	**na**	**na**	**NMGSU**[d]
GU-0.01 Spring	1.69	3.68	9.72E-07	2.07E-06	1.62

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV; if no BV, value is maximum detected value.

[a] na = Not available.

[b] MCL = EPA maximum contaminant level.

[c] Reg = EPA regional tap water screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) adjusted to a target risk of 10^{-5}.

[d] NMGSU = NMAC 20.6.2, Groundwater Standards (Unfiltered).

Table 6.3-13
General Inorganic COPCs in Filtered Springs Samples

Location	Bromide	Calcium	Fluoride	Nitrate-Nitrite as Nitrogen	Silicon Dioxide	Sodium
LANL Alluvial GW BV[a]	**100**	**26,360**	**270**	**570**	**64,210**	**15,540**
Standard Level	**na[b]**	**na**	**1600**	**10,000**	**na**	**na**
Standard Type	**na**	**na**	**NMGSF[c]**	**NMGSF**	**na**	**na**
GU-0.01 Spring	172	43,500	329	3060	65,500	27,600

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV.

[a] Alluvial groundwater BVs are from LANL (2007, 096665).

[b] na = Not available.

[c] NMGSF = NMAC 20.6.2, Groundwater Standards (Filtered).

Table 6.3-14
General Inorganic COPCs in Nonfiltered Springs Samples

Location	Bromide	Calcium	Chloride	Fluoride	Magnesium	Nitrate-Nitrite as Nitrogen	Potassium	Silicon Dioxide	Sodium	Sulfate	Total Kjeldahl Nitrogen	Total Phosphate as Phosphorus
Standard Level	**na[a]**	**na**	**na**	**4000**	**na**	**10000**	**na**	**na**	**na**	**na**	**na**	**na**
Standard Type	**na**	**na**	**na**	**MCL[b]**	**na**	**MCL**	**na**	**na**	**na**	**na**	**na**	**na**
GU-0.01 Spring	95	43700	4040	320	5340	1540	4240	66,600	27400	11,400	56	89

Notes: Values are in µg/L. Values are maximum values greater than the LANL BV; if no BV, value is maximum detected value.

[a] na = Not available.

[b] MCL = EPA maximum contaminant level.

Table 6.3-15
Inorganic COPCs in Filtered Surface-Water Samples

Location	Aluminum	Barium	Boron	Chromium	Cobalt	Iron	Lead	Manganese	Nickel	Strontium	Uranium	Vanadium	Zinc
ESL[a]	**87**	**3.8**	**540**	**77**	**3**	**1000**	**1.2**	**80**	**28**	**620**	**1.8**	**19**	**66**
Standard Level	**750**	**na[b]**	**750**	**100**	**50**	**na**	**17**	**na**	**169**	**na**	**na**	**100**	**42**
Standard Type	**AqAcF[c]**	**na**	**IrF[d]**	**IrF**	**IrF**	**na**	**AqAcF**	**na**	**AqAcF**	**na**	**na**	**IrF**	**AqAcF**
GU-0.01 Spring	—[e]	128	33.8	—	—	—	—	12.1	0.88	301	1.9	9	32.8
Guaje above Rendija	457	31.5	14.4	1.1	—	230	—	2.3	1.2	62.3	—	2.8	6
Guaje at SR-502	1100	34.7	—	—	3.7	566	0.62	37.8	2	—	—	2.6	4.8

Notes: Values are in µg/L. Values are maximum detected value. Shading indicates a standard screening value was exceeded.

[a] Water ESL, LANL ECORISK Database Version 2.3 (LANL 2008, 103352).

[b] na = Not available.

[c] AqAcF, NMAC 20.6.4, Aquatic Life Acute (Filtered) Hardness=30 mg/L.

[d] IrF, NMAC 20.6.4, Irrigation Standard (Filtered).

[e] — = Not detected or not analyzed.

Table 6.3-16
Inorganic COPCs in Nonfiltered Surface-Water Samples

Location	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Silver	Strontium	Thallium	Uranium	Vanadium	Zinc
ESL[a]	**87**	**100**	**150**	**3.8**	**5.3**	**540**	**0.15**	**77**	**3**	**5**	**1000**	**1.2**	**80**	**0.77**	**na**	**28**	**0.36**	**620**	**18**	**1.8**	**19**	**66**
Standard Level	**na[b]**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**10**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**
Standard Type	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**WHU[c]**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**
GU-0.01 Spring	—[d]	—	—	130	—	31.2	—	4.1	—	—	27.5	—	20.3	—	—	1.8	—	304	—	2	9.7	34.3
Guaje above Rendija	804	—	—	32.3	—	14.8	—	1.3	—	—	430	0.6	8.8	—	2.4	1.3	—	59.9	—	—	2.4	3.7
Guaje at SR-502	94100	0.54	15.3	1220	9.5	—	1.9	51.8	37.1	65.9	61800	85.5	5800	0.28	—	42.7	0.26	—	0.81	—	94.8	284

Notes: Values are in µg/L. Values are maximum detected value.

[a] Water ESL, LANL ECORISK Database Version 2.3 (LANL 2008, 103352).

[b] na = Not available.

[c] WHU = NMAC 20.6.4, Wildlife Habitat (Unfiltered).

[d] — = Not detected or not analyzed.

Table 6.3-17
Radionuclide COPCs in Filtered Surface-Water Samples

Location	Gross Alpha	Gross Beta	Uranium-234	Uranium-238
ESL[a]	**na[b]**	**na**	**22**	**24**
Standard Level	**na**	**na**	**200**	**200**
Standard Type	**na**	**na**	**BCG[c]**	**BCG**
GU-0.01 Spring	2.14	2.21	0.734	0.431

Notes: Values are in pCi/L. Values are maximum detected value.

[a] Water ESL, LANL ECORISK Database Version 2.3 (LANL 2008, 103352).

[b] na = Not available.

[c] BCG, DOE Biota Concentration Guidelines (BCGs) for radionuclides (DOE 2002, 085637).

Table 6.3-18
Radionuclide COPCs in Nonfiltered Surface-Water Samples

Location	Americium-241	Cesium-137	Gross alpha	Gross beta	Plutonium-239/240	Potassium-40	Radium-226	Radium-228	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235/236	Uranium-238
ESL[a]	**5.8**	**na[b]**	**na**	**na**	**20**	**na**	**0.1**	**0.09**	**570**	**5.9**	**6.8**	**0.81**	**1.6E+08**	**22**	**24**	**24**
Standard Level	**20**	**40**	**na**	**na**	**20**	**4000**	**60**	**60**	**300**	**na**	**na**	**300**	**1,000,000**	**200**	**300**	**200**
Standard Type	**NMRPS[c]**	**BCG[d]**	**na**	**na**	**NMRPS**	**NMRPS**	**NMRPS**	**NMRPS**	**BCG**	**na**	**na**	**BCG**	**NMRPS**	**BCG**	**NMRPS**	**BCG**
GU-0.01 Spring	—[e]	—	—	3.89	—	—	0.443	0.917	—	—	—	—	19.25379	0.758	—	0.513
Guaje above Rendija	—	—	—	—	—	—	—	—	—	—	—	—	48.8529	—	—	—
Guaje at SR-502	0.132	3.76	207	384	0.206	178	5.68	—	0.866	19.3	15.7	14.6	—	19.6	1.27	19.4

Notes: Values are in pCi/L. Values are maximum detected value.

[a] Water ESL, LANL ECORISK Database Version 2.3 (LANL 2008, 103352).

[b] na = Not available.

[c] NMRPS = NMEIB Radiation Protection Standards (http://www.nmcpr.state.nm.us/nmac/parts/title20/20.003.0004.htm).

[d] BCG = DOE Biota Concentration Guidelines (BCGs) for radionuclides (DOE 2002, 085637).

[e] — = Not detected or not analyzed.

Table 6.3-19
Organic COPCs in Nonfiltered Surface-Water Samples

Location	Dichloroethane[1,2-]	Methyl-2-pentanone[4-]	Pentachlorodibenzofuran[2,3,4,7,8-]	Pentachlorodibenzofurans [Totals]	Toluene
ESL[a]	**1100**	**na[b]**	**na**	**na**	**130**
GU-0.01 Spring	1.69	3.68	9.72E-07	2.07E-06	1.62
Guaje above Rendija	—[c]	—	—	—	—
Guaje at SR-502	—	—	—	—	—

Notes: Values are in µg/L. Values are maximum detected value.

[a] Water ESL, LANL ECORISK Database Version 2.3 (LANL 2008, 103352).

[b] na = Not available.

[c] — = Not detected or not analyzed.

Table 6.3-20

General Inorganic COPCs in Filtered Surface-Water Samples

Location	Ammonia as Nitrogen	Bromide	Calcium	Chloride	Fluoride	Magnesium	Nitrate-Nitrite as Nitrogen	Perchlorate	Potassium	Silicon Dioxide	Sodium	Sulfate	Total Dissolved Solids	Total Kjeldahl Nitrogen
ESL[a]	**na**[b]	**na**	**na**	**230,000**	**1600**	**na**	**na**	**35,000**	**na**	**na**	**na**	**na**	**na**	**na**
GU-0.01 Spring	—[c]	172	43,500	22,100	329	5330	3060	0.542	4080	65,500	27,600	18,000	26,9000	36
Guaje above Rendija	69	—	11,300	2940	186	3850	56.1	0.409	3490	51,200	7900	16,100	10,9000	33
Guaje at SR-502	—	—	14,200	—	—	3500	—	—	4130	—	19400	—	—	—

Notes: Values are in µg/L. Values are maximum detected value.

[a] Water ESL, LANL ECORISK Database Version 2.3 (LANL 2008, 103352).

[b] na = Not available.

[c] — = Not detected or not analyzed.

Table 6.3-21
General Inorganic COPCs in Nonfiltered Surface-Water Samples

Location	Bromide	Calcium	Chloride	Cyanide [Total]	Fluoride	Magnesium	Nitrate-Nitrite as Nitrogen	Perchlorate	Potassium	Silicon Dioxide	Sodium	Sulfate	Total Kjeldahl Nitrogen	Total Phosphate as Phosphorus
ESL[a]	**na**[b]	**na**	**23,0000**	**5.2**	**1600**	**na**	**na**	**35,000**	**na**	**na**	**na**	**na**	**na**	**na**
Standard Level	**na**	**na**	**na**	**na**	**na**	**na**	**132000**	**na**	**na**	**na**	**na**	**na**	**na**	**na**
Standard Type	**na**	**na**	**na**	**na**	**na**	**na**	**LWU**[c]	**na**	**na**	**na**	**na**	**na**	**na**	**na**
GU-0.01 Spring	95	43,700	4040	—[d]	320	5340	1540	—	4240	66,600	27,400	11,400	56	89
Guaje above Rendija	—	10,900	—	—	—	3730	—	—	3430	—	7600	—	100	—
Guaje at SR-502	—	50,600	—	7.4	—	18,400	—	0.531	20,300	—	19,800	—	—	—

Notes: Values are in µg/L. Values are maximum detected value.

[a] Water ESL, LANL ECORISK Database Version 2.3 (LANL 2008, 103352).

[b] na = Not available.

[c] LWU, NMAC 20.6.4, Livestock Watering (Unfiltered).

[d] — = Not detected or not analyzed.

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

Analyte	Field Preparation	Number of Detected Results > Lowest Comparison Value	Maximum Detected Concentration	Comparison Value	Units	Lowest Comparison Value Basis[a]	Locations with Results > Lowest Comparison Value
Aluminum	Filtered	21	38,300	750	µg/L	NM WQCC Acute Aquatic Life	B-SMA-1, Guaje above Rendija, Guaje at SR-502, R-SMA-1
Aroclor-1260	Nonfiltered	1	0.066	0.00064	µg/L	NM WQCC Human Health Persistent	Guaje at SR-502
Cadmium	Filtered	2	1.25	0.6	µg/L	NM WQCC Acute Aquatic Life	Guaje above Rendija
Copper	Filtered	8	16.1	4.3	µg/L	NM WQCC Acute Aquatic Life	B-SMA-1, Guaje above Rendija, Guaje at SR-502, R-SMA-1
Gross alpha	Nonfiltered	3	434	15	pCi/L	NM WQCC Livestock Watering[b]	Guaje above Rendija, Guaje at SR-502
Lead	Filtered	2	77.1	17	µg/L	NM WQCC Acute Aquatic Life	B-SMA-1, Guaje above Rendija
Mercury	Nonfiltered	2	0.85	0.77	µg/L	NM WQCC Wildlife Habitat[b]	R-SMA-1
Radium-226	Nonfiltered	1	49.9	30	pCi/L	NM WQCC Livestock Watering[b]	Guaje at SR-502
Radium-228	Nonfiltered	2	83.6	30	pCi/L	NM WQCC Livestock Watering[b]	Guaje above Rendija, Guaje at SR-502
Zinc	Filtered	2	101	42	µg/L	NM WQCC Acute Aquatic Life	B-SMA-1, Guaje above Rendija

[a] Basis from State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC).

[b] Basis is inconsistent with existing, designated, or reasonably anticipated attainable uses of stormwater in the north canyons.

Table 6.4-2
Ecologically Relevant Stormwater Comparisons

Analyte	Field Preparation	Maximum Detected Concentration (µg/L)	Benchmark (µg/L)*	Maximum > Benchmark?	Location with Maximum Detected Result
Aluminum	Filtered	38300	750	Yes	B-SMA-1
Cadmium	Filtered	1.25	0.6	Yes	Guaje above Rendija
Copper	Filtered	16.1	4.3	Yes	B-SMA-1
Lead	Filtered	77.1	17	Yes	Guaje above Rendija
Zinc	Filtered	101	42	Yes	B-SMA-1

*Basis from State of New Mexico Standards for acute aquatic life (20.6.4.900[H], 20.4.6.900[I], and 20.4.6.900[J] NMAC).

Table 6.4-3
Human Health-Relevant Stormwater Comparisons

Analyte	Field Preparation	Maximum Detected Concentration (µg/L)	Benchmark (µg/L)*	Maximum > Benchmark?
Aroclor-1260	Nonfiltered	0.066	4.65	No

*Benchmark calculated using ATSDR MRL (see Section 6.4.2.3).

Table 6.5-1
North Canyons COPC and Stormwater Summary

Analyte	Sediment	Nonstorm-Related Surface Water[a]	Alluvial Groundwater[a]	Regional Groundwater	Stormwater[b]
Metals					
Aluminum	X[c]	X	—[d]	X	X
Antimony	X	X	—	—	X
Arsenic	X	X	—	X	X
Barium	X	X	X	X	X
Beryllium	X	X	—	—	X
Boron	—	X	X	X	X
Cadmium	X	X	—	—	X
Calcium	X	X	X	X	X
Chromium	X	X	X	X	X
Chromium Hexavalent Ion	—	—	—	X	—
Cobalt	X	X	—	X	X
Copper	X	X	—	X	X
Iron	X	X	X	X	X
Lead	X	X	—	X	X
Lithium	—	—	—	X	—
Magnesium	X	X	X	X	X
Manganese	X	X	X	X	X
Mercury	X	X	—	X	X
Molybdenum	—	X	—	X	X
Nickel	X	X	X	X	X
Potassium	X	X	X	X	X
Selenium	X	—	—	—	X
Silver	—	X	—	—	X
Sodium	—	X	X	X	X
Strontium	—	X	X	X	X
Thallium	—	X	—	X	X
Tin	—	—	—	—	X
Uranium	—	X	X	X	X
Vanadium	X	X	X	X	X
Zinc	X	X	X	X	X
Other Inorganic Chemicals					
Ammonia as Nitrogen	—	X	—	—	X
Bromide	—	X	X	X	—
Carbonate	—	—	—	X	—
Chloride	—	X	X	X	X

Table 6.5-1 (continued)

Analyte	Sediment	Nonstorm-Related Surface Water[a]	Alluvial Groundwater[a]	Regional Groundwater	Stormwater[b]
Cyanide [Total]	—	X	—	X	X
Fluoride	—	X	X	X	X
Nitrate as Nitrogen	—	—	—	X	—
Nitrate-Nitrite as Nitrogen	—	X	X	X	X
Nitrite as Nitrogen	—	—	—	X	—
Oxalate	—	—	—	X	—
Perchlorate	X	X	—	X	—
Silicon Dioxide	—	X	X	X	X
Sulfate	—	X	X	X	X
Total Kjeldahl Nitrogen	—	X	X	X	X
Total Phosphate as Phosphorus	—	X	X	X	—
Dioxins and Furans					
Pentachlorodibenzofuran [2,3,4,7,8-]	—	X	X	—	—
Pentachlorodibenzofurans [Totals]	—	X	X	—	—
Pesticides and PCBs					
Aroclor-1242	X	—	—	—	—
Aroclor-1254	X	—	—	—	—
Aroclor-1260	X	—	—	—	X
Chlordane[alpha-]	X	—	—	—	—
Chlordane[gamma-]	X	—	—	—	—
DDE[4,4*-]	X	—	—	—	—
DDT[4,4*-]	X	—	—	—	—
Dieldrin	X	—	—	—	—
Endosulfan II	X	—	—	—	—
Endrin Aldehyde	—	—	—	X	—
SVOCs					
Acenaphthene	X	—	—	—	—
Anthracene	X	—	—	—	—
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	—	—	—	—
Benzyl Alcohol	X	—	—	—	—
Bis[2-ethylhexyl]phthalate	—	—	—	X	—

Table 6.5-1 (continued)

Analyte	Sediment	Nonstorm-Related Surface Water[a]	Alluvial Groundwater[a]	Regional Groundwater	Stormwater[b]
Chrysene	X	—	—	—	—
Di-n-butylphthalate	X	—	—	—	X
Fluoranthene	X	—	—	—	—
Methylphenol[4-]	X	—	—	—	—
Nitroaniline[4-]	—	—	—	—	X
Phenanthrene	X	—	—	—	—
Phenol	X	—	—	—	—
Pyrene	X	—	—	—	—
Total Petroleum Hydrocarbons					
Diesel Range Organics	X	—	—	—	X
Gasoline Range Organics	X	—	—	—	—
VOCs					
Acetone	—	—	—	X	—
Butanone[2-]	—	—	—	X	—
Chloroform	X	—	—	—	—
Chloromethane	—	—	—	X	—
Dichloroethane[1,2-]	—	X	X	—	—
Isopropylbenzene	X	—	—	—	—
Isopropyltoluene[4-]	X	—	—	—	—
Methyl-2-pentanone[4-]	—	X	X	—	—
Methylene Chloride	—	—	—	X	—
Naphthalene	X	—	—	—	—
Toluene	X	X	X	X	—
Trichloro-1,2,2-trifluoroethane[1,1,2-]	X	—	—	—	—
Radionuclides					
Americium-241	X	X	—	—	—
Cesium-137	X	X	—	—	X
Gross alpha	—	X	X	X	X
Gross beta	—	X	X	X	X
Lead-210	—	—	—	—	X
Plutonium-238	X	—	—	—	X
Plutonium-239/240	X	X	—	—	X
Polonium-210	—	—	—	—	X
Potassium-40	—	X	—	X	X
Radium-226	—	X	X	X	X
Radium-228	—	X	X	X	X
Strontium-90	X	X	—	—	X

Table 6.5-1 (continued)

Analyte	Sediment	Nonstorm-Related Surface Water[a]	Alluvial Groundwater[a]	Regional Groundwater	Stormwater[b]
Thorium-228	—	X	—	—	X
Thorium-230	—	X	—	X	X
Thorium-232	—	X	—	—	X
Tritium	X	X	—	—	X
Uranium-234	—	X	X	X	X
Uranium-235/236	—	X	—	X	X
Uranium-238	—	X	X	X	X

Note: Shading indicates that the analyte exceeded SAL or SSL for sediment or a standard for water.

[a] Springs are screened both as surface water and alluvial groundwater.

[b] For stormwater, an analyte is marked with "X" if it was detected and is shaded if it exceeded an acute value.

[c] X = Analyte is a COPC for given medium.

[d] — = Analyte is not a COPC for a given medium or not detected in stormwater.

Table 7.1-1
Inferred Primary Sources and Downcanyon Extent of Select COPCs in Sediment in the North Canyons Watersheds

Type of COPC	COPC	Inferred Primary Source(s) in the North Canyons Watersheds[a]	Inferred Downcanyon Extent from Laboratory Sources[b]
Inorganic chemical	Aluminum	Natural background and minor releases from SWMUs 00-001(a) or 00-015 or PMSR[c]	Rendija Canyon between reach R-3 and Guaje Canyon
	Antimony	Cerro Grande burn area	n/a[d]
	Arsenic	Natural background and minor releases from SWMUs 00-001(a) or 00-015 or PMSR	Rendija Canyon between reach R-3 and Guaje Canyon
	Chromium	Natural background and minor releases from former TA-10 and SWMUs 00-001(a) or 00-015 or PMSR	Rendija Canyon between reach R-3 and Guaje Canyon and Bayo Canyon between reaches BY-2 and BY-3
	Cyanide (total)	Cerro Grande burn area	n/a
	Iron	Natural background and minor releases from SWMUs 00-001(a) or 00-015 or PMSR	Rendija Canyon between reach R-3 and Guaje Canyon
	Lead	Cerro Grande burn area, Los Alamos townsite, and minor releases from former TA-10, SWMU 00-011(d), and AOC 00-015, SWMU 00-001, 00-015, or PMSR	Rendija Canyon between reach R-3 and Guaje Canyon
	Manganese	Cerro Grande burn area	n/a
	Selenium	Natural background	n/a
	Vanadium	Natural background and minor releases from SWMUs 00-001(a) or 00-015 or PMSR	Rendija Canyon between reach R-3 and Guaje Canyon
	Zinc	Natural background and minor releases from former TA-10 and SWMUs 00-001(a) or 00-015 or PMSR	Rendija Canyon between reach R-3 and Guaje Canyon and Bayo Canyon between reaches BY-2 and BY-3
Organic chemical	Aroclor-1242	Los Alamos townsite	n/a
	Aroclor-1254	Los Alamos townsite	n/a
	Aroclor-1260	Los Alamos townsite and possibly former TA-10	Bayo Canyon between reach BY-3 and Los Alamos Canyon
	Benzoic acid	Los Alamos townsite	n/a
	Pesticides	Los Alamos townsite	n/a
	Phenol	Los Alamos townsite	n/a
	SVOCs	Los Alamos townsite	n/a
Radionuclide	Cesium-137	Cerro Grande burn area	n/a
	Strontium-90	Cerro Grande burn area	n/a

[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 be traced to an upcanyon Laboratory source.

[c] PMSR = Poor man's shooting range.

[d] n/a = Not applicable (inferred source includes Cerro Grande burn area, natural background, and roads and other developed areas).

Table 8.1-1
HQs Based on Maximum Detected Concentrations of Inorganic COPCs in North Canyons Sediment Samples and Minimum Soil ESLs

Reach	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide [Total]	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Perchlorate	Potassium	Selenium	Vanadium	Zinc
Sediment BV (mg/kg)[a]	**15400**	**0.83**	**3.98**	**127**	**1.31**	**0.4**	**4420**	**10.5**	**4.73**	**11.2**	**0.82**	**13,800**	**19.7**	**2370**	**543**	**0.1**	**9.38**	**na[b]**	**2690**	**0.3**	**19.7**	**60.2**
Soil ESL (mg/kg)[c]	**pH dependent[d]**	**0.05**	**6.8**	**110**	**2.5**	**0.27**	**na**	**2.3**	**13**	**15**	**0.1**	**pH dependent**	**14**	**na**	**220**	**0.013**	**9.7**	**na**	**na**	**0.52**	**0.025**	**48**
BR-1	—[e]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BY-1	—	—	—	—	—	1.9	—	5.8	—	—	—	—	3.3	no ESL[f]	—	—	—	no BV	—	—	970	—
BY-2	—	—	—	—	—	—	—	6	—	—	—	—	2.6	no ESL	—	—	—	no BV	no ESL	—	860	2.9
BY-3	—	—	—	1.618182	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	890	—
G-1	—	—	—	—	—	—	—	4.9	—	—	—	5 < pH <8	—	—	—	—	—	—	—	—	1100	—
G-BKG	—	18	0.62	3.3	—	1.7	no ESL	—	0.51	1.2	20	—	2.7	no ESL	8.2	—	1	—	—	3.1	—	1.7
R-1E	pH >5.5	—	0.79	—	—	—	—	4.9	—	—	—	5 < pH <8	2	no ESL	—	13	—	—	—	4.6	960	—
R-1M	—	—	—	—	—	—	—	4.6	0.42	—	—	—	—	—	—	—	1.5	—	—	2.1	930	—
R-1S	—	—	0.66	1.2	—	—	—	5.2	0.38	—	—	—	—	no ESL	—	—	—	—	—	—	1000	—
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-3	—	1.4	0.88	1.9	0.8	—	no ESL	12	0.75	1.3	—	5 < pH <8	7.8	no ESL	7	—	1	—	no ESL	2	3100	5.6
R-3E	—	—	—	1.8	—	—	no ESL	—	0.51	0.8	11	—	2.1	—	4.4	—	1	—	—	2.5	—	—

Notes: Values reported are HQs (unitless). Black shading indicates HQ >3.0.

[a] Sediment BV value from LANL (2008, 103352).

[b] na = Not available.

[c] Soil ESL values from LANL (2008, 103352).

[d] pH dependent = ESL is dependent upon soil pH or pH range.

[e] — = Not a COPC.

[f] no ESL = Compound detected; no screening level available.

Table 8.1-2
HQs Based on Maximum Detected Concentrations of Radionuclide COPCs in North Canyons Sediment Samples and Minimum Soil ESLs

Reach	Americium-241	Cesium-137	Plutonium-239/240	Strontium-90	Tritium
Sediment BV (pCi/g)[a]	**0.04**	**0.9**	**0.068**	**1.04**	**0.093**
Soil ESL (pCi/g)[b]	**44**	**680**	**47**	**560**	**36,000**
BR-1	—[c]	<0.01	—	—	—
BY-1	<0.01	—	—	—	<0.01
BY-2	—	—	—	—	—
BY-3	—	—	—	—	—
G-1	—	—	—	—	<0.01
G-BKG	—	<0.01	<0.01	<0.01	—
R-1E	—	—	—	—	—
R-1M	—	—	—	—	<0.01
R-1S	—	—	—	—	<0.01
R-2	—	—	—	—	—
R-3	—	<0.01	<0.01	<0.01	—
R-3E	—	<0.01	<0.01	—	—

Note: Values reported are HQs (unitless).

[a] Sediment BV from LANL (1998, 059730).

[b] Soil ESL values from LANL (2008, 103352).

[c] — = Not a COPC.

Table 8.1-3
HQs Based on Maximum Detected Concentrations of Organic COPCs in North Canyons Sediment Samples and Minimum Soil ESLs

Reach	Acenaphthene	Anthracene	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	Benzyl Alcohol	Chlordane[alpha-]	Chlordane[gamma-]	Chloroform	Chrysene	DDE[4,4'-]	DDT[4,4'-]	Dieldrin	Di-n-butylphthalate	Endosulfan II	Fluoranthene	Isopropylbenzene	Isopropyltoluene[4-]	Methylphenol[4-]	Naphthalene	Phenanthrene	Phenol	Pyrene	Toluene	Total Petroleum Hydrocarbons Diesel Range Organics	Total Petroleum Hydrocarbons Gasoline Range Org.	Trichloro-1,2,2-trifluoroethane[1,1,2-]
Soil ESL (mg/kg)[a]	**0.25**	**6.8**	**0.041**	**0.041**	**0.14**	**3**	**53**	**18**	**24**	**62**	**1**	**na**[b]	**0.27**	**2.2**	**8**	**2.4**	**0.11**	**0.044**	**0.0045**	**0.011**	**na**	**na**	**na**	**na**	**na**	**1**	**5.5**	**0.79**	**10**	**23**	**na**	**na**	**na**
BR-1	—[c]	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	0.02	—	—	—	—	—	—	—	—	—	—	—	—	no ESL[d]	—	—
BY-1	0.05	<0.01	1.4	0.9	0.1	0.01	<0.01	—	—	—	—	—	0.01	<0.01	<0.01	0.01	<0.01	0.08	0.16	—	—	no ESL	—	no ESL	—	—	0.01	—	<0.01	<0.01	no ESL	—	—
BY-2	—	—	0.59	0.36	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	no ESL	no ESL	—	—	—	—	—	—	no ESL	no ESL	—
BY-3	—	—	0.4	0.15	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	no ESL	—	no ESL
G-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	—	no ESL	—	—
G-BKG	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1E	—	—	0.32	0.33	0.03	—	—	—	—	—	—	—	—	—	—	—	0.02	0.08	—	5	—	—							<0.01	—	no ESL	—	—
R-1M	—	—	—	—	—	0.02	<0.01	<0.01	<0.01	<0.01	—	—	—	—	—	0.02	0.02	0.02	—	—	—	no ESL	—	—	—	—	<0.01		0.01	—	no ESL	—	—
R-1S	—	—	0.06	—	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	no ESL	—	—
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	—	—	—	no ESL	—	—	—	—	—	—	—	—	—	no ESL	—	—
R-3	—	—	—	—	—	—	—	—	—	—	3.4	no ESL	—	—	—	—	<0.01	—	—	—	—	—	—	—	no ESL	0.13	0.01	1	—	—	no ESL	—	—
R-3E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes: Values reported are HQs (unitless). Black shading indicates HQ >3.0.

[a] Soil ESL values from LANL (2008, 103352).

[b] na = Not available.

[c] — = Not a COPC.

[d] no ESL = Compound detected; no screening level available.

Table 8.1-4
HQs Based on Maximum Detected Concentrations of Inorganic COPCs in North Canyons c1 Sediment Samples and Minimum Sediment ESLs

Reach	Aluminum	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Vanadium	Zinc
Sediment ESL (mg/kg)[a]	**280**	**48**	**0.33**	**na[b]**	**56**	**230**	**23**	**20**	**27**	**na**	**720**	**0.018**	**13**	**na**	**0.9**	**30**	**65**
BR-1	—[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BY-1	—	—	1.2	—	—	—	—	—	1.6	—	—	—	—	—	—	—	—
BY-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BY-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G-BKG	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1E	—	—	—	—	—	—	—	—	—	—	—	9.7	—	—	—	—	—
R-1M	—	—	—	—	—	—	—	—	—	—	—	—	1.1	—	1.2	—	—
R-1S	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-3	84	3.2	—	—	0.49	0.04	0.83	3400	1.7	no ESL[d]	2.1	—	—	no ESL	0.74	2.6	4.1
R-3E	—	2.9	—	no ESL	—	0.02	—	—	0.81	—	1	—	—	—	1.1	—	—

Notes: Values reported are HQs (unitless). Black shading indicates HQ >3.0.

[a] Sediment ESL values from LANL (2008, 103352).

[b] na = Not available.

[c] — = Not a COPC.

[d] no ESL = Compound detected; no screening level available.

Table 8.1-5
HQs Based on Maximum Detected Concentrations of Radionuclide COPCs in North Canyons c1 Sediment Samples and Minimum Sediment ESLs

Reach	Cesium-137	Plutonium-239/240	Tritium
Sediment ESL (pCi/g)[a]	**720**	**110**	**660,000**
BR-1	—[b]	—	—
BY-1	—	—	—
BY-2	—	—	—
BY-3	—	—	—
G-1	—	—	<0.01
G-BKG	—	—	—
R-1E	—	—	—
R-1M	—	—	—
R-1S	—	—	—
R-2	—	—	—
R-3	—	—	—
R-3E	<0.01	<0.01	—

Note: Values reported are HQs (unitless).

[a] Sediment ESL from LANL (2008, 103352).

[b] — = Not a COPC.

Table 8.1-6
HQs Based on Maximum Detected Concentrations of Organic COPCs in North Canyons c1 Sediment Samples and Minimum Sediment ESLs

Reach	Acenaphthene	Anthracene	Aroclor-1242	Aroclor-1260	Benzo[a]anthracene	Benzo[a]pyrene	Chlordane[alpha-]	Chlordane[gamma-]	Chloroform	Chrysene	DDE[4,4*-]	DDT[4,4*-]	Fluoranthene	Phenanthrene	Pyrene	Total Petroleum Hydrocarbons Diesel Range Organics	Total Petroleum Hydrocarbons Gasoline Range Org.	Trichloro-1,2,2-trifluoroethane[1,1,2-]
Sediment ESL (mg/kg)[a]	**0.62**	**0.00039**	**0.031**	**0.031**	**0.11**	**0.35**	**0.0005**	**0.0005**	**10**	**0.5**	**0.0022**	**0.0015**	**2.9**	**0.85**	**0.57**	**na[b]**	**na**	**na**
BR-1	—[c]	—	0.13	—	—	—	—	—	—	—	—	—	—	—	—	no ESL[d]	—	—
BY-1	0.02	20	—	0.2	0.34	0.08	5.1	3.8	<0.01	0.05	0.34	0.69	0.02	0.07	0.09	no ESL	—	—
BY-2	—	—	—	0.05	—	—	—	—	—	—	—	—	—	—	—	no ESL	no ESL	
BY-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	no ESL	—	no ESL
G-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	—	—	—
G-BKG	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1E	—	—	—	0.07	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1S	—	—	—	0.09	—	—	—	—	—	—	—	—	—	—	—	no ESL	—	—
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	no ESL	—	—
R-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	no ESL	—	—
R-3E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes: Values reported are HQs (unitless). Black shading indicates HQ >3.0.

[a] Sediment ESL values from LANL (2008. 103352).

[b] na = Not available.

[c] — = Not a COPC.

[d] no ESL = Compound detected; no screening level available.

Table 8.1-7
HQs Based on Maximum Detected Concentrations of Radionuclide COPCs in North Canyons Sediment Samples and Limiting Soil BCGs

Reach	Americium-241	Cesium-137	Plutonium-238	Plutonium-239/240	Strontium-90	Tritium	SOF
Sediment BV (pCi/g)[a]	**0.04**	**0.9**	**0.006**	**0.068**	**1.04**	**0.093**	na[b]
Soil BCG	**3880**	**20.8**	**No BCG**[c]	**6120**	**22.5**	**17,1000**	na
BR-1	—[d]	0.05	—	—	—	—	0.05
BY-1	<0.01	—	—	—	—	<0.01	<0.01
BY-2	—	—	—	—	—	—	na
BY-3	—	—	—	—	—	—	na
G-1	—	—	—	—	—	<0.01	<0.01
G-BKG	—	0.3	—	<0.01	0.06	—	0.36
R-1E	—	—	—	—	—	—	na
R-1M	—	—	—	—	—	<0.01	<0.01
R-1S	—	—	—	—	—	<0.01	<0.01
R-2	—	—	—	—	—	—	na
R-3	—	0.22	no BCG	<0.01	0.05	—	0.27
R-3E	—	0.17	—	<0.01	—	—	0.17

Note: Values are ratios of maximum detected concentrations to BCGs (unitless).

[a] Sediment BV from LANL (2008, 103352).

[b] na = Not available.

[c] BCG values are those published by RESRAD BIOTA Software (Version 1.21, Argonne National Laboratory, May 2006, URL: http://www.ead.anl.gov/resrad).

[d] — = Not a COPC.

Table 8.1-8
HQs Based on Maximum Detected Concentrations of Radionuclide COPCs in North Canyons c1 Sediment Samples and Limiting Sediment BCGs

Reach	Cesium-137	Plutonium-239/240	Strontium-90	Tritium	SOFs
LANL SED BV[a]	**0.9**	**0.068**	**1.04**	**0.093**	na[b]
DOE Sediment BCG[c]	**3130**	**5870**	**581**	**36,8000**	na
BR-1	—[d]	—	—	—	na
BY-1	—	—	—	—	na
BY-2	—	—	—	—	na
BY-3	—	—	—	—	na
G-1	—	—	—	<0.01	<0.01
G-BKG	—	—	—	—	na
R-1E	—	—	—	—	na
R-1M	—	—	—	—	na
R-1S	—	—	—	—	na
R-2	—	—	—	—	na
R-3	—	—	—	—	na
R-3E	<0.01	<0.01	<0.01	—	<0.01

Note: Values are ratios of maximum detected concentrations to BCGs (unitless).

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

[b] na = Not available.

[c] BCG values are those published by RESRAD BIOTA Software (Version 1.21), Argonne National Laboratory, May 2006, URL: http://www.ead.anl.gov/resrad).

[d] — = Not a COPC.

Table 8.1-9
HQs Based on Maximum Detected Concentrations of Inorganic COPCs in North Canyons Nonfiltered Nonstorm-Related Surface-Water Samples and Minimum Water ESLs

Sample Location	Alkalinity-CO3	Alkalinity-CO3+HCO3	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Bromide	Cadmium	Calcium	Chloride	Chromium	Cobalt	Copper	Cyanide [Total]	Fluoride	Hardness	Iron	Lead
Water ESL (µg/L)[a]	**na[b]**	**na**	**87**	**100**	**150**	**3.8**	**5.3**	**540**	**na**	**0.15**	**na**	**230,000**	**77**	**3**	**5**	**5.2**	**1600**	**na**	**1000**	**1.2**
GU-0.01 Spring	no ESL[c]	no ESL	—[d]	—	—	34	—	0.06	no ESL	—	no ESL	0.02	0.05	—	—	—	0.2	no ESL	0.03	—
Guaje at SR-502	—	no ESL	1100	<0.01	0.1	320	1.8	—	—	13	no ESL	—	0.67	12	13	1.4	—	no ESL	62	
Guaje above Rendija	—	—	9.2	—	—	8.5	—	0.03	—	—	no ESL	—	0.02	—	—	—	—	no ESL	0.43	0.5

Table 8.1-9 (continued)

Sample Location	Manganese	Mercury	Molybdenum	Nickel	Nitrate-Nitrite as Nitrogen	Perchlorate	Potassium	Silicon Dioxide	Silver	Sodium	Strontium	Sulfate	Thallium	Total Kjeldahl Nitrogen	Total Phosphate as Phosphorus	Uranium	Vanadium	Zinc
Water ESL (µg/L)	**80**	**0.77**	**na**	**28**	**na**	**35,000**	**na**	**na**	**0.36**	**na**	**620**	**na**	**18**	**na**	**na**	**1.8**	**19**	**66**
GU-0.01 Spring	0.25	—	—	0.06	no ESL	—	no ESL	no ESL	—	no ESL	0.49	no ESL	—	no ESL	no ESL	1.1	0.51	0.52
Guaje at SR-502	73	0.36	—	1.5	—	<0.01	no ESL	—	0.72	no ESL	—	—	0.04	—	—	—	5	4.3
Guaje above Rendija	0.11	—	no ESL	0.046	—	—	no ESL	—	—	no ESL	0.1	—	—	no ESL	—	—	0.13	0.06

Notes: Values reported are HQs (unitless). Black shading indicates HQ > 3.0.

[a] Water ESLs are from LANL (2008, 103352).

[b] na = Not available.

[c] no ESL = Compound detected; no screening level available.

[d] — = Not a COPC.

Table 8.1-10
HQs Based on Maximum Detected Concentrations of Radionuclide COPCs in North Canyons Nonfiltered Nonstorm-Related Surface-Water Samples and Minimum Water ESLs

Sample Location	Americium-241	Cesium-137	Gross alpha	Gross beta	Plutonium-239/240	Potassium-40	Radium-226	Radium-228	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235/236	Uranium-238
Water ESL (pCi/L)[a]	**5.8**	**1100**	**na**[b]	**na**	**20**	**na**	**0.1**	**0.09**	**570**	**5.9**	**6.8**	**0.81**	**160,000,000**	**22**	**24**	**24**
GU-0.01 Spring	—[c]	—	—	no ESL[d]	—	—	4.4	10	—	—	—	—	<0.01	0.03	—	0.02
Guaje at SR-502	0.02	<0.01	no ESL	no ESL	0.01	no ESL	57	—	<0.01	3.3	2.3	18	—	0.89	0.05	0.81
Guaje above Rendija	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	—	—	—

Notes: Values reported are maximum HQs (unitless). Black shading indicates HQ > 3.0.

[a] Water ESLs are from LANL (2008, 103352).

[b] na = Not available.

[c] — = Not a COPC.

[d] no ESL = Compound detected; no screening level available.

Table 8.1-11
HQs Based on Maximum Detected Concentrations of Organic COPCs in North Canyons Nonfiltered Nonstorm-Related Surface-Water Samples and Minimum Water ESLs

Sample Location	Dichloroethane[1,2-]	Methyl-2-pentanone[4-]	Pentachlorodibenzofuran[2,3,4,7,8-]	Toluene
Water ESL (pCi/L)[a]	**1100**	**na[b]**	**na**	**130**
GU-0.01 Spring	<0.01	no ESL[c]	no ESL	0.01
Guaje at SR-502	—[d]	—	—	—
Guaje above Rendija	—	—	—	—

Note: Values reported are maximum HQs (unitless).

[a] Water ESLs are from LANL (2008, 103352).

[b] na = Not available.

[c] no ESL = Compound detected; no screening level available.

[d] — = Not a COPC.

Table 8.1-12
HQs and SOFs Based on Maximum Detected Concentrations of Radionuclide COPCs in North Canyons Nonfiltered Nonstorm-Related Surface-Water Samples and Limiting Water BCGs

Sample Location	Americium-241	Cesium-137	Gross Alpha	Gross Beta	Plutonium-239/240	Potassium-40	Radium-226	Radium-228	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Tritium	Uranium-234	Uranium-235/236	Uranium-238	SOF
Water BCG[a]	**438**	**42.6**	**na[b]**	**na**	**187**	**250**	**4.08**	**3.4**	**278**	**374**	**2570**	**304**	**265,000,000**	**202**	**217**	**223**	**n/a[c]**
Limiting receptor	**Aquatic animal**	**Riparian animal**	**na**	**na**	**Aquatic animal**	**Riparian animal**	**Riparian animal**	**Riparian animal**	**Riparian animal**	**Aquatic animal**	**Aquatic animal**	**Aquatic animal**	**Riparian animal**	**Aquatic animal**	**Aquatic animal**	**Aquatic animal**	**(multiple receptors)**
GU-0.01 Spring	—[d]	—	—	no BCG[e]	—	—	0.11	0.27	—	—	—	—	<0.01	<0.02	—	<0.01	0.38
Guaje at SR-502	<0.01	0.09	no BCG	no BCG	<0.01	0.71	1.4	—	<0.03	0.05	<0.01	0.05	—	0.1	<0.01	0.09	2.49
Guaje above Rendija	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	—	—	—	<0.01

Note: Values are ratios of maximum detected concentrations to BCGs (unitless).

[a] BCG values are those published by RESRAD BIOTA Software (Version 1.21, Argonne National Laboratory, May 2006, URL: http://www.ead.anl.gov/resrad).

[b] na = Not available.

[c] n/a = Not applicable.

[d] — = Not a COPC.

[e] No BCG = Compound detected; no screening level available.

Table 8.1-13
COPECs Retained for Soil for the North Canyons

COPEC	North Canyons Maximum (mg/kg)	Minimum ESL (mg/kg)	Receptor Endpoint Where North Canyons Maximum HQ >3*
Antimony	1.2	0.05	Plant, shrew
Barium	360	110	Plant
Chromium	27.7	2.3	Plant, earthworm
Cyanide [total]	2	0.1	Robin (herbivore), robin (insectivore), robin (omnivore), kestrel (intermediate carnivore), kestrel (top carnivore)*
Lead	110	14	Robin (insectivore), robin (omnivore), robin (herbivore)
Manganese	1540	220	Plant, earthworm
Mercury	0.174	0.013	Robin (insectivore), robin (omnivore), earthworm, kestrel (intermediate carnivore), kestrel (top carnivore)*
Selenium	2.4	0.52	Plant, shrew, robin (insectivore)
Vanadium	76.8	0.025	Plant, robin (insectivore), robin (omnivore), robin (herbivore)
Zinc	267	48	Robin (insectivore), robin (omnivore)
Benzoic Acid	3.4	1	Shrew
Di-n-butylphthalate	0.0549	0.011	Robin (insectivore)

Note: Sediment in north canyons is evaluated as soil by comparing COPEC concentrations to soil ESLs (see Section 8.1.1).
*HQ >1 for American kestrel (top carnivore) representing the Mexican spotted owl.

Table 8.1-14
COPECs Retained for Sediment (c1 unit) for the North Canyons

COPEC	North Canyons Maximum (mg/kg)	Minimum ESL (mg/kg)	Receptor Endpoint Where North Canyons Maximum HQ >3
Aluminum	23,500	280	Bat
Barium	154	48	Aquatic community organisms
Iron	67700	20	Aquatic community organisms
Mercury	0.174	0.018	Swallow
Zinc	267	65	Aquatic community organisms, swallow
Anthracene	0.00764	0.00039	Aquatic community organisms
Chlordane[alpha-]	0.00257	0.0005	Aquatic community organisms
Chlordane[gamma-]	0.00191	0.0005	Aquatic community organisms

Table 8.1-15
COPECs Retained for Nonfiltered Nonstorm-Related Surface Water for the North Canyons

COPEC	North Canyons Maximum (µg/L)	Minimum ESL (µg/L)	Receptor Endpoint Where North Canyons Maximum HQ >3
Aluminum	94,100	87	Aquatic community organisms, deer mouse, cottontail rabbit, shrew, fox, bat
Barium	1220	3.8	Aquatic community organisms
Cadmium	1.9	0.15	Aquatic community organisms
Cobalt	37.1	3	Aquatic community organisms
Copper	65.9	5	Aquatic community organisms
Iron	61,800	1000	Aquatic community organisms
Lead	85.5	1.2	Aquatic community organisms
Manganese	5800	80	Aquatic community organisms
Vanadium	94.8	19	Aquatic community organisms
Zinc	284	66	Aquatic community organisms
Radium-226	5.68	0.1	Algae (Aquatic autotroph - producer)
Radium-228	0.917	0.09	Algae (Aquatic autotroph - producer)
Thorium-228	19.3	5.9	Algae (Aquatic autotroph - producer)
Thorium-232	14.6	0.81	Algae (Aquatic autotroph - producer)

Table 8.1-16
Comparison of Concentrations for Plant COPECs in the North Canyons with Concentrations from Sediment Used in Previous Plant Studies

COPEC	Sediment BV (mg/kg)	Plant ESL (mg/kg)	North Canyons Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)
Antimony	0.83	0.05	1.2	0.053	Not detected	0.198
Barium	127	110	210	203	125	500
Chromium	10.5	2.4	27.7	18.4	524	28.2
Manganese	543	220	1540	1080	614	1560
Selenium	0.3	0.52	2.4	0.819	Not detected	15
Vanadium	19.7	0.025	76.8	20.3	29.7	35.9

Note: Shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the north canyons.

Table 8.1-17
Comparison of Concentrations for Earthworm COPECs (mg/kg) in the North Canyons with Concentrations from Sediment Used in Previous Earthworm Studies

COPEC	Sediment BV (mg/kg)	Earthworm ESL (mg/kg)	North Canyons Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)
Chromium	10.5	2.3	27.7	18.4	524	28.2
Manganese	543	450	1540	1080	614	1560
Mercury	0.1	0.05	0.174	0.796	1.2	0.836

Note: Shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the north canyons.

Table 8.1-18
Comparison of Concentrations for Small Mammal COPECs in the North Canyons with Concentrations from Sediment and Nonstorm-Related Surface Water Used in Previous Mammal Studies

COPEC	Media	BV (mg/kg, µg/L)	Shrew ESL (mg/kg, µg/L)	North Canyons Maximum (mg/kg, µg/L)	Los Alamos and Pueblo Canyons Maximum (mg/kg, µg/L)	Mortandad Canyon Maximum (mg/kg, µg/L)
Antimony	Sediment	0.83	0.26	1.2	0.56	0.8
Benzoic Acid	Sediment	na*	1	3.4	1.8	0.13
Selenium	Sediment	0.3	0.66	2.4	1.1	0.97
Aluminum	Water	na	8600	94,100	4910	43,700

Note: Shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the north canyons.

*na = Not available.

Table 8.1-19
Comparison of Concentrations for Robin COPECs in the North Canyons with Concentrations from Sediment Used in Previous Bird Studies

COPEC	Sediment BV (mg/kg)	Robin ESL (mg/kg)	North Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)
Cyanide [Total]	0.82	0.1	1.1	Not detected	1.69
Lead	19.7	21	110	56.8	77.2
Mercury	0.1	0.07	0.174	0.32	1.58
Selenium	0.3	1	2.4	1.6	5.82
Vanadium	19.7	8.9	76.8	53.1	86.1
Zinc	60.2	48	267	169	154
Di-n-butylphthalate	na*	0.011	0.0549	Not detected	1.54

Note: Shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the north canyons.

*na = Not available.

Table 8.1-20
Comparison of Concentrations for Kestrel (Mexican Spotted Owl Surrogate) COPECs in the North Canyons with Concentrations from Sediment Used in Previous Mammal Studies

COPEC	Sediment BV (mg/kg)	Kestrel ESL (mg/kg)	North Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)
Cyanide [Total]	0.82	0.47	1.1	Not detected	1.69
Mercury	0.1	0.082	0.174	0.32	1.58

Note: Shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the north canyons.

Table 8.1-21
Comparison of Concentrations for Aquatic Community COPECs in the North Canyons Sediment (c1 unit) with Sediment Used in Previous Aquatic Studies

COPEC	Sediment BV (mg/kg)	Aquatic Community ESL (mg/kg)	North Canyons Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)
Barium	127	48	154	203	38	500
Iron	13,800	20	67,700	7340	Not studied	11700
Zinc	60.2	150	267	59.1	Not studied	38.8
Anthracene	na*	0.00039	0.00764	2.07	0.08	0.104
Chlordane[alpha-]	na	0.0005	0.00257	0.003	Not detected	0.004
Chlordane[gamma-]	na	0.0005	0.00191	0.004	Not detected	0.003

Note: Shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the north canyons.

*na = Not available.

Table 8.1-22
Comparison of Concentrations for Aquatic Community COPECs in the North Canyons with Nonfiltered Nonstorm-Related Surface Water Used in Previous Aquatic Studies

COPEC	Aquatic Community Water ESL (µg/L)	North Canyons Maximum (µg/L)	Los Alamos and Pueblo Canyons Maximum (µg/L)	Mortandad Canyon Maximum (µg/L)
Aluminum	87	94,100	4910	43,700
Barium	3.8	1220	391	198
Cadmium	0.15	1.9	0.834	0.56
Cobalt	3	37.1	30.2	2.3
Copper	5	65.9	24.6	55.4
Iron	1000	61,800	14,100	25,700
Lead	1.2	85.5	22.6	27
Manganese	80	5800	4010	1080
Vanadium	19	94.8	17.8	48.3
Zinc	66	284	213	271

Table 8.1-23
Comparison of Concentrations for Nonfiltered Nonstorm-Related Surface-Water COPECs in the North Canyons with Concentrations from Surface Water Used in Mortandad Canyon Algal Toxicity Studies

COPEC	Water ESL	North Canyons Maximum (pCi/L)	Reach with Maximum	Mortandad Canyon Maximum (pCi/L)	Comment
Radium-226	0.1	5.68	Guaje at SR-502	0.435	5 results unbounded
Radium-228	0.09	0.917	GU-0.01 Spring	Not analyzed	Uncertainty
Thorium-228	5.9	19.3	Guaje at SR-502	Not analyzed	Uncertainty
Thorium-232	0.81	14.6	Guaje at SR-502	Not analyzed	Uncertainty

Table 8.1-24
Comparison of Concentrations for Bat COPECs in the North Canyons with Concentrations from Sediment and Nonstorm-Related Surface Water Used in Previous Aquatic Studies

Sediment COPEC	Media	Sediment BV (mg/kg)	Bat ESL (mg/kg, µg/L)	North Canyons Maximum (mg/kg, µg/L)	Los Alamos and Pueblo Canyons Maximum (mg/kg, µg/L)	Mortandad Canyon Maximum (mg/kg, µg/L)	Pajarito Canyon Maximum (mg/kg)
Aluminum	Sediment	15,400	280	23,500	15,680	14,900	16,300
Aluminum	Water	na*	12000	94,100	4910	43,700	na

*na = Not available.

Table 8.1-25
Comparison of Concentrations for Swallow COPECs in the North Canyons with Concentrations from Sediment Used in Previous Aquatic Studies

COPEC	Sediment BV (mg/kg)	Swallow ESL (mg/kg)	North Canyons Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)
Mercury	0.1	0.018	0.174	0.796	1.2	0.836
Zinc	60.2	65	267	157	79.5	92.2

Note: Shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in the north canyons.

Table 8.1-26
Comparison of Concentrations for Other Mammal Drinking Water COPECs in the North Canyons with Nonfiltered Nonstorm-Related Surface Water Used in Previous Aquatic Studies

COPEC	Receptor	Water ESL (µg/L)	North Canyons Maximum (µg/L)	Los Alamos and Pueblo Canyons Maximum (µg/L)	Mortandad Canyon Maximum (µg/L)
Aluminum	Deer mouse	10000	94,100	4910	43,700
	Cottontail rabbit	19000			
	Fox	22000			

Table 8.1-27
Summary of North Canyons Soil COPECs Unbounded by Previous Canyons Biota Investigations

COPEC	Receptor	Soil ESL (mg/kg)	North Canyons Unbounded COPEC Concentration (mg/kg)		Affected Reach	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)	Comment
			Unbounded Result	Reach Average					
Antimony	Plant	0.05	1.2	1.1	R-3	0.053	Not detected	0.198	Cerro Grande source
			1.0						
			0.77	0.77	R-3E				
Antimony	Shrew	0.26	1.2	1.1	R-3	0.56	0.8	Not studied	Cerro Grande source, R-3E reach average is bounded
			1.0						
			0.77	0.77	R-3E				
Benzoic acid	Shrew	1	3.4	1.68	R-3	1.8	0.13	Not studied	Non-Laboratory source, reach average is bounded
Lead	Robin	21	110	19	R-3	Not studied	56.8	77.2	Two results unbounded, reach average is bounded
			78						
Selenium	Shrew	0.66	2.4	1.6	R-1E	1.1	0.97	Not studied	Natural background source, R-3E reach average is bounded
			2.05						
			1.91						
			1.77						
			1.21						
			1.3	0.89	R-3E				
Vanadium	Plant	0.025	76.8	19.9	R-3	20.3	29.7	35.9	One result unbounded, reach average is bounded
Zinc	Robin	48	267	59.2	R-3	Not studied	169	154	One result unbounded, reach average is bounded

Table 8.1-28
Summary of North Canyons c1 Sediment COPECs Unbounded by Previous Canyons Biota Investigations

COPEC	Receptor	Sediment ESL (mg/kg)	North Canyons Unbounded COPEC Concentration (mg/kg)		Affected Reach	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)	Comment
			Unbounded Result	Reach Average					
Aluminum	Bat	280	23,500	4835	R-3	15,680	14,900	16,300	One result unbounded, reach average bounded by max
Iron	Aquatic community	20	67,700	15,912	R-3	7340	Not studied	11,700	One result unbounded
Zinc	Aquatic community	150	267	149	R-3	59.1	Not studied	38.8	One result unbounded
Zinc	Swallow	65	267	149	R-3	157	79.5	92.2	One result unbounded, reach average bounded by max

Table 8.1-29
Summary of North Canyons Nonfiltered Nonstorm-Related Surface-Water COPECs Unbounded by Previous Aquatic Toxicity Biota Studies

COPEC	Receptor	Water ESL (µg/L or pCi/L)	Maximum North Canyons Concentration (µg/L or pCi/L)		Sample Location with Unbounded Result	Biota Study	Maximum Biota Study Concentration (µg/L or pCi/L)		Comment
			Unbounded Result	Average			Max	Average	
Aluminum	Aquatic community	87	94,100	29,751	Guaje at SR-502	Mortandad	43,700	8346	1 unbounded result, average is bounded by max
Barium	Aquatic community	3.8	1220	630	Guaje at SR-502	LA-P*	391	180.9	3 unbounded results
			1040						
			821						
Cadmium	Aquatic community	0.15	1.9	1.63	Guaje at SR-502	Mortandad	1	0.292	3 unbounded results
			1.5						
			1.5						
Cobalt	Aquatic community	3	37.1	19.4	Guaje at SR-502	LA-P	30.2	7.77	2 unbounded results, average is bounded by max
			33.2						
Copper	Aquatic community	5	65.9	36.9	Guaje at SR-502	Mortandad	55.4	19	1 unbounded result, average is bounded by max
Iron	Aquatic community	1000	61,800	14221	Guaje at SR-502	Mortandad	25700	5350	1 unbounded result, average is bounded by max
Lead	Aquatic community	1.2	85.5	58.2	Guaje at SR-502	Mortandad	27	6.17	3 unbounded results
			77.8						
			69.1						

Table 8.1-29 (continued)

COPEC	Receptor	Water ESL (µg/L or pCi/L)	Maximum North Canyons Concentration (µg/L or pCi/L)		Sample Location with Unbounded Result	Biota Study	Maximum Biota Study Concentration (µg/L or pCi/L)		Comment
			Unbounded Result	Average			Max	Average	
Manganese	Aquatic community	80	5800 5590	2846	Guaje at SR-502	LA-P	4010	1218	2 unbounded results, average is bounded by max
Vanadium	Aquatic community	19	94.8	25.1	Guaje at SR-502	Mortandad	48.3	9.8	1 unbounded result, average is bounded by max
Zinc	Aquatic community	66	284	66.8	Guaje at SR-502	Mortandad	271	66.9	1 unbounded result, average is bounded by max
Radium-226	Algae (aquatic autotroph)	0.1	5.68	5.68	Guaje at SR-502	Mortandad	0.435	0.435	2 unbounded results
			0.443	0.443	GU-0.01 Spring				
Radium-228	Algae (aquatic autotroph)	0.09	0.917	0.917	GU-0.01 Spring	Mortandad	Not analyzed	Not analyzed	COPEC not previously evaluated - uncertainty
Thorium-228	Algae (aquatic autotroph)	5.9	19.3	13.1	Guaje at SR-502	Mortandad	Not analyzed	Not analyzed	COPEC not previously evaluated - uncertainty
Thorium-232	Algae (aquatic autotroph)	0.81	14.6	10.3	Guaje at SR-502	Mortandad	Not analyzed	Not analyzed	COPEC not previously evaluated - uncertainty

*LA-P = Los Alamos and Pueblo Canyons.

Table 8.1-30

Summary of Measured Average and Predicted COPEC Concentrations Based on Suspended Sediment Concentrations in North Canyons Snowmelt Runoff

COPEC	SED BV[a] Concentration (mg COPEC/kg sed, pCi COPEC/g sed)	SED BV Concentration per Microgram Sediment (µg COPEC/µg sed, pCi COPEC/µg sed)	Predicted Snowmelt Concentration Based on SED BV and Measured Snowmelt SSC[b] (µg COPEC/L snowmelt, pCi COPEC/L snowmelt)[c]	Measured Average Nonfiltered Snowmelt COPEC Concentration (µg COPEC/L snowmelt, pCi COPEC/L snowmelt)
Aluminum	15,400	0.0154	91,900	39,400
Barium	127	0.000127	758	1030
Cadmium	0.4	0.0000004	2.39	1.63
Cobalt	4.73	0.00000473	28.2	30.8
Copper	11.2	0.0000112	66.9	36.9
Iron	13,800	0.0138	82,300	23,600
Lead	19.7	0.0000197	118	77.5
Manganese	543	0.000543	3240	4730
Vanadium	19.7	0.0000197	117.6	54.5
Zinc	60.2	0.0000602	359.4	157.2
Radium-226	2.59	0.00000259	15.5	5.68
Thorium-228	2.28	0.00000228	13.6	13.1
Thorium-230	2.29	0.00000229	13.7	10.6
Thorium-232	2.33	0.00000233	13.9	10.3

[a] SED BV = Sediment background value from LANL 1998 (LANL 1998, 059730).

[b] SSC = Suspended sediment concentration (measured average snowmelt SSC = 5970000 µg/L).

[c] Predicted snowmelt concentration is based on SED BV contribution multiplied by measured SSC.

Table 8.1-31

Detected COPCs in North Canyons Media for Which No ESLs Are Available

Sediment (all samples)
Iron, Magnesium, Potassium, Sodium, Perchlorate, Benzyl Alcohol, Endosulfan II, Fluoranthene, Isopropylbenzene, Isopropyltoluene[4-], Methylphenol[4-], Naphthalene, Phenanthrene, Total Petroleum Hydrocarbons Diesel Range Organics, Total Petroleum Hydrocarbons Gasoline Range Organics, Trichloro-1,2,2-trifluoroethane[1,1,2-]
Sediment (c1 samples)
Calcium, Magnesium, Potassium, Sodium, Perchlorate, Total Petroleum Hydrocarbons Diesel Range Organics, Total Petroleum Hydrocarbons Gasoline Range Organics, Trichloro-1,2,2-trifluoroethane[1,1,2-]
Nonstorm-Related Surface Water
Bromide, Calcium, Magnesium, Molybdenum, Potassium, Sodium, Sulfate

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

Reach	Acenaphthene	Aluminum	Anthracene	Antimony	Aroclor-1242	Aroclor-1254	Aroclor-1260	Barium	Benzoic Acid[a]	Benzyl Alcohol[a]	Beryllium	Cadmium	Cobalt	Copper	Di-n-butylphthalate	Endosulfan II[b]
Residential SL (mg/kg)	3730	77,800	22,000	31.3	1.12	1.12	1.12	15,600	24,0000	31,000	156	39	1520	3130	6110	367
BR-1	—[c]	—	—	—	<0.010	—	—	—	—	—	—	—	—	—	—	—
BY-1	<0.010	—	<0.010	—	0.052	0.033	0.012	—	—	—	—	0.013	—	—	—	—
BY-2	—	—	—	—	0.022	0.013	0.025	—	—	—	—	—	—	—	—	—
BY-3	—	—	—	—	0.015	<0.010	<0.01	0.011	—	—	—	—	—	—	—	—
G-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G-BKG	—	—	—	0.029	—	—	—	0.023	—	—	—	0.012	<0.010	<0.010	—	—
R-1E	—	0.22	—	—	0.012	0.012	<0.010	—	—	—	—	—	—	—	<0.010	—
R-1M	—	—	—	—	—	—	—	—	—	—	—	—	<0.010	—	—	—
R-1S	—	0.22	—	—	<0.010	—	<0.010	<0.010	—	—	—	—	<0.010	—	—	—
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.010
R-3	—	0.30	—	0.038	—	—	—	0.013	<0.010	<0.010	0.013	—	<0.010	<0.010	—	—
R-3E	—	—	—	—	—	—	—	0.013	—	—	—	—	<0.010	<0.010	—	—

Table 8.2-1 (continued)

Reach	Fluoranthene	Iron	Isopropylbenzene[d]	Isopropyltoluene[4-][d]	Lead	Manganese	Mercury[a]	Methylphenol[4-][a]	Naphthalene	Nickel	Phenanthrene	Phenol	Pyrene	Selenium	Vanadium	Zinc	SOF
Residential SL (mg/kg)	2290	23,500	271	271	400	3590	23	310	79.5	1560	1830	18300	2290	391	78.2	23,500	
BR-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.010
BY-1	<0.010	—	—	<0.01	0.12	—	—	—	—	—	<0.010	—	<0.010	—	0.31	—	0.59
BY-2	—	—	<0.01	<0.01	0.093	—	—	—	—	—	—	—	—	—	0.27	<0.010	0.48
BY-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.29	—	0.32
G-1	—	0.60	—	—	—	—	—	—	—	—	—	—	<0.010	—	0.36	—	1.0
G-BKG	—	—	—	—	0.095	0.50	—	—	—	<0.010	—	—	—	<0.010	—	<0.010	0.68
R-1E	—	0.61	—	—	0.071	—	<0.010	—	—	—	—	—	<0.010	<0.010	0.31	—	1.3
R-1M	<0.010	—	—	—	—	—	—	—	—	<0.010	<0.010	—	<0.010	<0.010	0.30	—	0.36
R-1S	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.32	—	0.61
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.010
R-3	—	2.9	—	—	0.28	0.43	—	0.035	<0.010	<0.010	<0.010	<0.010	—	<0.010	0.98	0.010	5.1
R-3E	—	—	—	—	0.073	0.27	—	—	—	<0.010	—	—	—	<0.010	—	—	0.37

Notes: Residential SLs are from NMED (2006, 092513), unless otherwise noted. Shaded cells indicate which reaches have SOFs >1 and which analytes have risk ratios >0.1.

[a] EPA regional SLs found at http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm. All values from EPA regional SLs adjusted to 10^{-5} target risk level.

[b] Endosulfan surrogate, NMED SLs.

[c] — = All results were nondetect, less than background, or no data were available.

[d] 4-Isoproplybenzene (cumene) surrogate, NMED SLs.

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

Reach	Aroclor-1242[a]	Aroclor-1254[a]	Aroclor-1260[a]	Arsenic	Chlordane[alpha-][b]	Chlordane[gamma-][b]	Chloroform	Chromium	Chrysene	Dieldrin	SOF
Residential SL (mg/kg)	2.2	2.2	2.2	3.9	16.2	16.2	4.0	2800	615	0.30	
BR-1	<0.010	—[c]	—	—	—	—	—	—	—	—	<0.010
BY-1	0.052	0.033	0.012	—	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.11
BY-2	0.022	0.013	0.015	—	—	—	—	<0.010	—	—	0.050
BY-3	0.014	<0.010	<0.010	—	—	—	—	—	—	—	0.022
G-BKG	—	—	—	1.1	—	—	—	<0.010	—	—	1.1
R-1E	0.012	0.012	<0.010	1.4	—	—	—	—	—	—	1.4
R-1M	—	—	—	—	—	—	—	<0.010	<0.01	—	<0.010
R-1S	<0.010	—	<0.010	1.2	—	—	—	<0.010	—	—	1.2
R-3	—	—	—	1.5	—	—	—	<0.010	—	—	1.5

Notes: Residential SLs are from NMED (2006, 092513), unless otherwise noted. Shaded cells indicate which reaches have SOFs >1 and which analytes have risk ratios >0.1.

[a] EPA SLs, found at http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm. All values from EPA regional SSLs adjusted to 10^{-5} target risk level.

[b] Chlordane surrogate, NMED SLs.

[c] — = All results were nondetect, less than background, or no data were available.

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

Reach	Americium-241	Cesium-137	Plutonium-238	Plutonium-239/240	Strontium-90	Tritium	SOF
Residential SAL (pCi/g)	30	5.6	37	33	5.7	750	
BR-1	—*	0.20	—	—	—	—	0.20
BY-1	<0.010	—	—	—	—	<0.010	<0.010
G-1	—	—	—	—	—	<0.010	<0.010
G-BKG	—	1.1	—	<0.010	0.22	—	1.3
R-1M	—	—	—	—	—	<0.010	<0.010
R-1S	—	—	—	—	—	<0.010	<0.010
R-3	—	0.84	<0.010	0.010	0.19	—	1.0
R-3E	—	0.64	—	<0.010	—	—	0.64

Notes: All values are from LANL (2005, 088493), unless otherwise noted. Shaded cells indicate which reaches have SOFs >1 and which analytes have risk ratios >0.1.

*— = All results were nondetect, less than background, or no data were available.

Table 8.2-4
Residential Risk Ratios Used to Identify Surface-Water COPCs for Human Health Risk Assessment, Noncarcinogens

Reach	Location ID	Aluminum	Antimony[a]	Barium	Beryllium	Boron	Cadmium	Cobalt	Copper	Chromium[a]	Iron	Lead	Manganese
Residential SL (µg/L)		37,000	6.0	7300	73	7300	18	11	1500	100	26,000	15	880
G-1	GU-0.01 Spring	—[b]	—	<0.010	—	<0.010	—	—	—	0.041	—	—	0.023
G-1	Guaje at SR-502	2.5	<0.010	0.17	0.13	—	0.11	3.4	0.044	0.52	2.4	5.7	6.6
G-BKG	Guaje above Rendija	<0.010	—	<0.010	—	<0.010	—	—	—	—	0.017	0.040	<0.010

Table 8.2-4 (continued)

Reach	Location ID	Mercury	Molybdenum	Nickel	Silver	Strontium	Thallium	Toluene	Uranium	Vanadium	Zinc	SOF
Residential SL (µg/L)		11	180	730	180	22,000	2.4	2300	110	180	11000	
G-1	GU-0.01 Spring	—	—	<0.010	—	0.014	—	<0.010	0.018	0.054	<0.010	0.14
G-1	Guaje at SR-502	0.025	—	0.058	<0.010	—	0.34	—	—	0.53	0.026	22
G-BKG	Guaje above Rendija	—	0.013	<0.010	—	<0.010	—	—	—	0.013	<0.010	0.13

Notes: Unless otherwise noted, all screening levels are EPA SLs for tap water (10^{-5} risk level). Shaded cells indicate which reaches and water locations have SOFs ≥1 and which analytes have risk ratios >0.1.

[a] MCL = EPA primary drinking water standard.

[b] — = All results were nondetect or no data were available.

Table 8.2-5
Residential Risk Ratios Used to Identify Surface-Water COPCs for Human Health Risk Assessment, Carcinogens

Reach	Location ID	Arsenic	PCDF [2,3,4,7,8-]	SOF
Residential SL (µg/L)		0.45	0.000017[a]	
G-1	GU-0.01 Spring	—[b]	0.057	0.057
G-1	Guaje at SR-502	34	—	34

Notes: Unless otherwise noted, all screening levels are EPA SLs for tap water (10^{-5} risk level). Shaded cells indicate which reaches and water locations have SOFs >1 and which analytes have risk ratios >0.1.

[a] MCL = EPA primary drinking water standard.

[b] — = All results were nondetect or no data were available.

Table 8.2-6
Residential Risk Ratios Used to Identify Surface-Water COPCs for Human Health Risk Assessment, Radionuclides

Reach	Location ID	Americium-241	Cesium-137	Plutonium-239/240[a]	Radium-226	Strontium-90	Thorium-228[a]
Residential SL (pCi/L)		1.2	120	3.5	4.0	40	4.5
G-1	GU-0.01 Spring	—[b]	—	—	—	—	—
G-1	Guaje at SR-502	0.11	<0.010	<0.010	1.4	<0.010	4.3
G-BKG	Guaje above Rendija	—	—	—	—	—	—

Table 8.2-6 (continued)

Reach	Location ID	Thorium-230[a]	Thorium-232[a]	Tritium	Uranium-234	Uranium-235/236	Uranium-238	SOF
Residential SL (pCi/L)		5.2	4.7	80,000	20	24	24	
G-1	GU-0.01 Spring	—	—	<0.010	<0.010	—	<0.010	<0.10
G-1	Guaje at SR-502	3.0	3.1	—	0.98	<0.010	0.81	14
G-BKG	Guaje above Rendija	—	—	<0.010	—	—	—	<0.10

Notes: Unless otherwise noted, all screening levels are from DOE DCGs (DOE Order 5400.5, "Radiation Protection of the Public and the Environment"). Shaded cells indicate which reaches and water locations have SOFs >1 and which analytes have risk ratios >0.1.

[a] From EPA guidance (EPA 2000, 106185).

[b] — = All results were nondetect or no data were available.

Table 8.2-7
Reaches and Analyte Classes Evaluated for Sediment, Surface Water, and Multimedia Exposure

Reach	Sediment	Surface Water	Multimedia
BR-1	—*	—	—
BY-1	—	—	—
BY-2	—	—	—
BY-3	—	—	—
G-BKG	M_c,R	—	—
G-1	—	$M_{\mathbf{nc}}$,M_c,O_c,R	—
R-1E	M_{nc},M_c	—	—
R-1M	—	—	—
R-1S	M_c	—	—
R-2	—	—	—
R-3	M_{nc},M_c,R	—	—
R-3E	—	—	—

Notes: Analyte class evaluated as R = radionuclide; Mc = metal, carcinogen; M_{nc} = metal, noncarcinogen; O_c = organic, carcinogen.

*— = Not evaluated (see Tables 8.2-1 through 8.2-6).

Table 8.2-8
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	X	—[b]
Dermal contact with surface water	X	—
External irradiation	X	X

[a] X = Complete pathway.

[b] — = Incomplete pathway.

Table 8.2-9
Risk-Based SLs for the Recreational Scenario

Medium	COPC	End Point[a]	Target Adverse-Effect Level	Recreational Screening Level	Units	Reference
Sediment	Aluminum	nc	HQ=1	100,000[b]	mg/kg	LANL (2007, 094496)
Sediment	Arsenic	ca	risk=10^{-5}	27.7	mg/kg	LANL (2007, 094496)
Sediment	Cesium-137	rad	15 mrem/yr	210	pCi/g	LANL (2005, 088493)
Sediment	Iron	nc	HQ=1	100,000[b]	mg/kg	LANL (2007, 094496)
Sediment	Lead	nc	HQ=1	560	mg/kg	LANL (2007, 094496)
Sediment	Manganese	nc	HQ=1	36,900	mg/kg	LANL (2007, 094496)
Sediment	Strontium-90	rad	15 mrem/yr	5600	pCi/g	LANL (2005, 088493)
Sediment	Vanadium	nc	HQ=1	792	mg/kg	LANL (2007, 094496)
Surface water	Aluminum	nc	HQ=1	2,790,000	µg/L	LANL (2004, 087390), calculated
Surface water	Americium-241	rad	4 mrem/yr	275	pCi/L	LANL (2005, 088493), calculated
Surface water	Arsenic	ca	risk=10^{-5}	78.4	µg/L	LANL (2004, 087390), calculated
Surface water	Barium	nc	HQ=1	462,000	µg/L	LANL (2004, 087390), calculated
Surface water	Beryllium	nc	HQ=1	1750	µg/L	LANL (2004, 087390), calculated
Surface water	Cadmium	nc	HQ=1	869	µg/L	LANL (2004, 087390), calculated
Surface water	Cobalt	nc	HQ=1	56,200	µg/L	LANL (2004, 087390), calculated
Surface water	Iron	nc	HQ=1	836,000	µg/L	LANL (2004, 087390), calculated
Surface water	Chromium	nc	HQ=1	4146	µg/L	LANL (2004, 087390), calculated
Surface water	Lead	nc	HQ=1	65.4	µg/L	LANL (2005, 091818)
Surface water	Manganese	nc	HQ=1	48,800	µg/L	LANL (2004, 087390), calculated
Surface water	Radium-226	rad	4 mrem/yr	752	pCi/L	LANL (2005, 088493), calculated
Surface water	Thallium	nc	HQ=1	184	µg/L	LANL (2004, 087390), calculated
Surface water	Thorium-228	rad	4 mrem/yr	1240	pCi/L	LANL (2005, 088493), calculated
Surface water	Thorium-230	rad	4 mrem/yr	1820	pCi/L	LANL (2005, 088493), calculated
Surface water	Thorium-232	rad	4 mrem/yr	366	pCi/L	LANL (2005, 088493), calculated
Surface water	Uranium-234	rad	4 mrem/yr	3530	pCi/L	LANL (2005, 088493), calculated
Surface water	Uranium-238	rad	4 mrem/yr	3720	pCi/L	LANL (2005, 088493), calculated
Surface water	Vanadium	nc	HQ=1	1760	µg/L	LANL (2004, 087390), calculated

[a] ca = Carcinogen, nc = noncarcinogen, rad = radionuclide.

[b] Toxicity based screening level exceeds aqueous solubility limit.

Table 8.2-10
Summary of Recreational Risk Assessment Results

Reach	Total Sediment Risk	Total Surface Water Risk	Total Multimedia Risk	Total Sediment HI	Total Surface Water HI	Total Multimedia HI	Total Sediment Dose (mrem/yr)	Total Surface Water Dose (mrem/yr)	Total Multimedia Dose (mrem/yr)
BY-1	—*	—	—	—	—	—	—	—	—
G-1	—	2.0E-06	—	—	1.6	—	—	0.33	—
G-BKG	1.2E-06	—	—	—	—	—	0.38	—	—
R-1E	1.8E-06	—	—	0.30	—	—	—	—	—
R-1S	1.0E-06	—	—	—	—	—	—	—	—
R-3	9.6E-07	—	—	0.39	—	—	0.30	—	—

Note: Shaded cell indicates a value that exceeds 10^{-5} carcinogenic risk, HI of 1, sediment dose of 15 mrem/yr, or ingested water dose of 4 mrem/yr.

*— = Incomplete pathway.

Table 8.2-11
Risk Ratios Based on EPCs for Sediment, Recreational Scenario

Carcinogens

Reach	Arsenic	Total Risk Ratio	Total Risk
Recreational SSL (mg/kg)	27.7		
G-BKG	0.12	0.12	1.2E-06
R-1E	0.18	0.18	1.8E-06
R-1S	0.10	0.10	1.0E-06
R-3	0.10	0.10	1.0E-06

Noncarcinogens

Reach	Aluminum	Iron	Lead	Manganese	Vanadium	Total Risk Ratio	Total HI
Recreational SSL (mg/kg)	100,000	100,000	560	36,900	792		
G-1	—*	0.12	—	—	0.029	0.15	0.15
R-1E	0.14	0.13	—	—	0.027	0.30	0.30
R-3	0.092	0.17	0.078	0.021	0.026	0.39	0.39

Radionuclides

Reach	Cesium-137	Strontium-90	Total Dose Ratio	Total Dose (mrem/yr)
Recreational SSL (pCi/g)	210	5600		
G-BKG	0.025	0.00021	0.025	0.38
R-3	0.020	0.00017	0.020	0.30

*— = All results were nondetect, less than background, or no data were available.

Table 8.2-12
Risk Ratios Based on EPCs for Surface Water, Recreational Scenario

Carcinogens

Reach	Arsenic	Total Risk Ratio	Total Risk
Screen (µg/L)	78		
G-1	0.20	0.20	2.0E-06

Noncarcinogens

Reach	Aluminum	Barium	Beryllium	Cadmium	Cobalt	Chromium	Iron	Lead	Manganese	Thallium	Vanadium	Total Risk Ratio	Total HI
Screen (µg/L)	2790,000	462,000	1750	869	56,200	4146	83,6000	65	48,800	184	1760		
G-1	0.034	0.0026	0.0054	0.0022	0.00066	0.012	0.074	1.3	0.12	0.0044	0.054	1.6	1.6

Radionuclides

Reach	Americium-241	Radium-226	Thorium-228	Thorium-230	Thorium-232	Uranium-234	Uranium-238	Total Dose Ratio	Total Dose (mrem/yr)
Screen (pCi/L)	275	752	1240	1820	366	3530	3720		
G-1	0.00048	0.0076	0.016	0.00086	0.040	0.0056	0.0052	0.083	0.33

Note: Shaded cells exceed 10^{-5} carcinogenic risk, hazard index of 1, sediment dose of 15 mrem/yr, or ingested water dose of 4 mrem/yr.

Table 8.2-13
EPCs for Sediment COPCs, Recreational Scenario

Reach	End Point*	Analyte	EPC	Units
G-1	nc	Iron	11,835	mg/kg
G-1	nc	Vanadium	23	mg/kg
G-BKG	ca	Arsenic	3.4	mg/kg
G-BKG	rad	Cesium-137	5.2	pCi/g
G-BKG	rad	Strontium-90	1.2	pCi/g
R-1E	nc	Aluminum	14,360	mg/kg
R-1E	ca	Arsenic	4.9	mg/kg
R-1E	nc	Iron	13,046	mg/kg
R-1E	nc	Vanadium	21	mg/kg
R-1S	ca	Arsenic	2.9	mg/kg
R-3	nc	Aluminum	9216	mg/kg
R-3	ca	Arsenic	2.7	mg/kg
R-3	rad	Cesium-137	4.2	pCi/g
R-3	nc	Iron	17,022	mg/kg
R-3	nc	Lead	43	mg/kg
R-3	nc	Manganese	757	mg/kg
R-3	rad	Strontium-90	1.0	pCi/g
R-3	nc	Vanadium	21	mg/kg

*ca = Carcinogen, nc = noncarcinogen, rad = radionuclide.

Table 8.2-14
EPCs for Surface Water COPCs, Recreational Scenario

Reach	Location	End Point*	Analyte	EPC	Units
G-1	Guaje at SR-502	nc	Aluminum	94,100	µg/L
G-1	Guaje at SR-502	rad	Americium-241	0.132	pCi/L
G-1	Guaje at SR-502	ca	Arsenic	15.3	µg/L
G-1	Guaje at SR-502	nc	Barium	1220	µg/L
G-1	Guaje at SR-502	nc	Beryllium	9.5	µg/L
G-1	Guaje at SR-502	nc	Cadmium	1.9	µg/L
G-1	Guaje at SR-502	nc	Cobalt	37.1	µg/L
G-1	Guaje at SR-502	nc	Chromium	51.8	µg/L
G-1	Guaje at SR-502	nc	Iron	61,800	µg/L
G-1	Guaje at SR-502	nc	Lead	85.5	µg/L
G-1	Guaje at SR-502	nc	Manganese	5800	µg/L
G-1	Guaje at SR-502	rad	Radium-226	5.68	pCi/L
G-1	Guaje at SR-502	nc	Thallium	0.81	µg/L
G-1	Guaje at SR-502	rad	Thorium-228	19.3	pCi/L
G-1	Guaje at SR-502	rad	Thorium-230	15.7	pCi/L
G-1	Guaje at SR-502	rad	Thorium-232	14.6	pCi/L
G-1	Guaje at SR-502	rad	Uranium-234	19.6	pCi/L
G-1	Guaje at SR-502	rad	Uranium-238	19.4	pCi/L
G-1	Guaje at SR-502	nc	Vanadium	94.8	µg/L

*ca = Carcinogen, nc = noncarcinogen, rad = radionuclide.

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

%D	percent difference
%R	percent recovery
%RSD	percent relative standard deviation
ALARA	as low as reasonably achievable
AOC	area of concern
AqAcF	NMAC 20.6.4, Aquatic Life Acute (Filtered)
asl	above sea level
ATAL	average target action level
ATSDR	Agency for Toxic Substances and Disease Registry
BCA	bias-corrected accelerated bootstrap method
BCG	Biota Concentration Guideline (DOE)
bgs	below ground surface
BV	background value
BW	body weight
c	channel
ca	carcinogen
Cal-EPA	California Environmental Protection Agency (Office of Environmental Health Hazard Assessment)
CAS	Chemical Abstract Service
CCV	continuing calibration verification
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CRDL	contract-required detection limit
CWA	Clean Water Act
D&D	decontamination and decommissioning
DCF	dose conversion factor
DCG	Derived Concentration Guideline (DOE)
DER	duplicate error ratio
DOE	Department of Energy (U.S.)
DRI	Desert Research Institute
EPA	Environmental Protection Agency (U.S.)

EPC	exposure point concentration
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERDB	Environmental Restoration Database
EQL	estimated quantitation limit
ESL	ecological screening level
ESP	Environmental Surveillance Program
f	floodplain
FD	field duplicate
GSA	General Services Administration
HE	high explosives
HEAST	Health Effects Assessment Summary Tables
HHMSSL	Human Health Medium-Specific Screening Level
HI	hazard index
HQ	hazard quotient
IA	interim action
ICPES	inductively coupled plasma emission spectroscopy
ICPMS	inductively coupled plasma mass spectrometry
ICR	incremental cancer risk
ICV	initial calibration verification
IFGMP	Interim Facility-Wide Groundwater Monitoring Plan
ILCR	incremental lifetime cancer
IP	individual permit
IrF	NMAC 20.6.4, Irrigation Standard (Filtered)
IRIS	Integrated Risk Information System (EPA)
IS	internal standard
KM	Kaplan–Meir
LAL	lower acceptance limit
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level (EPA)
MD	munitions debris
MDC	minimum detectable concentration
MDL	method detection limit

MEC	munitions and explosives of concern
mrem/yr	millirem per year
MRL	minimal risk level
MS	matrix spike
MSD	matrix spike duplicate
MSSL	Medium-Specific Screening Level
n/a	not applicable
nc	noncarcinogen
NCEA	National Center for Environmental Assessment
NFA	no further action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMEIB	New Mexico Environment Improvement Board
NMGSF	NMAC 20.6.2, Groundwater Standards (Filtered)
NMGSU	NMAC 20.6.2, Groundwater Standards (Unfiltered)
NMHWA	New Mexico Hazardous Waste Act
NMRPS	NMEID Radiation Protection Standards
NMSA	New Mexico Statutes Annotated
NMSWA	New Mexico Solid Waste Act
NMWQCC	New Mexico Water Quality Control Commission
NOD	notice of disapproval
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PMSR	poor man’s shooting range
PRG	preliminary remediation goal (EPA)
QA	quality assurance
QC	quality control
rad	radionuclide
RAIS	Risk Assessment Information System
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RF	response factor
RFI	RCRA facility investigation

RfDo	oral reference dose
RL	reporting limit
RME	reasonable maximum exposure
RN	request number
RPD	relative percent difference
RRF	relative response factor
SAL	screening action level
SF	slope factor
SL	screening level
SLERA	screening-level ecological risk assessment
SMA	site monitoring area
SMDB	Sample Management Database
SMDP	strategic management decision point
SMCL	EPA Secondary Maximum Concentration Level
SOF	sum of fraction
SOP	standard operating procedure
SOW	statement of work
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
T&E	threatened and endangered
TA	technical area
TAL	target action level
TPH-DRO	total petroleum hydrocarbons–diesel range organic
TPU	total propagated uncertainty
TRV	toxicity reference value
UAL	upper acceptance limit
UCL	upper confidence limit
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
VCA	voluntary corrective action
VOC	volatile organic compound
WHO	World Health Organization
WHU	NMAC 20.6.4, Wildlife Habitat (Unfiltered)

wt%	weight percent
wSAL	water screening action level
WQC	water-quality criteria
WQDB	Water Quality Database
WWTP	wastewater treatment plant

A-2.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain U.S. Customary Unit
kilometers (km)	0.62137	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.2808	feet (ft)
meters (m)	39.3701	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.3937	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.00004	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.4710	acres
square meters (m^2)	10.7639	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)	0.26471	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 (QA/QC) parameters.

Appendix B

Field Investigation Methods and Results

B-1.0 SEDIMENT INVESTIGATIONS IN REACHES

This appendix summarizes methods and results from field investigations of potentially contaminated sediment deposits in reaches within the north canyons that were conducted in 2006 and 2007 as part of implementation of the "Work Plan for the North Canyons" (LANL 2001, 071060). Some data are also included from sediment samples collected in Guaje and Rendija Canyons in 2000 and 2001 after the May 2000 Cerro Grande fire, which were previously presented in the "Los Alamos and Pueblo Canyons Investigation Report" (LANL 2004, 087390).

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 2 to 4. Unit designations followed those used in previous reports on canyons in and near Los Alamos National Laboratory (LANL or the Laboratory) (e.g., LANL 2004, 087390; LANL 2006, 094161; LANL 2008, 104909), 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 north canyons investigation reaches are presented in Table 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 and plastic). Sediment thickness measurements from the north canyons investigation reaches are shown in Table B-1.0-2 (see Attachment 1 on CD included with this document).

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 contaminant levels, where available, 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). 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 more contaminated geomorphic units and sediment facies.

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 are pH-dependent for some analytes (aluminum and iron). Particle-size organic matter and pH from the north canyons investigation reaches are shown in Table B-1.0-3 (see Attachment 1 on CD included with this document).

B-2.0 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.

Gilbert, R.O., 1987. *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold, New York, New York. (Gilbert 1987, 056179)

Janitzky, P., 1986. "Particle-Size Analysis," in *Field and Laboratory Procedures Used in a Soil Chronosequence Study*, U.S. Geological Survey Bulletin 1648, Washington, D.C., pp. 11-17. (Janitzky 1986, 057674)

LANL (Los Alamos National Laboratory), September 2001. "Work Plan for the North Canyons," Los Alamos National Laboratory document LA-UR-01-1316, Los Alamos, New Mexico. (LANL 2001, 071060)

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)

Malmon, D.V., June 2002. "Sediment Trajectories Through a Semiarid Valley," Ph.D. dissertation, University of California, Santa Barbara, California. (Malmon 2002, 076038)

Malmon, D.V., S.L. Reneau, and T. Dunne, 2004. "Sediment Sorting and Transport by Flash Floods," *Journal of Geophysical Research,* Vol. 109, F02005, 13 pp. (Malmon et al. 2004, 093018)

Ryti, R.T., S.L. Reneau, and D. Katzman, 2005. "Investigations of Contaminated Fluvial Sediment Deposits: Merging of Statistical and Geomorphic Approaches," *Environmental Management,* Vol. 35, No. 5, pp. 632-648. (Ryti et al. 2005, 093019)

Table B-1.0-1
Physical Characteristics of Post-1942 Geomorphic Units in the North Canyons 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
BR-1	c1	5.1	Fine	0.03	Fine sand[b]	Active channel
			Coarse	0.55	Coarse sand	
	c2	1.1	Fine	0.19	Fine sand	Low abandoned post-1942 channel
			Coarse	0.26	Coarse sand[b]	
	c3	1.4	Fine	0.24	Medium sand	High abandoned post-1942 channel
			Coarse	0.62	Coarse sand	
	f1	2.7	Fine	0.17	Very fine sand	Post-1942 floodplain
			Coarse	0.01	Coarse sand	
	f2	0.6	Fine	0.04	Very fine sand[b]	Possible post-1942 floodplain
	Total	**10.9**				
BY-1	c1	1.3	Fine	0.18	Coarse silt	Active channel
			Coarse	0.15	Very coarse sand	
	c1br	0.1	n/a[c]	0	n/a	Active channel on bedrock
	c2	1.8	Fine	0.48	Coarse silt	Abandoned post-1942 channel
			Coarse	0.14	Coarse sand	
	f1	1.9	Fine	0.13	Coarse silt	Post-1942 floodplain
			Coarse	0.01	Medium sand[b]	
	Total	**5.1**				
BY-2	c1	7.7	Fine	0.24	Fine sand[b]	Active channel
			Coarse	0.66	Very coarse sand	
	c2	10.3	Fine	0.23	Fine sand	Low abandoned post-1942 channel
			Coarse	0.65	Coarse sand	
	c3	1.9	Fine	0.12	Very fine sand	High abandoned post-1942 channel
			Coarse	0.64	Coarse sand	
	f1	8.1	Fine	0.16	Fine sand	Post-1942 floodplain
			Coarse	0.04	Medium sand[b]	
	Total	**28.0**				

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
BY-3	c1	8.4	Fine	0.02	Fine sand[b]	Active channel
			Coarse	0.51	Coarse sand	
	c2	8.3	Fine	0.05	Fine sand	Low abandoned post-1942 channel
			Coarse	0.52	Coarse sand	
	c3	8.3	Fine	0.13	Fine sand	High abandoned post-1942 channel
			Coarse	0.45	Coarse sand	
	f1	5.1	Fine	0.19	Fine sand	Post-1942 floodplain
	f2	1.2	Fine	0.04	Fine sand[b]	Possible post-1942 floodplain
	Total	**31.2**				
G-1	c1	7.9	Coarse	0.42	Coarse sand	Active channel; dominated by post-fire sediment
	c2	9.3	Fine	0.17	Fine sand	Low abandoned post-1942 channel; common post-fire sediment
			Coarse	0.37	Coarse sand[b]	
	c3	10.6	Fine	0.54	Medium sand	High abandoned post-1942 channel; some post-fire sediment
			Coarse	0.31	Coarse sand	
	f1	40.7	Fine	0.36	Medium sand	Post-1942 floodplain; some post-fire sediment
			Coarse	0.04	Coarse sand[b]	
	f2	11.6	Fine	0.04	Fine sand[b]	Possible post-1942 floodplain
	Total	**80.1**				
R-1E	c1	0.8	Fine	0.18	Very fine sand[b]	Active channel
			Coarse	0.15	Coarse sand	
	c1br	0.3	n/a	0	n/a	Active channel on bedrock
	c2	6.3	Fine	0.48	Coarse silt	Abandoned post-1942 channel
			Coarse	0.14	Coarse sand[b]	
	f1	1.6	Fine	0.13	Coarse silt	Post-1942 floodplain
			Coarse	0.01	Medium sand[b]	
	Total	**9.0**				
R-1M	c1	5.1	Coarse	0.51	Coarse sand	Active channel; dominated by post-fire sediment
	c2	1.3	Fine	0.05	Fine sand	Low abandoned post-1942 channel; common post-fire sediment
			Coarse	0.52	Medium sand	
	c3	0.7	Coarse	0.45	Very fine sand	High abandoned post-1942 channel; dominated by gravel-rich post-fire sediment with fine-grained matrix
	f1	2.6	Fine	0.19	Very fine sand	Post-1942 floodplain; some post-fire sediment
	Total	**9.7**				

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
R-1S	c1	7.6	Fine	0.05	Fine sand[b]	Active channel; dominated by post-fire sediment
			Coarse	0.5	Coarse sand	
	c2	1.8	Fine	0.22	Very fine sand	Abandoned post-1942 channel; common post-fire sediment
			Coarse	0.17	Coarse sand	
	f1	6.2	Fine	0.14	Coarse silt	Post-1942 floodplain; some post-fire sediment
			Coarse	0.02	Medium sand[b]	
	f2	0.1	Fine	0.03	Coarse silt[b]	Possible post-1942 floodplain
	Total	**15.8**				
R-2	c1	2.2	Fine	0.12	Medium sand[b]	Active channel; dominated by post-fire sediment
			Coarse	0.43	Coarse sand	
	c1br	0.1	n/a	0	n/a	Active channel on bedrock
	c2	1.9	Fine	0.19	Medium sand	Abandoned post-1942 channel; some post-fire sediment
			Coarse	0.15	Coarse sand	
	f1	0.3	Fine	0.05	Fine sand[b]	Post-1942 floodplain; some post-fire sediment
			Coarse	0.05	Coarse sand	
	Total	**4.3**				
R-3	c1	4.8	Coarse	0.29	Coarse sand	Active channel; dominated by post-fire sediment
	c2	4.7	Fine	0.15	Fine silt	Low abandoned post-1942 channel; common post-fire sediment
			Coarse	0.19	Coarse sand	
	c3	1.9	Fine	0.30	Fine sand	High abandoned post-1942 channel; some post-fire sediment
			Coarse	0.17	Medium sand	
	f1	4.1	Fine	0.23	Very fine sand	Post-1942 floodplain; some post-fire sediment
	f2	1.4	Fine	0.04	Coarse silt	Possible post-1942 floodplain
	Total	**5.0**				

[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.

Appendix C

Analytical Data

C-1.0 ANALYTICAL RESULTS

Data packages are included as Attachment C-1 on DVDs. The data packages include all available information, but some data packages are incomplete for the water data that were reported before 2000. Data related to the north canyons are presented on DVD in Attachment C-2. Data obtained from the Sample Management Database (SMDB) and Water Quality Database (WQDB) are grouped by sediment and 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. Data obtained from sources other than the SMDB and WQDB are included as Attachment C-3 on DVD.

C-1.1 SMDB and WQDB Data

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

- North Canyons Sediment Analytical Data
- North Canyons Sediment Field QC Data
- North Canyons Sediment Rejected Data
- North Canyons Water Analytical Data
- North Canyons Water Field QC Data
- North Canyons Water Rejected Data

C-1.2 Data Obtained from Other Sources

Data obtained from sources other than the SMDB and WQDB are included as Attachment C-3 on DVD. The water-level data presented in Attachment C-3 was taken from “Groundwater Level Status Report for 2008, Los Alamos National Laboratory” (Koch and Schmeer 2009, 105181).

C-2.0 SUMMARY OF SAMPLES COLLECTED

Samples collected in the north canyons and analyses performed by analytical laboratories are summarized in Tables C-2.0-1 (sediment) and C-2.0-2 (water); Tables C-2.0-1 and C-2.0-2 are included in Attachment 1 on CD. Table C-2.0-1 includes all of the sediment samples collected. Table C-2.0-2 includes all water samples collected. However, not all of the water data are evaluated in this report (e.g., only water data from 2003 to the present are included in the ecological risk screening and the human health risk assessment). Media code definitions are provided in Table C-2.0-3.

C-3.0 SAMPLE COLLECTION METHODS

Historical groundwater samples have been collected using a variety of sampling methods: automated pump sampler, bailer, bladder pump, direct container grab sampling, discharge pipe/faucet, gear-driven submersible pump, peristaltic pump, transfer device for grab samples, weighted bottle, or West Bay sampler. Historical surface-water samples have been collected using automated pump samplers, bailers, direct container grab sampling, peristaltic pumps, single-stage samplers, or transfer devices for grab samples. Historical stormwater samples have been collected using an automated pump sampler, direct container grab sampling, or single-stage samplers.

Current Los Alamos National Laboratory (LANL or the Laboratory) standard operating procedures (SOPs) for water sampling methods are

- SOP-5213, Revision 0, Collecting Storm Water Runoff Samples and Inspecting Samplers,
- SOP-5224, Revision 0, Spring and Surface Water Sampling,
- SOP-5226, Revision 0, Groundwater Sampling Using Pressure Probes Using Westbay System, and
- SOP-5232, Revision 0, Groundwater 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, Revision 2, Spade and Scoop Method for Collection of Soil Samples.

C-4.0 ANALYTICAL PROGRAM

Data contained in this report were obtained from the SMDB and the WQDB.

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 of the data from 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 packages are included in Attachment C-1 on DVDs.

For data obtained from the SMDB, data validation was performed by an 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). All data obtained from the SMDB that are 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:

- SOP-5161, Revision 0, Routine Validation of Volatile Organic Data
- SOP-5162, Revision 0, Routine Validation of Semivolatile Organic Compound (SVOC) Analytical Data
- SOP-5163, Revision 0, Routine Validation of Organochlorine Pesticide and PCB Analytical Data
- SOP-5164, Revision 0, Routine Validation of High Explosive Analytical Data
- SOP-5165, Revision 0, Routine Validation of Metals Analytical Data
- SOP-5166, Revision 0, Routine Validation of Gamma Spectroscopy, Chemical Separation Alpha Spectrometry, Gas Proportional Counting, and Liquid Scintillation Analytical Data
- SOP-5167, Revision 0, Routine Validation of General Chemistry Analytical Data
- SOP-5169, Revision 0, Routine Validation of Dioxin Furan Analytical Data (EPA Method 1618 and SW-846 EPA Method 8290)

- SOP-5171, Revision 0, Routine Validation of Total Petroleum Hydrocarbons Gasoline Range Organics/Diesel Range Organics Analytical Data (Method 80151B)
- SOP-5191, Revision 0, 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 of these instances, the analysis was rerun and a valid result was obtained and presented in the report. However, some rejected data represent data issues; 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 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 there were duplicate analytical results for an analyte in the same sample resulting from two methods, the result obtained from the more sensitive method (i.e., lower detection limit) was presented in the summary tables in Section 6 of the report. Reporting qualifiers are presented in parentheses next to the results in the summary tables. Reporting qualifier definitions are listed in Appendix A.

C-5.0 INORGANIC CHEMICAL ANALYSIS METHODS

The analytical methods used for inorganic chemicals are listed in Table C-5.0-1.

Laboratory control samples (LCSs), method blanks, matrix spike (MS) samples, and field 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) 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. LCS recoveries should fall into the control limits of 75%–125% (LANL 1995, 049738; LANL 2000, 071233; LANL 2007, 095258).

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 2007, 095258).

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 2007, 095258).

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 2007, 095258). Field duplicates were not assessed.

The validation of inorganic chemical data using QA/QC samples and other methods can result in the rejection of the data or the assignment of various qualifiers to individual sample results. Reporting qualifier definitions are 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, since 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 sample results with detection limits above the BVs were reported, they are presented in Section 6, Table 6.2-1.

Calculated Total Uranium

Total inorganic uranium was calculated from isotopic uranium to compare with the uranium sediment BV. The specific activity used to convert isotopic data to total uranium is presented in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (LANL 1998, 059730).

C-6.0 ORGANIC CHEMICAL ANALYSIS METHODS

The analytical methods used for organic chemicals are listed in Table C-6.0-1.

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 can result in rejecting the data or in assigning various qualifiers to individual sample results. Reporting qualifier definitions are listed 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 2007, 095258) 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 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 that are 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 fall within the control limits of 75%–125% (LANL 1995, 049738; LANL 2000, 071233; LANL 2007, 095258).

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 2007, 095258).

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 2007, 095258).

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 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 2007, 095258).

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 2007, 095258).

C-7.0 RADIOCHEMICAL ANALYSIS METHODS

Radionuclides were analyzed by the methods listed in Table C-7.0-1. Radionuclides with reported values less than the minimum detectable activity were qualified as not detected (U). Each radionuclide result was also compared with the corresponding 1 sigma total propagated uncertainty (TPU). If the result was <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 duplicates. The analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2007, 095258) 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 2007, 095258) 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 2007, 095258) specify that the method blank concentration should not exceed the required estimated quantitation limit (EQL).

C-8.0 OTHER ANALYSIS METHODS

Other analyses conducted on the north canyons sediment and water samples are dissolved organic carbon, total organic carbon, pH, specific conductance, specific gravity, total dissolved solids, and total suspended solids. These analytes were analyzed 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 that were qualified, 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

Sediment samples were collected in north canyons investigation reaches. A total of 18,310 results from sediment samples in these reaches were reported. Of these results, 107 results were rejected during data validation. These rejected results represent <1% of all the sediment results.

Forty inorganic chemical results were rejected (R) for antimony, magnesium, and manganese because the sample spike recovery was <30%. A total of 67 radionuclide results for samples analyzed by gamma spectroscopy were rejected (R) for Cs-134, Cs-137, and Na-22 because spectral interference prevented positive identification of the analytes. There were no organic chemical results that were rejected.

Although results were rejected for antimony, magnesium, and manganese within four different reaches, these inorganic chemicals were detected above BVs in other samples and are retained as COPCs. Cs-134, Cs-137, and Na-22 were rejected in multiple samples, but valid data were reported for these radionuclides in all of the reaches where results were rejected. Cs-134 and Na-22 were not detected in any of the valid results. Cs-137 was detected above BV in some samples and was retained as a COPC. Therefore, the rejected sediment data do not affect the conclusions of the report.

A total of 917 inorganic chemical results were reported as estimated, either detected (J, J-, or J+) or not detected (UJ). All inorganic chemical results that are detected and are between the method detection limit (MDL) and the EQL are qualified as estimated.

All inorganic chemical results that were estimated (J, J-, J+, or UJ) were caused by one of the following.

- The duplicate sample was analyzed on a non-Laboratory sample.
- Both the sample and duplicate sample results were ≥5 times the reporting limit (RL) and the duplicate RPD was >35% for soil samples.
- Either the sample or duplicate sample results or both were ≥5 times the RL, and the difference between the samples is >2 times the RL for soil samples.
- The serial dilution sample RPD was >10%, and the sample result was >50 times the MDL (>100 times the MDL for inductively coupled plasma mass spectrometry).
- There was insufficient sample volume for an MS to be analyzed on a Laboratory sample.
- The analyte was recovered above 150% in the associated spike sample.
- The analyte was recovered above the upper acceptance limit (UAL) but <150% of the associated spike sample.

- The analyte was recovered below the lower acceptance limit (LAL) but >30% in the associated spike sample.
- The associated LCS was recovered above the upper warning limit.
- The associated LCS was recovered below the lower warning limit but greater than or equal to the LAL.
- The associated ICS was recovered below the lower warning limit but greater than or equal to the LAL.

A total of 1990 organic chemical results were reported as estimated—either detected (J, J+, or J-) or not detected (UJ).

Volatile Organic Compounds (VOCs): VOC results were estimated (UJ) because the associated percent relative standard deviation (%RSD)/percent difference (%D) exceeded criteria in the initial or continuing calibration standards.

Semivolatile Organic Compounds (SVOCs): SVOC results were estimated (J or UJ) because the associated %RSD/%D exceeded the criteria in the initial or continuing calibration standards or the result was reported as estimated by the laboratory. One SVOC result was estimated (UJ) because the associated IS area counts are less than 50% but greater than 10%R when compared with the area counts in the applicable continuing calibration standard.

Pesticides and Polychlorinated Biphenyls (PCBs): Pesticide and PCB results were estimated (J, J-, or UJ) because of at least one of the following issues.

- The associated LCS %R was <70% recovery but ≥10% recovery.
- The associated %RSD or %D exceeded criteria in the initial or continuing calibration standards.
- The extraction holding time was exceeded.
- The result was reported as estimated by the laboratory.

Polycyclic Aromatic Hydrocarbons (PAHs): PAH results were estimated (J, J-, or UJ) because the extraction holding time was exceeded by less than 2 times the published method for holding time. Some PAH results were reported as estimated by the laboratory.

Explosive Compounds: Explosive compound results were estimated (UJ) because of one of the following issues.

- The associated LCS recovery was <LAL but >10% recovery.
- The associated %RSD/%D exceeded the criteria in the initial or continuing calibration standards.
- The associated IS area counts show greater than 200 %R when compared with the area counts in the applicable continuing calibration standard.

Total Petroleum Hydrocarbons–Diesel Range Organic (TPH-DRO): TPH results were estimated (J, J-, or UJ) because the associated %RSD/%D exceeded criteria in the initial or continuing calibration standards or the extraction holding time was exceeded by less than 2 times the published method for holding time. Some TPH-DRO results were reported as estimated by the laboratory.

Fifty-four radionuclide results were either estimated and biased low (J-), estimated and biased high (J+)or were estimated and not detected (UJ). All radionuclide results that were estimated were caused by one of the following conditions.

- The associated tracer recovery was <30% but >10%.
- The associated LCS was >120% recovery.
- The associated LCS was <80% recovery but ≥10% recovery.

C-9.2 Water Data

Water samples were collected in north canyons investigation reaches. Not all of the water data are evaluated in this report (e.g., only water data from 2003 to the present are included in the ecological risk screening and the human health risk assessment). A total of 24,511 results from water samples collected in the north canyons were reported. Samples that were collected between 1957 and 1999 did not have reason codes reported in the database for the validated data results, so their data quality is not discussed in this section. The 8981 results from these samples collected from 1957 to 1999 are provided on the DVD in Attachment C-2. Of the 15,530 results reported from samples collected between 2000 and 2008, 265 results were rejected during data validation. These rejected results represent about 1.7% of the water sample results discussed here.

The rejected water results were from a variety of analytes and locations. For every combination of rejected analyte and location, there were valid results for the same analyte at the same location. Therefore, the rejected water data do not affect the conclusions of the report.

A total of 40 inorganic chemical results were rejected (R) because of at least one of the following conditions.

- The spike %R value is <30% and the result is a nondetect, which increases the potential for false negatives being reported. This could be caused by analytical interferences.
- The spike %R value is >30% and less than the LAL (75%), and the sample result is a nondetect, which indicates a potential for false negatives being reported.
- Negative blank samples results were greater than the MDL.
- The sample temperature was elevated.
- There was a nonspecified QC failure.

A total of 189 organic chemical results were rejected (R) based on the following issues.

VOCs: VOC results were rejected (R) because of at least one of the following reasons.

- The holding time was exceeded.
- The MS and/or the MS duplicate analysis was not performed on a sample associated with a Laboratory request number (RN).
- The affected analytes were analyzed with a relative response factor (RRF) of <0.05 in the initial calibration and/or continuing calibration verification (CCV).
- There was a nonspecified QC failure.

- The sample was improperly preserved.
- Calibration verification %D was greater than the acceptance criteria but <60%.

SVOCs: SVOC results were rejected (R) because of at least one of the following reasons.

- Required calibration information is missing or samples were analyzed on an expired calibration. Data may not be acceptable for use.
- The RPD of the MS/matrix spike duplicate (MSD) is greater than the acceptance criteria.
- The LCS %R was <10%. Follow the external laboratory limits located within the associated data package.
- The result is a nondetect and a surrogate in the related fraction is <10%R, which indicates a greatly increased potential for false negative results.
- The affected analytes were analyzed with an RRF of <0.05 in the initial calibration and/or CCV.
- The LCS recovery was greater than the acceptance criteria.
- The spike %R value is <10%, which increases the potential for false negatives being reported. This could be caused by analytical interferences.
- There was a nonspecified QC failure.
- The sample was improperly preserved.

PCBs: PCB results were rejected (R) because of nonspecified QC failure.

Explosive Compounds: Explosive compound results were rejected (R) because of at least one of the following reasons.

- There was a nonspecified QC failure.
- The initial calibration y-intercept criteria were not met.
- The LCS %R failed low.
- The RPD of the MS/MSD is greater than the acceptance criteria or the recoveries fail both high and low.
- The IS area count failed high.

Thirty-six radionuclide results were rejected (R) because of at least one of the following issues.

- Analyte is not detected because the amount reported is less than the minimum detectable concentration (MDC).
- The duplicate and sample results have a duplicate error ratio (DER) that is >2.0.
- The affected analytes are qualified as rejected because the relative error ratio was >4.
- The result was less than the negative MDC.
- There was a nonspecified QC failure.

A total of 592 inorganic chemical results were reported as estimated—either detected (J, J-, or J+) or not detected (UJ). Results that were estimated were caused by one of the following reasons.

- The duplicate sample RPD is greater than the advisory limit and the sample result is a detect or not detected. Manual review is suggested to determine the source of the difference between analyses.
- The sample and the duplicate sample results were ≤5 times the RL and the duplicate RPD was >20% for water samples.
- The duplicate-sample analysis was not performed on a sample associated with this request number.
- The MS analysis was not performed on a sample associated with this request number.
- A CCV was not reported for this sample.
- The RPD is >10% in the serial dilution sample.
- The spike %R value is greater than or equal to the UAL (125%) but <150%, and the result is a detect, which indicates a potential high bias in the sample results.
- The spike %R value is >30% and less than the LAL (75%), and the sample result is a detect, which indicates a potential low bias in the results.
- The spike %R value is >30% and less than the LAL (75%), and the sample result is not detected, which indicates a potential for false negatives being reported.
- The sample result is detected and the spike %R value is >150%, which indicates a potential high bias in the sample result.
- The affected analytes are considered estimated and biased high because this analyte was identified in the method blank but was >5 times.
- The %R value of the analyte in the LCS is less than the LAL.
- The holding time was exceeded.
- The sample temperature was elevated.
- Negative blank samples results were greater than the MDL.
- There was a nonspecified QC failure.
- Reporting limit verification recovery was greater than the acceptance criteria.
- The MS/MSD %R failed high.
- The MS/MSD %R failed low.
- Sample was not maintained at required temperature.
- There is no measure of precision for the sample (i.e., no replicate, MSD or LCS duplicate was performed).
- The MS/MSD %R was between 10% and 75%.

A total of 842 organic chemical results were reported as estimated, either detected (J, J-, or J+) or not detected (UJ), based on the following issues.

VOCs: VOC results were estimated because of at least one of the following.

- The affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria and/or a continuing calibration standard that exceeded %D criteria.
- The initial calibration verification (ICV) and/or CCV recovered outside the method-specific criteria.
- The affected analytes were analyzed with an RRF of <0.05 in the initial calibration and/or CCV.
- The holding time was exceeded.
- The LCS recovery was greater than the acceptance criteria.
- The spike %R value is >10% and less than the LAL, which indicates a potential low bias in the results.
- Calibration %RSD was greater than the acceptance criteria but <60%.
- Calibration verification %D was greater than the acceptance criteria but <60%.

SVOCs: SVOC results were estimated (J, J-, J+, or UJ) because of at least one of the following.

- The LCS %R was less than the LAL but >10%.
- Required calibration information is missing or samples were analyzed on an expired calibration. Data may not be acceptable for use.
- The affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria and/or a continuing calibration standard that exceeded %D criteria.
- The ICV/CCV were recovered outside the method specific limits.
- The affected analytes were analyzed with an RRF <0.05.
- The RPD of the MS/MSD is greater than the acceptance criteria.
- The LCS recovery was greater than the acceptance criteria.
- The spike %R value is >10% and less than the LAL, which indicates a potential low bias in the results.
- There was a nonspecified QC failure.
- The sample was improperly preserved.
- Calibration verification %D was greater than the acceptance criteria but <60%.

Pesticides and PCBs: Pesticide and PCB results were estimated (J, J-, J+, or UJ) because of at least one of the following.

- The surrogate is <LAL but >10%R.
- The result is less than the EQL and the surrogate %R value is >10% but less than the LAL, which indicates a potential for false negative results being reported.
- The holding time was exceeded.
- The RPD of the MS/MSD is greater than the acceptance criteria.
- The sample was improperly preserved.

Explosive Compounds: Explosive compound results were estimated (J, J-, J+, or UJ) because of at least one of the following.

- Insufficient sample volume was received for an MS and/or an MSD analysis.
- The IS area count for the quantitating IS is >130% of the average of that obtained from the calibration standards.
- The CRDL check standard recovery failed low.
- The initial calibration slope or RF criteria were not met.
- The IS area count failed high.
- The LCS %R failed low.
- The LCS %Rs failed both high and low, or the LCS/LSCD RPD failed to meet criteria.
- An applicable MS/MSD analysis was not performed.
- The MS/MSD %R failed low.
- The RPD of the MS/MSD is greater than the acceptance criteria or the recoveries fail both high and low.
- Sample was not maintained at required temperature.

TPH-DRO: TPH-DRO results were estimated (J, J-, J+, or UJ) because of at least one of the following.

- The surrogate is <LAL but >10%R. Follow the external laboratory limits located within the associated data package.
- The holding time was exceeded.
- The RPD of the MS/MSD is greater than the acceptance criteria.
- The spike %R value is >10% and less than the LAL, which indicates a potential low bias in the results.
- The spike %R value is <10%, which increases the potential for false negatives being reported. This could be caused by analytical interferences.
- There was a nonspecified QC failure; see validation report.

Dioxins and Furans: Dioxin and furan results were estimated (J, J-, J+, or UJ) because there was a nonspecified QC failure.

A total of 275 radionuclide results were estimated (J, J-, J+, or UJ) because of at least one of the following.

- The MS analysis was not performed on a sample associated with this RN.
- The tracer %R value is 10%–30% inclusive and the sample result is greater than the MDA.
- The tracer %R value is 10%–30% inclusive and the sample result is less than the MDA.
- The tracer is <LAL but >10%R. Follow the external laboratory limits located within the associated data package. Tracer %R is not applicable for gamma spectroscopy.
- The MS %R value is less than the lower limit and the sample result is less than the MDA.
- The sample result is <5 times the concentration of the related analyte in the method blank.

- The method blank information is missing. The data may be acceptable for use.
- Analyte is not detected because the amount reported is less than the MDC.
- Recovery of the analyte in the LCS is greater than the upper limit and the analyte result is greater than the MDA.
- The duplicate and sample results have a DER that is >2.0.
- Planchets were flamed.
- Result values are <3 times the MDC.
- The tracer %R value is >105% but <125%.
- The tracer %R value is >125%.
- There was a nonspecified QC failure.

A total of 93 other results were estimated (J, J-, J+, or UJ) because of at least one of the following.

- The duplicate-sample analysis was not performed on a sample associated with this request number.
- The spike %R value is greater than or equal to the UAL (125%) but less than or equal to 150%, and the result is a detect, which indicates a potential high bias in the sample results.
- The affected analytes are considered estimated and biased high because this analyte was identified in the method blank but was greater than 5 times.
- The holding time is exceeded. Positive results may be biased low and nondetected analytes may be false negatives.
- The affected analytes should be regarded as estimated because the extraction holding time was exceeded by 2 times the acceptable holding time.
- The sample temperature was elevated.
- There was a nonspecified QC failure; see validation report.
- The analytical laboratory qualified the detected result as estimated (J) because the result was less the practical quantitation limit but greater than the MDL.

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 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.

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

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Koch, R.J., and S. Schmeer, March 2009. “Groundwater Level Status Report for 2008, Los Alamos National Laboratory,” Los Alamos National Laboratory report LA-14397-PR, Los Alamos, New Mexico. (Koch and Schmeer 2009, 105181)

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)

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

Table C-2.0-3
Media Code Definitions

Media Code	Media Description
SED	Sediment (SED)
WG	Alluvial Groundwater (WGA)
WG	Intermediate Groundwater (WGI)
WG	Regional Groundwater (WGR)
WG	Springs (WGS)
WM	Snowmelt (WM)
WP	Persistent Surface Water (WP)
WS	Surface Water (WS)
WT	Stormwater (WT)

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

Analytical Suite	Analytical Method
Metals	SW-846:6010 (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn)
	SW-846:6010B (Al, As, Ba, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, K, Se, Na, V, Zn)
	SW-846:6020 (Sb, Be, Ni, Ag, Tl)
	SW-846:7470A (Hg)
	SW-846:7471 (Hg)
	SW-846:7471A (Hg)
	EPA:245.1 (Hg)
	EPA:245.2 (Hg)
	EPA:200.7 (Al, As, Ba, Be, Boron, Ca, Cr, Co, Cu, Hardness, Fe, Mg, Mn, Molybdenum, Ni, K, Se, Ag, Silicon Dioxide, Na, Sr, Tin, V, Zn)
	EPA:200.8 (Al, Sb, As, Ba, Be, Boron, Cd, Cs, Cr, Co, Cu, Pb, Lithium, Mg, Mn, Hg, Molybdenum, Ni, Se, Ag, Sr, Tl, Tin, Titanium, U, V, Zn)
	EPA:200.9 (As and Se)
	EPA:370.1 (Silicon)
	SW-846:7060 (As)
	SW-846:7199 (Chromium hexavalent ion)
	SW-846:7740 (Se)
Perchlorate	SW-846:6850
Wet_chem	SW-846:9010 (Cyanide, Total)
	SW-846:9012A (Cyanide, Total)
Geninorg	EPA:160.2 (TSS and Suspended Sediment Concentrations)
	EPA:300.0 (Bromide, chloride, fluoride, nitrate as nitrogen, nitrite as nitrogen, oxalate, sulfate, total phosphate as phosphorus)
	EPA:310.1 (Alkalinity)
	EPA:314.0 (Perchlorate)
	EPA:335.1 (Cyanide)
	EPA:335.3 (Cyanide, Total)
	EPA:350.1 (Ammonia as Nitrogen)
	EPA:351.2 (Total Kjeldahl Nitrogen)
	EPA:353.1 (Nitrate-Nitrite as Nitrogen)
	EPA:353.2 (Nitrate-Nitrite as Nitrogen)
	EPA:365.4 (Total Phosphate as Phosphorus)
	EPA:410.4 (Chemical Oxygen Demand)
	SW-846:8321[M] (Perchlorate)

Table C-6.0-1
Analytical Methods for Organic Chemicals

Analytical Suite	Analytical Method
Dioxins and Furans	SW-846:8290
Explosive Compounds	SW-846:8321A_MOD
	SW-846:8330
PAHs	SW-846:8310
PCBs	SW-846:8082
	EPA:608
Pesticides	SW-846:8081A
SVOCs	SW-846:8270
	EPA:625
	SW-846:8270C
TPH-Diesel Range Organics (DRO)	SW-846:8015M_EXTRACTABLE
TPH-Gasoline Range Organics (GRO)	SW-846:8015M_PURGEABLE
VOCs	SW-846:8260B EPA:524.2

Table C-7.0-1
Analytical Methods for Radionuclide Analysis

Analytical Suite	Analytical Method
Americium-241 (AM_241)	HASL-300:AM-241
Gamma Spectroscopy (GAMMA_SPEC)	EPA:901.1
	EPA:903.1
	EPA:904
	EPA:905.0
	HASL-300
	Generic: Gamma Spec.
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
Gross Alpha	EPA:900
Gross Beta	EPA:900

Table C-8.0-1
Analytical Methods for Other Analyses

Analyte	Analytical Method
Specific Gravity	ASTM:D5057
Specific Conductance	EPA:120.1
	SW-846:9050A
pH	EPA:150.1
	SW-846:9040B
Total Dissolved Solids	EPA:160.1
Total Suspended Solids	EPA:160.2
Dissolved Organic Carbon	EPA:415.1
Total Organic Carbon	SW-846:9060

Attachments C-1 to C-3

Data Packages, Data from the Sample Management and Water Quality Databases, and Data from Other Sources (on DVDs included with this document)

Appendix D

Contaminant Trends

D-1.0 SEDIMENT

This section presents information on contaminants in sediments in the north canyons watersheds that supports the physical system conceptual model in Section 7 and the risk assessments in Section 8. 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 the north 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 each subwatershed: Barrancas, Bayo, Guaje, and Rendija. 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 Sample Management Database with complete and validated data packages 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 the north canyons that are discussed in Section 7.1 of this 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 how they vary with sediment facies. Averages were calculated separately for fine facies sediment samples and coarse facies samples to highlight differences between concentrations in these facies. For COPCs that are significantly elevated in ash from the Cerro Grande burn area, averages were calculated separately for samples collected from pre-fire (pre-2000) sediment and post-fire sediment in reaches affected by the fire or by post-fire floods.

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 elevated detection limits, 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 employed in Appendix E.

D-2.0 SURFACE WATER AND GROUNDWATER

This section provides statistical summaries of analytical data for analytes detected in regional groundwater (Tables D-2.0-1 to D-2.0-4), alluvial groundwater (GU-0.01 Spring) (Tables D-2.0-5 to D-2.0-8), and nonstorm-related surface water (including springs) (Tables D-2.0-9 to D-2.0-12) analyzed from the north canyons watersheds. Trace metals are shown in Tables D-2.0-1, D-2.0-5, and D-2.0-9, radionuclides are shown in Tables D-2.0-2, D-2.0-6, and D-2.0-10, organic compounds are shown in Tables D-2.0-3, D-2.0-7, and D-2.0-11, and other analyses are shown in Tables D-2.0-4, D-2.0-8, and D-2.0-12. All section D-2.0 tables are included as an attachment on CD.

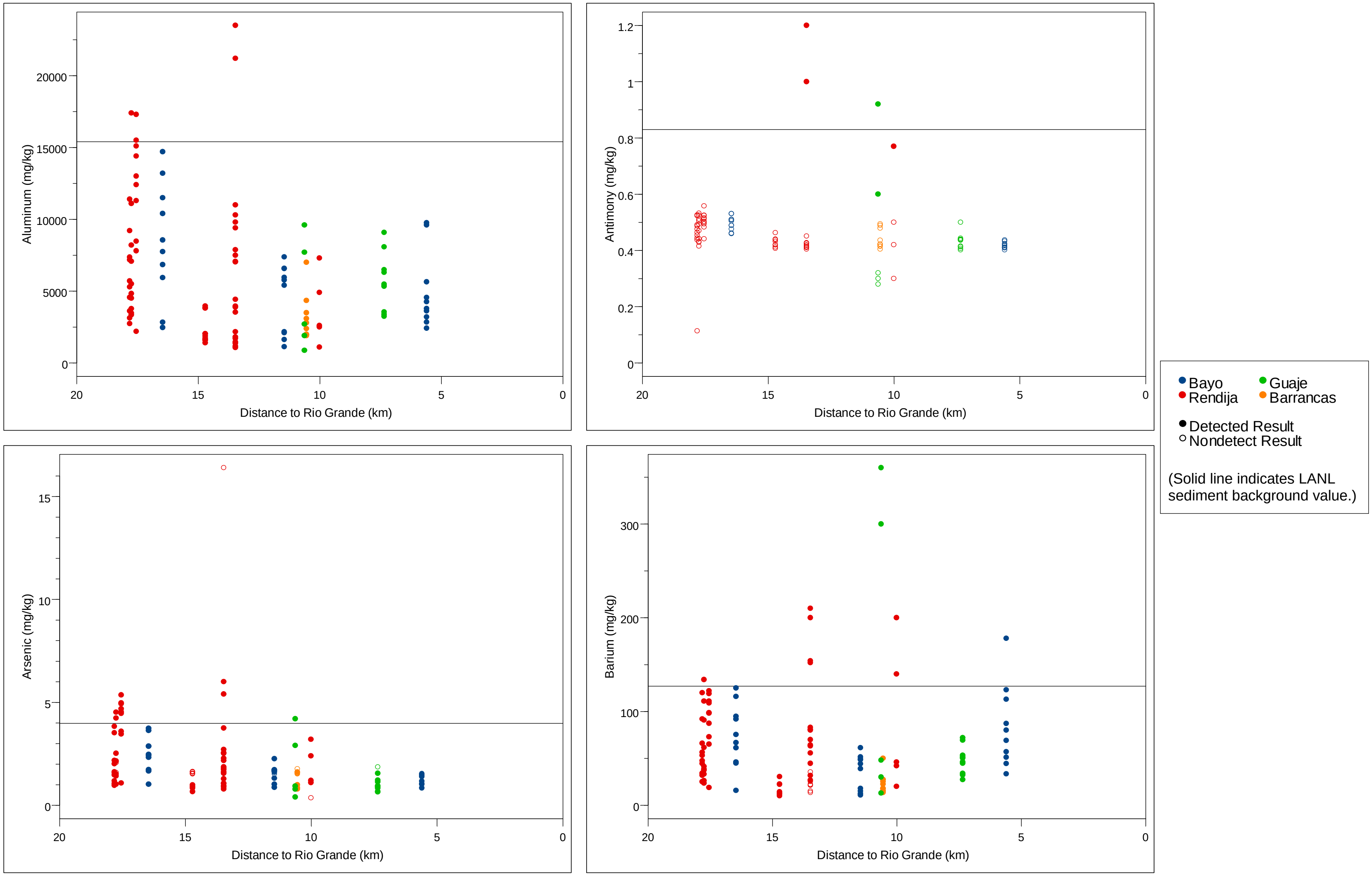


Figure D-1.1-1 **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in the north canyons**

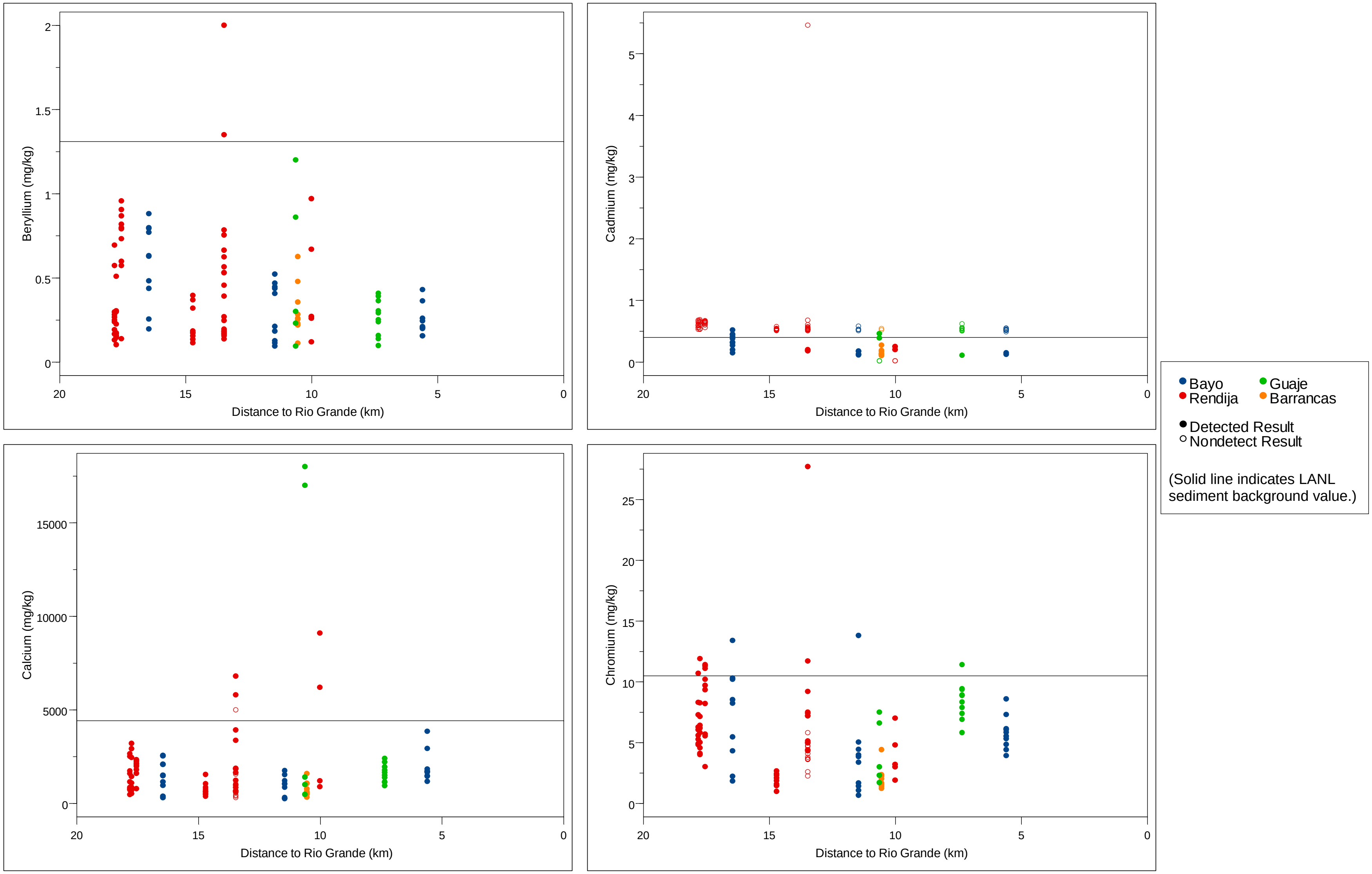


Figure D-1.1-1 (continued) **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in the north canyons**

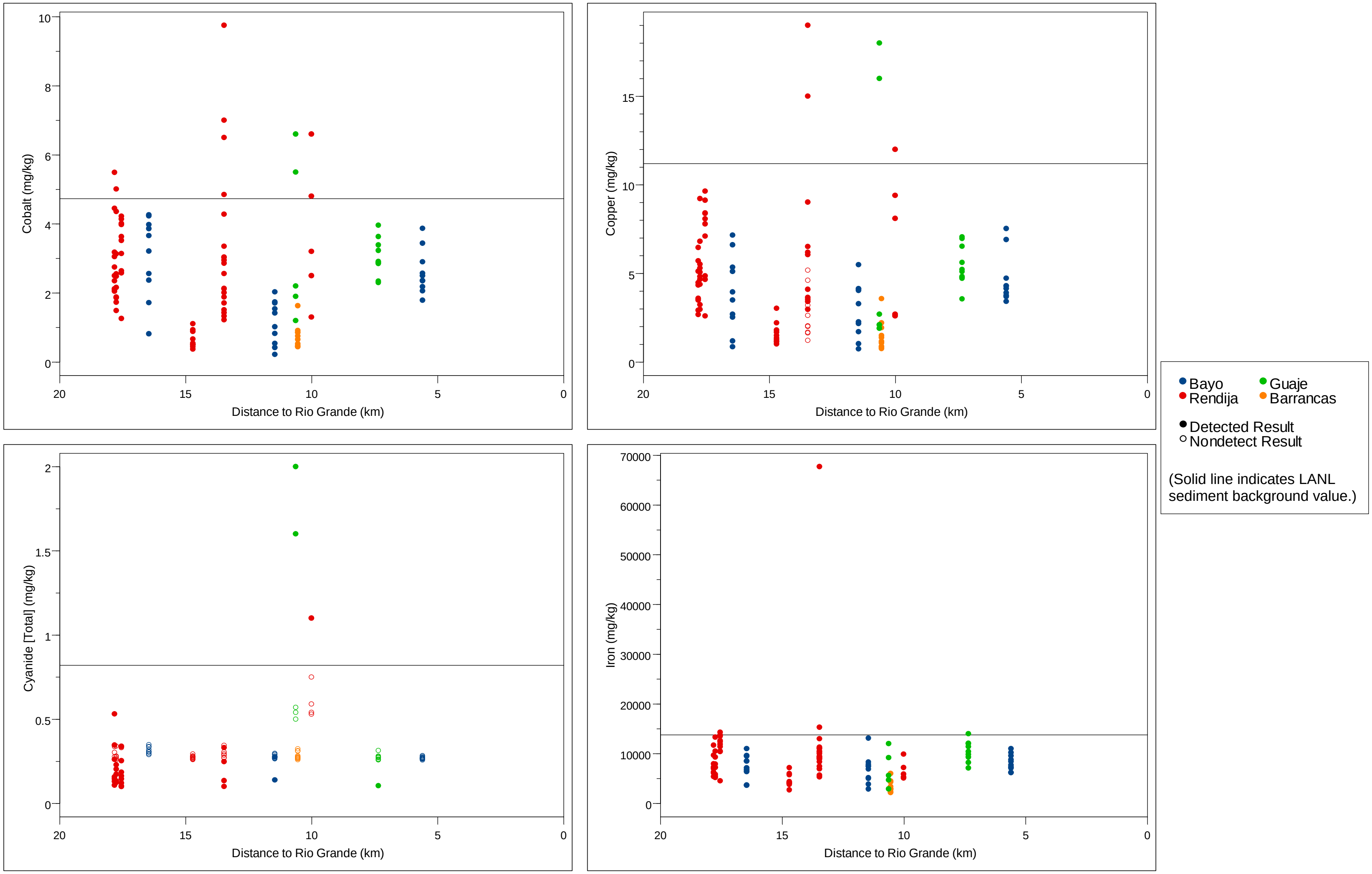


Figure D-1.1-1 (continued) **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in the north canyons**

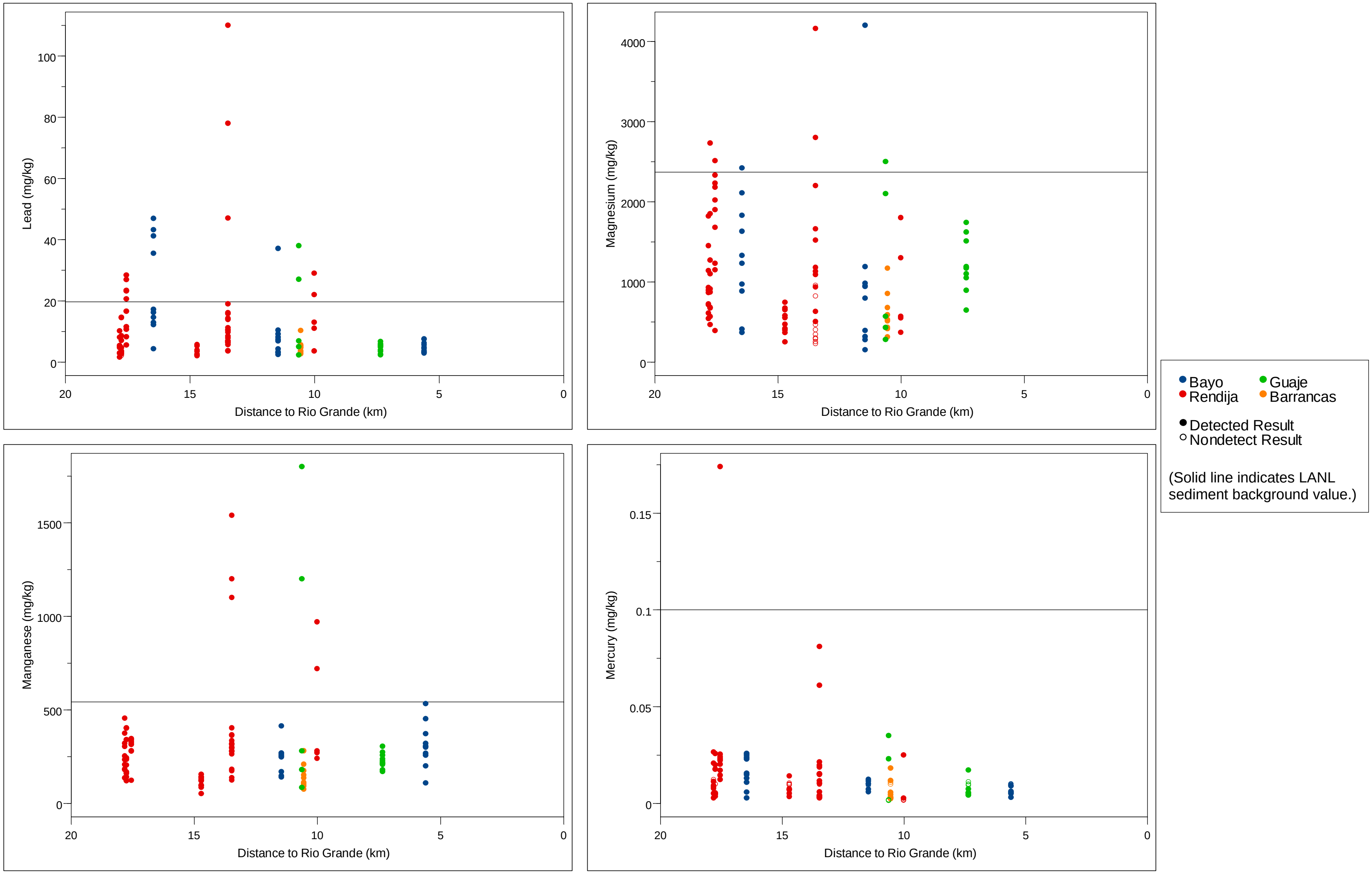


Figure D-1.1-1 (continued) **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in the north canyons**

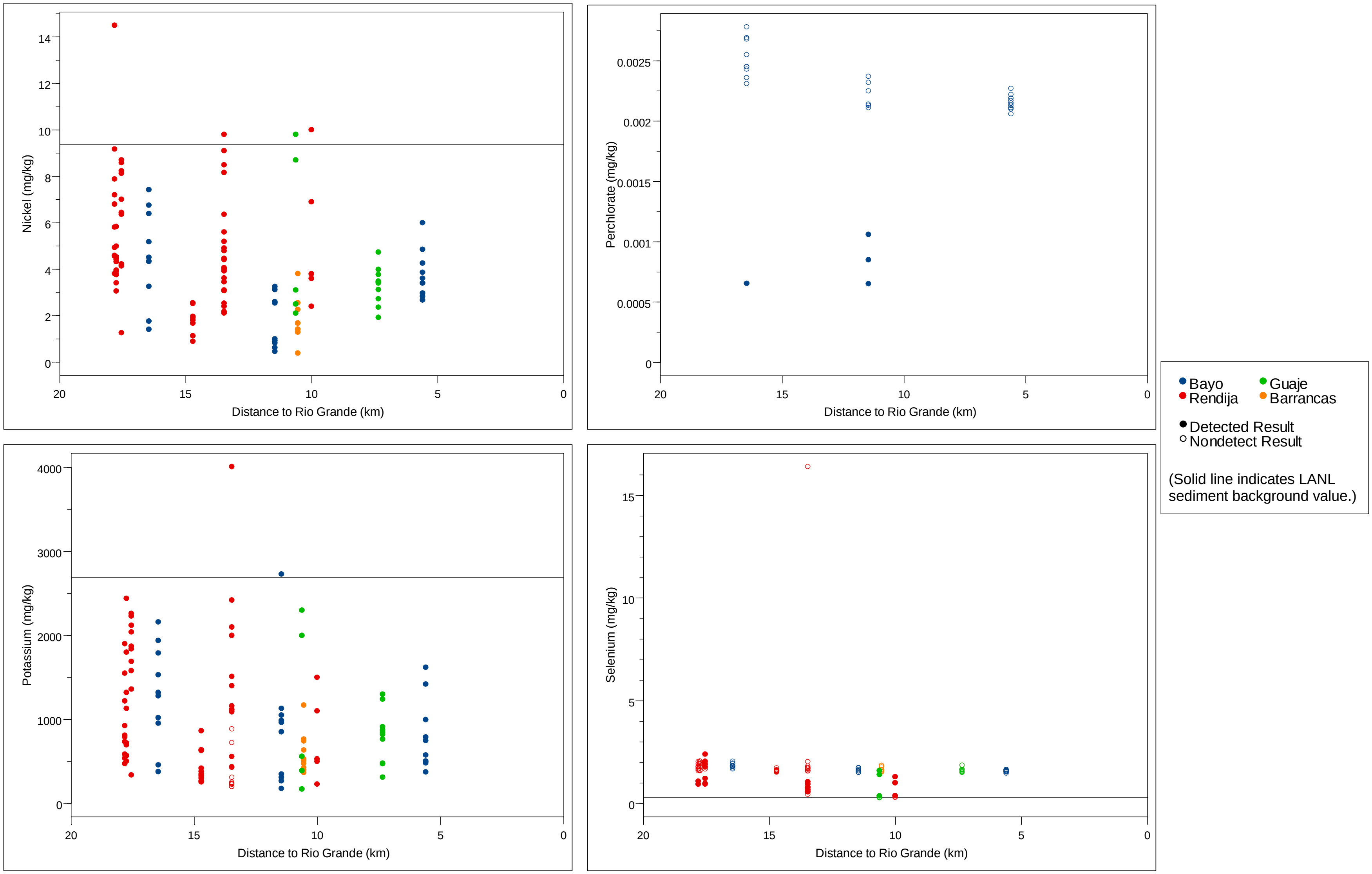


Figure D-1.1-1 (continued) **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in the north canyons**

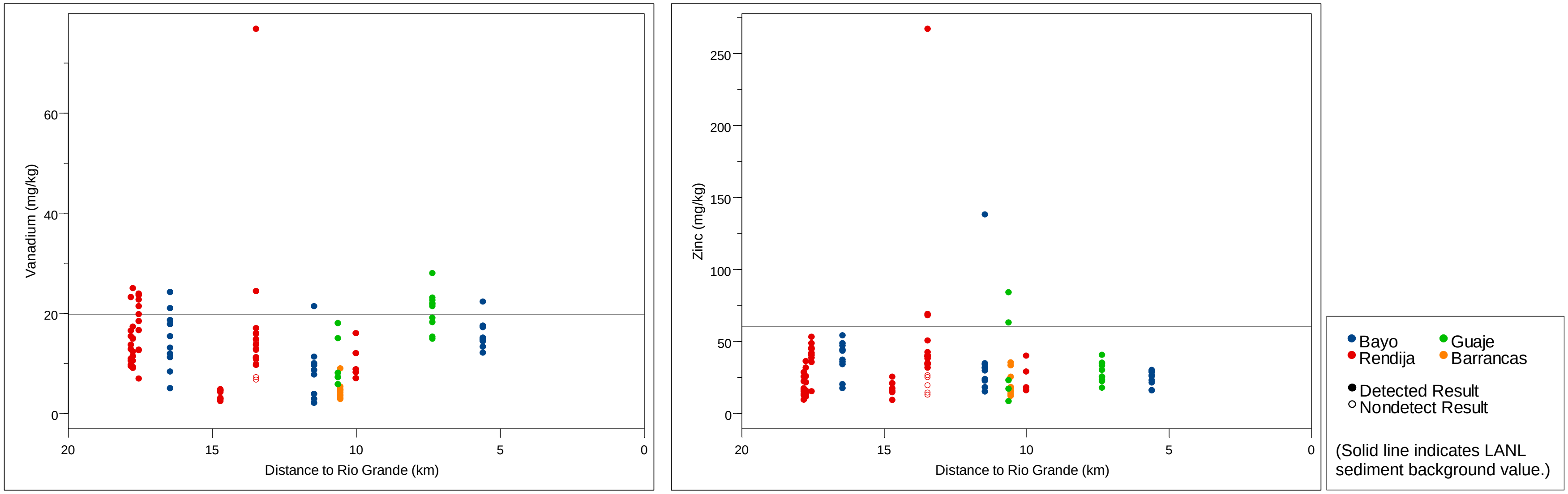


Figure D-1.1-1 (continued) **Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in the north canyons**

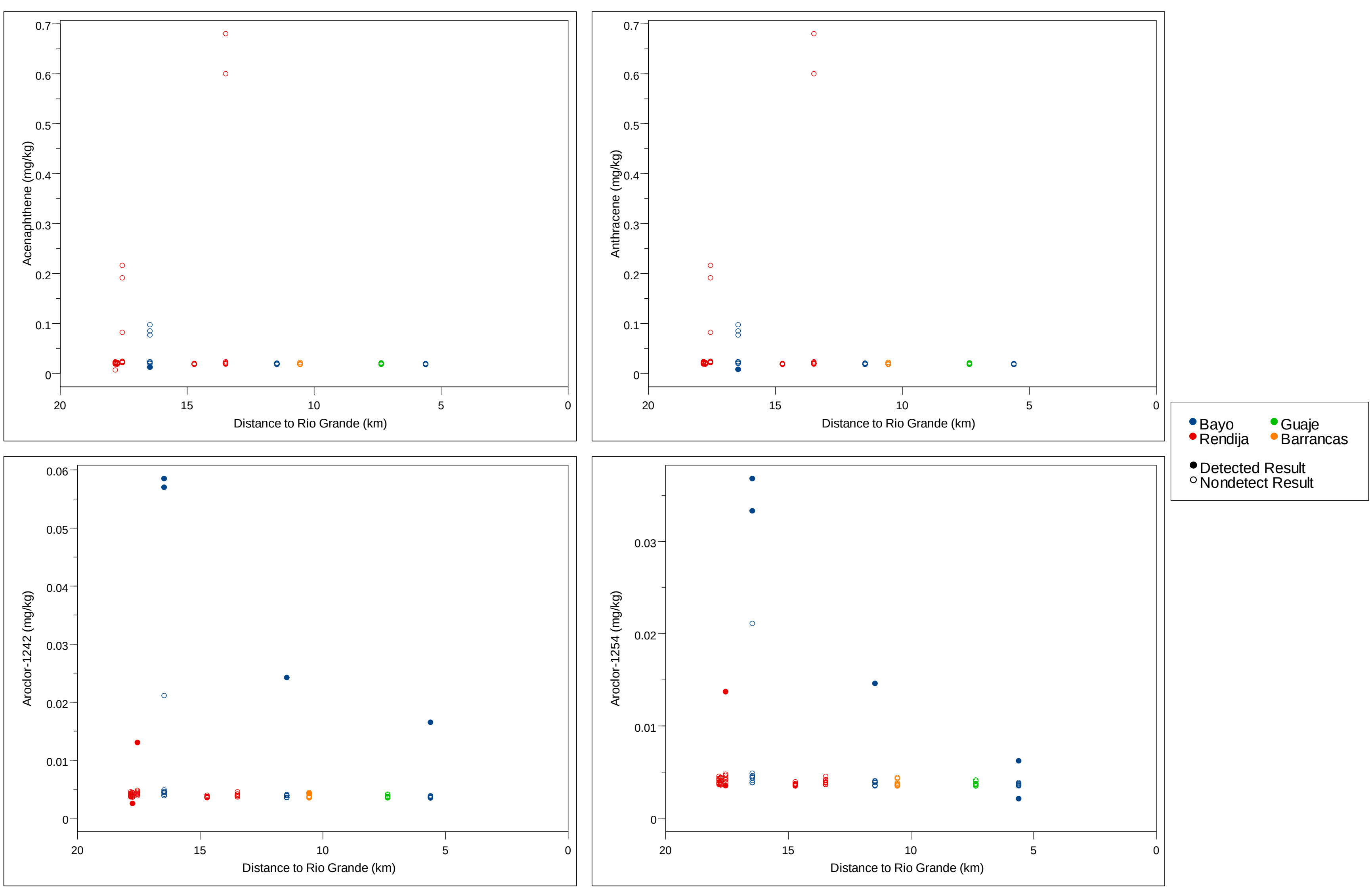


Figure D-1.1-2 **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

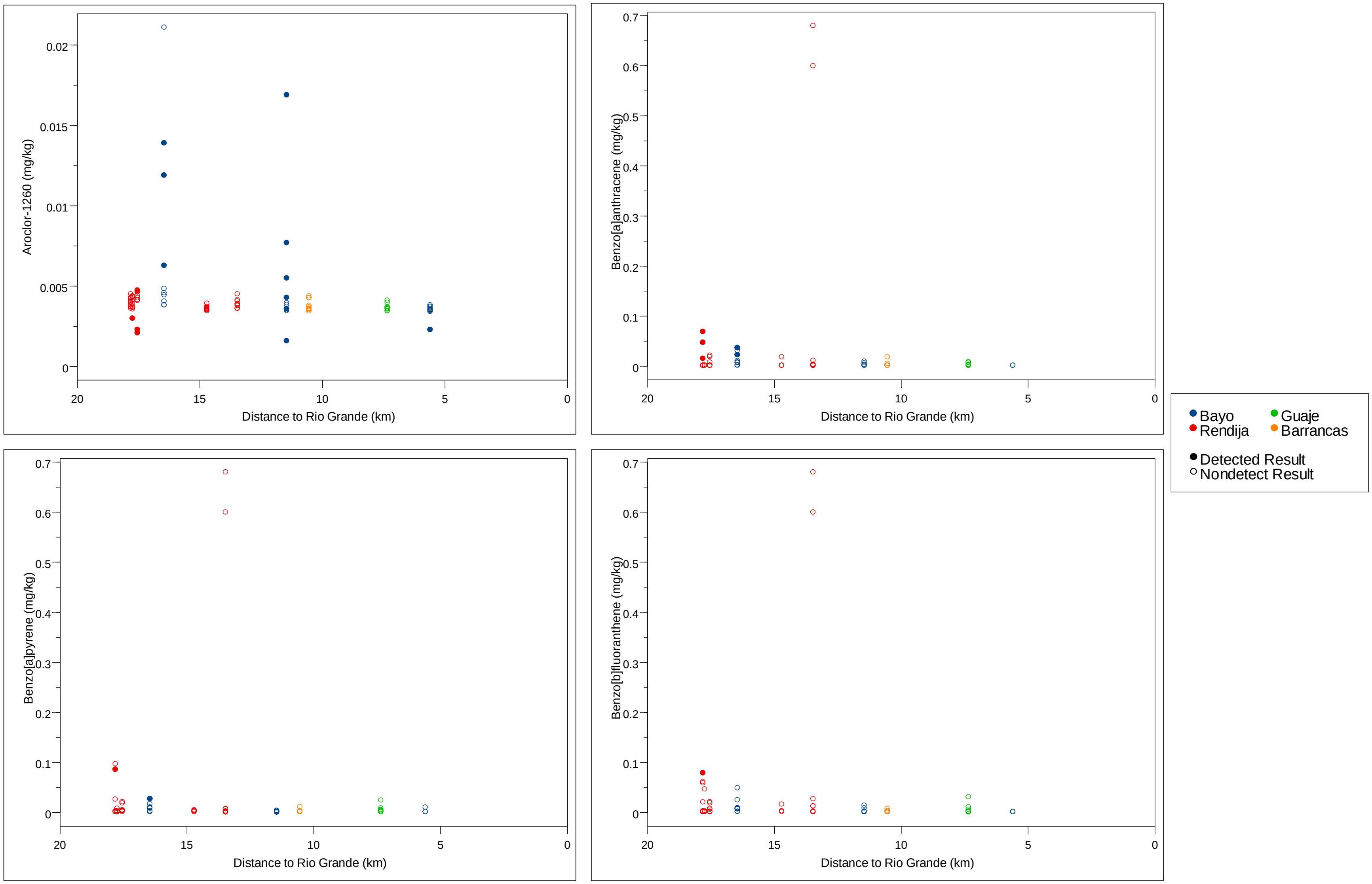


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

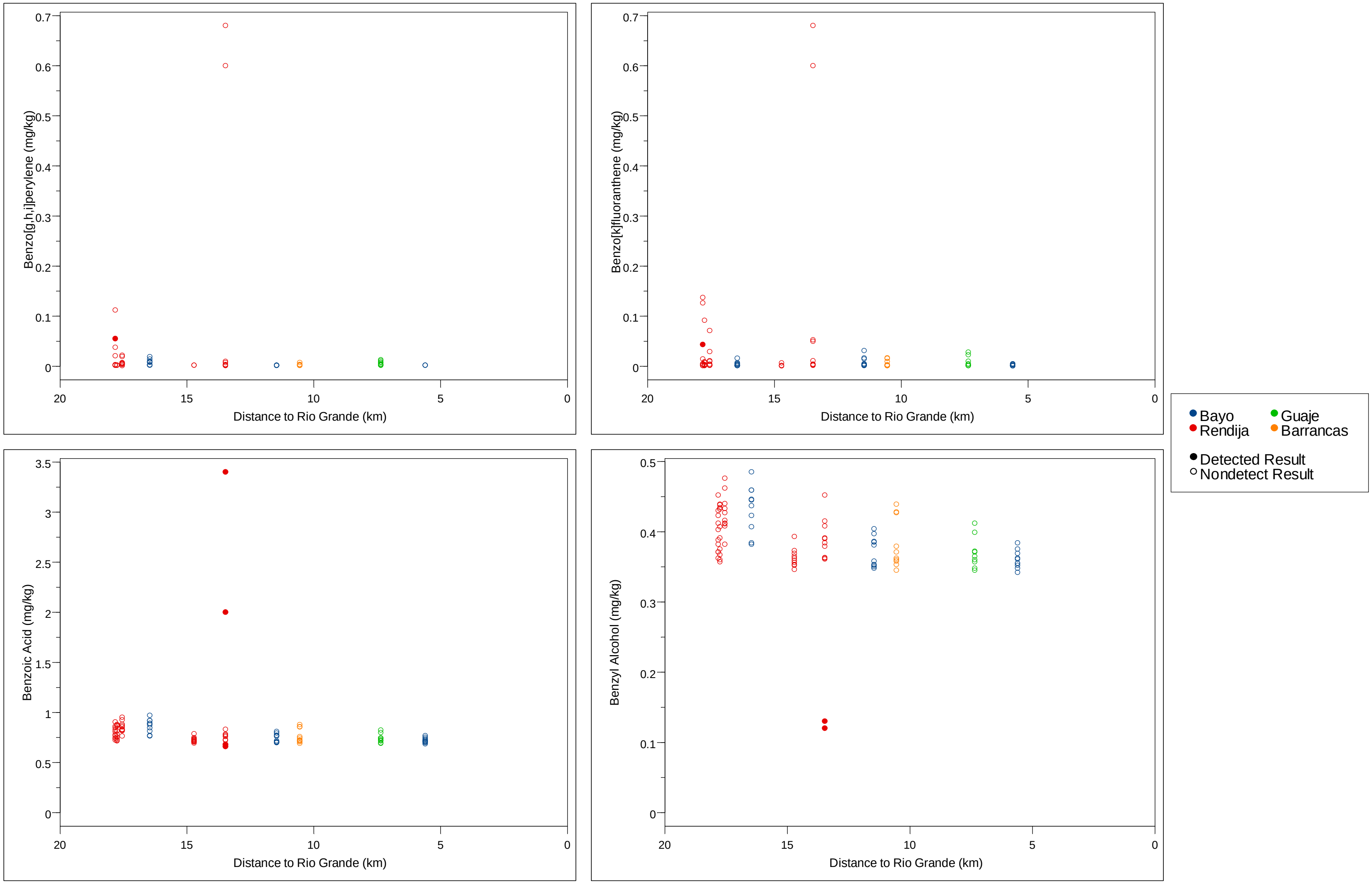


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

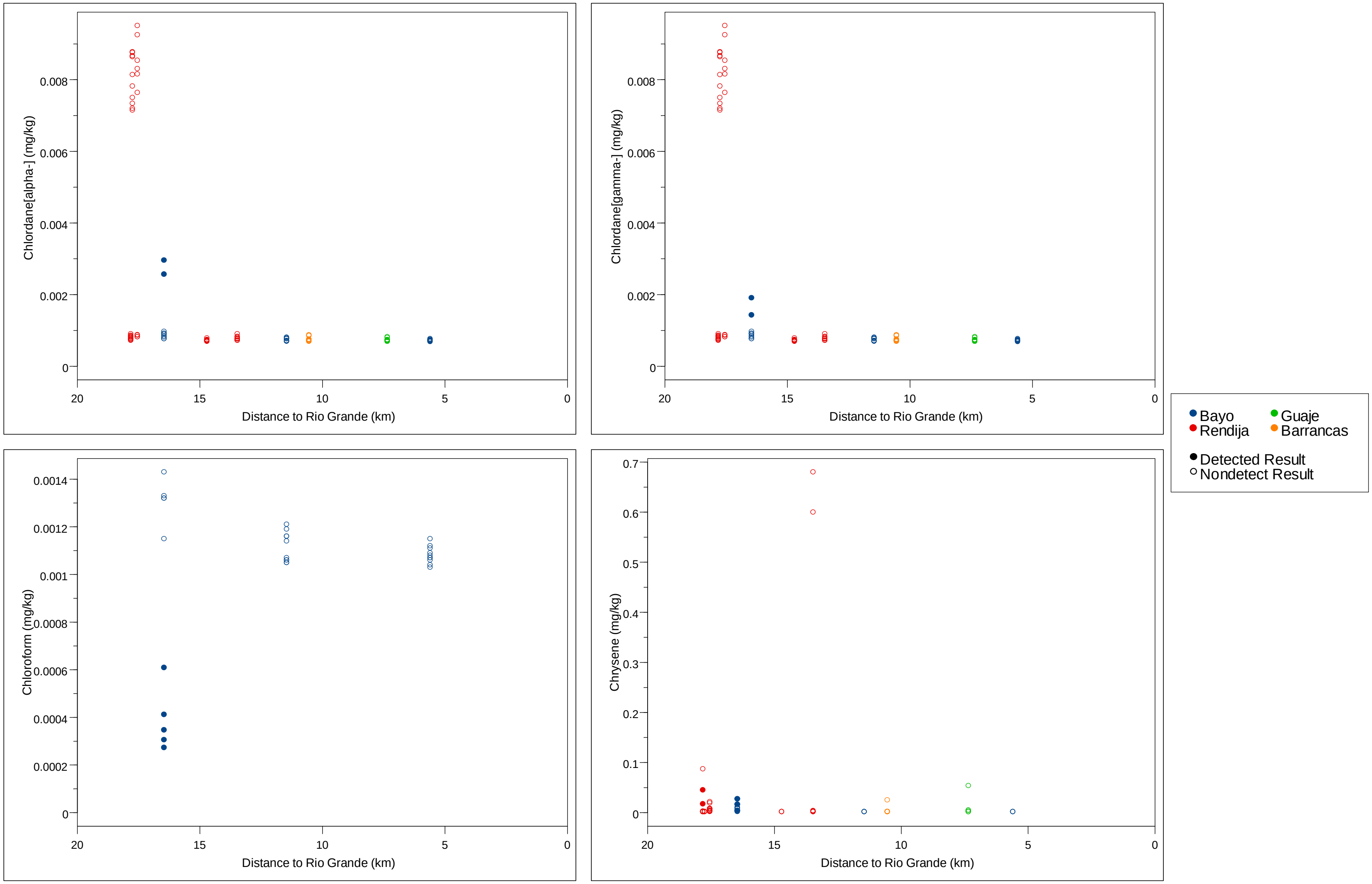


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

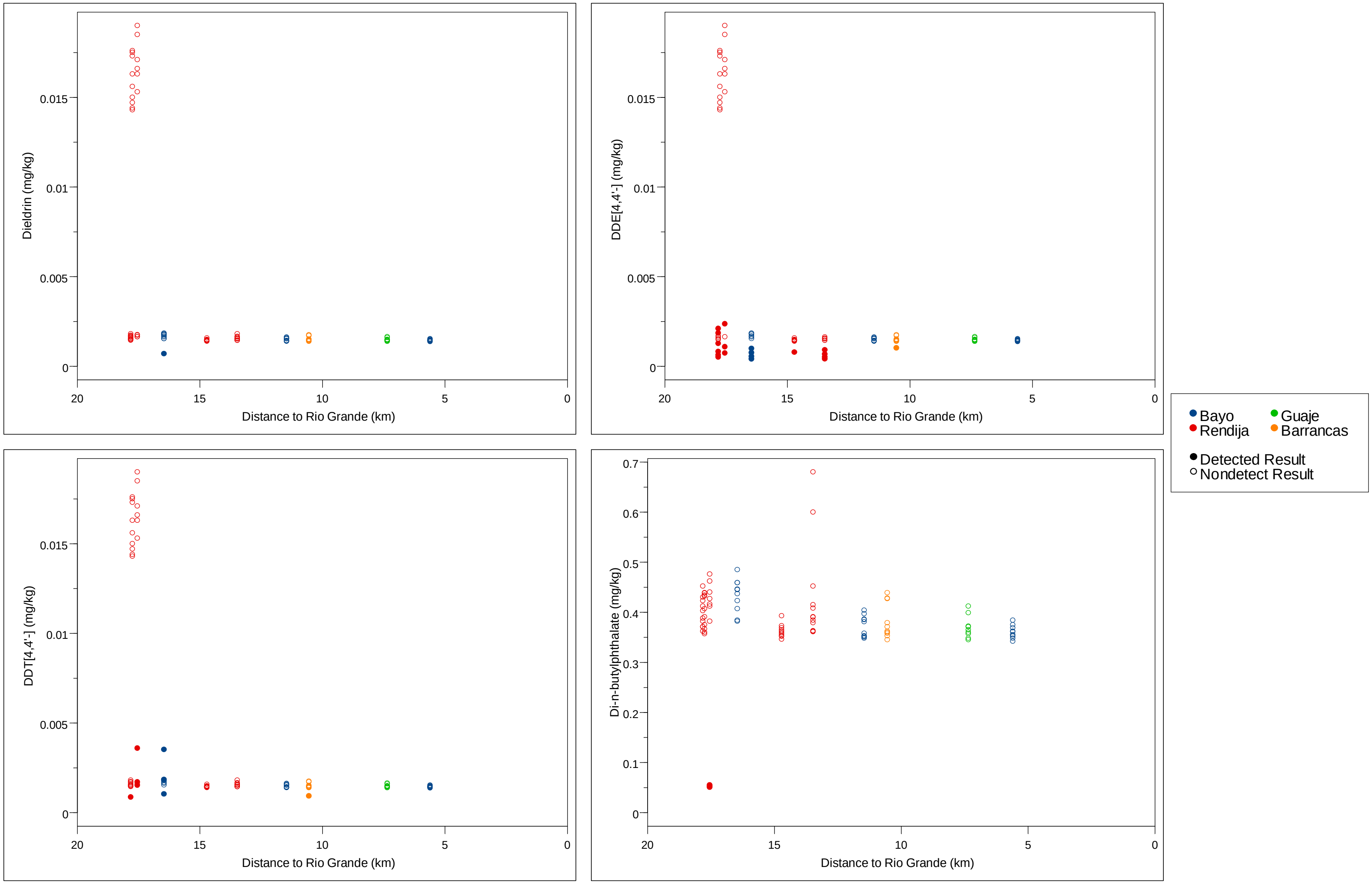


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

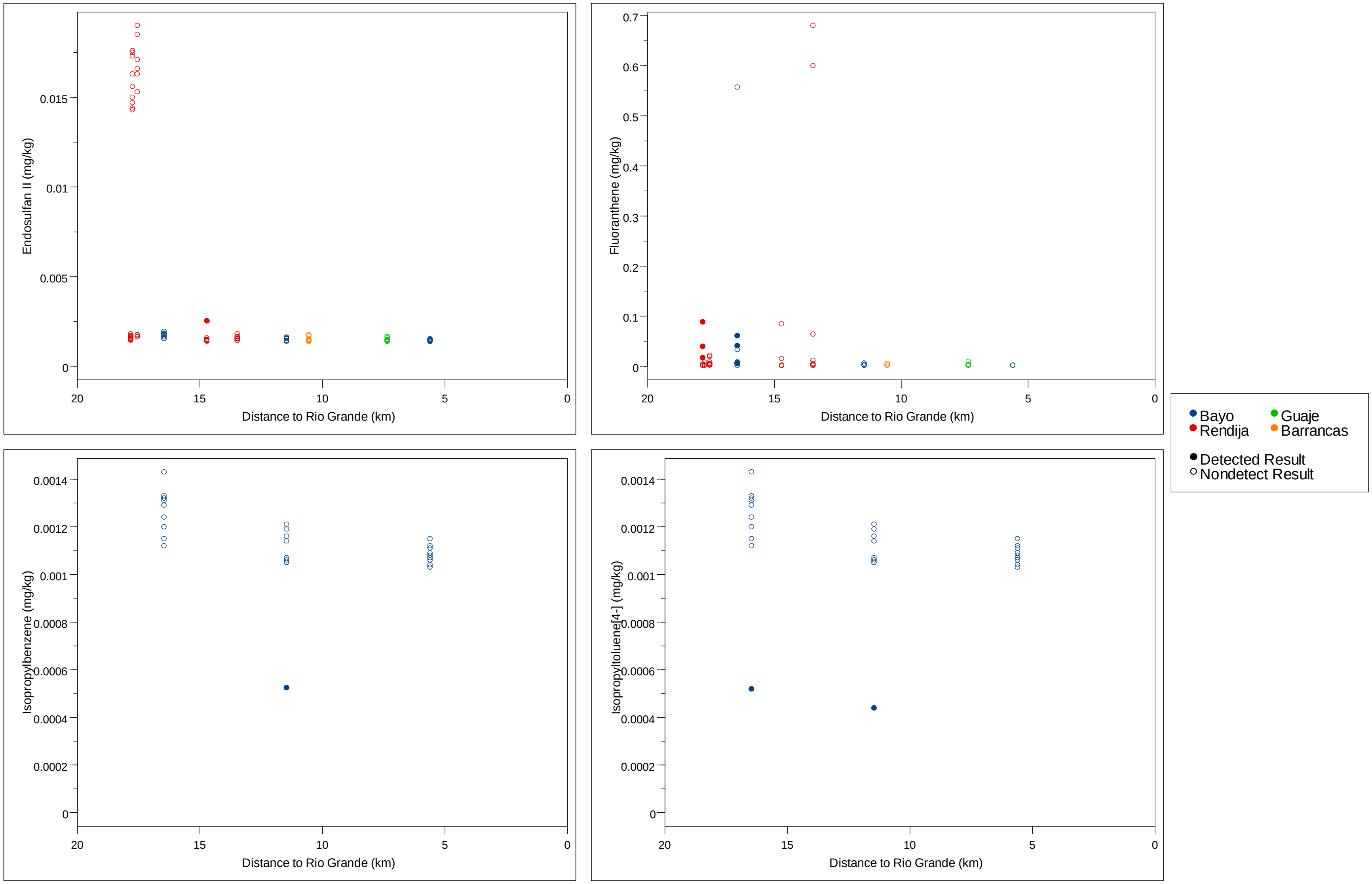


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

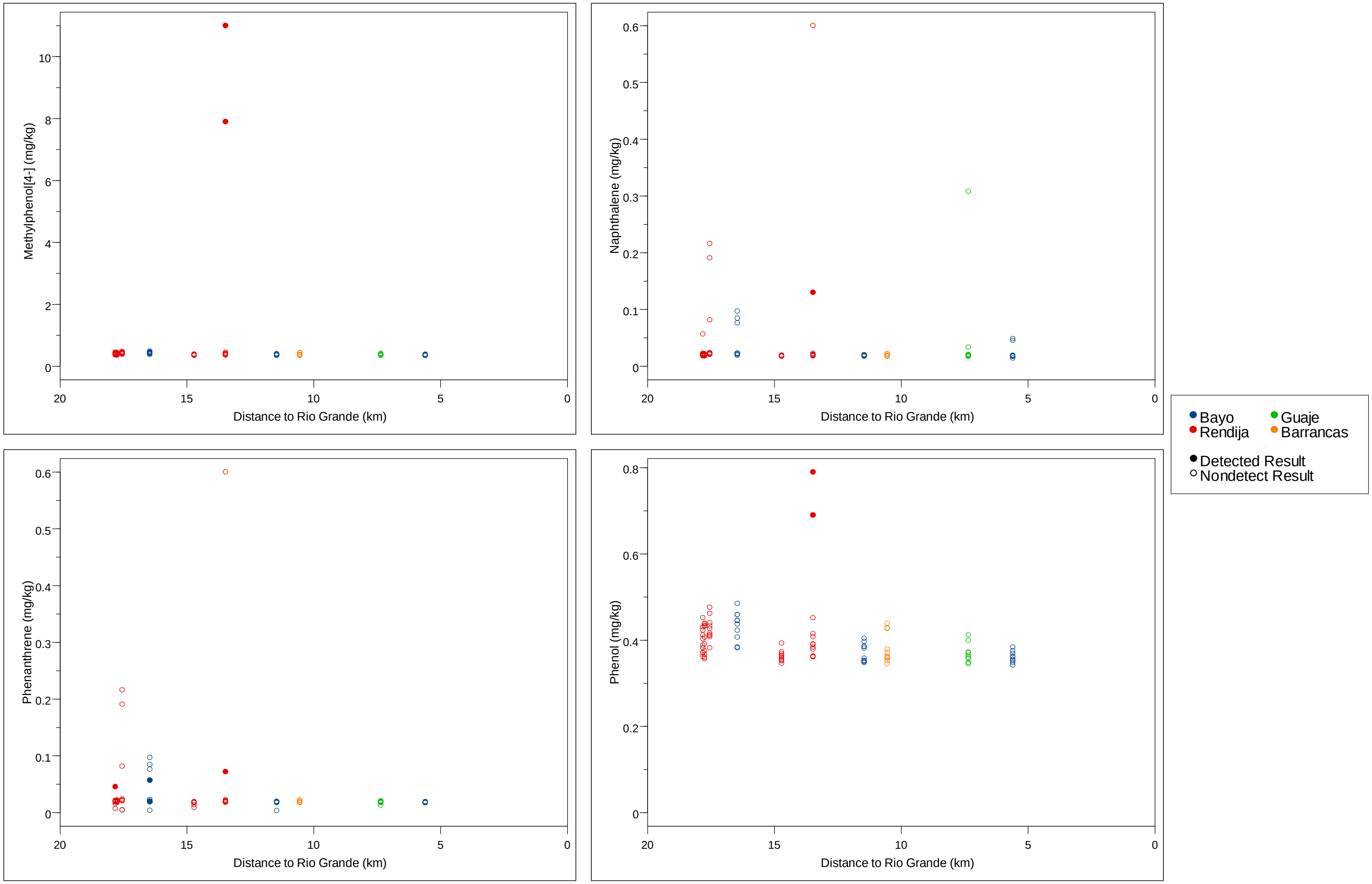


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

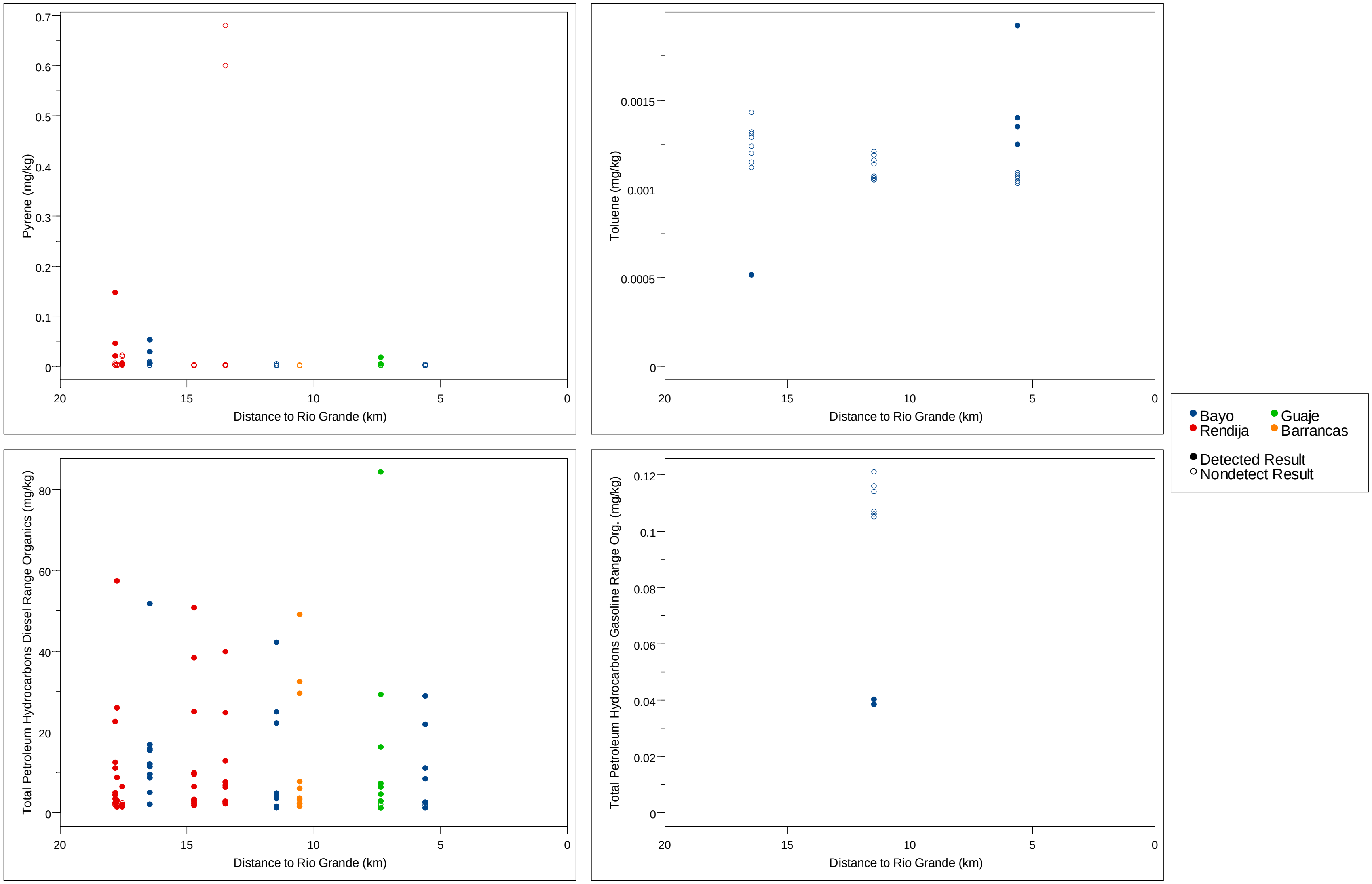


Figure D-1.1-2 (continued) **Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons**

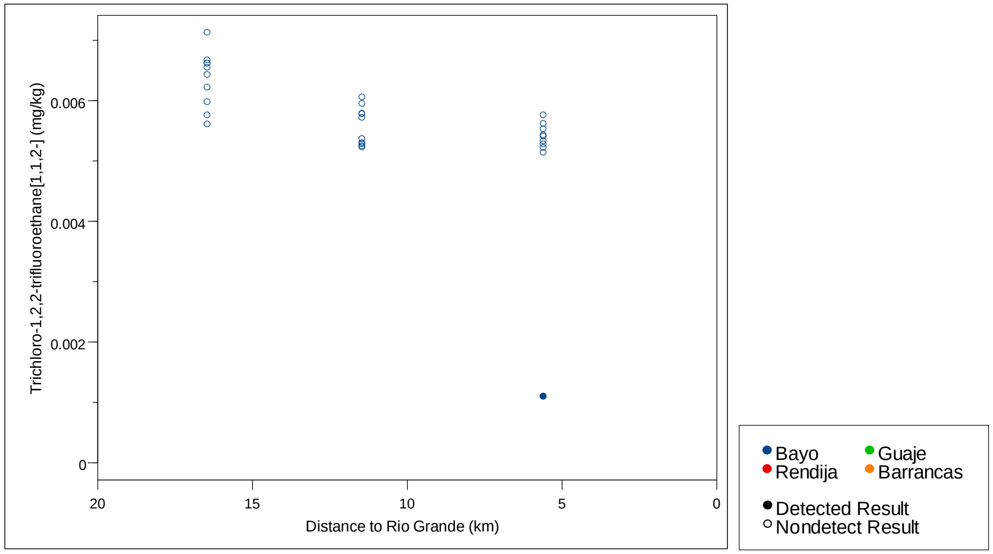


Figure D-1.1-2 (continued) Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the north canyons

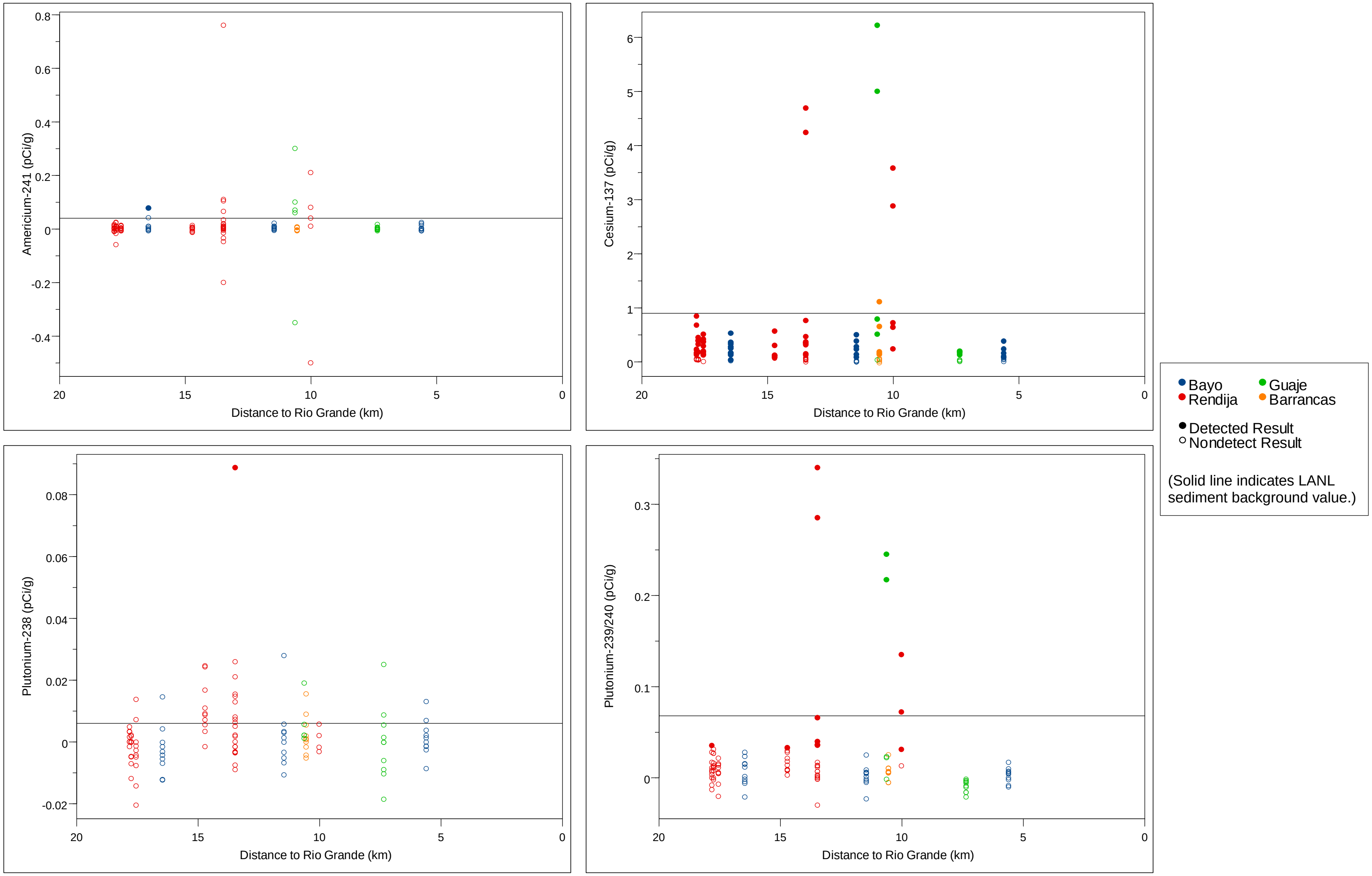


Figure D-1.1-3 Plots of sample results versus distance from the Rio Grande for all radionuclide COPCs identified in sediment in the north canyons

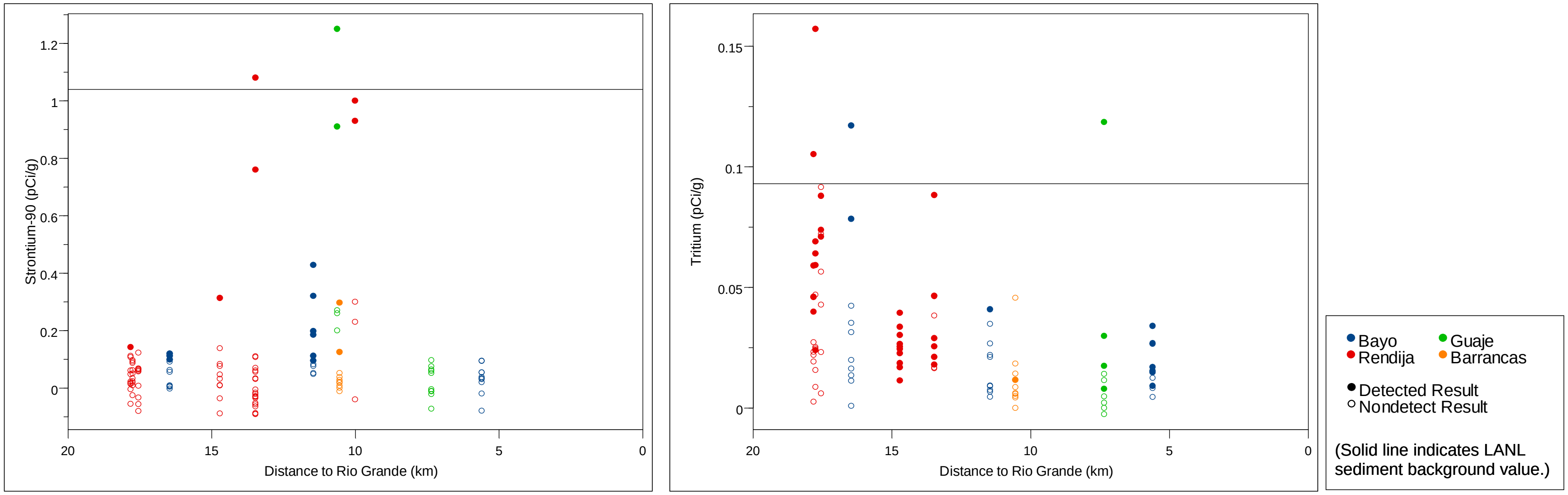


Figure D-1.1-3 (continued) **Plots of sample results versus distance from the Rio Grande for all radionuclide COPCs identified in sediment in the north canyons**

Table D-1.2-1
Summary of Average Concentrations of Select Inorganic Chemicals in the North Canyons

	Aluminum		Antimony									Arsenic				Cadmium						Chromium						Cyanide					
	Fine Facies	Coarse Facies	Pre-Fire Fine Facies			Post-Fire Fine Facies			Coarse Facies, Pre-Fire and Post-Fire			Fine Facies	Coarse Facies			Fine Facies			Coarse Facies			Fine Facies			Coarse Facies			Post-Fire Fine Facies			Post-Fire 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	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper 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	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean
BV	**15400**		**0.83**									**3.98**				**0.40**						**10.5**						**0.82**					
BR-1	—[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BY-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.39	0.39	0.39	0.17	0.17	0.17	8.2	8.2	8.2	2.0	2.0	2.0	—	—	—	—	—	—
BY-2	—	—	n.d.[b]	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	—	—	—	—	—	—	—	—	—	—	4.1	4.1	4.1	3.7	3.7	3.7	—	—	—	—	—	—
BY-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G-BKG	—	—	n.d.	n.d.	n.d.	0.54	0.46	0.38	0.28	0.14	0.00	2.20	0.40	0.40	0.40	0.22	0.22	0.21	0.02	0.01	0.00	—	—	—	—	—	—	1.18	1.04	0.90	0.50	0.25	0.00
G-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8.8	8.8	8.8	7.1	7.1	7.1	—	—	—	—	—	—
R-1E	12808	2190	—	—	—	—	—	—	—	—	—	4.59	1.08	1.08	1.08	0.64	0.32	0.00	0.56	0.28	0.00	9.2	9.2	9.2	3.0	3.0	3.0	—	—	—	—	—	—
R-1M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.62	0.31	0.00	0.59	0.29	0.00	7.4	7.4	7.4	5.5	5.5	5.5	—	—	—	—	—	—
R-1S	10943	4235	—	—	—	—	—	—	—	—	—	3.35	1.63	1.32	1.02	0.64	0.32	0.00	0.57	0.28	0.00	8.0	8.0	8.0	5.2	5.2	5.2	—	—	—	—	—	—
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.55	0.27	0.00	0.53	0.26	0.00	—	—	—	—	—	—	—	—	—	—	—	—
R-3	9204	4214	0.44	0.22	0.00	1.10	1.10	1.10	0.42	0.21	0.00	3.00	2.58	1.83	1.08	—	—	—	—	—	—	7.0	6.5	5.9	5.9	4.7	3.5	—	—	—	—	—	—
R-3E	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.75	0.51	0.28	0.53	0.27	0.00

Table D-1.2-1 (continued)

	Iron		Lead		Manganese				Selenium						Vanadium						Zinc					
	Fine Facies	Coarse Facies	Fine Facies	Coarse Facies	Pre-Fire Fine Facies	Post-Fire Fine Facies	Pre-Fire Coarse Facies	Post-Fire Coarse Facies	Fine Facies			Coarse Facies			Fine Facies			Coarse Facies			Fine Facies			Coarse Facies		
Reach	Average	Average	Average	Average	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	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
BV	**13800**		**19.7**		**543**				**0.30**						**19.7**						**60.2**					
BR-1	—	—	—	—	—	—	—	—	1.77	0.89	0.00	1.58	0.79	0.00	—	—	—	—	—	—	—	—	—	—	—	—
BY-1	—	—	27.8	10.8	—	—	—	—	1.86	0.93	0.00	1.76	0.88	0.00	16.7	16.7	16.7	6.7	6.7	6.7	—	—	—	—	—	—
BY-2	—	—	8.4	10.0	—	—	—	—	1.71	0.86	0.00	1.55	0.78	0.00	9.5	9.5	9.5	6.8	6.8	6.8	32.3	32.3	32.3	43.5	43.5	43.5
BY-3	—	—	—	—	—	—	—	—	1.63	0.82	0.00	1.54	0.77	0.00	16.7	16.7	16.7	15.3	15.3	15.3	—	—	—	—	—	—
G-BKG	—	—	19.2	2.3	n.d.	865	n.d.	85	0.91	0.88	0.84	0.27	0.14	0.00	—	—	—	—	—	—	46.8	46.8	46.8	8.4	8.4	8.4
G-1	11244	8205	—	—	—	—	—	—	1.61	0.80	0.00	1.69	0.84	0.00	21.7	21.7	21.7	16.6	16.6	16.6	—	—	—	—	—	—
R-1E	12300	4510	18.8	5.6	—	—	—	—	1.67	1.46	1.25	1.67	0.84	0.00	19.1	19.1	19.1	6.9	6.9	6.9	—	—	—	—	—	—
R-1M	—	—	—	—	—	—	—	—	1.85	0.92	0.00	1.41	0.90	0.40	14.7	14.7	14.7	11.8	11.8	11.8	—	—	—	—	—	—
R-1S	—	—	—	—	—	—	—	—	1.93	0.96	0.00	1.71	0.85	0.00	16.7	16.7	16.7	11.7	11.7	11.7	—	—	—	—	—	—
R-2	—	—	—	—	—	—	—	—	1.65	0.82	0.00	1.58	0.79	0.00	—	—	—	—	—	—	—	—	—	—	—	—
R-3	11027	13566	28.8	10.9	328	873	287	371	1.34	0.79	0.23	2.47	1.39	0.31	15.2	13.9	12.5	16.3	12.9	9.5	44.1	40.7	37.4	48.8	43.3	37.9
R-3E	—	—	18.8	3.6	n.d.	560	n.d.	240	0.73	0.65	0.58	0.37	0.37	0.37	—	—	—	—	—	—	—	—	—	—	—	—

Note: All units are in mg/kg.

[a] — = Not a COPC in reach (not detected or no detects > BV).

[b] n.d. = No data; includes rejected data and post-fire columns for reaches where there are no significant fire effects.

Table D-1.2-2
Summary of Average Concentrations of PCBs in the North Canyons

Reach	Aroclor-1242						Aroclor-1254						Aroclor-1260					
	Fine Facies			Coarse Facies			Fine Facies			Coarse Facies			Fine Facies			Coarse Facies		
	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
BR-1	0.0042	0.0021	0.0000	0.0037	0.0022	0.0007	—[a]	—	—	—	—	—	—	—	—	—	—	—
BY-1	0.0198	0.0171	0.0144	0.0042	0.0021	0.0000	0.0141	0.0114	0.0088	0.0042	0.0021	0.0000	0.0088	0.0064	0.0040	0.0042	0.0021	0.0000
BY-2	0.0039	0.0020	0.0000	0.0077	0.0062	0.0048	0.0039	0.0020	0.0000	0.0057	0.0043	0.0029	0.0073	0.0066	0.0058	0.0035	0.0028	0.0021
BY-3	0.0069	0.0055	0.0041	0.0035	0.0018	0.0000	0.0044	0.0030	0.0016	0.0033	0.0018	0.0004	0.0034	0.0020	0.0006	0.0035	0.0018	0.0000
G-BKG	n.d.[b]	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
G-1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1E	0.0053	0.0034	0.0014	0.0038	0.0019	0.0000	0.0053	0.0036	0.0019	0.0038	0.0019	0.0000	0.0039	0.0025	0.0010	0.0023	0.0023	0.0023
R-1M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-1S	0.0044	0.0022	0.0000	0.0036	0.0020	0.0004	—	—	—	—	—	—	0.0044	0.0022	0.0000	0.0037	0.0021	0.0005
R-2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R-3E	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

Note: All units are in mg/kg.

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

[b] n.d. = No data.

Table D-1.2-3
Summary of Average Concentrations of Select Radionuclides in the North Canyons

	Cesium-137				Strontium-90			
Reach	Pre-Fire Fine Facies	Post-Fire Fine Facies	Pre-Fire Coarse Facies	Post-Fire Coarse Facies	Pre-Fire Fine Facies	Post-Fire Fine Facies	Pre-Fire Coarse Facies	Post-Fire Coarse Facies
BV	**0.90**				**1.04**			
BR-1	0.52	n.d.[a]	0.05	n.d.	—[b]	—	—	—
BY-1	—	—	—	—	—	—	—	—
BY-2	—	—	—	—	—	—	—	—
BY-3	—	—	—	—	—	—	—	—
G-BKG	n.d.	3.13	n.d.	0.04	n.d.	0.66	n.d.	0.26
G-1	—	—	—	—	—	—	—	—
R-1E	—	—	—	—	—	—	—	—
R-1M	—	—	—	—	—	—	—	—
R-1S	—	—	—	—	—	—	—	—
R-2	—	—	—	—	—	—	—	—
R-3	0.32	3.09	0.00	0.15	0.04	0.64	—0.07	—0.03
R-3E	n.d.	1.96	n.d.	0.24	—	—	—	—

Note: All units are in pCi/g.

[a] n.d. = No data; includes cells for post-fire sediment in reaches where there are no significant fire effects.

[b] — = Not a COPC in reach; not detected or all detects below BVs.

Appendix E

Risk and Statistics Information

E-1.0 ECOLOGICAL SCOPING CHECKLISTS

E-1.1 Part A—Scoping Meeting Documentation

Site ID	Affected Media in North Canyons 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.	Solid waste management units (SWMUs) and areas of concern (AOCs) in canyon bottoms and on adjacent mesas have introduced inorganic and organic chemicals and radionuclides to some reaches of Barrancas, Bayo, Guaje, and Rendija Canyons, collectively referred to as the north canyons. Non-Laboratory sources, particularly along paved roads and in residential areas in the Los Alamos townsite, as well as the redistribution of ash from the Cerro Grande burn area, are additional sources of contaminants in the north canyons. Mechanisms of contaminant release to the north canyons system include airborne releases from firing sites, liquid releases, and contaminants mobilized by storm runoff. Investigation reaches include three reaches of Bayo Canyon (BY-1, BY-2, and BY-3), one reach in Barrancas Canyon (BR-1), five reaches in Rendija Canyon (R1-M, R-1S, R-1E, R-2, and R-3), and one reach in Guaje Canyon (G-1).
List of primary impacted media **(indicate all that apply)**	**Surface soil**—Yes **Sediment**—Yes **Surface water**—Yes (persistent water, snowmelt) **Subsurface**—No **Groundwater**—Yes (spring water) **Other**—Stormwater (evaluated qualitatively)
Vegetation land-cover class **(indicate all that apply)**	**Aspen-riparian-wetland**—No **Cerro Grande fire high affected**—Yes **Grass species**—Yes **Mixed conifer**—Yes **Spruce-fir**—No **Open water**—No **Ponderosa pine**—Yes **Piñon-juniper**—Yes **Shrub species**—Yes **Urban-sparse-bare rock**—No Note: The north canyons investigation reaches are not well covered by Plate I, the vegetation land cover class map (LANL 2004, 087630).
Is threatened and endangered species (T&E) habitat present? **List species if applicable.**	The Mexican spotted owl is estimated to nest, roost, and forage at varying levels in north canyons watershed reaches. (See Keller 2009, 105243.)
Provide list and description of neighboring/ contiguous/ upgradient AOCs/SWMUs. **(Consider need to aggregate AOCs/SWMUs for screening.)**	Figure A-1 and Table B-1 in the north canyons work plan provide a comprehensive list of SWMUs/AOCs in the watershed (LANL 2001, 071060).
Is there evidence of run-on/runoff, erosion or a terminal point of surface-water transport?	Run-on and runoff are evident in all north canyons reaches. Minor erosion was observed as a result of intermittent stormwater flow. Canyon bottoms serve as the terminal point for surface water transport.

Other scoping meeting notes	All site visits to the reaches occurred in December 2008. Reaches in Bayo, and Rendija Canyons were investigated individually on foot. Access to Pueblo de San Ildefonso (including reaches BR-1, BY-3, and G-1) was not requested for the ecoscoping survey, although observations of habitat had been made previously during field investigations and are incorporated into this checklist. Reach BR-1 in Barrancas Canyon was evaluated from atop Barranca Mesa in December 2008, viewed from a distance of approximately 1.5 km. Ecoscoping in Guaje Canyon was performed immediately upstream of reach G-1, in similar habitat. Bayo Canyon below reach BY-3 was observed from NM 502. North canyons sediment was sampled between 2000 and 2007. All samples were collected after the Cerro Grande fire in May 2000. Samples were collected in both fire-affected regions and those that were not impacted by the Cerro Grande fire. Aquatic habitat and receptors were not observed in any of the north canyons reaches. However, the timing of the site visit, which was in December, between periods of significant precipitation may have precluded observation of ephemeral or intermittent aquatic habitat and receptors. Water from snowmelt runoff in some years can extend the full length of Rendija Canyon, including the middle and south forks, and in Guaje Canyon as far east as somewhere between Rendija Canyon and NM 502 (near the Los Alamos Canyon confluence). Intermittent flow is possible in reaches R-1M, R-1S, R-3, and G-1. The presence of a spring downstream of reach G-1 (GU-0.01 Spring) indicates the presence of alluvial groundwater in this part of the canyon. Persistent surface-water data are available for three locations in Guaje Canyon. Persistent surface water is present above reach G-1 at the background location “Guaje above Rendija” (reach G-BKG, which was not visited during ecoscoping). Snowmelt data are available for location Guaje at SR-502. Spring water is present in Guaje Canyon at location GU-0.01 Spring. The other reaches have only ephemeral flow and therefore no pathway for chronic exposure to water.

E-1.2 Part B—Site Visit Documentation

E-1.2.1 Reach R-1M

Site ID	Reach R-1M
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and 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)	Open ponderosa pine, shrub oak, and grass
Field notes on T&E habitat, if applicable	Reach R-1M contains moderate nesting, roosting, and foraging habitat for the Mexican spotted owl.
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present in reach R-1M. No aquatic receptors were present.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Surface-water transport in Rendija Canyon is ephemeral or intermittent from stormwater runoff and snowmelt. Stormwater may resuspend sediment contaminants.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes. Ephemeral or intermittent surface water from snowmelt or 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 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 R-1M shows some evidence of transport and deposition of material following storm events or snowmelt runoff.
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.)**	Samples of both fire-affected and nonaffected sediment 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. However, contaminant data for stormwater and snowmelt are not available for reach R-1M because there are no monitoring locations within or near the reach.

Additional Field Notes:

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

Reach R1-M is located in a fire-affected area and was subject to deposition of material following the Cerro Grande fire in May 2000.

Species observed during the site visit included raven, woodpecker, and Abert's squirrel. There was some evidence of deer use and there was also fossorial activity.

E-1.2.2 Reach R-1S

Site ID	Reach R-1S
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and 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 vegetation class	Open ponderosa pine, shrub oak, and grass
Field notes on T&E habitat, if applicable	Reach R-1S contains moderate nesting, roosting, and foraging habitat for the Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present in reach R-1S. No aquatic receptors were observed.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Surface water in Rendija Canyon is intermittent or ephemeral flow from stormwater runoff or snowmelt. Stormwater may resuspend and transport contaminants present in sediment.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes. Ephemeral or intermittent surface water from snowmelt or stormwater serves as a transport pathway. Erosion and deposition of material are evident in reach R-1S. 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.)**	Reach R-1S shows some evidence of transport and deposition of material following storm events or snowmelt runoff. Several large boulders are present in the drainage. Disturbed area at the Guaje Pines Cemetery is located 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.)**	Both fire-affected and unaffected 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 available within the reach. However, contaminant data for stormwater and snowmelt are not available for reach R-1S because there are no monitoring locations within or near the reach.

Additional Field Notes:

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

Terrestrial receptors observed included raven, coyote, passerine birds, and Abert’s squirrel.

Reach R-1S has a large drainage area and deeper channel than R-1M, with ~1-ft erosion evident post-fire. No surface water is present at the site; however, the site is subject to intermittent flow from snowmelt runoff and ephemeral flow following storm events. The reach is located in a fire-affected area and has been subject to deposition of material and subsequent erosion following the Cerro Grande fire in May 2000.

E-1.2.3 Reach R-1E

Site ID	Reach R-1E
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and 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)** = low
Field notes on the FIMAD vegetation class	Open ponderosa pine and grass
Field notes on T&E habitat, if applicable	Reach R-1E contains habitat of high potential roosting and nesting use by the Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present. No aquatic receptors were observed.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Surface water was not observed in reach R1-E. Reach R-1E has the smallest drainage area of the upper Rendija Canyon reaches and receives urban runoff from the townsite. Surface water in reach R-1E is ephemeral, originating from snowmelt or stormwater runoff. The reach terminates in bedrock.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes. Ephemeral or intermittent surface water from snowmelt or stormwater serves as a transport pathway. Some transport of sediment was evident as sediment deposition was observed at the channel split. However, significant surface-water runoff/erosion was not indicated. Because of the high vegetative cover and factors mitigating dust from the active channel deposits, air is not a major transport pathway. Alluvial groundwater is not present in reach R-1E.
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.)**	Exposure of subsurface asphalt from AOC C-0-0041 was observed in the bank cut of this reach. The reach is also influenced by urban runoff during storm events and has been minimally impacted by the Cerro Grande fire in relation to the other Rendija Canyon reaches. Disturbed area at the Guaje Pines Cemetery is located adjacent to the reach.

Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No. Ecological effects from emerging asphalt were not evident; however, the reach is revisited every other year to inspect for and remove debris (LANL 2008, 102726). The site will be revisited in fall 2009.
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 ecological effects are evident; however, the reach will be revisited in fall 2009 to remove emergent asphalt to prevent potential contaminant mobilization.

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 available within the reach, and stormwater samples are collected from site monitoring area (SMA) R-SMA-1 at the east end of the reach.

Additional Field Notes:

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

Passerine birds and burrowing activity by fossorial mammals were observed. Burrowing activity was observed in grassy portions of the c2 geomorphic unit.

Asphalt was visibly emerging from the channel bank. This site was previously remediated for this condition but continues to show signs of asphalt entering the drainage.

E-1.2.4 Reach R-2

Site ID	Reach R-2
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and 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 vegetation class	Open ponderosa pine with chamisa, juniper, mountain mahogany, apache plume and piñon.
Field notes on T&E habitat, if applicable	Reach R-2 contains habitat with high probability of use for roosting and nesting by the Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present. No aquatic receptors were observed.

Contaminant Transport Information:

Surface water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Surface water in this Rendija Canyon tributary is ephemeral flow from stormwater runoff. Ephemeral surface water may resuspend and transport contaminants from underlying sediment.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes, ephemeral surface water in the form of stormwater is a potential transport pathway. Surface-water runoff/erosion during storm events is an obvious pathway. Alluvial groundwater may be present in part of the canyon, and pathways to deeper saturated zones are possible. Because some contamination is surficial, dust is a potential pathway in areas of lower vegetative cover. The main areas with low plant cover are the active channel (c1) geomorphic units.
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.)**	Active channel erosion is evident in reach R-2 following periods of intermittent flow (i.e., storm events or snowmelt runoff).

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 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. Intermittent flow of stormwater is a transport mechanism for sediment contaminants, and a stormwater sample location is present in R-2 (R-SMA-2.3), although no events have been recorded or sampled here.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Passerine birds were observed. Ephemeral flow of stormwater may occur; however, there is no persistent surface-water flow in this reach. The active channel is relatively narrow in this reach and forms a sandy substrate with little vegetation. There is moderate grass cover and few shrubs and some large ponderosa pines adjoining the reach. No fossorial activity was noted in this reach.

E-1.2.5 Reach R-3

Site ID	Reach R-3
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and S. Reneau

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = medium **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = none
Field notes on the FIMAD vegetation class	Upstream portions of R-3 consist of moderately dense ponderosa pine with shrub (primarily oak) understory. Downstream portions are open grass with ponderosa pine overstory.
Field notes on T&E habitat, if applicable	Reach R-3 contains habitat with high probability of nesting, roosting, and foraging use by the Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present. No aquatic receptors were observed.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Ephemeral flow of stormwater or intermittent snowmelt runoff occurs in this reach. The reach has been subject to active sediment transport, and surface-water transport may be an important pathway during storm/flood events.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes. Ephemeral or intermittent surface water in the form of stormwater or snowmelt runoff is a potential transport pathway. Because some contamination is surficial, dust is a potential pathway in areas of lower vegetative cover. The main areas with low plant cover are the active channel (c1) geomorphic units. Thus, fugitive dust emanation from the active channel deposits is unlikely because of vegetative cover. Alluvial groundwater is not known to be present in Rendija Canyon.
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.)**	Reach R-3 was affected by the Cerro Grande fire of 2000. The reach was lightly burned and has been heavily impacted by post-fire flooding, as evidenced by flood debris (logs and boulders).

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.)**	Yes. Sediment samples were collected from representative locations within the mapped geomorphic units. Analytical suites for sediment samples are adequate to cover the potential contaminant sources. Because surface water in reach R-3 is not persistent, water samples are not required.
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. Intermittent flow of stormwater is a transport mechanism for sediment contaminants, but sediment data are adequate to evaluate this pathway.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Terrestrial receptors observed included raven, woodpecker, raptors, and passerine birds. This reach was subject to a low severity burn during the Cerro Grande fire in May 2000 and was affected post-fire by flooding, flood debris, and ash deposition.

E-1.2.5 Reach G-1

Site ID	Reach G-1
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and 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 vegetation class	Open juniper/chamisa with instances of piñon and apache plume
Field notes on T&E habitat, if applicable	Reach G-1 contains moderate roosting habitat for the Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present. Aquatic receptors were not observed; however, the full extent of this reach was not investigated on foot.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Guaje Canyon supports perennial surface water in upstream portions near the confluence with Rendija Canyon. Surface-water transport in Guaje Canyon reach G-1 is intermittent from snowmelt runoff or ephemeral from stormwater runoff events. Stormwater flow may extend down the canyon to the confluence with Los Alamos Canyon.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes. Surface water may resuspend sediment contaminants. Contaminated sediment that is transported by stormwater runoff (floods) may be redeposited downstream in the active channel or in adjacent abandoned channels or floodplains. These same floods also erode uncontaminated sediment, causing general downstream dilution and decreases in contaminant concentrations.
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.)**	Intermittent physical disturbance would occur from seasonal flooding and runoff.

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.)**	Yes. 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. Perennial surface water has been collected at two locations downcanyon from reach G-1 that are relevant for the part of the canyon that includes G-1: GU-0.01 Spring (emergent groundwater data) and Guaje at SR-502 (snowmelt data).
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 and surface-water data are adequate to address potential transport pathways.

Additional Field Notes:

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

There was evidence of site usage by birds, coyote, deer, and fossorial mammals.

This reach was not subject to burning during the Cerro Grande fire in May 2000.

E-1.2.6 Reach BR-1

Site ID	Reach BR-1
Date of Site Visit	12/08/2008 (Note: The canyon was observed from atop Barranca Mesa, which was approximately 1.5 km from the reach, during this site visit, although habitat observations had been previously made during field investigations.)
Site Visit Conducted by	J. Linville and 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 vegetation class	Ponderosa pine forest with juniper and piñon.
Field notes on T&E habitat, if applicable	Reach BR-1 contains high-quality nesting and roosting habitat for the Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Vegetation is present and terrestrial receptors are likely.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Ephemeral stormwater runoff events occur in this reach.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes, ephemeral stormwater
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, besides occasional floods

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 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 address potential contaminant transport.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Reach is dominated by ponderosa pine, with some juniper and piñon.

E-1.2.7 Reach BY-1

Site ID	Reach BY-1
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and S. Reneau

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = medium **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = none
Field notes on the FIMAD vegetation class	Open ponderosa, juniper, scrub oak
Field notes on T&E habitat, if applicable	Reach BY-1 has very high potential for nesting by the Mexican spotted owl (100%). (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present. Aquatic receptors were not observed.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	The stream flow in Bayo Canyon is entirely ephemeral from stormwater runoff and snowmelt. During periods of prolonged storms, runoff in Bayo Canyon occasionally may extend to Los Alamos Canyon.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	No. Stormwater may resuspend sediment contaminants. Vegetative cover and depth to contamination would mitigate dust from the active channel deposits; therefore, air is not expected to be a major transport pathway. Alluvial groundwater is not present in Bayo Canyon.
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.)**	Yes. Sediment samples were collected from representative locations within the mapped geomorphic units. Analytical suites for these samples were adequate to characterize the extent of 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 samples were collected from representative locations within the mapped geomorphic units of BY-1. Characterization data collected from Bayo Canyons are sufficient to address potential transport pathways from former TA-10.

Additional Field Notes:

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

Reach BY-1 was not affected by the Cerro Grande fire of May 2000. The area is a dry, open ponderosa pine habitat. Abert's squirrels were observed during the site visit. Reach BY-1 has a narrow channel with minimal flooding.

E-1.2.8 Reach BY-2

Site ID	Reach BY-2
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and S. Reneau

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = medium **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = none
Field notes on the FIMAD vegetation class	Vegetation consists of ponderosa pine with instance of chamisa and mullein.
Field notes on T&E habitat, if applicable	Reach BY-2 has very high nesting habitat potential for Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes, terrestrial receptors are present. Wildlife species were not observed during the site visit; however, evidence of deer (tracks, scat) was present. No aquatic habitat is present.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Reach BY-2 is located in a dry canyon. The stream flow in reach BY-2 is entirely ephemeral from stormwater runoff. During storm events, runoff in Bayo Canyon occasionally may extend to Los Alamos Canyon.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	No. While flood channel activity was noted, no hydraulic connections contributing to off-site contamination have been observed in Bayo Canyon. Vegetative cover and depth to contamination would mitigate dust from the active channel deposits; therefore, air is not expected to be a major transport pathway. No alluvial groundwater exists in Bayo Canyon.
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.)**	Recent flood deposits are evident in the c1 geomorphic unit and adjacent areas, including flood debris.

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.)**	Yes. 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 samples collected in BY-2 are adequate to characterize potential transport of contaminants. No additional water samples are required because of the dry nature of this reach.

Additional Field Notes:

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

Reach BY-2 begins as a wide drainage. The reach has a back channel and shows evidence of recent flooding (i.e., flood debris).

In addition to ponderosa pine, vegetation observed included chamisa, sumac, and mullein.

E-1.2.9 Reach BY-3

Site ID	Reach BY-3
Date of Site Visit	12/08/2008
Site Visit Conducted by	J. Linville and S. Reneau

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = medium **Relative wetland cover (high, medium, low, none)** = none **Relative structures/asphalt, etc., cover (high, medium, low, none)** = none
Field notes on the FIMAD vegetation class	Species observed include juniper, apache plume, chamisa, and piñon.
Field notes on T&E habitat, if applicable	Reach BY-3 has low roosting and foraging habitat potential for Mexican spotted owl. (See Keller 2009, 105243.)
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes. Terrestrial receptors are present. No aquatic habitat is present in reach BY-3.

Contaminant Transport Information:

Surface-water transport **Field notes on the terminal point of surface-water transport (if applicable)**	Reach BY-3 has a dry channel. The stream flow in Bayo Canyon is entirely ephemeral from stormwater runoff. During storm events, runoff in Bayo Canyon occasionally may extend to Los Alamos Canyon.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	No. Bayo Canyon is a dry canyon and its hydrology precludes potential infiltration and subsequent transport of surface contaminants. Stormwater may resuspend sediment contaminants. Vegetative cover and depth to contamination would mitigate dust from the active channel deposits; therefore, 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.)**	Yes. Sediment samples were collected from representative locations within the mapped geomorphic units. Analytical suites for these samples were adequate to represent 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. Existing data provide sufficient data to address potential pathways of site contamination.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Reach BY-3 is the lowest elevation of the north canyons reaches. The site is vegetated predominantly by piñon, juniper, and shrubs.

E-1.3 Part C—Ecological Pathways Conceptual Exposure Model

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

Question A:

Could soil contaminants reach receptors 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: Samples have been collected and analyzed for volatile organic compounds (VOCs) in Bayo Canyon investigation reaches upstream and downstream of former Technical Area 10, the primary potential contaminant source in the north canyons. Generally, only trace levels of VOCs have been detected in these samples, with a low overall frequency of detection. There are no known sources of VOCs in north canyons–affected media. The lack of ubiquitous VOCs in the geomorphically active sediment is consistent with the sources and 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.

Question B:

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

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

Answer (likely/unlikely/uncertain): likely

Provide explanation: Most areas of contaminated sediment are well vegetated, mitigating fugitive dust carried in air. Burrowing animals are as likely to encounter wetted subsurface sediment contamination via ingestion or direct contact than as dust in burrow air.

Question C:

Can contaminated soil be transported to aquatic ecological communities? (Use Standard Operating Procedure [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): likely

Provide explanation: Persistent surface water was sampled at three locations in Guaje Canyon only. Snowmelt and spring water (groundwater) data are available for two locations in reach G-1. Intermittent snowmelt runoff in some years can extend the full length of Rendija Canyon, including the middle and south forks, and in Guaje Canyon as far downstream as between Rendija Canyon and NM 502 (near the Los Alamos Canyon confluence). Intermittent flow is therefore possible in reaches R-1M, R-1S, R-3, G-BKG, and G-1. The other reaches have ephemeral flow or very minor, local snowmelt.

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.

- **Contaminants have the potential 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): likely

Provide explanation: Alluvial groundwater emerges as a spring only in reach G-1 (GU-0.01 Spring). Receptors could potentially be exposed to contaminants at this location.

Question E:

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 possibly 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 not contacting groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): unlikely

Provide explanation: No alluvial groundwater is present in Bayo or Barrancas Canyons. Contaminant concentrations in any potential alluvial groundwater in Rendija Canyon are expected to be low, if at all present, because of the absence of historic effluent releases in the watershed. In Guaje Canyon, alluvial groundwater discharges in reach G-1 at GU-0.01 Spring. Exposure to potentially contaminated emergent groundwater would be limited to reach G-1.

Question F:

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

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

Answer (likely/unlikely/uncertain): unlikely

Provide explanation: Erosion and mass wasting are minimal.

Question G:

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 detected infrequently and at low concentrations in Bayo 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 some 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 may be 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 soil (if present) 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: 2

Provide explanation: Because bioaccumulating chemicals of potential concern (COPCs) are only sparsely detected in north canyons sediment. For example, high explosive compounds were not detected in north canyons sediment, and only low concentrations of three polychlorinated biphenyl compounds (Aroclor-1242, Aroclor-1254, and Aroclor-1260) were detected in a limited number of 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 most contamination is subsurface. However, it could be a major pathway for fossorial animals because they will be digging through contaminated sediment and could 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: The type of COPCs present in north canyons (are mostly not lipophilic) and most contamination is subsurface. 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: Sediment concentrations of cesium-137 (a gamma-emitting radionuclide) are greater than background concentrations. However, the cesium-137 was derived from the redistribution of ash from the Cerro Grande burn area and not from releases from SWMUs or AOCs.

Question N:

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

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

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

Terrestrial plants: 2

Provide explanation: Persistent surface water is not prevalent in the north canyons. With the exception of two locations in reach G-1, surface water is limited to ephemeral stormwater or intermittent snowmelt runoff. Sediment contamination may pose a minor pathway for direct uptake by plants. Similarly, rain splash containing surface contamination (from sediment) may contribute to direct uptake of contaminants by plants.

Question O:

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: 2

Provide explanation: Contaminants present in persistent surface water and sediment may interact with receptors in the aquatic food web, if present.

Question P:

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: 3

Provide explanation: Contaminants present in persistent surface water and sediment may interact with receptors through ingestion.

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: 2

Provide explanation: Contaminants present in persistent surface water and sediment may interact with receptors in the aquatic food web; however, contaminants are mostly nonlipophilic.

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: 2

Terrestrial animals: 2

Provide explanation: Active channel (c1 geomorphic unit) sediment concentrations of cesium-137 (a gamma-emitting radionuclide) are greater than background concentrations. Cesium-137 was also detected in water samples. However, the cesium-137 was derived from the redistribution of Cerro Grande fire ash and not from releases from SWMUs or AOCs.

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: 3

Provide explanation: Contaminants present in persistent surface water and sediment may interact with emergent vegetation through uptake.

Question T:

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: 3

Provide explanation: Contaminants present in persistent surface water and sediment may interact with receptors in the aquatic food web.

<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: 2

Provide explanation: Contaminants present in persistent surface water and sediment may interact with receptors in the aquatic food web. However, compounds prone to bioaccumulation (i.e., organic compounds) were infrequently detected in water and sediment.

<u>Question V</u>:

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

- **External irradiation effects are most relevant for gamma-emitting radionuclides.**
- **The water column acts to absorb radiation; 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):

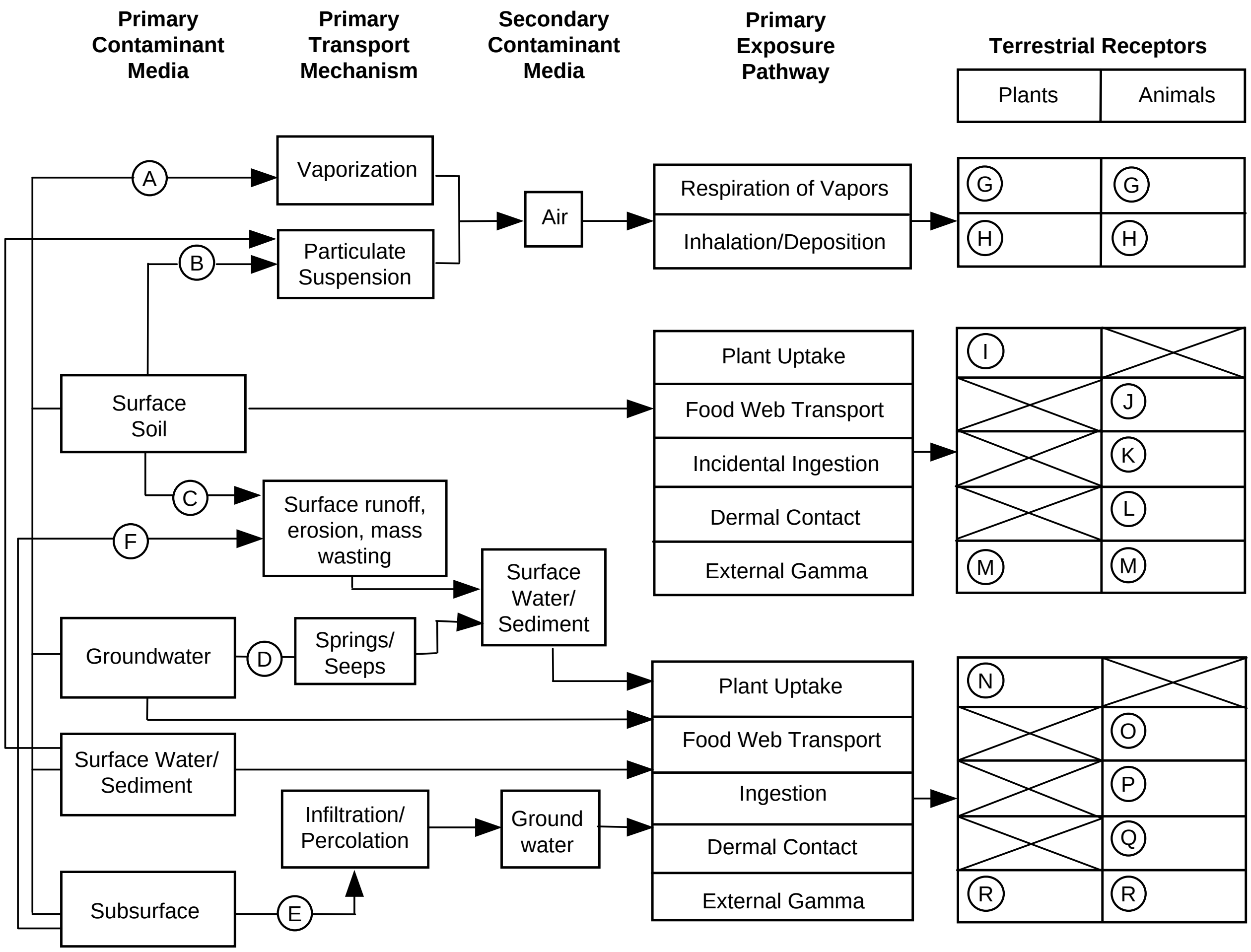
Aquatic plants: 2

Aquatic animals: 2

Provide explanation: Active channel (c1 geomorphic unit) sediment concentrations of cesium-137 (a gamma-emitting radionuclide) are greater than background concentrations. Cesium-137 was also detected in water samples. However, the cesium-137 was derived from the redistribution of Cerro Grande ash and not from releases from SWMUs or AOCs.

Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the Scoping Checklist

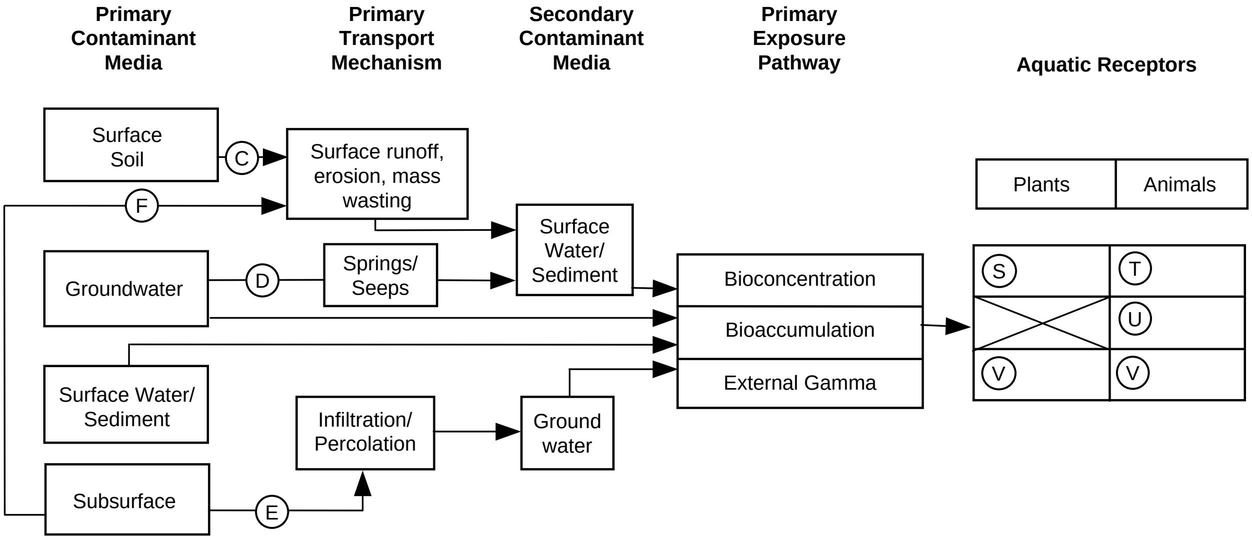


Ecological Scoping Checklist

Aquatic Receptors

Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the Scoping Checklist



Signatures and certifications:

Checklist completed by (provide name, organization, and phone number):

Name (printed): Jenifer Linville

Name (signature): Jenifer K Linville

Organization: Neptune and Company, Inc.

Phone number: (505) 662-0707, ext. 37

Date completed: January 16, 2009

Verification by a member of Environmental Restoration Project Ecological Risk Task Team (provide name, organization, and phone number)

Name (printed): Rich Mirenda

Name (signature): Richard Mirenda

Organization: Los Alamos National Laboratory

Phone number: (505) 665-6953

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

As discussed in Section 8.1.7, most chemicals of potential ecological concern (COPECs) identified for the north canyons have biota study-relevant data from previous canyons investigations. This appendix presents relevant COPEC exposure data for each north canyons assessment endpoint assembled from the Los Alamos and Pueblo Canyons, Mortandad Canyon, and Pajarito Canyon investigation reports (LANL 2004, 087390; LANL 2006, 094161; LANL 2008, 104909).

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-2.0-2 lists the active channel sediment samples used for riparian and aquatic receptors (bats, swallow, and the aquatic community) in the north canyons and biota investigation reaches in other watersheds. Table E-2.0-3 lists the water samples evaluated for the aquatic community in the north canyons and biota investigation reaches in other watersheds. Tables E-2.0-1, E-2.0-2, and E-2.0-3 are 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).

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 Table E-3.1-1 (SSLs for inorganic and organic chemicals), Table E-3.1-2 (recreational SALs for radionuclides), Table E-3.1-3 (surface-water ingestion for SSLs for inorganic and organic chemicals), and Table E-3.1-4 (residential SALs for radionuclides). Toxicity information for chemicals of potential concern (COPCs) for which surface-water screening levels (SLs) were calculated is provided in Table E-3.1-5 (inorganic and organic chemicals) and Table E-3.1-6 (radionuclides).

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 COPCs fall into three general categories. The first consists of COPCs detected in all of the investigation samples for a data subset of COPCs (radionuclides) that are not censored at the detection limit and that are reported as the actual measurement value from the instrument with a nondetect qualifier. The second includes inorganic or organic COPCs for which the data are a mixture of detected and nondetected values for a data subset. Nondetect sample results are censored at the detection limits and are reported with a data qualifier starting with “U” (e.g., U or UJ). For inorganic and organic chemicals, ProUCL Version 4.00.02 incorporates approaches to representing the censored nondetect values for the calculation of upper confidence limits (UCLs) for use as EPCs. The third category is either an extreme case of the second category where the number of nondetects (the rate of censorship) is so high that methods for the second category are unreliable, or the data set is too small to calculate a UCL and the maximum detected sample result is used as the EPC. Section E-3.2.1 describes the methods used to analyze data that fall into the above three categories.

E-3.2.1 UCL Calculation Methods

The statistical methods used to calculate UCLs are consistent with U.S. Environmental Protection Agency (EPA) guidance (EPA 1989, 008021). ProUCL Version 4.00.02, was used to calculate UCLs to use as EPCs in the human health risk assessment. Many of the data sets for sediment investigation reaches are censored at the detection limits. ProUCL software includes methods, such as Kaplan–Meyer, for calculation of the UCLs when censored data exist. When only small sample data sets were available ($\leq$3 samples) for a specific COPC, the maximum detected sample result was used to represent the EPC.

The first step in calculating a UCL is to determine whether the data fit a probability distribution. The ProUCL software assesses normal, lognormal, and gamma 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.
- Three or fewer sample results are available; the maximum detected concentration is used.

Generally speaking, the method ProUCL recommends is based upon the sample size, distribution of the data, sample standard deviation, and level of data censorship (number of nondetects). Details are provided in the “ProUCL Version 4.00.02 User Guide” (EPA 2007, 102895) and “ProUCL Version 4 Technical Guide” (EPA 2007, 106124).

When ProUCL recommended a UCL that exceeded the maximum value for the data, a UCL calculated using one of the alternative methods was used. This approach is consistent with EPA guidance (EPA 2007, 102895). The calculated EPCs based upon the ProUCL UCLs for sediments are provided in Tables 8.2-13 and E-3.2-1.

E-3.3 Nonstorm-Related Surface-Water EPCs

Only nonstorm-related surface-water samples were evaluated and samples collected before 2003 were excluded. The pre-2003 results are not used to calculate EPCs because concentrations in older samples are not representative of current site conditions. Field duplicates (indicated by “FD” in the field quality control [QC] type code column in Appendix C tables) were excluded from EPC calculations. These results are from samples obtained for quality assurance (QA)/QC purposes and not as primary characterization data. Filtered water sample results were excluded, and unfiltered water sample results were used to represent surface water that could be encountered during recreational activities in the canyons. Unfiltered samples provide a protective estimate in that concentrations in unfiltered samples are typically larger than in filtered samples.

Surface-water data were evaluated for each sampling location; surface-water sample locations were associated with a sediment investigation reach.

Table E-3.3-1 presents the EPCs for surface-water COPCs retained for the human health risk assessment. Because of the small samples sizes for all the COPCs evaluated, maximum detected values were used as the EPCs for water, which are provided in Tables 8.2-14 and E-3.3-1.

E-3.4 Supplemental Human Health Risk Scenario

The SSLs and SALs used for the supplemental human health risk scenario (residential) are provided in Table E-3.4-1. The risk assessment results for the residential scenario are provided in Table E-3.4-2. The ratios and sum of fraction values for the residential scenario are provided in Table E-3.4-3. Sediment EPCs used for this analysis are provided in Table 8.2-13 and E-3.2-1.

E-3.5 Calculation of Surface-Water Recreational Screening Levels

The method used to calculate the surface-water screening levels (SLs) is based upon the methodology used to calculate the recreational soil screening values (LANL 2007, 094496) and EPA Risk Assessment Guidance for Superfund, Part E (EPA 2004, 090800). The equations used for noncarcinogens, carcinogens, and radionuclides are detailed below. The parameter values used for the calculations were presented in Table E-3.1-3.

Noncarcinogens

$$SWSL\,(ug/L) = \frac{(1000\,ug/ml)\,x\,(AT_{cnc}\,x\,THQ\,x\,BW_c)}{(EF\,x\,ED)\,x\,[(\frac{Ing}{RfDo}) + (\frac{ET\,x\,SA_c\,x\,Kp\,x\,0.001\,L/cm^3}{RfDd})]}$$

Carcinogens

$$SWSL\,(ug/L) = \frac{(1000\,ug/ml)\,x\,(AT_c\,x\,TR)}{(EF/ET)\,x\,[(IFSW\,x\,SFo) + (DFSW\,x\,Kp\,x\,SFd\,x\,0.001\,L/cm^3)]}$$

Radionuclides

$$SWSL(pCi/L) = \frac{TD}{EF \times Ing \times DCFi}$$

Where, $SFd = SFo/GIAbs\,Factor$

$$RfDd = RfDo\,x\,GIAbs\,Factor$$

$$IFSW = \frac{ED_c\,x\,Ing}{BW_c} + \frac{(ED - ED_c)\,x\,Ing}{BW}$$

$$DFSW = \frac{ED_c\,x\,SA_c}{BW_c} + \frac{(ED - ED_c)\,x\,SA}{BW}$$

and SWSL = surface-water SL

AT_{cnc} = averaging time, child, noncarcinogens

AT_c = averaging time, carcinogens

BW_c = body weight, child

BW = body weight, adult

EF = exposure frequency

ED = exposure duration

ET = exposure time

GIABs factor = gastrointestinal absorption factor

SA_c = exposure surface area child

SA = exposed surface area, adult

Kp = dermal permeability constant

Ing = surface-water ingestion quantity per event

IFSW = age-adjusted surface water ingestion factor

DFSW = age-adjusted surface water dermal absorption factor

SFo = oral slope factor

SFd = dermal slope factor

RfDo = oral reference dose

RfDd = dermal reference dose

DCFi = ingestion dose conversion factor

THQ = target hazard quotient

TR = target risk

TD = target dose

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 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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LANL (Los Alamos National Laboratory), January 2007. “Technical Approach for Calculating Recreational Soil Screening Levels for Chemicals,” Los Alamos National Laboratory document LA-UR-06-8828, Los Alamos, New Mexico. (LANL 2007, 094496)

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LANL (Los Alamos National Laboratory), April 2008. “Asphalt Monitoring and Removal Plan for Area of Concern C-00-041, Guaje/Barrancas/Rendija Canyons Aggregate,” Los Alamos National Laboratory document LA-UR-08-2666, Los Alamos, New Mexico. (LANL 2008, 102726)

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

Parameters	Residential Values[a]	Recreational Values[b]
Target hazard quotient (HQ)	1	1
Target cancer risk	1.00E-05	1.00E-05
Averaging time (carcinogen)	70 yr × 365 d	70 yr × 365 d
Averaging time (noncarcinogen)	Exposure duration × 365 d	Exposure duration × 365 d
Skin absorption factor	SVOC[c] = 0.1	SVOC = 0.1
	Chemical-specific	Chemical-specific
Adherence factor–child	0.2 mg/cm^2	0.2 mg/cm^2
Body weight–child	15 kg (0–6 yr-old)	31 kg (6–11-yr-old)
Cancer slope factor–oral (chemical-specific)	mg/kg-d^{-1}	mg/kg^{-}d^{-1}
Cancer slope factor–inhalation (chemical-specific)	mg/kg-d^{-1}	mg/kg-day^{-1}
Exposure frequency	350 d/yr	200 events/yr
Exposure duration–child	6 yr (0–6-yr-old)	6 yr (6–11-yr-old)
Age-adjusted ingestion factor	114 mg-yr/kg-d	22.6 mg-yr/kg-d
Age-adjusted inhalation factor	11 m^3-yr/kg-d	0.8 m^3-yr/kg-d
Inhalation rate–child	10 m^3/d	1.2 m^3/h
Soil ingestion rate–child	200 mg/d	71.4 mg/d
Particulate emission factor	6.61 × 10^9 m^3/kg	6.61 × 10^9 m^3/kg
Reference dose–oral (chemical-specific)	mg/kg-d	mg/kg-d
Reference dose–inhalation (chemical-specific)	mg/kg-d	mg/kg-d
Exposed surface area–child	2800 cm^2/d (head, hands, forearms, lower legs, feet)	3525 cm^2/d (face, hands, forearms, lower legs, and feet)
Age-adjusted skin contact factor for carcinogens	361 mg-yr/kg-d	273.3 mg-yr/kg-d
Volatilization factor for soil (chemical-specific)	m^3/kg	m^3/kg
Body weight–adult	70 kg	70 kg
Exposure duration	30 yr[d]	30 yr
Adherence factor–adult	0.07 mg/cm^2	0.07 mg/cm^2
Soil ingestion rate–adult	100 mg/d	25.6 mg/event
Exposed surface area–adult	5700 cm^2/d (head, hands, forearms, lower legs)	5700 cm^2/d (head, hands, forearms, lower legs)
Inhalation rate–adult	20 m^3/d	1.6 m^3/h
Event time	n/a[e]	1 h

[a] Parameter values from NMED (2006, 092513).

[b] Parameter values from LANL (2007, 094496).

[c] SVOC = Semivolatile organic compound.

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

[e] n/a = Not applicable.

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

Parameters	Adult	Child
Target dose water millirem per year (mrem/yr)	4	4
Target dose soil (mrem/yr)	15	15
Inhalation rate (m^3/yr)	14,035[a]	10,526[b]
Mass loading (g/m^3)	0.002[c]	0.002[c]
Outdoor time fraction	0.0228[d]	0.0228[d]
Indoor time fraction	0	0
Soil ingestion (g/yr)	225[e]	605[f]
Surface-water ingestion	0.2 L/event	0.2 L/event
Surface-water exposure frequency	20 events/yr	20 events/yr

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

[b] Calculated as [1.2 m^3/h × 200 h/yr]/[indoor + outdoor time fractions], where 1.6 m^3/h 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 used for residential and industrial scenarios (NMED 2004, 085615).

[d] Calculated as (1 h/d × 200 d/yr)/8766 h/yr, where 1 h/d is the exposure time for a recreational adult or child (LANL 2005, 088494).

[e] Calculated as [(0.1 g/d/3.9 h/d) × 200 h/yr)]/[indoor + outdoor time fractions], where 3.9 h/d is the time-weighted average for "doers" across ages 12–44 (EPA 1997, 066598, Table 15-10; data are from a key activity pattern study for adults), and where 0.1 g/d is the adult soil ingestion rate (NMED 2004, 085615).

[f] Calculated as [(0.2 g/d /2.9 h/d) × 200 h/yr)]/[indoor + outdoor time fractions] where 2.9 h/d is the time-weighted average across ages 5–11 (EPA 1997, 066598, Table 15-10; data are from a key activity pattern study for adults), and where 0.2 g/d is the child soil ingestion rate (NMED 2004, 085615).

Table E-3.1-3
Parameters Used to Calculate Chemical Surface-Water Screening Levels

Parameters	Recreational Scenario Values[a]
Target HQ	1
Target cancer risk	1.00E-05
Averaging time (carcinogen)	70 yr × 365 d
Averaging time (noncarcinogen)	Exposure duration × 365 d
Skin absorption factor	SVOC = 0.1
	Chemical-specific
Cancer slope factor–oral (chemical-specific)	mg/kg-d^{-1}
Cancer slope factor–inhalation (chemical-specific)	mg/kg-d^{-1}
Reference dose–oral (chemical-specific)	mg/kg-d
Reference dose–inhalation (chemical-specific)	mg/kg-d
Body weight–child	31 kg (6–11-yr-old)
Exposure duration–child	6 yr (6–11-yr-old)
Exposed surface area–child	3140 cm^2 (hands, forearms, lower legs, and feet)
Body weight–adult	70 kg
Surface-water Ingestion	0.2 L/event
Exposure duration–adult	30 yr
Exposed surface area[b]–adult	2130 cm^2 (hands and feet)
Exposure time	1 h/d
Exposure frequency[b]	20 d/yr

[a] Parameter values from LANL (2007, 099829), unless otherwise noted.

[b] Parameter value from LANL (2004, 087390).

Table E-3.1-4
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 2005, 090802).

[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 2005, 090802).

[c] Calculated as [1/ $6.6 \times 10^{+9}$ m^3/kg) × 1000 g/kg, where $6.6 \times 10^{+9}$ m^3/kg is the particulate emission factor (NMED 2005, 090802).

[d] Calculated as [5.6 h/d × 350 d/yr]/8766 h/yr, where 5.6 h/day is an estimate of time spent outdoors for a 3–11 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 2005, 090802).

[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 2005, 090802).

Table E-3.1-5
Toxicity Values for Chemical COPCs for Surface-Water Chemical Screening Values

Chemical	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Reference[a]	Reference Dose Oral (mg/kg-day)	Reference[a]
Aluminum	na[b]	na	1.00E+00	NCEA
Arsenic	1.50E+00	IRIS	3.00E-04	IRIS
Barium	na	na	2.00E-01	IRIS
Beryllium	na	na	2.00E-03	IRIS
Cadmium	na	na	5.00E-04	IRIS
Cobalt	na	na	2.00E-02	NCEA
Chromium	na	na	3.0-03	IRIS[c]
Iron	na	na	3.00E-01	NCEA
Manganese	na	na	2.40E-02	IRIS
Thallium	na	na	6.60E-05	IRIS
Vanadium	na	na	1.00E-03	NCEA

[a] IRIS = Integrated Risk Information System, HEAST = Health Effects Assessment Summary Tables, NCEA = National Center for Environmental Assessment, WHO = World Health Organization, CalEPA = California Environmental Protection Agency (Office of Environmental Health Hazard Assessment).

[b] na = Not available.

[c] RfDo for total chromium not available; RfDo for Cr (VI) used as conservative estimate.

Table E-3.1-6
Toxicity Values for Radionuclide COPCs for Which Surface-Water Chemical Screening Values Were Calculated

Radionuclide	Ingestion Dose Conversion Factor (mrem/pCi)	Reference
Americium-241	0.00364	RESRAD v6.21
Radium-226	0.00133	RESRAD v6.21
Thorium-228	0.000808	RESRAD v6.21
Thorium-230	0.000548	RESRAD v6.21
Thorium-232	0.00273	RESRAD v6.21
Uranium-234	0.000283	RESRAD v6.21
Uranium-238	0.000269	RESRAD v6.21

Table E-3.2-1
EPCs for Sediment COPCs

Reach	Analyte	Number Detects	Number Nonetects	% Nondetects	Minimum Detected	Maximum Detected	Mean	Median	Standard Deviation (SD)	Skewness	Coefficient of Variation	EPC	Units	UCL Method
G-BKG	Arsenic	5	0	0	0.4	4.2	1.842	0.93	1.637	0.887	0.889	3.403	mg/kg	95% UCL Student's-t
G-BKG	Cesium-137	4	1	20	0.51	6.22	3.13	2.895	2.909	0.142	0.929	5.244	pCi/g	95% UCL KM[a] (Percentile Bootstrap)
G-BKG	Strontium-90	2	3	60	0.91	1.25	1.08	1.08	0.24	—[b]	0.223	1.161	pCi/g	95% UCL KM (t)
R-1E	Aluminum	10	0	0	2190	17300	11746	12700	4510	-1.039	0.384	14360	mg/kg	95% UCL Student's-t
R-1E	Arsenic	10	0	0	1.08	5.36	4.242	4.605	1.285	-1.882	0.303	4.947	mg/kg	95% UCL Modified-t
R-1E	Iron	10	0	0	4510	14300	11521	12150	2788	-1.959	0.242	13046	mg/kg	95% UCL Modified-t
R-1E	Vanadium	10	0	0	6.93	23.9	17.86	19.1	5.625	-0.795	0.315	21.12	mg/kg	95% UCL Student's-t
R-1S	Arsenic	8	2	20	1.02	4.52	2.439	2.14	1.288	0.892	0.528	2.897	mg/kg	95% UCL KM (Percentile Bootstrap)
R-3	Aluminum	22	0	0	1060	23500	6482	4185	6127	1.656	0.945	9216	mg/kg	95% UCL Approximate Gamma
R-3	Arsenic	20	2	9	0.782	6.0	2.15	1.76	1.43	1.688	0.665	2.655	mg/kg	95% UCL KM (BCA[c])
R-3	Cesium-137	11	6	35	0.127	4.69	1.105	0.356	1.672	1.896	1.513	4.215	pCi/g	99% UCL KM (Chebyshev)
R-3	Iron	22	0	0	5320	67700	12412	9705	12566	4.429	1.012	17022	mg/kg	95% UCL Student's-t
R-3	Lead	22	0	0	3.59	110	19.03	10.08	26.32	2.744	1.384	43.49	mg/kg	95% UCL Chebyshev (Mean, SD)
R-3	Manganese	22	0	0	124	1540	418.4	307	364.6	2.278	0.872	757.2	mg/kg	95% UCL Chebyshev (Mean, Standard Deviation)
R-3	Strontium-90	2	20	91	0.76	1.08	0.92	0.92	0.226	—	0.246	0.9745	pCi/g	99% UCL KM (Chebyshev)
R-3	Vanadium	12	10	45	9.65	76.8	19.95	15.4	18.31	3.208	0.918	20.69	mg/kg	95% UCL KM (t)

Note: EPC = Exposure point concentration is based upon selected UCL method.

[a] KM = Kaplan–Meier.

[b] — = Not available or not applicable.

[c] BCA = Bias-corrected accelerated bootstrap method.

Table E-3.3-1
EPCs for Surface-Water COPCs

Reach	Location	Analyte	Number Detects	Number Nondetects	% Nondetects	Minimum Detected	Maximum Detected	Mean	Median	Standard Deviation	Skewness	Coefficient of Variation	EPC	Units
G-1	Guaje at SR-502	Aluminum	3	0	0	10700	94100	39400	13400	47391	1.726	1.203	94100	µg/L
G-1	Guaje at SR-502	Americium-241	2	1	33	0.0718	0.132	0.102	0.102	0.0426	—*	0.418	0.132	pCi/L
G-1	Guaje at SR-502	Arsenic	1	2	67	15.3	15.3	15.3	15.3	—	—	—	15.3	µg/L
G-1	Guaje at SR-502	Barium	3	0	0	821	1220	1027	1040	199.8	-0.292	0.195	1220	µg/L
G-1	Guaje at SR-502	Beryllium	3	0	0	6	9.5	8.033	8.6	1.818	-1.267	0.226	9.5	µg/L
G-1	Guaje at SR-502	Cadmium	3	0	0	1.5	1.9	1.633	1.5	0.231	1.732	0.141	1.9	µg/L
G-1	Guaje at SR-502	Chromium	3	0	0	12.0	51.8	29.4	24.3	20.4	1.05	0.694	51.8	µg/L
G-1	Guaje at SR-502	Cobalt	3	0	0	22.1	37.1	30.8	33.2	7.783	-1.256	0.253	37.1	µg/L
G-1	Guaje at SR-502	Iron	3	0	0	3450	61800	23550	5400	33140	1.725	1.407	61800	µg/L
G-1	Guaje at SR-502	Lead	3	0	0	69.1	85.5	77.47	77.8	8.205	-0.183	0.106	85.5	µg/L
G-1	Guaje at SR-502	Manganese	3	0	0	2790	5800	4727	5590	1680	-1.702	0.356	5800	µg/L
G-1	Guaje at SR-502	Radium-226	1	0	0	5.68	5.68	5.68	5.68	—	—	—	5.68	pCi/L
G-1	Guaje at SR-502	Thallium	2	1	33	0.41	0.81	0.61	0.61	0.283	—	0.464	0.81	µg/L
G-1	Guaje at SR-502	Thorium-228	2	0	0	6.99	19.3	13.15	13.15	8.704	—	0.662	19.3	pCi/L
G-1	Guaje at SR-502	Thorium-230	2	0	0	5.43	15.7	10.57	10.57	7.262	—	0.687	15.7	pCi/L
G-1	Guaje at SR-502	Thorium-232	2	0	0	6.07	14.6	10.34	10.34	6.032	—	0.584	14.6	pCi/L
G-1	Guaje at SR-502	Uranium-234	3	0	0	6.33	19.6	13.01	13.1	6.635	-0.061	0.51	19.6	pCi/L
G-1	Guaje at SR-502	Uranium-238	3	0	0	6.39	19.4	13.03	13.3	6.509	-0.186	0.5	19.4	pCi/L
G-1	Guaje at SR-502	Vanadium	3	0	0	34.1	94.8	54.53	34.7	34.87	1.731	0.639	94.8	µg/L

Notes: There are insufficient samples to calculate upper confidence limits for any of the surface water COPCs, consequently all of the surface water EPCs are based upon maximum detected values. Exposure point concentration is based upon selected UCL method.

*— = Not available or not applicable.

Table E-3.4-1
SLs for the Residential Scenario

Medium	COPC	End Point*	Target Adverse-Effect Level	Residential Screening Level	Units	Reference
Sediment	Aluminum	nc	HQ=1	77800	mg/kg	NMED (2006, 092513)
Sediment	Arsenic	ca	risk=10-5	3.9	mg/kg	NMED (2006, 092513)
Sediment	Cesium-137	rad	15 mrem/yr	5.6	pCi/kg	LANL (2005, 088493)
Sediment	Iron	nc	HQ=1	23500	mg/kg	NMED (2006, 092513)
Sediment	Lead	nc	HQ=1	400	mg/kg	NMED (2006, 092513)
Sediment	Manganese	nc	HQ=1	3590	mg/kg	NMED (2006, 092513)
Sediment	Strontium-90	rad	15 mrem/yr	5.7	pCi/kg	LANL (2005, 088493)
Sediment	Vanadium	nc	HQ=1	78.2	mg/kg	NMED (2006, 092513)

* nc = Noncarcinogen, ca = carcinogen, rad = radionuclide dose.

Table E-3.4-2
Summary of Residential Risk Assessment Results

Reach	Carcinogenic ILCR[a]	Noncarcinogenic Hazard Index	Total Radionuclide Dose (mrem/yr)
G-1	—[b]	0.80	—
G-BKG	8.7E-06	—	17
R-1E	1.3E-05	1.0	—
R-1S	7.4E-06	—	—
R-3	7.2E-06	1.4	14

Note: Shaded cells exceed 10^{-5} carcinogenic risk, hazard index of 1, or dose of 15 mrem/yr.

[a] ILCR = Incremental lifetime cancer risk.

[b] — = Incomplete pathway.

Table E-3.4-3
Risk Ratios Based on EPCs for Sediment, Residential Scenario

Carcinogens

Reach	Arsenic	Total Risk Ratio	Total Risk
Residential MSSL[a] (mg/kg)	3.9		
G-BKG	0.87	0.87	8.7E-06
R-1E	1.3	1.3	1.3E-05
R-1S	0.74	0.74	7.4E-06
R-3	0.68	0.68	7.2E-06

Noncarcinogens

Reach	Aluminum	Iron	Lead	Manganese	Vanadium	Total Risk Ratio	Total Hazard Index
Residential MSSL (mg/kg)	77800	23500	400	3590	78		
G-1	—[b]	0.50	—	—	0.29	0.80	0.80
R-1E	0.18	0.56	—	—	0.27	1.0	1.0
R-3	0.12	0.72	0.11	0.21	0.26	1.4	1.4

Radionuclides

Reach	Cesium-137	Strontium-90	Total Dose Ratio	Total Dose (mrem/yr)
Residential MSSL	5.6	5.7		
G-BKG	0.94	0.20	1.1	17
R-3	0.75	0.17	0.92	14

Notes: All results were nondetect, less than background, or no data were available. Shaded cells exceed 10-5 carcinogenic risk, hazard index of 1, dose of 15 mrem/yr, or risk ratio for individual COPC and/or reach greater than 1.

[a] MSSL = Medium-Specific Screening Level.

[b] — = All results were nondetect, less than background, or no data were available.

Appendix F

Summary of Stormwater Analytical Results

This appendix presents a summary of the stormwater results collected within the north canyons from 2003 to 2008 (Table F-1.0-1). This period is representative of current site conditions, as presented in Section 6.1. Table F-1.0-1 summarizes the stormwater results at each sampling location by field preparation (filtered or nonfiltered) for analytes that exceed comparison values. 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 analytical concentrations are compared with stormwater comparison values presented in Table F-1.0-2; the basis for these values is provided in Section 5.4. The classification of sampling locations is ephemeral, consistent with New Mexico Administrative Code (NMAC) § 20.6.4.

Table F-1.0-1
North 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
B-SMA-1	Filtered	INORGANIC	Aluminum	17	16	1	3800	64.1	38300	10	750	µg/L
B-SMA-1	Filtered	INORGANIC	Copper	15	10	5	4.7	2.2	16.1	3	4.3	µg/L
B-SMA-1	Filtered	INORGANIC	Lead	17	12	5	5	0.54	38.8	1	17	µg/L
B-SMA-1	Filtered	INORGANIC	Zinc	17	10	7	19	5.4	101	1	42	µg/L
Guaje above Rendija	Filtered	INORGANIC	Aluminum	2	2	0	10000	5020	15900	2	750	µg/L
Guaje above Rendija	Filtered	INORGANIC	Cadmium	2	2	0	0.96	0.675	1.25	2	0.6	µg/L
Guaje above Rendija	Filtered	INORGANIC	Copper	2	2	0	7.6	1.94	13.3	1	4.3	µg/L
Guaje above Rendija	Filtered	INORGANIC	Lead	2	2	0	47	16.1	77.1	1	17	µg/L
Guaje above Rendija	Filtered	INORGANIC	Zinc	2	2	0	35	13.1	56.7	1	42	µg/L
Guaje above Rendija	Nonfiltered	RAD	Gross alpha	1	1	0	100	100	100	1	15	pCi/L
Guaje above Rendija	Nonfiltered	RAD	Radium-228	1	1	0	38	38.2	38.2	1	30	pCi/L
Guaje at SR-502	Filtered	INORGANIC	Aluminum	3	3	0	1500	41.5	3220	2	750	µg/L
Guaje at SR-502	Filtered	INORGANIC	Copper	3	3	0	3.3	1.88	4.54	1	4.3	µg/L
Guaje at SR-502	Nonfiltered	ORGANIC	Aroclor-1260	2	1	1	0.066	0.066	0.066	1	0.00064	µg/L
Guaje at SR-502	Nonfiltered	RAD	Gross alpha	2	2	0	280	116	434	2	15	pCi/L
Guaje at SR-502	Nonfiltered	RAD	Radium-226	2	2	0	26	2.69	49.9	1	30	pCi/L
Guaje at SR-502	Nonfiltered	RAD	Radium-228	1	1	0	84	83.6	83.6	1	30	pCi/L
R-SMA-1	Filtered	INORGANIC	Aluminum	15	15	0	1200	57.5	5800	7	750	µg/L
R-SMA-1	Filtered	INORGANIC	Copper	14	10	4	3.5	1.5	5.4	3	4.3	µg/L
R-SMA-1	Nonfiltered	INORGANIC	Mercury	11	5	6	0.55	0.19	0.85	2	0.77	µg/L

*See Table F-1.0-2 for comparison value.

Table F-1.0-2
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	5000	—[b]	—	750
Antimony	Filtered	Antimony, dissolved	7440-36-0	—	—	640	—
Arsenic	Filtered	Arsenic, dissolved	7440-38-2	200	—	9.0	340
Boron	Filtered	Boron, dissolved	7440-42-8	5000	—	—	—
Cadmium	Filtered	Cadmium, dissolved	7440-43-9	50	—	—	0.6
Chromium	Filtered	Chromium, dissolved	18540-29-9	1000	—	—	213
Cobalt	Filtered	Cobalt, dissolved	7440-48-4	1000	—	—	—
Copper[c]	Filtered	Copper, dissolved	7440-50-8	500	—	—	4.3
Lead[c]	Filtered	Lead, dissolved	7439-92-1	100	—	—	17.0
Mercury	Nonfiltered	Mercury	7439-97-6	10	0.77	—	1.4
Nickel[c]	Filtered	Nickel, dissolved	7440-02-0	—	—	4600	169
Selenium	Nonfiltered	Selenium	7782-49-2	50	5.0	4200	20.0
Silver[c]	Filtered	Silver, dissolved	7440-22-4	—	—	—	0.4
Thallium	Filtered	Thallium, dissolved	7440-28-0	—	—	6.3	—
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[d]	Nonfiltered	Cyanide, weak acid dissociable	57-12-5	—	5.2	—	22.0
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	—	—	0.00050	3.0
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

Table F-1.0-2 (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)
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.

[d] Results for cyanide, amenable to chlorination are compared to screening value for cyanide, weak acid dissociable.

Attachment 1

Supplemental Tables for Appendixes B through E
(on CD included with this document)