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Cañada del Buey Investigation Report

Los Alamos
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EXECUTIVE SUMMARY

This investigation report for Cañada del Buey presents the results of studies conducted from 1999 to 2008 by Los Alamos National Laboratory (the Laboratory). The investigations reported herein address sediment, surface water, and shallow perched groundwater potentially impacted by solid waste management units (SWMUs) and areas of concern (AOCs) located within the Cañada del Buey watershed. Investigations occurred along 10 km (6 mi) of canyon bottom downcanyon of SWMUs or AOCs. The objectives of the investigations included defining the nature and extent of chemicals of potential concern (COPCs) in sediment and shallow groundwater and assessing the potential risks to human health and the environment from these COPCs. Analytical data from stormwater samples were also evaluated. The investigations address the sources, fate, and transport of COPCs in Cañada del Buey and evaluate the need for additional characterization or remedial actions.

Sediment investigations included geomorphic mapping, associated geomorphic characterization, and sediment sampling in eight investigation reaches located downcanyon from SWMUs or AOCs. Groundwater investigations included evaluation of analytical data from samples collected at two shallow monitoring wells within Cañada del Buey. Surface-water investigations included evaluation of analytical data from stormwater samples collected at three stream gages along Cañada del Buey.

Sediment COPCs in Cañada del Buey include 23 inorganic chemicals, 35 organic chemicals, and 7 radionuclides. These COPCs are derived from a variety of sources, including Laboratory SWMUs and AOCs; 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 sediment COPCs was determined by comparing COPC concentrations with human health residential screening action levels and soil screening levels and ecological screening levels.

No persistent surface water occurs in the Cañada del Buey investigation area; therefore, surface water does not present potential chronic ecological or human health risks and no surface-water COPCs were identified. Stormwater comparison values were exceeded by five inorganic chemicals and one organic chemical in samples from Cañada del Buey, but these chemicals do not present acute exposure risks.

A small spatially limited saturated groundwater zone is present in the vicinity of wells CDBO-6 and CDBO-7. This zone is likely recharged by surface water in Cañada del Buey that infiltrates the canyon floor to the west of CDBO-6, flows laterally through the subsurface, and perches near the base of Bandelier Tuff unit Qbt 1v in the vicinity of CDBO-6 and CDBO-7. Migration of contaminants to deeper zones is inhibited because of the small amount of surface-water recharge within Cañada del Buey. In addition, very few mobile contaminants are present in the watershed. Groundwater COPCs in Cañada del Buey include 27 inorganic chemicals, 11 organic chemicals, and 7 radionuclides. However, of these, only beryllium, bis(2-ethyhexyl)phthalate, and di-n-octylphthalate were detected at concentrations exceeding a water-quality standard, all in shallow perched groundwater in CDBO-6. These exceedances were observed only one time for each constituent out of seven or eight samples. Therefore, neither surface-water flow in the canyon nor the limited, perched zone at CDBO-6 and CDBO-7 represents significant sources of contamination to deeper groundwater.

The results of this investigation indicate that potential human health risks in Cañada del Buey are within acceptable limits for present-day and reasonably foreseeable future land uses. The site-specific human health risk assessment uses a recreational exposure scenario for most of the canyon and indicates that there are no unacceptable risks from carcinogens (incremental cancer risk criterion of 1×10^{-5}), noncarcinogens (hazard index of 1.0), or radionuclides (target dose limit of 15 millirems per year) due to

COPCs in sediment. One sediment investigation reach, CDB-4, is in an area owned by Los Alamos County and planned for residential and commercial development, but COPC concentrations are low there and do not present an unacceptable risk under a residential exposure scenario.

Chemicals of potential ecological concern (COPECs) identified in the ecological screening assessment were compared with results from other watersheds where more detailed biota investigations were conducted. This comparison indicated that concentrations of COPECs in Cañada del Buey derived from Laboratory SWMUs or AOCs are unlikely to produce adverse ecological impacts, and no additional biota investigations, mitigation, or monitoring is required.

The conceptual model indicates that conditions for sediments are likely to stay the same or improve because of decreases in contaminant concentrations after peak releases; therefore, no further monitoring of sediments is necessary. However, stormwater in Cañada del Buey will continue to 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.”

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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 and the master drainage in the region, in addition to investigations at SWMUs and AOCs.

1.1 Purpose and Scope

This investigation report presents the results of studies conducted from 1999 to 2008 in Cañada del Buey and its tributaries. This area is collectively referred to in this report as the Cañada del Buey watershed and is shown in Figure 1.1-1. The investigations reported herein address sediment, surface water, and shallow perched groundwater potentially impacted by SWMUs and AOCs located within the watershed. 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 Sandia Canyon and Cañada del Buey” (hereafter, “the work plan”) (LANL 1999, 064617) describes work scope and regulatory requirements for characterizing the Cañada del Buey watershed by the Laboratory. It contains a background review of SWMUs and AOCs in the watershed, 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 responses to a request for supplemental information (RSI) and a subsequent notice of disapproval (NOD) (LANL 2003, 081597; NMED 2003, 076014; LANL 2005, 091542; NMED 2005, 091689; NMED 2005, 089312). The scope of work was later modified per an agreement between NMED and the Laboratory (LANL 2009, 105287; NMED 2009, 105600). The requirement to implement the work plan was also included by reference in Section IV.B.5.b.i of the March 1, 2005, Compliance Order on Consent (the Consent Order).

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

Results of investigations of perched intermediate and regional groundwater beneath the Cañada del Buey watershed are not included in this report. Instead, they are included in sections pertaining to groundwater beneath the adjoining watershed of Pajarito Canyon in a report being prepared concurrently, the “Pajarito Canyon Investigation Report, Revision 1” (LANL 2009, 106771). Consolidation of perched intermediate and regional groundwater investigation results in the Pajarito Canyon report enables a more integrated evaluation to be conducted, especially for the area beneath Mesita del Buey where Technical Area 54 (TA-54) is located.

Data collected during the investigations included in this report are used to (1) define the nature and extent of contamination within canyon bottoms in the Cañada del Buey watershed; (2) update the conceptual model for contaminant distribution and transport within the canyon; (3) assess potential present-day human health and ecological risk from contaminants within the canyon; (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 the Laboratory collected since 1999 to evaluate current environmental conditions. Data from prior investigations and from environmental surveillance sampling are used as comparisons with current concentrations and help identify any temporal trends in contamination.

This report addresses characterization and risk assessment on the spatial scale of an entire canyon system, encompassing approximately 10 km (6 mi) of canyon bottom downcanyon 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 Cañada del Buey watershed and by helping identify and prioritize remedial activities within the watershed. 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 Cañada del Buey watershed. Section 2 provides background information on the sources and history of contaminant releases, previous investigations of canyons media, and remediation activities that have occurred in the watershed. Section 3 describes the scope of activities in this investigation. Section 4 introduces the field investigations. Section 5 describes the regulatory context of this investigation. Section 6 presents screening level (SL) assessments that identify chemicals of potential concern (COPCs) and that help focus subsequent sections on the subset of the most important COPCs for evaluating potential human health risk. Section 7 presents a physical system conceptual model, including discussions of the nature, sources, extent, fate, and transport of select COPCs that are most relevant for evaluating potential human health and ecological risk and contaminant transport. Section 8 presents ecological screening assessments and human health risk assessments and results. Section 9 presents conclusions and recommendations. Acknowledgements of those who contributed to this report are listed in Section 10. Section 11 presents references cited in this report.

This report has the following appendixes. Appendix A presents a list of acronyms and abbreviations, a table showing conversion of metric units to U.S. customary units, and data qualifier definitions. Appendix B presents field investigation methods and results. Appendix C presents analytical results from sediment and water samples and summarizes data quality. Data packages are included as Attachment C-1 on DVDs. Analytical data from the Sample Management Database (SMDB) and Water Quality Database (WQDB) used in this report are on DVD in Attachment C-2. Data obtained from sources other than the SMDB and WQDB are included as Attachment C-3 on DVD. 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. Appendix G is a copy of a technical letter from the Laboratory to NMED.

1.3 Watershed Description

Cañada del Buey is located within the Mortandad Canyon watershed. It heads on the Pajarito Plateau in TA-63, has a maximum elevation of approximately 2190 m (7190 ft) above sea level (asl), and extends approximately 12.4 km (7.7 mi) to Mortandad Canyon at an elevation of approximately 1705 m (5600 ft) asl (Figure 1.1-1). The watershed has a drainage area of 11 km^2 (4.2 mi^2), of which 38% is on Laboratory land, 43% is on Pueblo de San Ildefonso land, and 19% is on private land or land owned by the County of Los Alamos. The part of the watershed upcanyon from New Mexico State Highway 4 (NM 4) and White Rock, the primary focus of this investigation, has a drainage area of 5.5 km^2 (2.1 mi^2), of which 75% is on Laboratory land, 21% is on Pueblo de San Ildefonso land, and 4% is on land owned by Los Alamos County.

Bedrock geologic units exposed within the Cañada del Buey watershed consist largely of the Tshirege Member of the Bandelier Tuff and basaltic rocks of the Cerros del Rio volcanic field (Griggs and Hem 1964, 092516; Smith et al. 1970, 009752; Dethier 1997, 049843). Geologic units within this watershed are discussed in more detail in Section 7 of this report.

A comprehensive overview of the biological setting of the Cañada del Buey watershed is provided in Section 3.5.6 of the work plan (LANL 1999, 064617), and notes on specific sediment investigation reaches are included in Appendix E-1.0. Details about the hydrology of the watershed are provided in Section 7 and Appendix B of this report.

1.4 Current Land Use

The portion of the Cañada del Buey watershed downcanyon from SWMUs and AOCs is located on DOE land, Los Alamos County land, private land in the White Rock townsite, and Pueblo de San Ildefonso land. Laboratory activities in the canyon bottom are restricted to environmental work, such as sediment and water sampling. Currently, there is no public access to the watershed on Laboratory land downcanyon from SWMUs and AOCs, although parts of the canyon may be used by Laboratory personnel for recreational activities, such as hiking. Part of the Cañada del Buey watershed west of NM 4 was transferred from DOE to the County of Los Alamos in 2002 (October 30, 2002 Quitclaim deed between DOE and County of Los Alamos) and is planned for residential and commercial development (LANL 1999, 063037). The portion of the Cañada del Buey watershed east of NM 4 includes residential areas in White Rock and Los Alamos County open space that includes a sports complex with playing fields and trails used for hiking, horseback riding, bike riding, and other recreational activities. A Los Alamos County wastewater treatment plant (WWTP) is located in Cañada del Buey and discharges treated effluent into the stream channel, which flows downcanyon past the confluence with Mortandad Canyon on Pueblo de San Ildefonso land, approximately 1.4 km (0.8 mi) east of the WWTP outfall. Additional Pueblo land is located in the Cañada del Buey watershed west of NM 4, including some areas transferred from DOE in 2002. The Pueblo land is used for various traditional uses, including hunting.

2.0 BACKGROUND

Releases from SWMUs and AOCs within the Cañada del Buey watershed may have occurred as a result of air emissions, including dispersal from a former firing site; potential leaks from septic systems, tanks, water lines and drains; discharges from outfalls; and spills. Effluent discharges to Cañada del Buey have been minor, as summarized in the work plan (LANL 1999, 064617; Table 2.2.1-3). There are currently no active outfalls in the watershed west of NM 4 except one associated with Los Alamos County's water supply well PM-4, which discharges approximately 10,000 to 12,000 gal. of water when the well is purged at start-up. The canyon also receives stormwater runoff from roads, parking lots, and other developed areas at Laboratory TAs. Previous sampling results from within the canyon indicated contamination from inorganic chemicals, organic chemicals, and radionuclides (LANL 2008, 101803). Additional sampling has been proposed and/or conducted to further define nature and extent of contamination of some SWMUs and AOCs located in the Upper and Middle Cañada del Buey Aggregate Areas (LANL 2007, 102622; LANL 2008, 101802; LANL 2009, 105754).

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

2.1.1 Former TA-04, TA-52, and TA-63

TA-52 and TA-63 are located at the head of the Cañada del Buey watershed and include some sites in former TA-04. Former TA-04 included Alpha Site, which was established in 1944 as a test firing site and abandoned in 1946. Former TA-04 also included a darkroom and laboratory building where photographic film was developed from 1948 to 1955 (SWMU 04-004) and an outfall that drained toward Cañada del Buey [SWMU 04-003(a)] (LANL 1999, 064617, pp. 2-452-46). Former TA-04 was decontaminated and decommissioned in 1985; some additional sampling is proposed for the area as part of the Upper Cañada del Buey Aggregate Area investigations (LANL 2008, 101802).

TA-52 was established in the mid-1960s to house the ultra-high-temperature reactor experiment. The reactor was shut down in 1970 and removed in 1990. Since then, TA-52 has housed offices and laboratories (LANL 1992, 007666). TA-52 includes several SWMUs and AOCs within the Cañada del Buey watershed that have been approved for no further action (NFA) or are pending approval (LANL 2008, 101802).

TA-63 has no SWMUs or AOCs within the Cañada del Buey watershed, except for the sites at former TA-04 discussed above.

2.1.2 TA-46

TA-46 was established on Mesita del Buey on the south side of Cañada del Buey in 1954 and housed the Rover Program to develop nuclear reactors for propulsion of space rockets until 1973. The Jumper Program was active at TA-46 from 1976 to the early 1980s and involved the use of lasers to develop uranium-isotope enrichment methods. SWMUs and AOCs at TA-46 within the Cañada del Buey watershed include outfalls, surface disposal areas, surface impoundments, and septic systems. The Laboratory's Sanitary Wastewater System Consolidation (SWSC) Plant was opened at TA-46 in 1992. The SWSC Plant is permitted to discharge effluent to Cañada del Buey at national Pollutant Discharge Elimination System (NPDES) Outfall 13S. However, effluent has never been released at this outfall and is instead pumped to TA-03 and discharged into Sandia Canyon at NPDES Outfall 01A001. Various inorganic and organic chemicals and radionuclides have been identified as contaminants at TA-46 SWMUs and AOCs, and additional sampling is proposed for the area as part of the Upper Cañada del Buey Aggregate Area investigations (LANL 1999, 064617, pp. 2-46–2-56, 3-95; LANL 2008, 101802; LANL 2008, 101803.

2.1.3 TA-51

TA-51 was established on Mesita del Buey in 1980 for research on techniques for burial of wastes in semiarid climates and includes support offices. AOC 51-001 is a former septic system within the Cañada del Buey watershed (LANL 1999, 064617, pp. 2-59-2-60; LANL 2007, 102622). AOC 51-001 was investigated previously and remediated, but additional sampling has been conducted as part of the Middle Cañada del Buey Aggregate Area investigations (LANL 2009, 105754).

2.1.4 TA-54

TA-54 is located on Mesita del Buey and has been used for storage and disposal of waste since 1957. TA-54 includes three material disposal areas (MDAs) within the Cañada del Buey watershed. MDA G has been the active radioactive low-level radioactive waste disposal area for the Laboratory since 1957 and is still in operation. MDA J opened in 1961 for disposal of administratively controlled waste, for surface storage of asbestos and for land-farming (aeration) of petroleum-contaminated soils. MDA J has been closed since 2002 and is regulated as a solid waste disposal facility under New Mexico Solid Waste Regulations; the site is currently undergoing post-closure monitoring (LANL 2007, 102622). MDA L was used for subsurface disposal of liquid hazardous wastes between the late 1950s and 1985 (SWMU 54-006), and the area is currently used for temporary aboveground hazardous waste storage. Additional facilities were present in the western part of TA-54, where a radiation exposure facility existed from 1962 to the mid-1970s (LANL 1999, 064617, pp. 2-62–2-69, 3-87–3-95). TA-54 West is now used to conduct waste characterization and packaging operations associated with shipment of transuranic wastes from the Laboratory to the Waste Isolation Pilot Plant in Carlsbad, New Mexico (LANL 2007, 102622). Transport of low levels of some radionuclides and other contaminants in surface runoff has been documented in drainages along the north side of Mesita del Buey below MDA G, and tritium migration has been measured in the subsurface. In addition, volatile organic compound (VOC) plumes are present in the subsurface below MDA L and MDA G (e.g., LANL 1996, 054462; LANL 1997, 055873; LANL 1999, 064617, pp. 2-62-2-69, 3-97-3-99, 3-101-3-102; LANL 2008, 105241).

2.1.5 Cerro Grande Fire

In May 2000, the Cerro Grande fire burned part of the Cañada del Buey watershed. Approximately 1.7 km^2 (0.6 mi^2) of the watershed was within the burn perimeter (BAER 2000, 072659), comprising 31% of its area above NM 4; 81% of the area within the burn perimeter was classified as low burn severity or not burned and 19% as 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 sediments before the fire, and the transport of ash has resulted in elevated levels of these analytes in post-fire sediment deposits in some canyons (Katzman et al. 2001, 072660; Kraig et al. 2002, 085536; LANL 2004, 087390). Elevated levels of inorganic chemicals and radionuclides that can be attributed to the transport of ash have also been found in stormwater samples in some canyons (Gallaher and Koch 2004, 088747).

2.2 Potential Contamination in Canyons Media

Potential contamination in sediment, surface water, and shallow perched groundwater in the Cañada del Buey watershed has been evaluated in several studies before this report, dating back to 1970 (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 has sampled and analyzed sediments, surface water, and shallow perched groundwater in the Cañada del Buey watershed since 1970. 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; Childs and Conrad 1997, 057518), 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 Cañada del Buey watershed from 1978 to 1997 is presented in the work plan (LANL 1999, 064617, pp. 3-84–3-92).

Three shallow observation wells (CDBO-1, CDBO-2, and CDBO-3) were installed in the south fork of Cañada del Buey near MDA L (Plate 1) in 1985 to monitor potential shallow perched groundwater. An additional monitoring well, CDBO-4, was installed in the main part of Cañada del Buey near the eastern boundary of MDA G. These four wells were dry at the time of installation (Purtymun 1995, 045344), and periodic attempts to sample these wells as part of the Laboratory's annual environmental surveillance activities have failed because of lack of water.

Five additional observation wells (CDBO-5 through CDBO-9) and two moisture-access holes (CDBM-1 and CDBM-2) were installed in the main fork of Cañada del Buey (Plate 1) in 1992 to study the effect of planned effluent releases from the Laboratory's SWSC Plant constructed on the south side of Cañada del Buey in TA-46 (Purtymun 1995, 045344). However, effluent from the SWSC Plant is instead diverted to the head of Sandia Canyon where it is discharged, and Cañada del Buey has never received effluent from this facility. Two of the observation wells, CDBO-6 and CDBO-7, encountered shallow perched groundwater and the other holes were dry.

2.2.2 Resource Conservation and Recovery Act and Consent Order Investigations

Since 1994, studies of canyons media in the Cañada del Buey watershed have been conducted by the Laboratory as part of Resource Conservation and Recovery Act (RCRA) and Consent Order investigations. Results of these investigations have been presented in several (e.g., LANL 1995, 045978; LANL 1996, 054462; Drakos et al. 2000, 068739; LANL 2005, 090513; Reneau et al. 2005, 088716). The work presented in this investigation report builds on these previous studies.

2.2.3 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 Cañada del Buey watershed as part of oversight activities (e.g., NMED 1998, 057583; NMED 1999, 063495; 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 as stormwater and snowmelt runoff, and shallow perched groundwater in the Cañada del Buey watershed, as presented in the work plan and subsequent documents (LANL 1999, 064617; LANL 2003, 081597; LANL 2005, 091542). These investigations are discussed below.

3.1 Sediment Investigations

The sediment investigations presented in this report focused on characterizing the nature, extent, and concentrations of COPCs in post-1942 sediment deposits in a series of reaches in the Cañada del Buey watershed. Data from these reaches are used to evaluate potential human health and ecological risks and to identify spatial trends of 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 1999, 064617), and in the canyons core document (LANL 1997, 055622; LANL 1998, 057666).

The scope of this investigation included characterization of the seven reaches identified as priority reaches in the work plan (LANL 1999, 064617, p. 7-74) and one additional reach (CDB-3W) that was requested by NMED (2005, 089312). One of the priority reaches (CDB-4) was investigated in 1999 in support of planned land transfer from DOE to the County of Los Alamos and the Pueblo de San Ildefonso (Drakos et al. 2000, 068739). The investigations in that reach included collection of local sediment background samples from adjacent drainages (CDB-4 BKG samples) to evaluate background variability. Another priority reach (CDB-3E) was investigated in 2004 in support of investigations at MDA G at TA-54 (LANL 2005, 090513). Both CDB-3E and CDB-4 were resampled in 2008 to enlarge analytical suites. In addition, samples were collected from another priority reach (CDB-2C) in 2000 after the Cerro Grande fire to provide data on potential contaminants that could be remobilized by post-fire floods. 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 on Plate 1.

3.2 Surface-Water and Groundwater Investigations

The water investigations presented in this report focus on watershed-scale characterization of surface water (as stormwater) and shallow perched groundwater in and beneath the Cañada del Buey watershed. Because of the small size of its watershed, surface-water flow in Cañada del Buey occurs as a result of storm events and snowmelt. Purge water releases from water supply well PM-4 and sanitary effluent releases from the White Rock WWTP also contribute to surface water within the watershed. Figure 3.2-1 and Plate 1 show the locations of stream gages and shallow perched groundwater monitoring wells sampled as part of this investigation.

These water investigations satisfy requirements set forth in the “Work Plan for Sandia Canyon and Cañada del Buey” (LANL 1999, 064617), the “Approval, Sandia Canyon and Cañada del Buey Work Plan” (NMED 2005, 091689), and the “Approval with Direction for the Addendum to the Work Plan for Sandia Canyon and Cañada del Buey” (NMED 2007, 095486).

3.2.1 Observation Well Installations

NMED required installation of seven additional shallow observation wells in alluvium in Cañada del Buey in an NOD dated June 15, 2005, to further define the extent of saturation observed near wells CDBO-6 and CDBO-7 (LANL 2005, 091542; NMED 2005, 089312). However, subsequent data analysis led the Laboratory to request that the agreement to install these wells be waived because the perched zone near CDBO-6 appears to be of limited extent and has minimal contamination at very low concentrations (LANL 2009, 105287). The technical letter from the Laboratory to NMED that supports the alluvial wells waiver is included as Appendix G. NMED agreed that the Laboratory had provided adequate justification to eliminate the requirement to install the additional alluvial wells, provided that other field data be collected to confirm the extent of saturation and to identify potential water sources, as described in Sections 3.2.2 and 3.2.3 (LANL 2009, 105287; NMED 2009, 105600).

3.2.2 Surface-Water and Groundwater Sampling

Sampling activities included collection of stormwater at four stream gages (E218, E220, E225, and E230), runoff from a rain-on-snow event at one gage (E230), and shallow groundwater at two observation wells (CDBO-6 and CDBO-7). Analyses from stormwater and the rain-on-snow event are reported in Appendix F and in Section 6.4. 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. The list of surface-water sites and groundwater monitoring wells used to prepare this investigation report is 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.

Nitrogen and oxygen isotopes were recently added to the analytical suite for waters collected at CDBO-6 and CDBO-7 to better evaluate sources of this groundwater.

3.2.3 Water-Level and Gaging Station Measurements

Both manual and automated water-level data have been collected from monitoring wells CDBO-6 and CDBO-7, which are completed in Bandelier Tuff unit Qbt 1v-c. Manual water-level measurements from the other shallow wells (CDBO-1 through CDBO-5, CDBO-8, and CDBO-9) have been attempted, but the wells have been dry during periodic monitoring (Appendix B). Transducers were added to wells CDBO-4, CDBO-5, CDBO-8, and CDBO-9 in January 2009 to better evaluate whether transient saturated conditions occur following storm events (LANL 2009, 105287).

Stream-flow measurements from three gages (E218, E225, and E230) are used to assess spatial infiltration and surface-water balance along the canyon bottom between wells CDBO-5 and CDBO-4 (NMED 2009, 105600). In addition, well CDBO-6 was purged dry, and its recovery was monitored. These water-balance analyses were performed to better define the volume of water present near CDBO-6 and CDBO-7 (LANL 2009, 105287; NMED 2009, 105600).

3.3 Deviations from Planned Activities

There were no deviations in the implementation of the work plan or subsequent NMED requirements that are associated with letters.

4.0 FIELD INVESTIGATIONS

Field investigations in the Cañada del Buey watershed included investigations of sediment, surface water, and shallow perched 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 field investigations results is presented in Appendix B.

4.1 Sediment

Sediment investigations in the Cañada del Buey watershed included detailed geomorphic characterization and sediment sampling in a series of discrete reaches, following the general process described in the NMED-approved work plan and canyons core document (LANL 1997, 055622; LANL 1999, 064617). The geomorphic characterization in most reaches included preparing a detailed geomorphic map delineating the horizontal extent of geomorphic units with varying physical characteristics and/or age. The geomorphic characterization also included measuring the 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, CDB-4, 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, on a CD.

Plates 2 and 3 present geomorphic maps of the sediment investigation reaches in the Cañada del Buey watershed, including sample locations and stratigraphic description locations within these reaches. The horizontal extent of contaminated or potentially contaminated sediment deposits in each reach is delineated by the extent of the channel ("c") and floodplain ("f") units in these maps. Section B-1.0 of Appendix B includes field investigation results, including sediment thickness measurements.

4.2 Surface Water and Groundwater

The surface-water and groundwater field investigations in Cañada del Buey were designed to define the nature and extent of contamination, identify the physical and chemical processes controlling contaminant distributions, and identify the transport pathways that could result in potential human health and ecological exposure and risk. This work included sampling stormwater and runoff from a rain-on-snow event and sampling existing shallow groundwater observation wells.

4.2.1 Monitoring Well Installation

No additional groundwater monitoring wells were installed as part of the Cañada del Buey investigation under agreement between the Laboratory and NMED (LANL 2009, 105287, Appendix G; NMED 2009, 105600).

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 in 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. Continued sampling of groundwater in Cañada del Buey is conducted as part of the IFGMP (LANL 2009, 106115) and field and analytical procedures are described in that document.

4.2.3 Water-Level and Gaging Station Measurements

Water-level data were compiled for the wells CDBO-6 and CDBO-7. Observations from the wells CDBO-1 through CDBO-5, CDBO-8, and CDBO-9 were also compiled, although these wells have been dry. These data, which include both manual and automated measurements, allow interconnections between groundwater bodies to be assessed by correlating water-level responses with surface-water flows recorded at gages and local precipitation events. Manual water-level measurements have been taken periodically at wells CDBO-1 through CDBO-4 since 1985 and at wells CDBO-5 through CDBO-9 since 1993. Automated pressure transducer probes were placed in wells CDBO-6 and CDBO-7 in 2005, and high-frequency water-level data are collected and reported in annual water-level reports (Koch and Schmeer 2009, 105181). Automated pressure transducers were installed in January 2009 for acquisition of water levels in observation wells CDBO-4, CDBO-5, CDBO-8, and CDBO-9 to determine whether transient saturation occurs following storms. Details of the field methodology and results are presented in Section B-2.0 of Appendix B.

5.0 REGULATORY CRITERIA

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

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 watersheds" (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 within the Cañada del Buey watershed, 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 Cañada del Buey are incorporated into Module VIII through work plans approved by NMED. The approved work plans include the "Work Plan for Sandia Canyon and Cañada del Buey" (LANL 1999, 064617) 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 Cañada del Buey (Section IV.B.2, "Mortandad Canyon Watershed"). The Consent Order was issued pursuant to NMHWA, New Mexico Statutes Annotated (NMSA) 1978 § 74-4-10 and the New Mexico Solid Waste Act 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 Individual Permit (IP) issued by EPA Region 6, pursuant to the 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. Concentrations of chemicals and radionuclides in sediment are compared with various risk-based SLs, which are described in Sections 5.2 and 5.3. Surface-water and groundwater standards are used to support the assessment of nature and extent of contamination. Applicable water-quality standards are discussed in Section 5.4. Stormwater comparison values are discussed in Section 5.5.

5.2 Human Health SLs

Soil screening levels (SSLs) for inorganic and organic chemicals and screening action levels (SALs) for radionuclides are media-specific concentrations derived for residential exposure. If environmental concentrations of contaminants are below SALs or SSLs, then the potential for adverse human health effects is highly unlikely. For sediment COPCs with carcinogen or noncarcinogen endpoints, SSLs from NMED guidance (NMED 2009, 106420) 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 (adjusted to 10^{-5} risk to conform with NMED SSLs). The SSLs for noncarcinogens are based on a hazard quotient (HQ) of 1.0. The SSLs for carcinogens are based on a cancer risk level of 10^{-5}. For nonradionuclide COPCs without NMED SSLs, approved surrogate chemicals were used (NMED 2003, 081172), where applicable. 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 DOE guidance (2000, 067489).

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

5.3 Ecological Screening Levels

ESLs are used to determine chemicals of potential ecological concern (COPECs) for sediment. The document, “Screening Level Ecological Risk Assessment Methods, Revision 2” (LANL 2004, 087630), contains information about how ESLs are derived. ESLs are developed for a suite of receptors designed to represent individual feeding guilds. Receptors such as the robin and kestrel are modeled with multiple diets to represent multiple feeding guilds. Concentrations of each COPC in sediment were compared with ESLs from the ECORISK Database Version 2.3 (LANL 2008, 103352); these comparisons are provided in Section 6. Additional information regarding the potential for ecological risks from COPCs in affected media in Cañada del Buey 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. There are no data for nonstorm-related surface water in Cañada del Buey; therefore, no COPCs in surface water are identified. Tabulation of data relative to stormwater to comparison values is discussed in Section 5.5.

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

- human health (20.6.2.3103[A] New Mexico Administrative Code [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)
- New Mexico Environment Improvement Board 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:

- DOE Derived Concentration Guidelines (DCGs) based on 4 mrem/yr
- EPA regional tap water SLs

Comparisons of 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 available. Stormwater monitoring data for Cañada del Buey are evaluated relative to the following values from the State of New Mexico Standards for Interstate and Intrastate Surface Waters (§ 20.6.4 NMAC):

- 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 screening assessments conducted to identify COPCs in sediment and groundwater samples collected in Cañada del Buey. 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 used in the 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 screen for sediment, Section 6.3 presents the screen for groundwater, and 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 the analytical data for all media are presented in Attachment C-1 in Appendix C. The data used in the assessments were obtained from the SMDB and the WQDB and are presented in Attachment C-2 in Appendix C. Samples collected, analytical methods, and data quality issues are summarized in Appendix C, and data qualifiers are defined in Appendix A.

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

- Duplicate sample results for analytes analyzed by a less sensitive method—For example, semivolatile organic compound (SVOC) results from samples that were also analyzed by a VOC, polycyclic aromatic hydrocarbon (PAH), or high explosive (HE) analytical method. The duplicate results from the SVOC method are excluded from the screen because the VOC, PAH, and HE analytical methods provide lower detection limits.
- Results from subsequent sampling that overlap earlier analyses—-When a location was resampled to enlarge the suite of compounds analyzed, the first set of results was maintained for analytes analyzed in both instances.
- 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.

The only surface-water sample collected from Cañada del Buey after 2002 that was assigned a media code other than “stormwater” (WT) was from a short-duration, rain-on-snow event in January 2008 with 15 h of total flow. This event was more similar to typical stormwater events than snowmelt runoff that provides persistent flow in other canyons, and this sample is included as part of the stormwater screen in Section 6.4.

6.2 Sediment COPCs

This section presents the process for screening analytical results obtained from sediment samples collected in Cañada del Buey. Samples collected and analyses performed by the analytical laboratories are presented in Table C-2.0-1 in Appendix C. Sample locations are presented on Plates 2 and 3. 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 25 inorganic chemicals, 35 organic chemicals, and 7 radionuclides were retained as COPCs in sediment in Cañada del Buey. Maximum sample results in each reach (which include detection limits for some inorganic chemicals) for these COPCs are presented in Tables 6.2-1, 6.2-2, and 6.2-3 for inorganic chemicals, organic chemicals, and radionuclides, respectively. ESLs and residential SSLs and SALs are included in the tables for comparison purposes. The assessment of the potential for adverse ecological risks, including the screen against ESLs, is presented in Section 8.1. The assessment of the potential for adverse effects on human health, including the screen against residential SSLs and SALs, is presented in Section 8.2.

6.2.2 Comparison of Sediment COPC Concentrations to Residential SSLs and SALs

Maximum concentrations (including detection limits for inorganic chemicals) of sediment COPCs in each reach were compared with residential SSLs for inorganic and organic chemicals or residential SALs for radionuclides to identify which COPCs are most important for understanding potential human health risk. One inorganic COPC, arsenic, has maximum concentrations exceeding the residential SSL and is highlighted in gray in Table 6.2-1. No organic or radionuclide COPCs have maximum concentrations exceeding residential SSLs or SALs in Cañada del Buey.

6.3 Groundwater COPCs

This section presents the process for screening groundwater sample results from Cañada del Buey. All groundwater samples included in this data set were collected from shallow perched groundwater that is closely related to alluvial groundwater, and these samples are therefore treated as alluvial groundwater in the subsequent screening assessments. Groundwater 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 on Plate 1. Analytical results from groundwater samples were screened to develop a list of COPCs, as presented in Section 6.3.1.

6.3.1 Identification of Groundwater COPCs

Groundwater COPCs are identified by a screening process that includes comparing the maximum detected concentrations with Laboratory alluvial groundwater BVs (LANL 2007, 096665) for filtered and nonfiltered samples.

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 27 inorganic chemicals in filtered and nonfiltered samples, 11 organic chemicals in nonfiltered samples, and 7 radionuclides in nonfiltered samples were retained as COPCs in groundwater in Cañada del Buey. Maximum sample results for groundwater are presented in Tables 6.3-1 to 6.3-4. No radionuclide COPCs were identified in filtered groundwater samples.

6.3.2 Comparison of Groundwater COPC Concentrations to Standards

Maximum detected concentrations of COPCs in filtered and nonfiltered groundwater samples were compared with applicable water-quality standards, as discussed in Section 5, to identify which COPCs are most important from a regulatory perspective.

One inorganic COPC (beryllium) and two organic COPCs (bis[2-ethylhexyl]phthalate and di-n-octylphthalate) in nonfiltered groundwater from Cañada del Buey have maximum concentrations exceeding a water-quality standard. These COPCs are highlighted in gray in Tables 6.3-2 and 6.3-5. No radionuclide COPCs have maximum concentrations exceeding a water-quality standard.

6.4 Stormwater

This section presents the process for screening analytical results obtained from stormwater samples collected in Cañada del Buey. 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 samples against the lowest comparison value applicable for that field preparation from the State of New Mexico Standards for Interstate and Intrastate Surface Waters (§ 20.6.4 NMAC), as described in Section 5.5. 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 three inorganic chemicals (aluminum, copper, and zinc) in filtered samples, two inorganic chemicals (mercury and selenium) in nonfiltered samples, and one organic chemical (Aroclor-1254) in nonfiltered samples. The stormwater comparison value for gross-alpha radiation was also exceeded in nonfiltered samples. 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

Analytes with concentrations that are greater than comparison values were further evaluated relative to the potential for acute exposure to human health or the environment. The acute exposure benchmarks for the protection of ecological receptors are a subset of the comparison values discussed in Section 6.4.1. Specifically, the comparison values associated with acute aquatic life address the protection of ecological receptors to acute exposures; these benchmark comparisons are discussed in Section 6.4.2.1. Human health benchmarks were calculated for those analytes that exceeded persistent human health comparison values; the comparisons to acute human health benchmarks and their derivation are discussed in Sections 6.4.2.2 and 6.4.2.3. Both livestock watering and wildlife habitat values are protective of the potential for adverse effect based on chronic exposures and therefore do not pertain to effects associated with acute exposures. Analytes exceeding these values (mercury, selenium, and gross-alpha radiation) are not evaluated further.

6.4.2.1 Acute Ecological Comparisons

The maximum detected concentrations of three analytes (aluminum, copper, and zinc) exceeded stormwater comparison values based on acute aquatic life criteria. Because the stormwater comparison values are based on an acute exposure, the acute aquatic life standards are also used as the benchmarks for acute ecological exposures. Table 6.4-2 summarizes the maximum detected concentrations of the analytes exceeding an acute benchmark. Because Cañada del Buey has no persistent water, there are no aquatic receptors or pathways and these analytes in stormwater are not discussed further. Section 8.1 contains more information on ecological receptors and exposure pathways.

6.4.2.2 Acute Human Health Comparisons

The maximum detected concentration of one analyte, Aroclor-1254, exceeded a stormwater comparison value based on the human health persistent criterion. Because the human health persistent value does not represent an acute exposure, a human health acute exposure benchmark was developed for Aroclor-1254. 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-1254 (0.083 µg/L) does not exceed the benchmark (4.65 µg/L), so Aroclor-1254 in stormwater is not an issue as a potential acute human health concern in Cañada del Buey.

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 or are media-specific screening values based upon acute toxicity data. To evaluate the acute toxicity due to short-term exposure to stormwater in Cañada del Buey, 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. Risk Assessment Information System 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 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-1254 is 3E-05 mg/kg-d (the ATSDR intermediate oral MRL for Aroclor-1254 is used); therefore, the SL for Aroclor-1254 is

SL Aroclor-1254 (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 and groundwater and detected analytes in stormwater in Cañada del Buey. Table 6.5-1 indicates which COPCs have maximum results that exceed residential SSLs and SALs for sediment and water-quality standards for groundwater. Table 6.5-1 also indicates stormwater analytes with maximum detected concentrations that exceed acute exposure benchmark values.

7.0 PHYSICAL SYSTEM CONCEPTUAL MODEL

This section discusses aspects of the physical system conceptual model that are relevant for understanding the nature, sources, extent, fate, and transport of contaminants in the Cañada del Buey watershed, particularly in sediment, surface water and shallow perched groundwater. 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 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 and transport of contaminants. Section 7.2 describes the hydrology of the watershed, including descriptions of surface water and shallow groundwater, and summarizes the occurrence of select COPCs in water.

7.1 COPCs in Sediments

The following sections first use spatial variations in concentrations of sediment COPCs in Cañada del Buey 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 natural background variations or ash from the Cerro Grande burn area. 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 some reaches in Cañada del Buey, 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. Section D-1.3 in Appendix D presents some statistical evaluations comparing concentrations of select COPCs in Cañada del Buey sediment samples with background data.

7.1.1 Inorganic Chemicals in Sediments

One inorganic COPC in Cañada del Buey sediment, arsenic, has maximum detected concentrations greater than residential SSLs and is most important for assessing potential human health risk. Four other inorganic COPCs are also included in the human health risk assessment in Section 8.2: aluminum, cobalt, iron, and thallium. Additional inorganic chemicals detected in sediment samples are important for assessing potential ecological risk (antimony, cyanide, lead, and perchlorate; Section 8.1). The spatial distribution of these inorganic chemicals (discussed below) indicates that they are derived from a variety of sources, including Laboratory SWMUs or AOCs, naturally occurring soils and bedrock, and ash from the Cerro Grande burn area. 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 Cañada del Buey. 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.

The plots in Figure 7.1-1 include both the sediment BV for each inorganic chemical, which is an estimate of the upper level of background concentrations, and the average value from the background sediment data set, where available (averages from McDonald et al. 2003, 076084, Table 10, pp. 49-50). The background averages are included to be consistent with the presentation of averages from potentially contaminated samples, although averages for fine facies sediment are expected to be higher than the entire background data set, which also includes coarse facies samples. For reaches where an inorganic chemical is not a COPC, the average background concentration is plotted in Figure 7.1-1 except for antimony, where there were no detected results in the background data set; reach averages for fine facies sediment are used for antimony in CDB-1 and CDB-4 where it is not a COPC.

Figure 7.1-2 presents relations of concentrations of select inorganic COPCs with silt and clay content in Cañada del Buey sediment samples and background samples (background data from McDonald et al. 2003, 076084). The local background data obtained from reach CDB-4 (CDB-4 BKG samples; Drakos et al. 2000, 068739) are also shown on these plots. 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 included in the evaluation of potential human health risk in Section 8.2 in one investigation reach, CDB-3E. CDB-3E is also the only reach with maximum concentrations of aluminum above the sediment BV of 15,400 mg/kg, although below the residential SSL of 78,100 mg/kg (Table 6.2-1). The average aluminum concentration in fine facies sediment in CDB-3E is below the BV, as shown in Figure 7.1-1 and Table D-1.2-1. Three out of 10 samples in CDB-3E have aluminum concentrations above the BV, with a maximum of 25,000 mg/kg in a fine-grained subsurface sample (sample CACB-04-53724). This sample has an anomalously high aluminum concentration for the amount of silt and clay, as shown in Figure 7.1-2, suggesting a limited release from TA-54 between CDB-3E and the next upcanyon reach (CDB-3W). Aluminum was also identified as a COPC in MDA G drainages in a prior study (LANL 1996, 054462) and as statistically above the CDB-4 BKG data in CDB-3E (LANL 2005, 090513; Section D-1.3 of Appendix D of this report).

Antimony is identified in Section 8.1 as being important for evaluating potential ecological risk in Cañada del Buey. Maximum detected concentrations are greater than the sediment BV of 0.83 mg/kg in five of the seven reaches with antimony data (Table 6.2-1; all antimony analyses from reach CDB-3E were rejected). Antimony concentrations are statistically higher than the CDB-4 BKG samples in four of these reaches (CDB-2C, CDB-3W, CDBS-1E, and CDBS-1W; Section D-1.3 of Appendix D). Average concentrations in fine facies sediment are also above the BV in these four reaches, although there is uncertainty in average concentrations in some reaches due to a high frequency of nondetects (32%) and elevated detection limits (Figure 7.1-1 and Table D-1.2-1). The average detection limit for nondetects (1.18 mg/kg) is higher than both the BV and the average detected concentration (0.89 mg/kg). The two highest detected concentrations are from reach CDB-2C (3.2 and 2.04 mg/kg), suggesting releases from TA-46 into the SWSC tributary. The highest average concentrations in fine facies sediment are in reaches CDB-3W and CDBS-1W, suggesting additional releases into Cañada del Buey from the west half of MDA G and into the head of the south fork of Cañada del Buey upcanyon of MDA L. Antimony concentrations show no strong relation with silt and clay content and also common nondetect results with detection limits above the BV, as indicated in Figure 7.1-2 and Section D-1.3 of Appendix D. The CDB-2C samples with the two highest detected concentrations show up as outliers in Figure 7.1-2, again suggesting releases from TA-46 into the SWSC tributary.

Arsenic is an important inorganic chemical for evaluating potential human risk in Cañada del Buey, with maximum concentrations being greater than the sediment BV of 3.98 mg/kg and the residential SSL of 3.59 mg/kg in seven of the eight investigation reaches (all except CDB-4; 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.) Arsenic concentrations are statistically higher than the CDB-4 BKG samples in six of these reaches (CDB-1, CDB-2C, CDB-2W, CDB-3W, CDBS-1E, and CDBS-1W; Section D-1.3 of Appendix D). Average concentrations of arsenic in fine facies sediment are greater than the sediment BV in six reaches, with the highest being in reach CDB-3W (6.20 mg/kg; Figure 7.1-1 and Table D-1.2-1). As shown in Figures 7.2-1, D-1.1-1, and D-1.3-3, arsenic is relatively uniformly elevated in the upper reaches of Cañada del Buey and its south fork, not showing any spatial trends that would indicate major releases from SWMUs or AOCs, suggesting that most or all of the arsenic is naturally occurring. In addition, Figure 7.1-2 and Figure D-1.3-8 in Appendix D show that all samples display a generally positive correlation between arsenic concentration and silt and clay content with no outliers that would indicate significant releases.

Figure 7.1-2 also shows that there is a lot of variability in the relation between arsenic and silt and clay content that suggests natural background variability.

Cobalt is included in the evaluation of potential human health risk in Section 8.2 in two investigation reaches, CDB-3E and CDB-4, and is also present above the BV of 4.73 mg/kg in CDB-1, CDB-2W, and CDB-4 BKG samples (Table 6.2-1). Average cobalt concentrations in fine facies sediment are only above the BV in CDB-4 and the CDB-4 BKG samples, and the average is slightly higher in the CDB-4 BKG data set (Figure 7.1-1 and Table D-1.2-1). Cobalt concentrations are plotted against silt and clay content in Figure 7.1-2 and show both a general positive correlation with silt and clay content and elevated concentrations in the eastern part of Cañada del Buey, particularly CDB-4 and CDB-4 BKG. There are two anomalous results for cobalt in this data set, one from CDB-2W and one from CDB-4. The CDB-2W sample has the highest cobalt and manganese concentrations measured in Cañada del Buey and has higher cobalt concentrations than other samples from this reach with similar silt and clay content, suggesting either a background outlier with unusual mineralogy or minor releases from TA-46. The CDB-4 sample is of coarse-grained active channel sediment that is not elevated in other metals, and the source of this cobalt is not known. The cobalt concentration in this CDB-4 sample (9.0 mg/kg) is lower than the maximum in the CDB-4 BKG samples (9.3 mg/kg), and a previous study concluded that cobalt in CDB-4 represents a locally elevated background (Drakos et al. 2000, 068739). Statistical analyses presented in Section D-1.3 of Appendix D also indicate that cobalt concentrations in Cañada del Buey are not significantly different than background concentrations.

Cyanide is identified in Section 8.1 as being important for evaluating potential ecological risk in Cañada del Buey. Cyanide was detected at concentrations above the sediment BV of 0.82 mg/kg in six samples from four reaches (CDB-1, CDB-2C, CDB-2W, and CDBS-1E), with a maximum concentration of 2.79 mg/kg in a fine-grained sample from reach CDB-1 (Table 6.2-1). Field descriptions indicated that three of these six samples contained visible Cerro Grande ash, and cyanide has been shown to be 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 cyanide concentrations in fine facies sediment in all reaches are below the BV and are only clearly above the average background concentration in CDB-1, a reach that was burned in the Cerro Grande fire (Figure 7.1-1). Only one sample collected from outside the burn area has cyanide above the BV, from reach CDBS-1E downcanyon from MDA L. These data indicate that Cerro Grande ash is the main source of elevated cyanide in Cañada del Buey, although the results from one sample suggest small releases from MDA L into the south fork.

Iron is an important inorganic chemical for evaluating potential human health and ecological risk in Cañada del Buey. Maximum concentrations are greater than the sediment BV of 13,800 mg/kg in four investigation reaches (CDB-1, CDB-2C, CDB-3E, and CDB-4), as well as in several CDB-4 BKG samples (Table 6.2-1). Average concentrations of iron in fine facies sediment are below the BV in these four reaches (Figure 7.1-1 and Table D-1.2-1). The iron data from the CDB-4 BKG samples indicates locally elevated background levels, as shown in a previous study (Drakos et al. 2000, 068739). The relation of iron concentration to silt and clay content is shown in Figure 7.1-2, and indicates the same general positive correlations discussed previously. Figure 7.1-2 also shows the elevated CDB-4 BKG samples as well as the elevated CDB-3E and CDB-4 samples. These data indicate that iron is elevated in the eastern Cañada del Buey reaches associated with a locally elevated background and not anthropogenic releases. Statistical analyses presented in Section D-1.3 of Appendix D also indicate that iron concentrations in Cañada del Buey are not significantly different than background concentrations.

Lead is an important COPC for evaluating potential ecological risk in Cañada del Buey and has maximum concentrations exceeding the sediment BV of 19.7 mg/kg in four investigation reaches (CDB-1, CDB-2C, CDB-2W, and CDB-3E; Table 6.2-1). Average lead concentrations in fine facies sediment exceed the BV in one reach, CDB-2W (Figure 7.1-1 and Table D-1-2-1), and this reach also includes the 10 highest sample results in this data set, indicating releases from TA-46. Lead had been previously reported as a COPC at TA-46 (LANL 2008, 101803). Average lead concentrations are much lower in the next downcanyon reach, CDB-2C, and all lead results are below the BV in reach CDB-3W. These data indicate that there is relatively little downcanyon transport of lead below CDB-2W or that the lead is rapidly reduced to background levels by mixing with other sediment. 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, mostly within CDB-2W or immediately downcanyon in CDB-2C. Lead is also present at low concentrations above the BV in CDB-1, below paved areas in TA-52 and TA-63. 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).

Perchlorate is identified as an uncertainty for evaluating potential ecological risk in Section 8.1 because of the absence of an ESL. It also has no BV and is considered as a COPC in a reach based solely on detection status. Perchlorate was detected in all reaches except CDB-4. It has an overall low detection frequency in Cañada del Buey sediment samples (26% detects) and an average detection limit for nondetects (0.00565 mg/kg) that is more than 3 times higher than the average detected value (0.00154 mg/kg). The average perchlorate concentrations in coarse and fine facies sediment samples are shown in Table D-1.2-1, indicating that there is large uncertainty in average concentrations because of the high frequency of nondetects. The average for perchlorate in fine facies sediment are plotted in Figure 7.1-1, and also indicate that there are no clear spatial trends in perchlorate concentration that would indicate significant releases into Cañada del Buey; instead, estimated average concentrations in each reach with detects are similar except for reach CDB-3E. The CDB-3E data (from 2004) were obtained with a different analytical method than the rest of the data set (EPA Method 314 in 2004 versus SW-846:6850 in 2008) and have higher detection limits. These results suggest that the detected perchlorate represents natural background and not Laboratory releases, a conclusion also reached in other watersheds at the Laboratory (LANL 2008, 104909, p. 27).

Thallium is included in the evaluation of potential human health risk in Section 8.2 in one reach, CDB-4, which is the only reach where thallium is a COPC. Thallium is above the BV of 0.73 mg/kg in two samples from CDB-4, at 0.86 and 1.1 mg/kg. The average concentration in fine facies sediment, 0.31 mg/kg, is less than half the BV (Table D-1.2-1). It was previously inferred that thallium in CDB-4 is derived from naturally occurring parent material (Drakos et al. 2000, 068739), and the absence of thallium above the BV in upcanyon reaches closer to SWMUs and AOCs supports this conclusion. Statistical analyses presented in Section D-1.3 of Appendix D also indicate that thallium concentrations in Cañada del Buey are not significantly different than background concentrations.

7.1.2 Organic Chemicals in Sediments

This section focuses on spatial variations in select organic chemicals in Cañada de Buey. No organic chemicals in Cañada de Buey sediments have maximum detected concentrations greater than residential SSLs, and none are included in the human health risk assessment in Section 8.2. Also, no organic chemicals were detected in the downcanyon investigation reach, CDB-4, indicating minimal off-site transport. One organic chemical detected in sediment samples is identified in Section 8.1 as being important for assessing potential ecological risk, the PCB Aroclor-1248. PCBs are 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). The following discussion is therefore limited to the distribution of PCBs in Cañada de Buey sediment.

PCBs were detected in every Cañada de Buey reach except one, CDB-4 (Table 6.2-2), at concentrations well below residential SSLs (maximum of 0.145 mg/kg for Aroclor-1248 in CDB-3W versus the SSL of 1.7 mg/kg). PCBs have low solubilities and a strong affinity for organic material and sediment particles (Chou and Griffin 1986, 083419). PCBs were widely used in electric transformers and other industrial applications (e.g., Walker et al. 1999, 082308, pp. 364-365), and their widespread use is consistent with their spatial distribution in sediments in Cañada de Buey. The sediment data indicate that PCBs were derived from multiple sources in the watershed and that concentrations 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, 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. Table-D-1.2-2 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. This table 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 two samples from reach CDBS-1W in the south fork of Cañada de Buey downcanyon from MDA J, at 0.0067 and 0.0077 mg/kg (1% detection frequency in the watershed). Aroclor-1248 was detected in only one sample, downcanyon of the western half of MDA G (reach CDB-3W, 0.145 mg/kg). Aroclor-1254 and Aroclor-1260 were both detected at higher frequencies, in 23% and 32% of the samples, respectively. The highest concentrations of Aroclor-1254 and Aroclor-1260 (0.0986 and 0.0175 mg/kg, respectively) were both from the CDB-3W sample with the highest Aroclor-1248 concentration. The second highest concentrations of each were from reach CDB-1 near the head of the watershed (0.0266 and 0.0173 mg/kg, respectively), indicating multiple sources.

Spatial variations in the average concentrations of each detected PCB in fine facies sediment in each reach are shown in Figure 7.1-3. Although there is considerable uncertainty in these values in some reaches associated with nondetected sample results, the data indicate at least three sources in the watershed: at the head of Cañada del Buey above CDB-1 (former TA-04, TA-52, and/or TA-63), in the upper part of the south fork of Cañada del Buey above CDBS-1W (TA-51, TA-54 West, and/or MDA J) and from the western part of MDA G above CDB-3W. TA-46 may be an additional source of PCBs. The available data indicate that average concentrations decrease downcanyon from these sources, and as mentioned previously, PCBs have not been detected in the farthest downcanyon reach (CDB-4), constraining their downcanyon extent.

7.1.3 Radionuclides in Sediments

No radionuclides in sediments in Cañada del Buey are identified as being important for the evaluation of potential human health risk in Section 8.2, and none are identified as important for evaluating ecological risk in Section 8.1. However, three radionuclides have been previously identified as being above background levels in drainages below MDA G (americium-241, plutonium-238, and plutonium-239/240; e.g., LANL 2008, 105241), and their distribution is discussed below to evaluate the extent of contamination from this site and other release points in the watershed. Table D-1.2-3 in Appendix D shows average concentrations of these three radionuclides in fine and coarse facies sediment in each reach where they are COPCs, and Figure 7.1-4 shows the spatial variations in their average concentrations in fine facies sediment. Figure 7.1-5 shows the concentrations of these radionuclides plotted against silt and clay content.

Americium-241 was detected above the sediment BV of 0.04 pCi/g in three reaches (CDB-3E, CDB-3W, and CDBS-1E). The highest concentrations were measured in two samples from reach CDBS-1E (0.281 and 0.136 pCi/g; Figure 7.1-5), and the highest average concentration in fine facies sediment is in reach CDB-3W (Table D-1.2-3 and Figure 7.1-4). These data suggest releases into the south fork of Cañada del Buey in the vicinity of MDA L and into Cañada del Buey from the west half of MDA G.

Plutonium-238 was detected above the sediment BV of 0.006 pCi/g in the same three reaches as americium-241 (CDB-3E, CDB-3W, and CDBS-1E). The seven highest concentrations were measured in fine facies samples from reach CDB-3W (0.119 to 2.76 pCi/g; Figure 7.1-5), and the highest average concentration in fine facies sediment is also in reach CDB-3W (Table D-1.2-3 and Figure 7.1-4). These data suggest the largest releases into Cañada del Buey from the west half of MDA G, and smaller amounts into the south fork of Cañada del Buey in the vicinity of MDA L. Plutonium-238 was also identified as a COPC in MDA L drainages, as well as MDA G drainages, in a prior study (LANL 1996, 054462).

Plutonium-239/240 was detected above the sediment BV of 0.068 pCi/g in all Cañada del Buey reaches except CDBS-1W. The highest concentration was measured in a sample from reach CDB-1 (0.373 pCi/g; Figure 7.1-5). The highest average concentration in fine facies sediment is in CDB-3W, and the next highest average concentrations are in CDB-1 and CDB-2W (Table D-1.2-3 and Figure 7.1-4). These data suggest multiple releases into Cañada del Buey, including into the upper canyon above CDB-1 and below TA-46, as well as the areas mentioned previously for americium-241 and plutonium-238. Plutonium-239/240 had been previously reported as a COPC at former TA-04 and TA-46 (LANL 2008, 101802), as well as at TA-54.

Because the average concentrations of americium-241, plutonium-238, and plutonium-239/240 are each highest in reach CDB-3W (Figure 7.2-5), this indicates that the largest releases of each were from the west half of MDA G at TA-54. Concentrations decrease rapidly downcanyon and are lower in reach CDB-3E immediately east of the easternmost MDA G drainage. Neither americium-241 nor plutonium-238 was detected above the BV in the next downcanyon reach, CDB-4, constraining their downcanyon extent. Plutonium-239/240 was detected slightly above the BV in one sample from CDB-4 (0.076 pCi/g), suggesting some transport this far east, although average concentrations here are below the background average and a previous investigation had indicated the CDB-4 data were not statistically different from local background samples (Drakos et al. 2000, 068739).

7.1.4 Summary of Sources and Distribution of Key Sediment COPCs

The data discussed in the previous sections indicate that the sediment COPCs in Cañada del Buey have a variety of sources, including Laboratory TAs and associated SWMUs or AOCs, natural background, and ash from the Cerro Grande burn area. Table 7.1-1 summarizes the inferred primary sources of the sediment COPCs discussed above and also the inferred downcanyon extent of COPCs that are or may be derived from Laboratory sources. Sources and downcanyon extent for these COPCs are discussed further below.

7.1.4.1 Natural Background Variability

Sediment data from different canyons indicate that natural background concentrations for many inorganic chemicals and radionuclides are more variable than 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 (e.g., LANL 2009, 106506). In the Cañada del Buey sediment data set, the spatial distribution of some inorganic COPCs and their relations to silt and clay content (Figures 7.1-1 and 7.1-2) indicate that they are dominantly or entirely derived from naturally occurring materials, representing locally elevated background levels. These include arsenic, iron, and thallium. For several inorganic COPCs (aluminum, antimony, and cobalt) these data indicate that concentrations are predominantly naturally derived, with possible minor releases from Laboratory TAs (Table 7.1-1). Several of these inorganic COPCs had been previously identified as being above BVs in reach CDB-4 but not different from local background samples (cobalt, iron, and thallium; Drakos et al. 2000, 068739). One inorganic COPC with no BV, perchlorate, also has a spatial distribution that suggests it largely or entirely represents naturally occurring material and not releases from Laboratory sites.

7.1.4.2 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; LANL 2009, 106506). Cañada del Buey was relatively lightly affected by the fire, and only one inorganic COPC, cyanide, appears locally elevated because of the presence of Cerro Grande ash. Because cyanide is not above the BV along the main Cañada del Buey channel east of CDB-2C, the effects of the fire on sediment chemistry appear restricted to the canyon above the confluence with the south fork of Cañada del Buey (west of reach CDB-3W).

7.1.4.3 Former TA-04, TA-52, and TA-63

Former TA-04, TA-52, and TA-63 are located at the head of the Cañada del Buey watershed, and the presence of low concentrations of several COPCs in reach CDB-1 indicates releases from one or more of these TAs. These COPCs include lead and plutonium-239/240, which had been previously reported as COPCs at former TA-04 (LANL 2008, 101802). They are also elevated downcanyon associated with releases from TA-46, as discussed below, and TA-46 appears to be a more important source for these COPCs in Cañada del Buey.

7.1.4.4 TA-46

TA-46 is a source for several COPCs in Cañada del Buey sediment, most notably lead, which has its highest concentrations in reach CDB-2W upcanyon from the small tributary drainage where the SWSC plant is located. Plutonium-239/240 is also above the BV in some of the samples with elevated lead, suggesting concurrent releases of these COPCs from TA-46. Similarly, the PCBs Aroclor-1254 and/or Aroclor-1260 were also detected, at low concentrations, in all samples with elevated lead. Cobalt has its highest concentrations in a CDB-2W sample with lead at the BV, also suggesting releases from TA-46. One COPC, antimony, was detected at higher concentrations downcanyon in reach CDB-2C, suggesting releases into the SWSC tributary. All of these have been previously reported as COPCs at TA-46, although antimony was considered a COPC only because of detection limits above the BV (LANL 2008, 101803).

Reaches CDB-2W and CDB-2C are in a part of Cañada del Buey where the valley bottom widens and floodwaters disperse, dissipating flood energy and enhancing the deposition of sediment and associated contaminants. These reaches have a discontinuous channel system, features common in many arid and semi-arid landscapes (Bull 1997, 093908) and occurring in other canyons that head on the Pajarito Plateau, such as Mortandad Canyon (LANL 2006, 094161, p. 33). A defined stream channel enters the west end of CDB-2W but does not continue through the entire reach (Plate 2). Floodwaters start to converge in the east part of CDB-2C, dropping over headcuts and entering a new channel segment. As shown in Figure 7.1-6, the estimated widths and volumes of post-1942 sediment in Cañada del Buey are highest in reaches CDB-2W and CDB-2C (volumes normalized by reach length to units of cubic meters per kilometers; sediment characteristics in each reach are shown in Table D-1.0-1). The high sediment volumes are associated with aggradation and burial of older sediment and associated contaminants, minimizing their downcanyon transport. As a result, contaminants released from TA-46, such as lead, and also derived from farther upcanyon, are not found in the next downcanyon reach, CDB-3W. Because of the relatively low flood energy in these reaches, the potential for remobilization of this sediment in future floods is low.

7.1.4.5 TA-54 and TA-51

Based on their spatial distribution, TA-54 is a source for several COPCs in Cañada del Buey sediment, including low levels of radionuclides (e.g., americium-241, plutonium-238, and plutonium-239/240) and PCBs. Near TA-54, the concentrations of these COPCs are highest in reach CDB-3W, indicating a primary source or sources in the western half of MDA G. Small quantities of several inorganic chemicals may also have been released from TA-54 (e.g., aluminum, antimony, and cyanide). The presence of several COPCs in reach CDBS-1W (e.g., antimony, Aroclor-1254, and Aroclor-1260) in the south fork of Cañada del Buey upcanyon from MDA L indicates releases from the western part of TA-54 (including MDA J) and/or TA-51, although their specific sources are not known. Concentrations of COPCs released from the western part of MDA G decrease rapidly downcanyon from CDB-3W, are generally present at lower concentrations in CDB-3E, and are not detected or are not detected above BVs in CDB-4 above NM 4 and White Rock. This downcanyon decrease is the result of mixing with noncontaminated sediment and with the deposition of some of the contaminated sediment. The absence of confirmed contaminants in CDB-4, as also reported in a previous study (Drakos et al. 2000, 068739), indicates that contaminants released from MDA G and upcanyon have had little to no off-site impact and that Laboratory sites in Cañada del Buey are not a recognizable source of contaminants for White Rock or the Rio Grande.

7.1.5 Temporal Trends in Contaminant Concentration

Data on sediment contamination in other canyons at the Laboratory indicate that concentrations were highest at the time of peak releases and subsequently decreased over time due to mixing of contaminated and noncontaminated sediment (e.g., Malmon 2002, 076038; LANL 2004, 087390; Reneau et al. 2004, 093174; LANL 2006, 094161). These same temporal trends have also been documented in other regions (e.g., Lewin et al. 1977, 082306; Rowan et al. 1995, 082303). Although there are no direct records of the release history of contaminants from Laboratory sites in the Cañada del Buey watershed, contaminant concentrations here are expected to follow the same trends found elsewhere and decrease over time because of improved waste disposal practices and associated decreases in the release of contaminants.

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 Cañada del Buey where Laboratory operations were conducted. This discussion focuses particularly on the shallow hydrology of the watershed, including descriptions of surface water and shallow, perched groundwater near wells CDBO-6 and CDBO-7, and summarizes the distribution of contaminants in these media. Figure 7.2-1 shows a conceptual hydrogeologic cross-section that follows the canyon floor. Perched intermediate and regional groundwater for wells in and adjacent to the Cañada del Buey watershed are discussed in context of regional hydrology and geochemistry as part of the "Pajarito Canyon Investigation Report, Revision 1" (LANL 2009, 106771).

7.2.1 Hydrology of Surface Water and Shallow Perched Groundwater

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

7.2.1.1 Surface Water

Figure 7.2-1 shows a conceptual hydrogeologic cross-section for Cañada del Buey and illustrates many of the features of the dry canyon conceptual model. The canyon heads on the Pajarito Plateau in the central part of the Laboratory and has a relatively small drainage area of 11 km^2 (4.2 mi^2), as described in Section 1.3. Surface-water flow in the canyon is ephemeral on Laboratory property and occurs as runoff, primarily following infrequent, intense thunderstorms or during snowmelt. Its source is direct precipitation and runoff from surrounding mesa tops, including stormwater from parking lots and roof top drainage (LANL 2001, 071060). The only active outfall that discharges to the canyon on Laboratory property is associated with Los Alamos County's water supply well PM-4 (Plate 1), which discharges approximately 10,000 to 12,000 gal. of noncontaminated, regional aquifer water when the well is purged at start-up. The White Rock WWTP releases effluent to lower Cañada del Buey east of White Rock. Releases from the treatment plant are too far downstream to affect the near-surface hydrology associated with Laboratory-derived contaminants.

Figure 7.2-2 shows mean daily stream-flow measurements from gages E218 and E230 (Plate 1), located near the head of the watershed and at NM 4, respectively, along with precipitation data measured at the TA-54 meteorological station. Between January 1, 2005, and September 30, 2008, 267 and 34 surface-water flow events were measured at gages E218 and E230, respectively (Appendix B, Table B-2.0-1). These events were generally less than 0.5 cfs mean daily flow, and most of the events at E218 were less than 0.05 cfs mean daily flow (Figure 7.2.2). In addition, stream flow at the two gages appears to be quite local because the gages only rarely measure flow simultaneously. This indicates that localized precipitation drives much of the flow measured at the two gages, and that runoff is lost to the stream bed over relatively short distances. This is further supported by the lack of flow measured at gage E225 (Plate 1), which is located along Cañada del Buey between gages E218 and E230. Only two surface-water flow events were measured at gage E225 between January 1, 2005, and September 30, 2008.

Those two flows coincided with large storms that caused flow at both gages E218 and E230 (Appendix B, Table B-2.0-1), but mean daily flows at E225 were very low (0.007 cfs on August 6, 2006, and 0.02 cfs on January 28, 2008).

7.2.1.2 Alluvial and Perched Shallow Groundwater

Alluvium in the canyon floor appears to be dry, based on data from wells CDBO-1, CDBO-2, CDBO-3, CDBO-4, CDBO-5, CDBO-8, and CDBO-9, which are completed at depths of 12 to 34 ft (LANL 1999, 064617). These shallow observations wells are completed in alluvium and were dry when drilled and during all subsequent sampling (Section 2.2.1). Table B-2.0-2 indicates the number of times that these wells were visited to measure water level in the recent past; each well was found to be dry for 100% of the measurement events (Koch and Schmeer 2009, 105181). In addition, to evaluate the potential for transient occurrences of perched groundwater, pressure transducers were installed in wells CDBO-4, CDBO-5, CDBO-8, and CDBO-9 in January 2009 to continuously record water levels. Between January and July 2009, the transducer data indicate that the wells were continuously dry (Table B-2.0-3). In addition to these alluvial wells, vadose-zone wells CDBM-1 and CDBM-2, which penetrate the Otowi Member of the Bandelier Tuff (Figure 7.2-1), were dry when drilled and when recently examined for the presence of water (Table B-2.0-2). These data do not necessarily confirm the continuous absence of saturation at these wells but rather the lack of saturation at the times the measurements were made. It is possible, and even likely, that short-term saturated conditions may occur temporarily in the alluvium due to infiltration of stormwater or local snowmelt runoff; thus, longer continuous water-level monitoring of wells CDBO-4, CDBO-5, CDBO-8, and CDBO-9 is planned to check for such conditions.

A small spatially limited saturated zone is observed below Cañada del Buey at wells CDBO-6 and CDBO-7 within the colonnade portion of unit 1v of the Tshirege Member of the Bandelier Tuff (Qbt 1v), which lies stratigraphically below the alluvium (Figure 7.2-1). These wells are stratigraphically deeper than the alluvial wells discussed above (LANL 1999, 064617). Figure 7.2-2 shows water levels measured in CDBO-6 and CDBO-7 from May 2005 to July 2009. Water is continuously present at CDBO-6 but is often absent at CDBO-7. This shallow, perched zone does not appear to extend as far east as CDBM-1 (Figure 7.2-1), which had measured volumetric water content of less than 20% over its length (189 ft) when drilled (Rogers and Gallaher 1995, 097569; also see Appendix G, Attachment 3). The moisture conditions at CDBM-1 result in an estimated infiltration rate at that location of 2 mm/yr or less (Rogers et al. 1996, 055543). The eastern extent of the perched zone at CDBO-7 may be limited by rising of the colonnade unit Qbt 1v above the canyon floor between CDBO-7 and CDBM-1. The base of the colonnade unit is thought to be a hydrostratigraphic perching horizon (LANL 1999, 064617). The perched zone does not appear to extend beneath MDA H to the south, as evidenced by neutron-log data measured in boreholes 54-01023 and 54-15462 (Appendix G, Attachment 4). In addition, during recent drilling at well R-37 just to the southeast of CDBO-6 and CDBO-7, water was not observed within the unit Qbt 1v interval.

In Figure 7.2-2, water-level data from wells CDBO-6 and CDBO-7 are plotted with E218 and E230 gage data and precipitation data to determine if any correlation exists between surface-water flow and water-level responses in CDBO-6 and CDBO-7. Water levels in the wells respond to precipitation and runoff events recorded at the nearby TA-54 meteorological station and to events recorded at stream gages, indicating that stormwater runoff is the predominant source of recharge to these two wells. Groundwater levels at CDBO-6 and CDBO-7 reach peak levels approximately 4 to 6 mo and 7 to 9 mo, respectively, after large runoff events in Cañada del Buey (Table B-2.0-4). Further evidence that the perched zone is recharged by surface water is provided by the relatively long-term, low groundwater levels (May–October 2006) that followed the dry spring in 2006 and the relatively long-term high groundwater levels (August–December 2007) that followed the wet spring, summer, and fall 2007. The highest groundwater levels at CDBO-6 followed a rain-on-snow event that occurred on January 28, 2008, and probably caused runoff along the entire length of the canyon. The lags between runoff events and peak groundwater levels indicate that infiltration of stream flow likely occurs upstream of CDBO-6 in Cañada del Buey and that the water reaches the wells though lateral, unsaturated, subsurface flow. The discussion of Figure B-2.0-1 in Appendix B provides further evidence that the perched zone at CDBO-6 is of limited extent and is sporadically and slowly recharged. Peak groundwater levels occur later at CDBO-7 because the well is located farther downstream from where surface water infiltrates.

Other possible sources of recharge to wells CDBO-6 and CDBO-7 were evaluated, including water supply well PM-4 purge water and potential leaks from the SWSC plant at TA-46. As noted above, approximately 10,000 to 12,000 gal. of noncontaminated, regional aquifer water is released to Cañada del Buey, just west of CDBO-6, when PM-4 is purged with each start-up. Such releases occur roughly 10 to 20 times per year, based on the PM-4 operating schedule. A comparison of CDBO-6 and CDBO-7 water-level data to the PM-4 purge schedule shows that the releases do not correlate to the groundwater-level fluctuations. However, although the purge water does not control fluctuations in the water level, the purge water may recharge the saturated zone near CDBO-6 and increase its overall groundwater level. Given the several-month lag between surface flow and water-level responses at CDBO-6, any signal from the regular releases at PM-4 likely yields a damped response at CDBO-6 (if those releases do affect the water level). The geochemistry of several surface water, spring water, and regional groundwater samples from Cañada del Buey and Pajarito Canyon were compared with that of CDBO-6 (Appendix G, Attachment 6). The geochemical signature of CDBO-6 is not similar to regional groundwater and does not contain sewage constituents, indicating that water there is not derived from leaks from the SWSC Plant. Its chemistry is most similar to TA-18 Spring and Threemile Spring, which emerge into the Pajarito watershed and is believed to be fed directly or indirectly by water from colonnade Qbt 1v (LANL 2008, 104909).

To summarize, a small spatially limited saturated zone is present in the vicinity of wells CDBO-6 and CDBO-7. This zone is likely recharged by local runoff in Cañada del Buey that infiltrates the canyon floor to the west of CDBO-6, flows laterally through the subsurface, and perches near the base of Qbt 1v in the vicinity of CDBO-6 and CDBO-7. Migration of contaminants to deeper zones is inhibited because of the small amount of surface-water recharge within Cañada del Buey. In addition, very few mobile contaminants are present in the watershed, as discussed in Sections 6 and 7.2.2. Therefore, neither surface-water flow in the canyon nor the limited, perched zone at CDBO-6 and CDBO-7 represents significant sources of contamination to deeper groundwater.

7.2.2 COPCs in Surface Water and Shallow, Perched Groundwater

No persistent surface water occurs in the Cañada del Buey investigation area, and no surface-water COPCs were identified. Stormwater COPCs are discussed in Section 6.4. Inorganic chemicals, organic chemicals, and radionuclides have been identified as COPCs in shallow groundwater beneath Cañada del Buey at CDBO-6 and CDBO-7, as presented in Section 6.3.

Groundwater samples have been collected from wells CDBO-6 and CDBO-7 and analyzed for metals, organic compounds, and radionuclides since May 1, 2001. Beryllium and bis(2-ethyhexyl)phthalate were detected at concentrations of 4.5 and 7.23 μg/L, respectively, in nonfiltered samples collected from CDBO-6 during a sampling round conducted on February 11, 2008. The EPA drinking water standards for beryllium, and bis(2-ethylhexyl)phthalate are 4 and 6 μg/L, respectively. Di-n-octylphthalate was also detected once at a concentration of 9.36 μg/L in a sample collected on February 27, 2007, at CDBO-6. The EPA drinking water standard for di-n-octylphthalate is 6 μg/L. Each of these three chemicals was detected only once during seven or eight sampling rounds conducted at CDBO-6. Suspended particles consisting of the Bandelier Tuff within the groundwater sample are the most likely source of elevated beryllium at CDBO-6. The sources of bis(2-ethyhexyl)phthalate and di-n-octylphthalate are unknown. However, bis(2-ethyhexyl)phthalate has been detected in soil samples at TA-46 (LANL 1999, 064617, pp. 2-47–2-56). These two SVOCs are common constituents leached from plastics.

Other dissolved chemicals, including barium, lead, strontium, vanadium, and zinc, exceeded background levels for alluvial groundwater at wells CDBO-6 and CDBO-7. The sources of these inorganic chemicals may include natural variability in alluvial groundwater that is recharged by surface water during storm events and erosion from Laboratory sites in the upper watershed. These chemicals each exceeded background concentrations in only 1 or 2 samples out of a total of 9 to 14 groundwater samples. In addition, tritium exceeded background levels in four out of five groundwater samples from CDBO-6 and CDBO-7 with concentrations ranging from 57.5 to 110 pCi/L. Unknown sources in the upper watershed or MDAs at TA-54 may contribute tritium to the watershed.

8.0 RISK 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), which identifies COPECs and ecological receptors potentially at risk. This section presents ecological screening results based on the comparison of ESLs with available sediment data. Additional information on the screening methodology and development of ESLs is provided in the SLERA methods document (LANL 2004, 087630). The ESLs used for screening soil and sediment data in this report are from ECORISK Database, Version 2.3 (LANL 2008, 103352). Where DOE and Laboratory-specific Biota Concentration Guidelines (BCGs) for radionuclides are more conservative than radiological ESLs, maximum radionuclide concentrations in each reach are compared with the DOE and Laboratory-specific BCGs (DOE 2002, 085637; DOE 2004, 085639). These screening assessments identified COPECs and formed the basis for determining whether to proceed to the baseline ecological risk assessment (ERAGS Steps 3 to 8).

8.1.1 Problem Formulation for Ecological Screening

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

Historical contaminant releases into Cañada del Buey have occurred from multiple SWMUs and/or AOCs, as discussed in Section 2.1 and shown by sediment data (Section 7.1). Mechanisms of contaminant release to Cañada del Buey include releases to soil from adjacent container storage and waste disposal areas, liquid releases from cooling tower and sanitary wastewater outfalls, and contaminants mobilized by storm runoff. Potential Laboratory contaminant sources are in former TA-04, TA-46, TA-51, TA-52, and TA-54. For ecological receptors, the primary impacted media in the canyons are sediment deposits (soils) in the canyon bottom. Sediment in the canyon bottom is not exposed to persistent water; therefore, the sediment in all geomorphic units (active and abandoned channels and floodplains) is evaluated as soil by comparing COPC concentrations with the soil ESLs. Because no persistent surface water is present in the Cañada del Buey investigation area, there is no mechanism for water or active channel sediment to interact with aquatic receptors or the aquatic food web. Therefore, there is no exposure pathway to an aquatic community.

An ecological scoping checklist was completed for sediment investigation reaches within Cañada del Buey; the completed ecological scoping checklist is provided in Appendix E-1 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 Cañada del Buey have ponderosa pine as the dominant overstory vegetation, although some reaches also contain mixed conifer, piñon, or juniper trees, depending on elevation and microclimate. These reaches include narrow high-walled areas, wider areas with grass beneath the tree cover, and (particularly toward the lower end of the watershed) some wide open areas with shrubs and large forbs but little tree cover. Upper reaches of the watershed were burned during the May 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 in situ and/or 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 terrestrial receptors for a particular chemical or radionuclide. The ESLs for soil developed for each of the receptors consider both direct exposure and (except for plants and earthworms) uptake through food. The toxicity reference values (TRVs) used to develop the ESLs are based on no observed adverse effect levels (NOAELs) for survival, growth, or reproduction. These are conservative estimates of concentrations of a chemical or radionuclide that have shown no effect on individuals in scientific studies presented in the literature. The development of TRVs and the values for TRVs and ESLs are documented in the ECORISK Database, Version 2.3 (LANL 2008, 103352).

8.1.2 Ecological Screening Approach for Cañada del Buey

Extensive sampling of sediment has been done within Cañada del Buey. To evaluate whether the concentrations of chemicals and radionuclides represent a potential risk to ecological receptors in the canyon, the maximum detected concentration of each COPC in each reach was compared with the appropriate screening concentrations. Maximum COPC concentrations in soil (as defined in Section 8.1.1) were compared with the soil ESLs for terrestrial receptors (Tables 8.1-1 through 8.1-3). Results for detected essential nutrients (i.e., calcium, magnesium, potassium, and sodium) are presented but not evaluated as COPECs.

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

8.1.3 Data Evaluation for Screening of Soil

The data evaluation in Section 6 determined which chemicals and radionuclides were retained as COPCs. As discussed in Section 6.2, a total of 22 inorganic chemicals, 35 organic chemicals, and 7 radionuclides were retained as COPCs in sediment in Cañada del Buey. Maximum sample results in each reach for these COPCs are presented in Tables 6.2-1, 6.2-2, and 6.2-3 for inorganic chemicals, organic chemicals, and radionuclides, respectively.

Evaluation of the sample data before ecological screening follows a similar approach to that used in the "Los Alamos and Pueblo Canyons Investigation Report" (LANL 2004, 087390, pp. 6-2–6-5), the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 089308, pp. B-4–B-7), the "Pajarito Canyon Biota Investigation Work Plan" (LANL 2006, 093553), and the "North Canyons Investigation Report" (LANL 2009, 106506). All COPCs are compared with minimum soil ESLs to identify COPECs, as presented in Section 8.1.4.

8.1.4 Results of the Screening Comparison for Soil

As explained in the SLERA methods document (LANL 2004, 087630, p. 31), the criterion for retaining a COPC as a COPEC is a hazard index (HQ) greater than 0.3. This HQ is calculated based on dividing the maximum detected concentration of a chemical or radionuclide COPC by the minimum ESL applicable to that media. The COPECs identified by the minimum ESL comparisons are further defined as potential study design COPECs based on an HQ greater than 3. The criterion of an HQ greater than 3 is based on the geometric mean of the ratio between the NOAEL and the lowest observed adverse effect level (LOAEL) (Dourson and Stara 1983, 073474). An HQ greater than 3 represents levels that may potentially impact receptors and is therefore appropriate for determining which COPECs should be included in site-specific biota studies in Cañada del Buey, if required. 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). In consideration of threatened and endangered (T&E) species, COPEC concentrations are evaluated using an HQ greater than 1 to ensure protection of each individual within the population. In Cañada del Buey, the American kestrel is a surrogate receptor species for the Mexican spotted owl; therefore; any HQ >1 for the kestrel (a top carnivore) is evaluated.

Table 8.1-1 provides the HQ for the maximum detected concentration of each inorganic COPC in soil. Table 8.1-2 shows the same HQ evaluation for radionuclide COPCs, and Table 8.1-3 shows the HQ evaluation for organic COPCs. The HQs in these three tables are based on a comparison to the minimum soil ESLs, which are designed for the protection of terrestrial receptors and aerial herbivores, insectivores, omnivores, and carnivores (robin and kestrel). Surrogate ESLs are used for ethylbenzene (based on the ESL for benzene) and isopropyltoluene[4-] (based on the ESL for toluene). No ESLs are available in the current version of the ECORISK Database (LANL 2008, 103352) for styrene; however, styrene has an interim ESL for at least one receptor based on toxicity information from the Oak Ridge National Laboratory Risk Assessment Information System (Table 8.1-3). COPECs with an HQ >3 (or greater than 1 for the American kestrel) are shaded in black in these tables. Analytes for which no ESLs are available include calcium, magnesium, nitrate, perchlorate, potassium, and aniline.

Soil Screening Results. Sediment COPECs identified with maximum soil ESL HQs >3 (or HQs > 1 for the American kestrel) included nine inorganic chemicals and two organic chemicals in eight reaches (Tables 8.1-1 and 8.1-3). No maximum detected radionuclide concentrations exceeded an HQ of 3 (or HQs >1 for the American kestrel).

8.1.5 Evaluation of Cañada del Buey COPEC Concentrations for Biota Studies

The COPECs, exposure pathways, and receptors in Cañada del Buey 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 Cañada del Buey. 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 Cañada del Buey to determine potential risks.

This section describes the approach and results for evaluating COPEC concentrations in Cañada del Buey with soil concentrations and results of biota studies from other canyons where ecological risk has been evaluated. This assessment approach follows those presented in the NMED-approved documentation for the “Mortandad Canyon Biota Investigation Work Plan” (LANL 2005, 089308), the “Mortandad Canyon Investigation Report” (LANL 2006, 094161), the “Pajarito Canyon Biota Investigation Work Plan” (LANL 2006, 093553), and the “Sandia Canyon Biota Investigation Work Plan” (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 COPEC concentrations in Cañada del Buey soils are less than concentrations in the soils evaluated in previous canyons investigation reports, and if these reports concluded there was no unacceptable ecological risk to this assessment endpoint, then Cañada del Buey biota studies are not necessary.

Potential study design COPECs for Cañada del Buey and potentially affected receptors are summarized in Table 8.1-4. 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 2005, 089308; LANL 2006, 093553; LANL 2008, 104909). The types of data are summarized below along with the rationale for including these previous studies.

Most potential study design COPECs identified for Cañada del Buey have biota-relevant soil data from these previous investigations. Samples with biota-relevant exposure data from the previous canyons investigation reports are tabulated in Attachment E-1, Table E-2.0-1. 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).

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 Cañada del Buey 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 Cañada del Buey sediment that are less than concentrations correlated to effects (or no effects) observed in previous studies. All plant-relevant COPECs identified for Cañada del Buey 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 Attachment E-1, Table E-2.0-1.

Table 8.1-5 shows the maximum detected concentrations of COPECs with HQs greater than 3 for plants in Cañada del Buey 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 Cañada del Buey maximum detected concentrations are lower than previous investigations include chromium, manganese, thallium, and vanadium. The maximum concentration of antimony exceeded maximum values reported from the previous investigations. Average concentrations of antimony in specific investigation reaches in Cañada del Buey also exceeded average concentrations of antimony in sediment from the Los Alamos and Pueblo Canyons 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 Cañada del Buey soil that are less than toxicity test concentrations correlated to effects or no effects observed in previous studies. All earthworm-relevant COPECs identified for Cañada del Buey have earthworm-relevant soil data from these previous investigations, and sample IDs with earthworm-relevant exposure data from the canyons investigation reports are tabulated in Attachment E-1, Table E-2.0-1.

Earthworm COPECs are chromium and mercury. All maximum earthworm-relevant COPEC concentrations for these metals in Cañada del Buey are bounded by results from previous investigations (Table 8.1-6).

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 on a reach scale (composite samples were collected from trapping arrays) and therefore are not directly comparable to the discrete samples from Cañada del Buey 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 Cañada del Buey that are less than concentrations reported in previous studies collected from discrete locations or composite samples representing reaches in these watersheds. All small mammal-relevant COPECs identified for Cañada del Buey 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 Attachment E-1, Table E-2.0-1. Sediment data from those investigations are compared with maximum detected Cañada del Buey sediment concentrations in Table 8.1-7.

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 generally conservative. Use of the shrew ESL applies an additional level of conservatism, as the dry soils associated with Cañada del Buey are not likely to be occupied by this sensitive receptor. Maximum detected sediment concentrations of thallium in Cañada del Buey reaches are lower than in previous investigations. Maximum detected concentrations of antimony and Aroclor-1248 in Cañada del Buey are not bounded by concentrations observed in the Los Alamos and Pueblo Canyons or Mortandad Canyon investigations.

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 Cañada del Buey that are less than the soil concentrations reported in previous studies. All bird-relevant COPECs identified for Cañada del Buey 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 Attachment E-1, Table E-2.0-1. Sediment data from bird-relevant reach locations from the previous studies were summarized and maximum COPEC concentrations are compared with maximum Cañada del Buey sediment concentrations in Table 8.1-8. The American robin is modeled as the representative for insectivorous birds, omnivorous birds, and herbivorous birds. The minimum ESL for each COPEC based on any of the three robin diets was used in the ESL screen.

COPECs where Cañada del Buey maximum detected concentrations are less than those from previous investigations include mercury, vanadium, zinc, and bis(2-ethylhexyl)phthalate. COPECs where Cañada del Buey maximum detected concentrations are greater than in previous investigations include total cyanide, lead, and Aroclor-1248.

<u>Avian Predator (Kestrel)</u>: 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 Cañada del Buey that are less than soil concentrations reported in previous studies. All kestrel-relevant COPECs identified for Cañada del Buey have corresponding kestrel-relevant location soil data (corresponding to reaches where dietary exposure to small mammals was assessed) from these previous investigations; samples with avian predator-relevant exposure data from the previous canyons investigations are tabulated in Attachment E-1, Table E-2.0-1.

The kestrel modeled with a 100% flesh diet is used to represent all avian top carnivores, including the Mexican spotted owl. Because the Mexican spotted owl represents a T&E species, an HQ >1 (instead of an HQ >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 Cañada del Buey sediment concentrations in Table 8.1-9. Cañada del Buey maximum detected concentrations of mercury and bis (2-ethylhexyl) phthalate are less than those observed from previous studies. Total cyanide concentrations in Cañada del Buey sediment were not bounded by previous investigations.

Unbounded COPECs: Maximum concentrations in Cañada del Buey sediment samples that are greater than previous canyons investigation results ("unbounded COPECs") for terrestrial receptors for which they were COPECs included antimony, total cyanide, lead, and Aroclor-1248. All other maximum COPEC concentrations are less than those from previous biota investigations that evaluated ecological exposures and the potential for adverse effects. Table 8.1-10 summarizes concentrations of all unbounded sediment COPECs in Cañada del Buey.

As discussed in Section 7.1, the inferred primary sources of antimony include naturally occurring background and potentially minor releases from TA-46, TA-54, and/or TA-51. The two highest detected concentrations are from reach CDB-2C, suggesting releases from TA-46 into a short tributary to Cañada del Buey. The highest average concentrations in fine facies sediment are in reaches CDB-3W and CDBS-1W, suggesting additional releases into Cañada del Buey from the west half of MDA G and into the head of the south fork of Cañada del Buey upcanyon of MDA L. Cañada del Buey average soil concentrations of antimony were only bounded in some of the reaches. The highest detected concentration of antimony in sediment (3.2 mg/kg in CDB-2C, sample ID CACB-09-54) is a statistical outlier among the Cañada del Buey antimony results (Figure 7.1-1). It was primarily based on this antimony result that a source from TA-46 was suggested for antimony. This sample was collected from a depth of 28 to 48 cm, which represents a soil horizon deeper than would be prescribed for phytotoxicity testing (0–30 cm) or small mammal studies (0–15 cm) (LANL 2006, 093553; LANL 2007, 099152) Sandia. Because this sample result was collected from a nonbiologically relevant depth, this antimony is unlikely to represent an ecological risk and no additional studies are required for antimony in sediment in Cañada del Buey.

The inferred primary sources of total cyanide include the Cerro Grande burn area as well as potentially minor releases from TA-54. As indicated in Section 7.1, Cerro Grande ash is the main source of elevated cyanide in Cañada del Buey, although the results from one sample suggest small releases from the vicinity of MDA L into the south fork. Reach average concentrations of total cyanide are bounded by previous biota investigations; therefore, total cyanide is not predicted to result in ecological effects.

As discussed in Section 7.1, the primary source of lead in the Cañada del Buey watershed is released from TA-46. Sediment data indicate that there is relatively little downcanyon transport of lead below reach CDB-2W or that the lead is rapidly reduced to background levels by mixing with other sediment. Average reach concentrations of lead are bounded by previous biota investigations; therefore, lead is not predicted to result in ecological effects.

Aroclor-1248 was detected in only one sample in Cañada del Buey, from reach CDB-3W downcanyon of the western half of MDA G. Two additional PCBs, Aroclor-1254 and Aroclor-1260, which did not exceed the soil ESL, were both detected at higher frequencies (see Section 7.1). The highest concentrations of Aroclor-1254 and Aroclor-1260 were both from the CDB-3W sample with the highest Aroclor-1248 concentration. While Arcolor-1248 was not one of the PCB mixtures investigated in other canyons, Aroclor-1254 and Aroclor-1260 were studied in the Mortandad Canyon and Los Alamos and Pueblo Canyons biota investigations at concentrations that bound the maximum concentrations of Aroclor-1248 in Cañada del Buey. Adverse effects from a single detected result for Aroclor-1248 are unlikely and do not warrant additional biota studies.

8.1.6 Ecological Risk Assessment Uncertainties

There are several ecological risk assessment uncertainties related to Cañada del Buey. Uncertainties associated with established soil ESLs fall into two main categories. The first group is associated with COPECs, including toxicity and bioavailability (or transfer factors between soil and food). The second group relates to receptors, including feeding rates, the amount of incidental soil ingestion, and diets. These uncertainties are addressed by selecting inputs to the soil ESL calculations that represent worst-case conditions. For some detected COPCs, no ESLs were available for ecological screening and it is therefore not possible to evaluate potential ecological impacts from these COPCs. Sediment COPCs that were detected in Cañada del Buey but have no ESLs include five inorganic chemicals (including calcium, magnesium, potassium, and sodium, which are considered to be essential nutrients, and perchlorate) and one organic chemical (aniline). Chemicals identified as essential nutrients are not predicted to pose risk to terrestrial ecological receptors. Perchlorate was detected in 37 of 140 samples and was measured at its highest concentration (0.015 mg/kg) in a sample from reach CDB-3W. Perchlorate was most frequently detected in reaches CDB-2W (13 of 20 detections) and CDB-2C (11 of 20 detections), with detections in all reaches except CDB-4. Maximum perchlorate concentrations in all other reaches were less than 0.003 mg/kg. Because perchlorate is likely present in sediment and no ESL is available, it remains an ecological risk uncertainty. Aniline was detected only once in 147 samples and therefore is not likely to pose an ecological risk.

8.1.7 Summary of the SLERA

COPECs were identified for Cañada del Buey sediment based on the comparison of maximum detected concentrations against applicable soil ESLs. Where COPEC concentrations in Cañada del Buey sediment samples resulted in an HQ >3 they were compared with a range of concentrations reported in previous biota studies where associated effects information indicated no unacceptable ecological risks. Where Cañada del Buey sediment concentrations were greater than in previous investigations and/or have non-Laboratory sources (e.g., natural background or the Cerro Grande burn area), risks are not

Laboratory-related. Based on this information, no COPECs in sediment are recommended for additional biota studies.

8.2 Human Health Risk Assessment

The human health risk assessment evaluates the potential risk to human health in Cañada del Buey from COPCs identified in Section 6 of this report. The risk assessment approach used in this report follows guidance from NMED (2009, 106420) and is organized in seven major subsections. The approach utilizes media- and scenario-specific SLs to evaluate the potential for human health risks from sediment in Cañada del Buey. Risks from surface water are not quantitatively evaluated because there is no persistent surface water in the Cañada del Buey investigation area. Section 8.2.1 provides the basis for selecting the exposure scenarios for the human health risk assessment. In Section 8.2.2, the data collection and evaluation processes described in previous sections of the report are summarized, focusing on aspects of data analysis that are pertinent to the risk assessment. Section 8.2.2 also lays out the logic for selecting COPCs for the human health risk assessment. The exposure assessment (Section 8.2.3) provides information used in quantifying human exposure to sediment COPCs. 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 scenario-specific SSLs and SALs. Risk characterization (Section 8.2.5) is based on the sum of fractions (SOFs) method for evaluating the potential for additive effects with COPCs that are classified as noncarcinogens, carcinogens, or radionuclides. Uncertainty related to the various assumptions and inputs used in the risk assessment is evaluated in Section 8.2.6 to support interpretation of the risk characterization. A summary of the risk assessment is provided in Section 8.2.7.

8.2.1 Problem Formulation

The risk assessment uses information pertaining to current and reasonably foreseeable future land use in Cañada del Buey to assess potential impacts under reasonable maximum exposure (RME) conditions. The canyon bottoms in Cañada del Buey include a mixture of land ownership, as discussed in Section 1.3, potentially supporting a variety of land uses.

The assessment employs the recreational exposure scenario, which combines both adult trail user and child-extended backyard exposures, to represent the current and reasonably foreseeable potential future exposure activities for contaminated sediment in Cañada del Buey. The trail user scenario describes an adult individual who contacts contaminated sediment while hiking or jogging in the canyons. The extended backyard scenario describes an older child (age 6–11-yr-old) living in a home sufficiently close to the canyon that he or she may use 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 watershed where COPCs are at levels requiring a human health risk assessment. One reach, CDB-4, was also evaluated using a residential scenario due to the transfer of part of this area to Los Alamos County for potential residential and commercial development (LANL 1999, 063037). The remaining reaches were evaluated for residential exposure as a supplemental exposure scenario 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 does not represent a current or reasonably foreseeable future land use for reaches other than CDB-4.

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 comparison with BVs. Persistent surface waters are not present in Cañada del Buey; therefore, surface water data were not evaluated. Stormwater is discussed in Section 6.

Identifying COPCs for the Human Health Risk Assessment

COPCs for the human health risk assessment are identified based on SL comparisons and calculations using residential SSLs and SALs. This approach is similar to that described and used in previous canyons investigation reports (LANL 2004, 087390; LANL 2006, 094161; LANL 2008, 104909; LANL 2009, 106506). This process includes calculating a ratio, which is the maximum concentration of an analyte in a reach divided by the SL. Ratios based on maximum detected concentrations for all COPCs within a reach are summed to calculate the SOF for the risk type. An SOF is the sum of these ratios for each risk type, i.e., carcinogens (SOF_{ca}), noncarcinogens (SOF_{nc}), and radionuclides (SOF_{rad}). If a reach has an SOF greater than 1.0 for a risk type, all COPCs in the reach for that risk type with a ratio greater than 0.1 are retained and evaluated in the site-specific risk assessment. COPCs with a ratio less than or equal to 0.1 are excluded because they are unlikely to substantially contribute to risk. If the ratio for an individual COPC was greater than 0.1 but the SOF for the reach and risk type was less than 1.0, the COPC was not carried forward 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 Version 5.0 (NMED 2006, 092513). For chemicals for which NMED does not provide a value, the residential screening value from the current EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) was used as the SL (carcinogens are adjusted to a 10^{-5} risk level to be consistent with the NMED target risk level). NMED-approved surrogate compounds were used for some COPCs that lack NMED or EPA SLs (NMED 2003, 081172). Residential SALs were used for radionuclides based on 15 mrem/yr and derived using RESRAD Version 6.21 (LANL 2005, 088493).

Tables 8.2-1 to 8.2-3 present the residential SSLs and SALs used to calculate the ratios based on the maximum detected concentrations for each COPC. These tables also provide the SOFs for each reach for each risk type for all sediment COPCs. COPCs and reaches shaded gray are those retained for the risk assessment. Table 8.2-1 provides the results for noncarcinogens and shows that four COPCs (aluminum, cobalt, iron, and thallium) are retained for further evaluation as noncarcinogens,, Table 8.2-2 provides the results for carcinogens and shows that one COPC (arsenic) is retained for further evaluation as carcinogens, and Table 8.2-3 provides the results for radionuclides and shows that no COPCs are retained for further evaluation as radionuclides.

Surface-Water COPCs. There is no persistent surface water in Cañada del Buey; therefore, water is not evaluated under the recreational scenario. However, Aroclor-1254 in stormwater was evaluated for acute exposure in Section 6 and found not to be a risk issue.

COPC Summary. Table 8.2-4 summarizes the analyte classes and reaches evaluated, and Table 8.2-5 summarizes the exposure pathways evaluated for the recreational and residential scenarios. Table 8.2-6 presents a summary of SLs and endpoints for COPCs carried forward to the human health risk assessment for Cañada del Buey.

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.

The investigation approach for sediment resulted in representative samples associated with different geomorphic units and sediment facies within each reach. These data are combined to estimate means and UCLs 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 as 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 (e.g., the highest calculated UCL less than the maximum detected value). 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).

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

8.2.3 Exposure Assessment

The recreational scenario applies to all reaches identified in Tables 8.2-1 and 8.2-2. The residential scenario is also applicable to reach CDB-4 because part of this reach is on land owned by the County of Los Alamos that is planned for commercial and residential development (LANL 1999, 063037). Additionally, potential risk associated with the residential scenario is provided as a point of comparison for the remaining reaches (see Appendix E, Section E-3.0). Residential SSLs are from NMED guidance (NMED 2006, 092513) and residential SALs are from Laboratory guidance (LANL 2005, 088493). Sediment SSLs and SALs for the recreational scenario are provided in Laboratory guidance (LANL 2007, 094496).

8.2.3.1 Recreational Exposure Scenario

The human health risk assessment focuses on potential risks and doses resulting from direct exposure to contaminants in sediments through ingestion, inhalation, and dermal contact. No persistent surface waters are present in Cañada del Buey, so the water pathways consisting of ingestion and dermal contact (chemicals only) were not evaluated. Stormwater data in comparison to applicable standards are summarized in Section 6. Only Aroclor-1254 was evaluated for potential acute human health effects based on exposure to stormwater and was found to not be an issue (Section 6.4.2.3). Stormwater is not included as part of the quantitative human health risk assessment because stormwater is transient and does not occur frequently enough to sustain chronic exposures and the qualitative assessment suggests unacceptable acute effects. Exposure to groundwater is not evaluated because no groundwater in Cañada del Buey is available for human use under current or reasonably foreseeable future conditions for the recreational scenario. Exposures to the recreational receptor are evaluated at the scale of sediment investigation reaches. This local-scale evaluation is protective compared with an assessment based on a larger scale encompassing numerous reaches and areas between reaches because it includes areas closest to contaminant sources where contaminant concentrations are highest.

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

The recreational scenario addresses limited site use for outdoor activities, such as hiking, playing, and jogging. The receptor for this scenario is anticipated to be an adult hiker or a child playing in the canyon over an extended period of time. Therefore, receptors for the recreational scenario are defined as adults and older children (6–11-yr-old). A complete description of the parameter values and associated rationale is provided in Laboratory guidance (LANL 2004, 087390, p. 8-37). Exposure parameters for the recreational scenario are provided in Appendix E, Section E-3.0.

8.2.3.2 Residential Exposure Scenario

Risk estimates for a residential exposure scenario are provided for reach CDB-4 because of the potential for residential development (LANL 1999, 063037). For the remaining reaches, risk estimates for residents are provided as a supplemental scenario in Appendix E-3. 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 residential scenario are provided in Appendix E, Section E-3.0.No carcinogens or radionuclides in CDB-4 were carried through to the risk assessment, so only results for noncarcinogens are provided.

8.2.3.3 Spatial Scales of Application for the Exposure Scenarios

Each exposure scenario is evaluated at the scale of an investigation reach. The risk assessment does not attempt to integrate exposure across multiple reaches. By assessing each reach separately, the impacts of local variability in COPC concentrations upon the 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), including areas closest to SWMUs and AOCs where contaminant concentrations would be highest. Risks for more realistic exposures from multiple reaches within Cañada del Buey 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 between the two types of risk that are evaluated in this assessment: systemic toxicants (noncarcinogens) and chemical carcinogens. 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 2009, 106420; LANL 2007, 094496; http://cfpub.epa.gov/ncea/iris/index.cfm).

SLs are from several sources based on COPC type:

- recreational scenario for carcinogens and noncarcinogens:
    - ❖ recreational SSLs in Laboratory guidance (LANL 2004, 087800)
- residential scenario for carcinogens and noncarcinogens:
    - ❖ SSLs from NMED guidance (2006, 092513), except for certain values from EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm)
- residential scenario for radionuclides:
    - ❖ residential SALs in Laboratory guidance (LANL 2005, 088493)

Table 8.2-6 summarizes the recreational SSLs and the target levels. Comparing the screening values with COPCs for a given risk endpoint provides some information of the relative toxicity of these analytes. The toxicity values used to calculate the recreational SSLs for the COPCs listed in Tables 8.2-1 and 8.2-2 were reviewed. None of the toxicity values for the COPCs listed have been updated since 2006; hence, the recreational SSLs (see Appendix E, Section E-3.0) used to calculate ratios are based upon current toxicological data.

SSLs compiled by NMED (NMED 2009, 106420) and EPA regional SLs dated 2009 (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm) were utilized for the residential assessment. These compilations are the most up-to-date available and therefore the SSLs used in the residential risk assessment reflect the latest toxicity information available for any given analyte. Consequently, all of the residential SSLs used are based upon the most up-to-date toxicity data available.

8.2.5 Risk Characterization

In this section information provided in the exposure and toxicity assessments (Sections 8.2.3 and 8.2.4, respectively) is integrated to characterize potential risks and doses. 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, 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 calculations of SLs; 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 (SOFs) for an investigation reach within the COPC classes of carcinogens, noncarcinogens, and radionuclides. A SOF less than 1.0 indicates that exposure is unlikely to result in an unacceptable cancer risk, hazard, or radiation dose. The SOF values are then multiplied by the target effect level (i.e., HI = 1, risk = 1×10^{-5}) to provide risk and dose estimates for each effect type.

Tables 8.2-7 and 8.2-8 present the COPC and reach-specific recreational risk values for carcinogens and noncarcinogens, and Table 8.2-9 presents the COPC and reach-specific residential risk values for noncarcinogens in sediment, respectively. The sediment EPCs used in these calculations are presented in Table 8.2-10.

8.2.5.1 Noncarcinogenic Effects

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 SLs for noncarcinogenic effects. When the potentially additive effects of two or more chemicals are considered, HQs are summed to generate an HI. However, summing 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 HIs in all cases are well below 1.0. Potential noncarcinogenic effects for COPCs in sediment were calculated for reaches CDB-3E and CDB-4 (Table 8.2-7).

Potential residential noncarcinogenic effects for contaminants in sediment were calculated for reach CDB-4 (Table 8.2-9). The calculated sediment HI for this reach is less than 1.0.

8.2.5.2 Carcinogenic Effects

Cancer risk for an individual chemical is defined by the incremental cancer risk (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 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 SLs (NMED 2006, 092513). Lifetime cancer risk is considered to be additive over time; childhood and adulthood exposures are summed to calculate the ICR.

Potential recreational risks due to carcinogens (arsenic) in sediment were evaluated for all reaches, except CDB-4. There were no carcinogenic COPCs evaluated for CDB-4. All of the ICRs were less than or equal to 2×10^{-6} (Table 8.2-8), indicating that risk due to carcinogens in sediment in Cañada del Buey is not a concern for the recreational scenario.

8.2.6 Uncertainty Analysis

The uncertainty analysis uses qualitative and semiquantitative information to evaluate the uncertainty associated with the risk and hazard estimates described in Section 8.2.5. This uncertainty analysis pertains to the results of the recreational and residential scenarios. 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 retained for calculation of EPCs were those that had ratios greater than 0.1 for endpoints with SOF values greater than 1.0 for the residential screen. Thus, the COPCs retained represent an inclusive list of potential human health risk drivers.

Most of the COPCs retained for the human health risk assessments have their main inferred source in naturally occurring material in the Cañada del Buey watershed (see Section 7.1, Table 7.1-1). The assessment is protective by including all of these COPCs in the assessment of the potential for human health risks.

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 material, excluding areas not impacted by dispersion of contaminants by post-1942 floods. The process of characterizing reaches and focusing on sampling is discussed further in Section 4.1 and in Section B-1.0 of Appendix B. Second, UCLs on the average sediment concentrations were 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.

8.2.6.2 Exposure Assessment

This section focuses on the recreational scenario as it applies across all the reaches. In addition, because CDB-4 is in a flood plain, it is unlikely that residential development will occur.

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 the key COPCs and exposure pathways associated with potential health impacts. This evaluation of uncertainty in exposure is focused on these COPCs and pathways.

Key exposure pathways for contaminated sediment for the recreational scenario include dermal absorption, incidental soil ingestion, and inhalation. 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.

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 carcinogens, the exposure assessment should be evaluating incremental exposures that are greater than background. EPCs are calculated that include background concentrations. Background exposures are not negligible because carcinogenic risks are based on concentrations of arsenic that has a strong background component in all reaches; thus, incremental risk was overestimated. Dermal contact with sediment and incidental ingestion has 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 recreational exposure. Adult soil ingestion was assumed to be 100 mg/d, which is twice the EPA-recommended value for adults (EPA 1997, 066596).

8.2.6.3 Toxicity Assessment

Section 8.2.4 discusses the toxicity information used to calculate the SLs used in the risk assessments. For both residential and recreational SLs, the toxicity factors used to derive the SLs were reviewed to insure that the most up-to-date toxicity factors were utilized.

8.2.7 Summary of the Human Health Risk Assessment

The potential risks associated with COPCs in Cañada del Buey were based on either a cancer risk level of 1×10^{-5} or a target level of an HI of 1.0. The risk assessment results are below these thresholds for the recreational and residential scenario.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The results of this investigation indicate that the nature and extent of contamination in canyons media in Cañada del Buey are defined and that human health risks are acceptable for present-day and reasonably foreseeable future land uses. In addition, ecological screening of sediment and surface-water data indicates 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 Cañada del Buey. Potential corrective actions at SWMUs or AOCs within the Cañada del Buey watershed 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 most of the Cañada del Buey investigation area. A residential exposure scenario is applicable in one area, reach CDB-4, which was transferred from DOE to the County of Alamos in 2002. The assessment of potential chronic exposure includes only COPCs in sediment because there is no persistent surface water in Cañada del Buey within the investigation area. The assessment results indicate that for the recreational scenario, there are no unacceptable risks from carcinogens (ICR criterion of 1×10^{-5}), noncarcinogens (HI of 1), or radionuclides (target dose limit of 15 mrem/yr) due to COPCs in sediment. For the residential scenario, COPC concentrations in sediment are low and do not present an unacceptable risk.

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 Cañada del Buey derived from Laboratory SWMUs or AOCs are unlikely to produce adverse ecological impacts; no additional biota investigations, mitigation, or monitoring is required.

Investigations of sediment and shallow groundwater in Cañada del Buey indicate that inorganic, organic, and radionuclide COPCs are present in these media, in some cases at concentrations above screening levels or standards. These COPCs are derived from several sources, including Laboratory SWMUs and AOCs; 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 potential 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 because of decreases in contaminant concentrations after peak releases; therefore, no further monitoring of sediments in Cañada del Buey is necessary. However, stormwater in Cañada del Buey will continue to 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 Cañada del Buey indicates that low levels of contaminants have been released and transported downcanyon from several TAs in the watershed, including former TA-04, TA-46, and TA-54. Concentrations are highest in reaches close to the sources and decrease rapidly downcanyon and do not pose an unacceptable risk in the canyon bottom. No Laboratory-derived COPCs have been identified in the farthest downcanyon reach, CDB-4 above NM 4 and White Rock, indicating that Laboratory sites in this watershed are not a recognizable source of contaminants for White Rock or the Rio Grande.

A small spatially limited saturated zone is present in the vicinity of wells CDBO-6 and CDBO-7. This zone is likely recharged by surface-water runoff from storms and snowmelt in Cañada del Buey that infiltrates the canyon floor to the west of CDBO-6, flows laterally through the subsurface, and perches near the base of Bandelier Tuff unit Qbt 1v in the vicinity of CDBO-6 and CDBO-7. Migration of contaminants to deeper zones is inhibited because of the minimal amount of surface-water recharge within Cañada del Buey. In addition, very few mobile contaminants are present in the watershed. Groundwater COPCs in Cañada del Buey include 27 inorganic chemicals, 11 organic chemicals, and 7 radionuclides. However, of these, only beryllium, bis(2-ethyhexyl)phthalate, and di-n-octylphthalate were detected at concentrations exceeding a water-quality standard, all in shallow perched groundwater in CDBO-6. These exceedances were observed only one time for each constituent out of seven or eight samples. Therefore, neither surface-water flow in the canyon nor the limited, perched zone at CDBO-6 and CDBO-7 represents significant sources of contamination to deeper groundwater.

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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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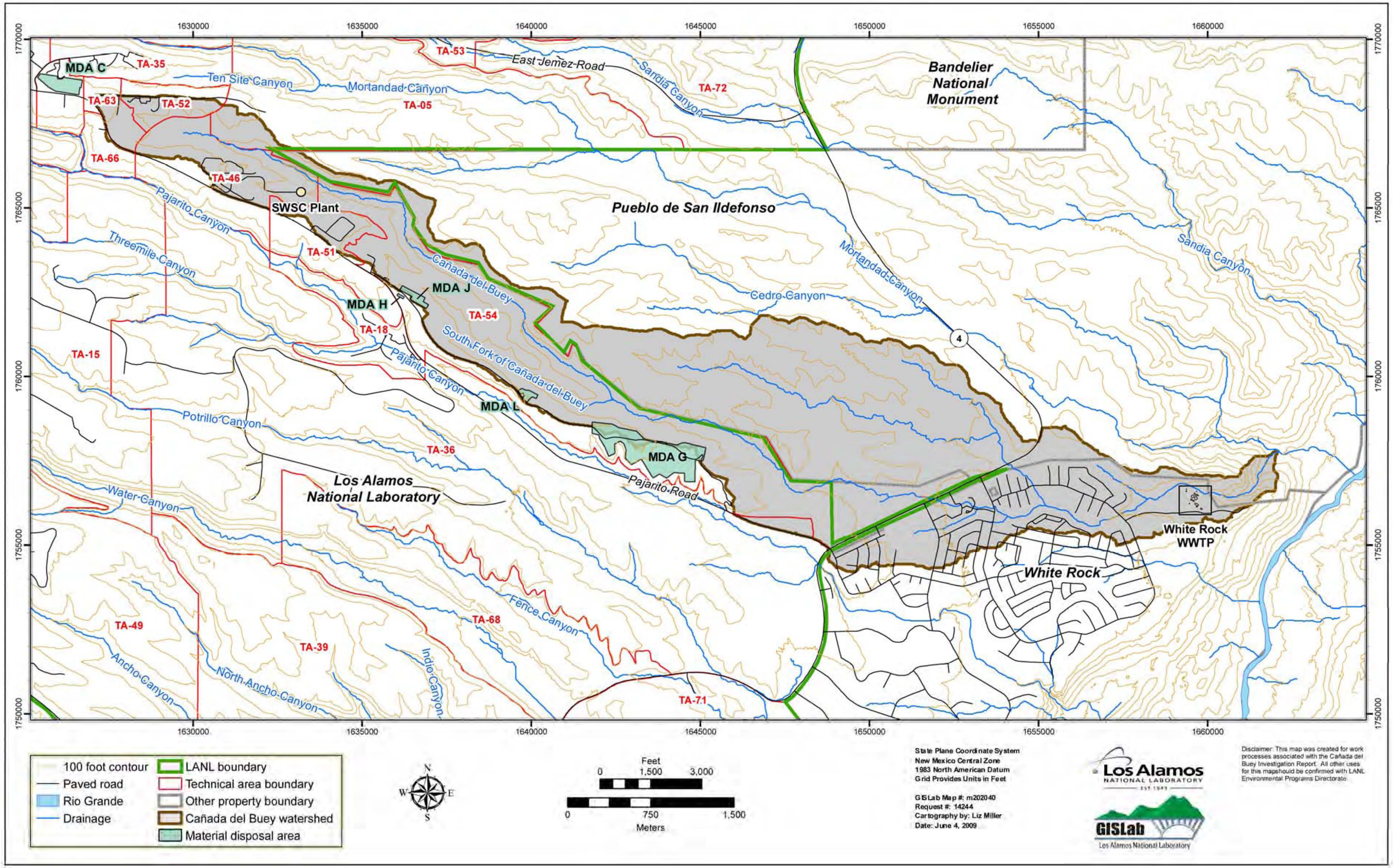


Figure 1.1-1 Cañada del Buey watershed showing technical area boundaries

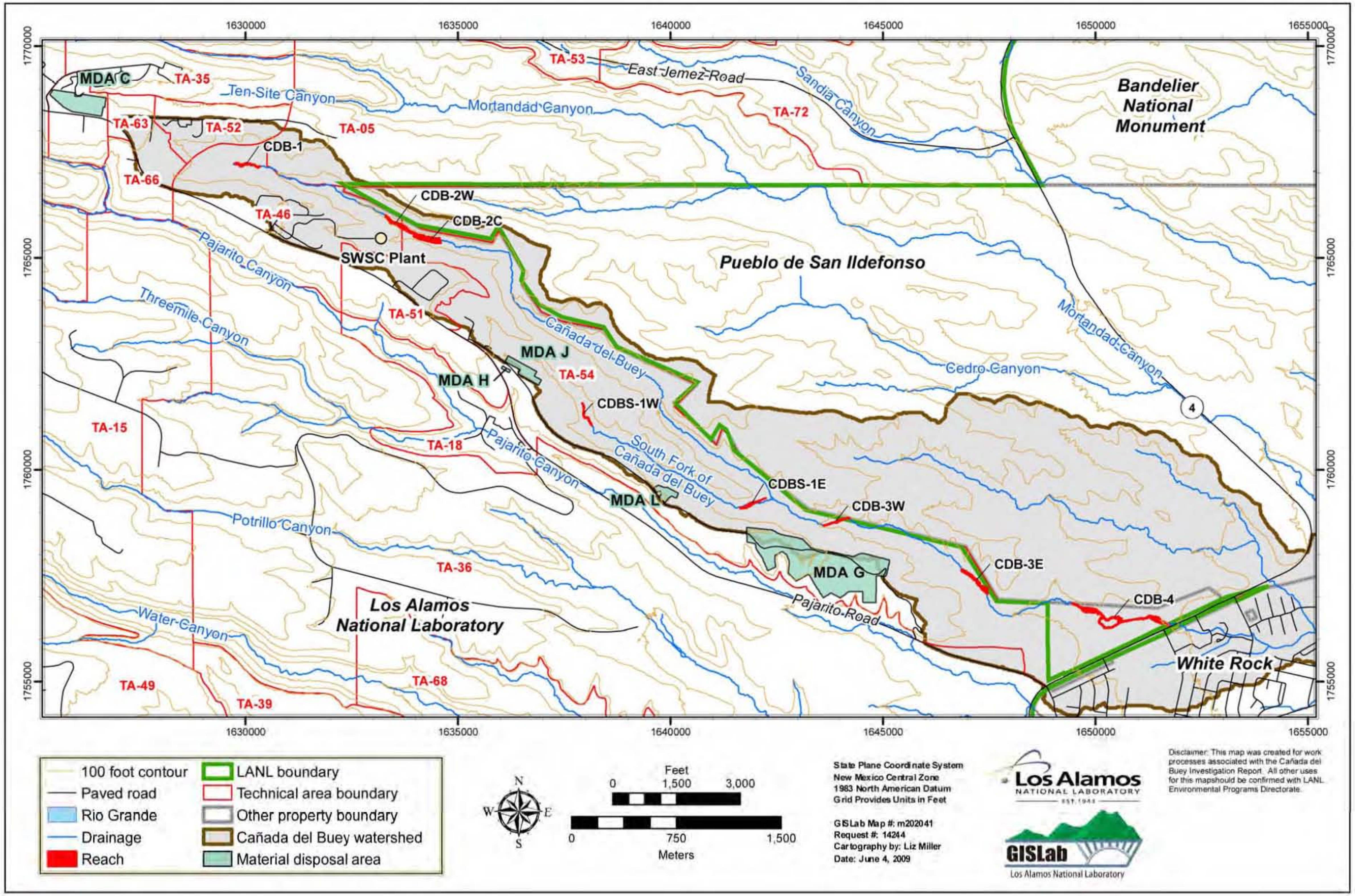


Figure 3.1-1 Cañada del Buey watershed showing sediment investigation boundaries

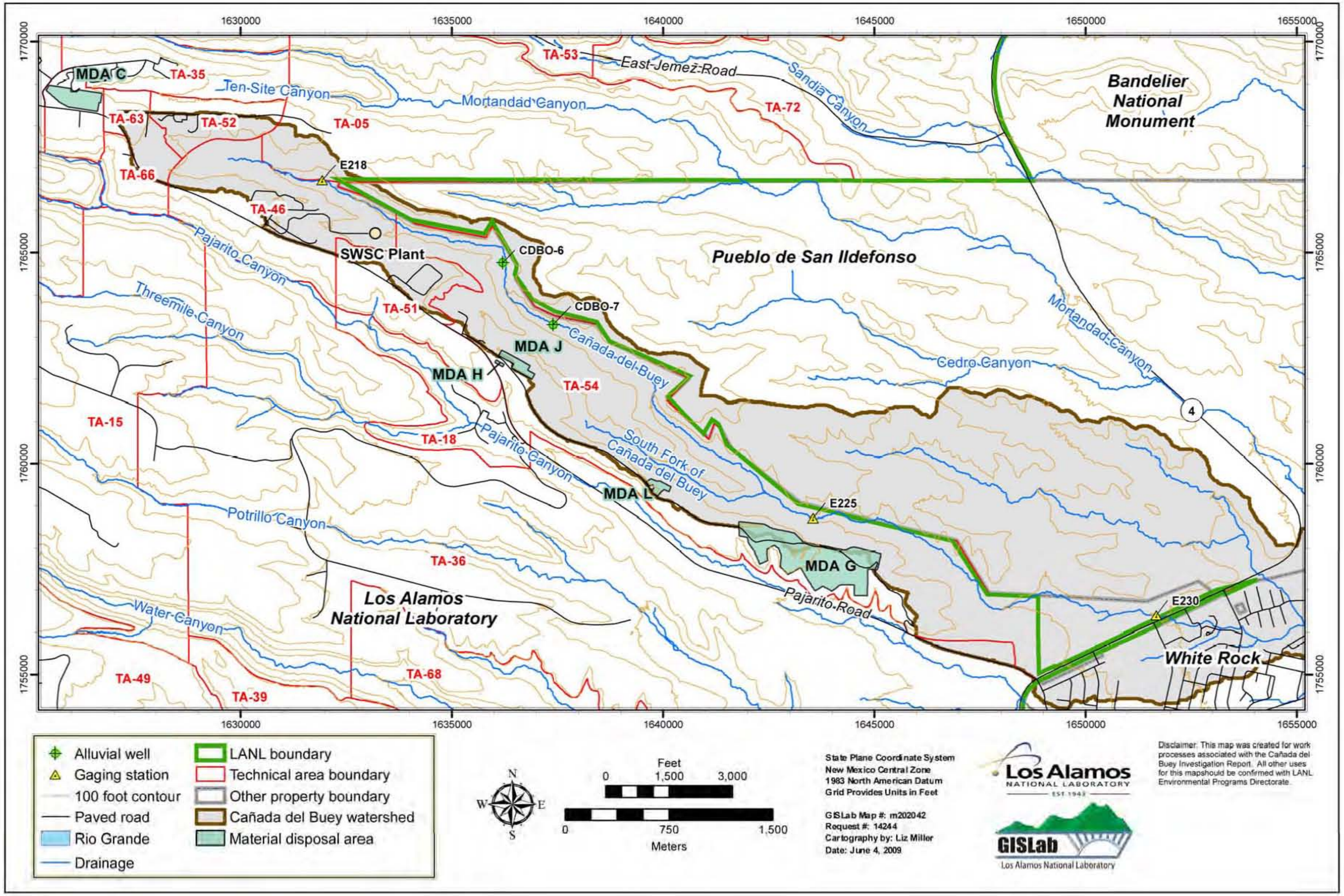


Figure 3.2-1 Cañada del Buey watershed showing water-sampling locations

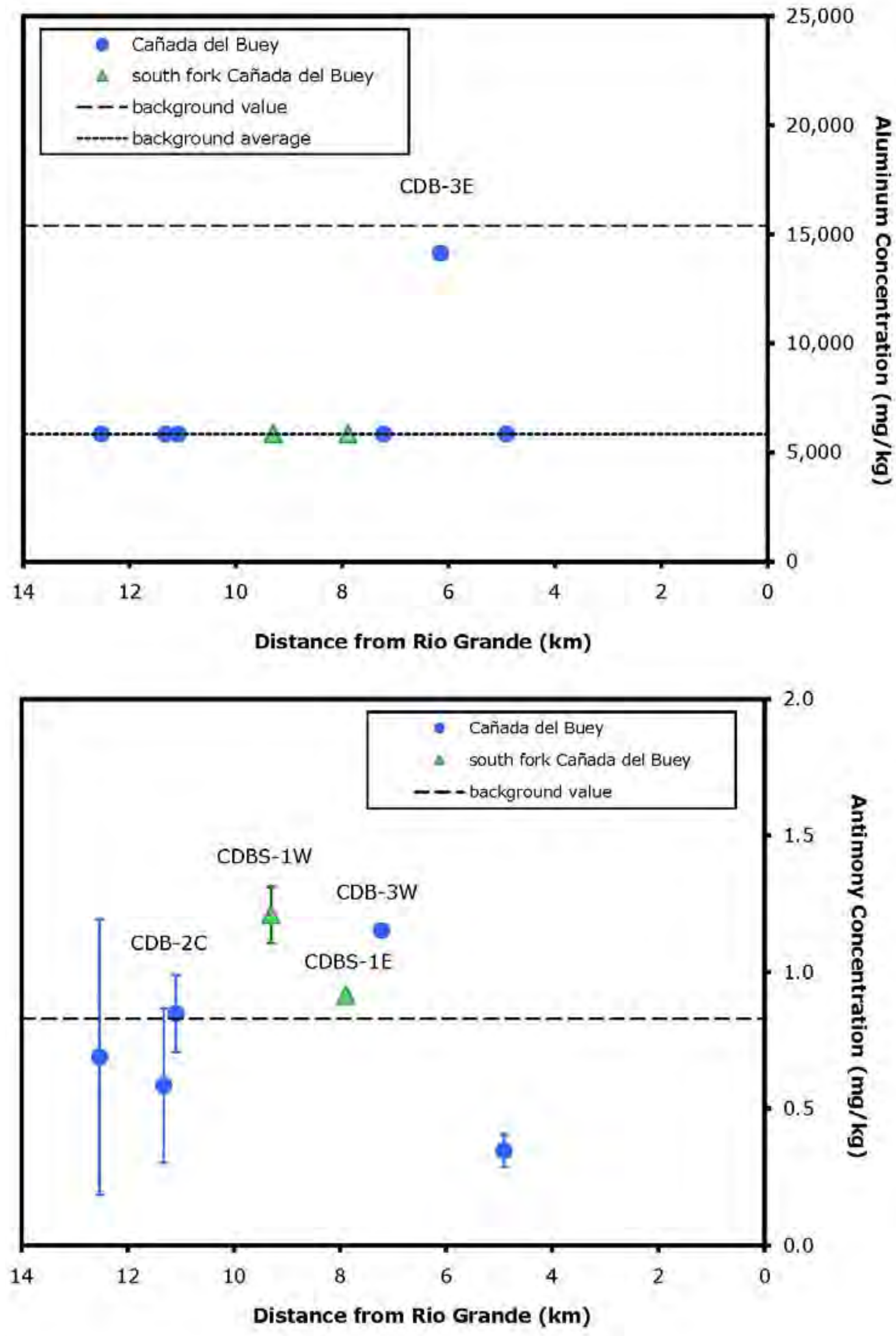
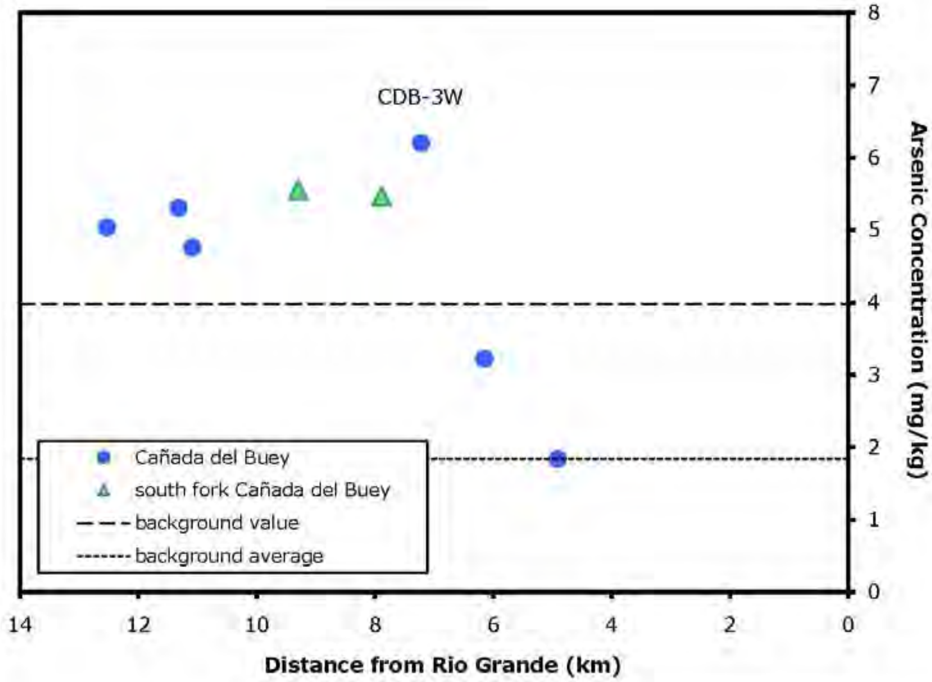


Figure 7.1-1 Estimated average concentrations of select inorganic chemicals in fine facies sediment in Cañada del Buey



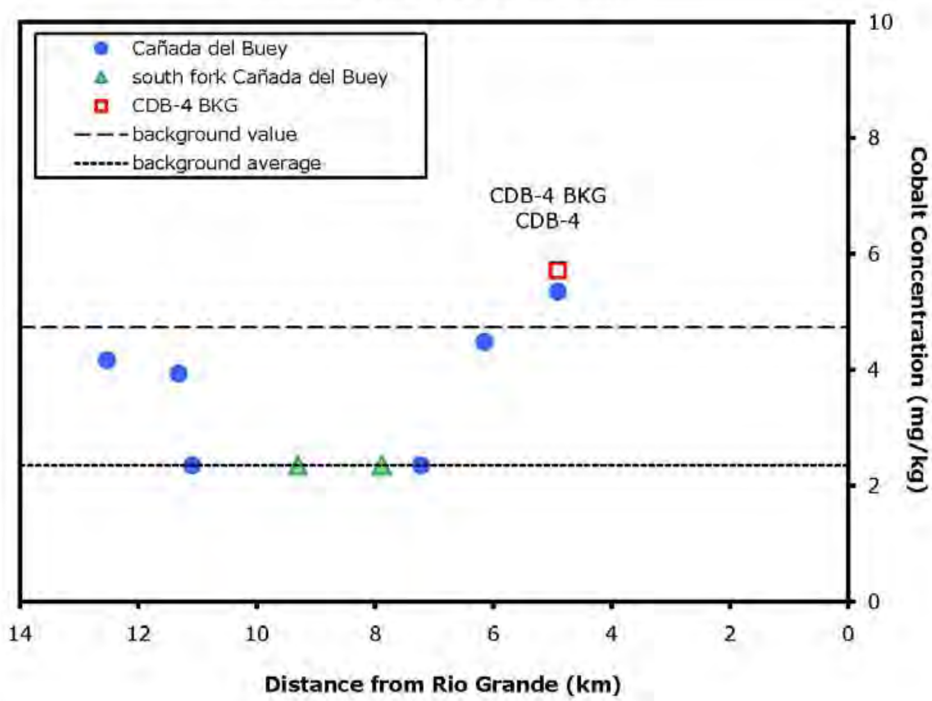


Figure 7.1-1 (continued)

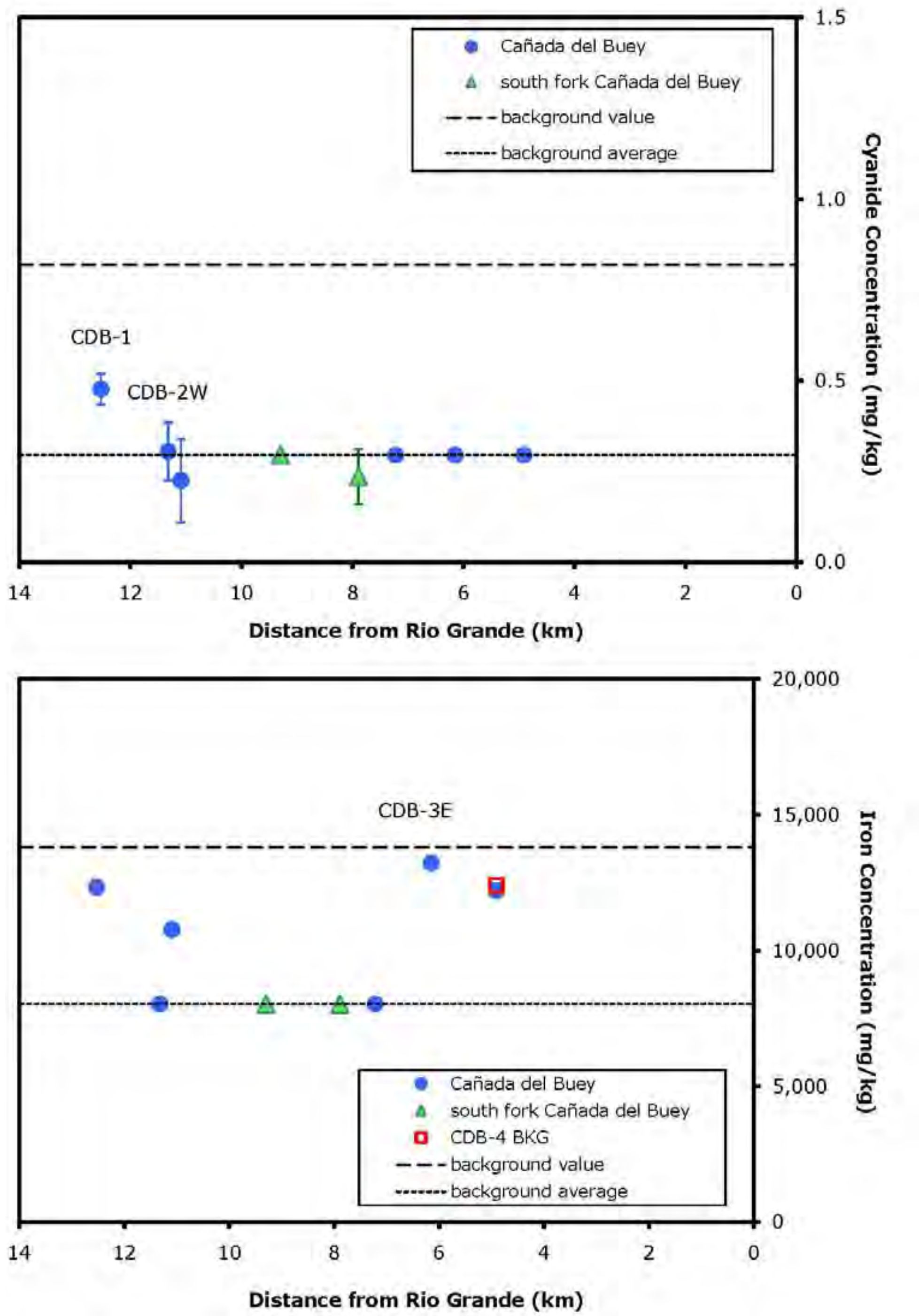


Figure 7.1-1 (continued)

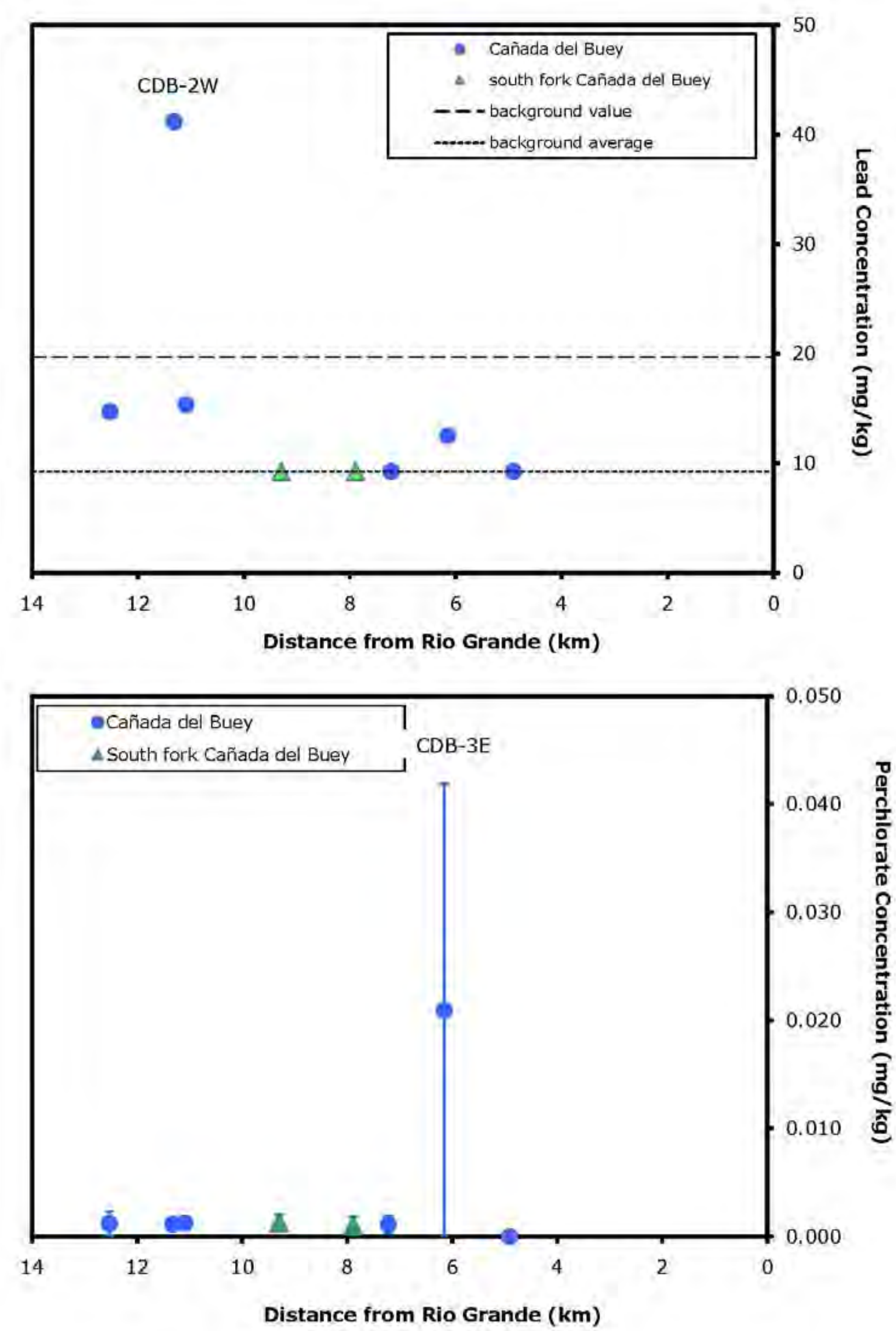


Figure 7.1-1 (continued)

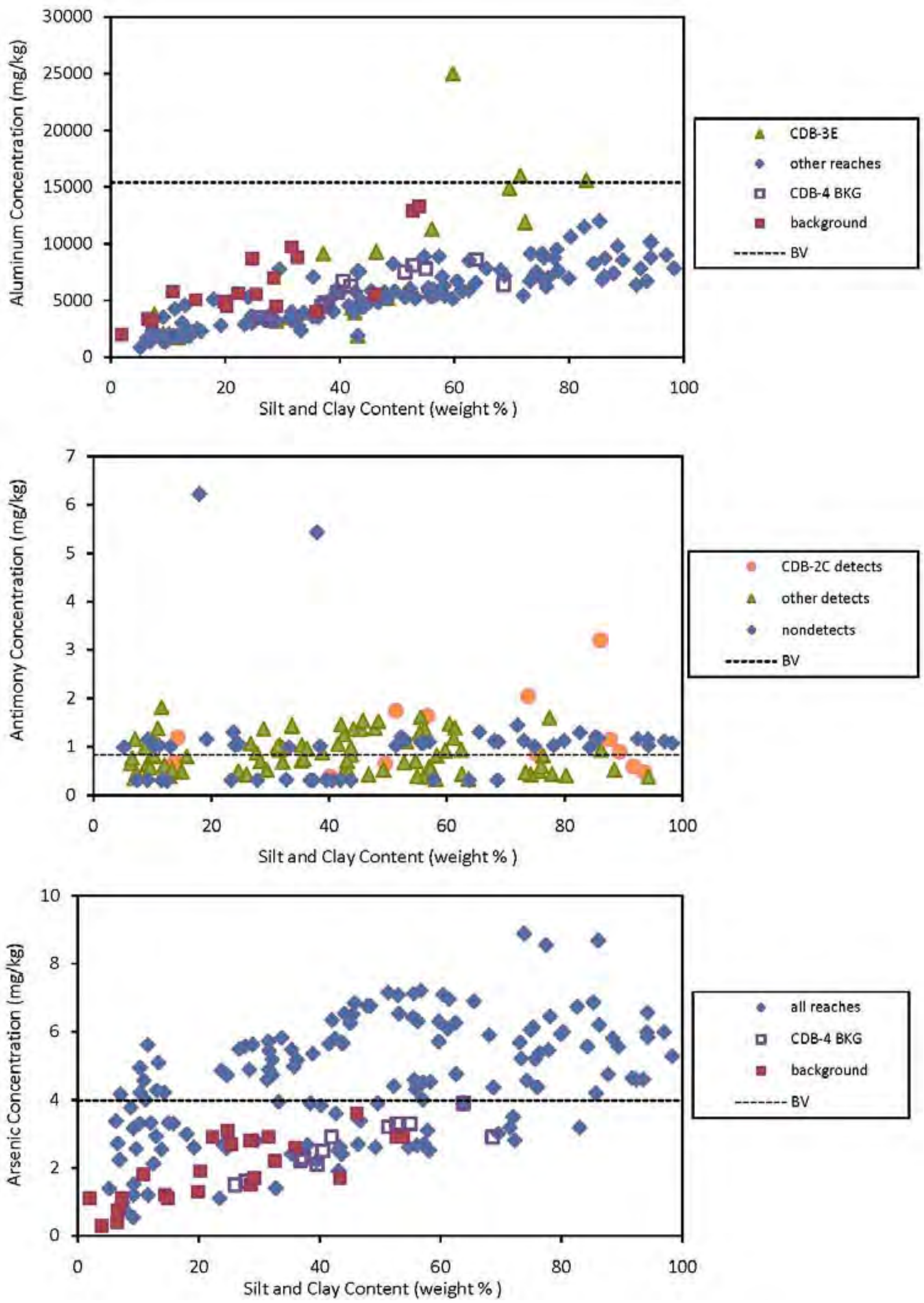


Figure 7.1-2 Concentrations of select inorganic chemicals in Cañada del Buey and background sediment samples versus silt and clay content

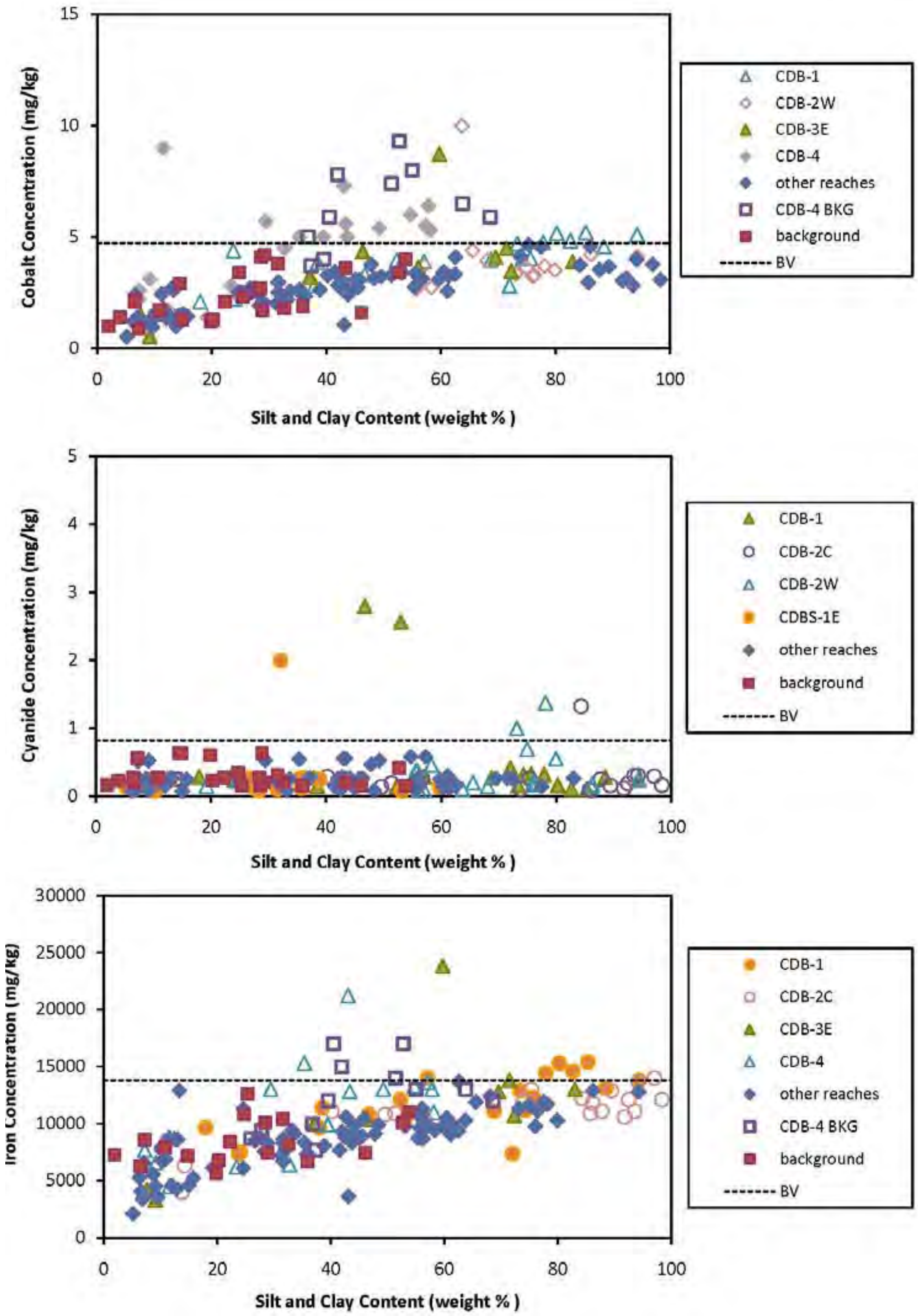


Figure 7.1-2 (continued)

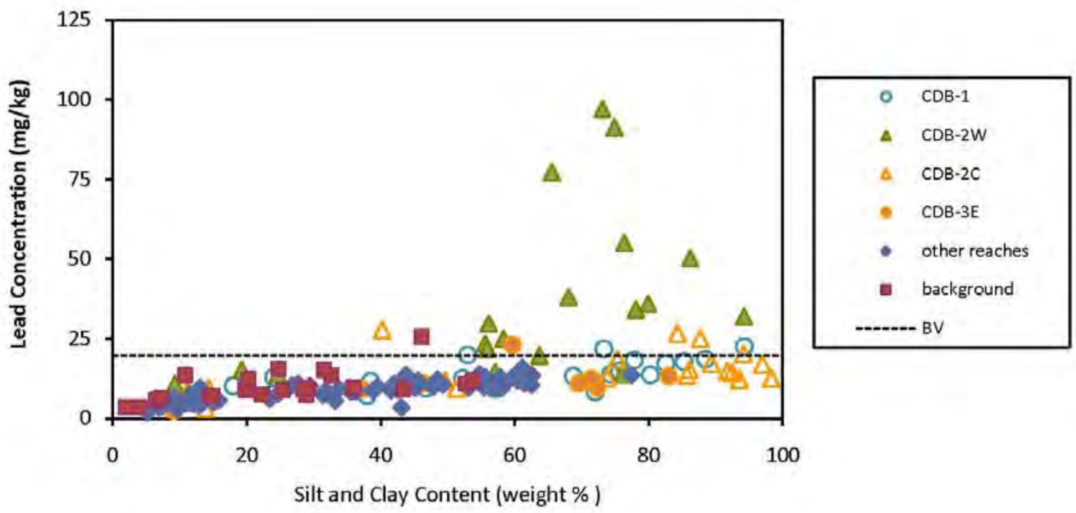


Figure 7.1-2 (continued)

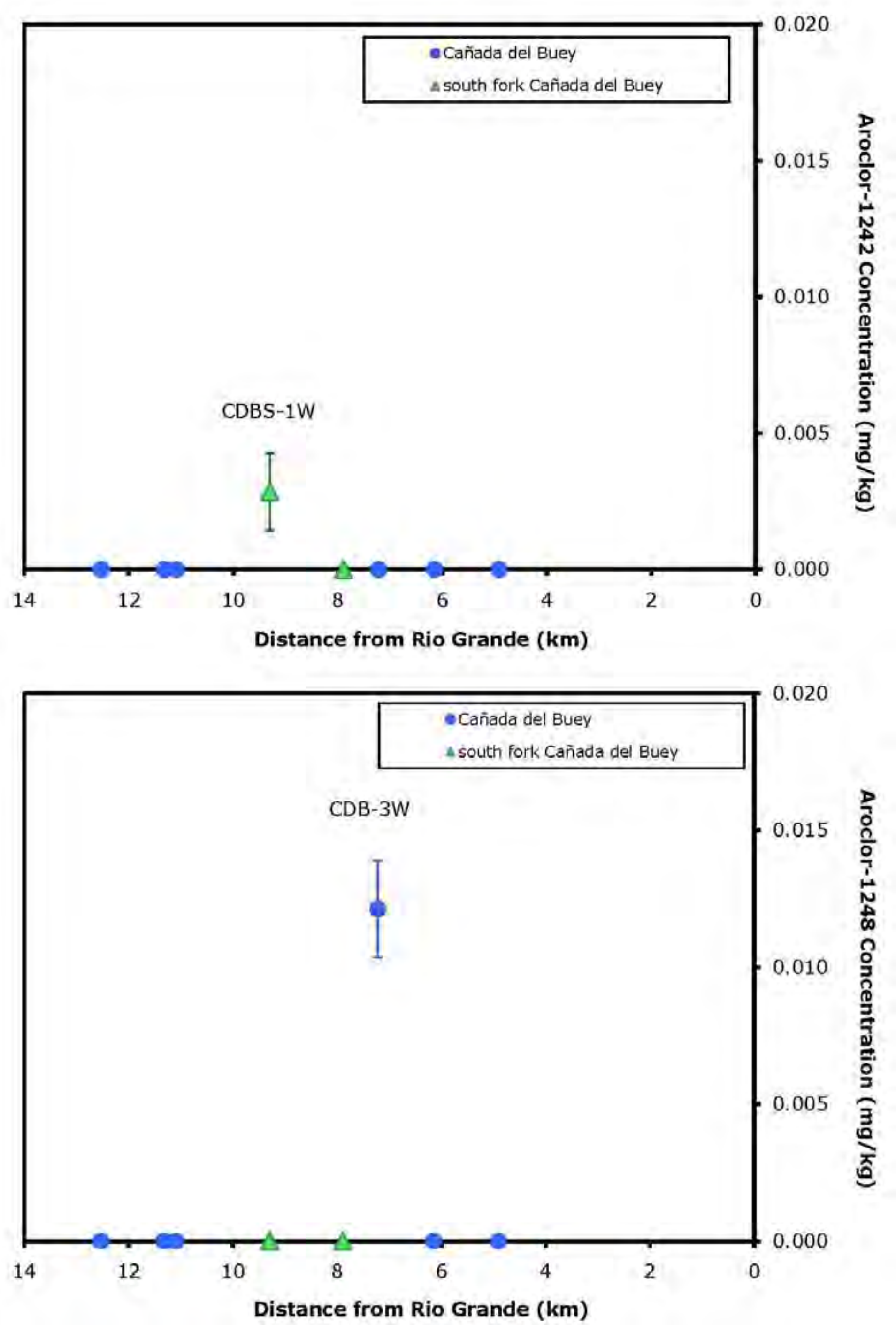


Figure 7.1-3 Estimated average concentrations of PCBs in fine facies sediment in Cañada del Buey

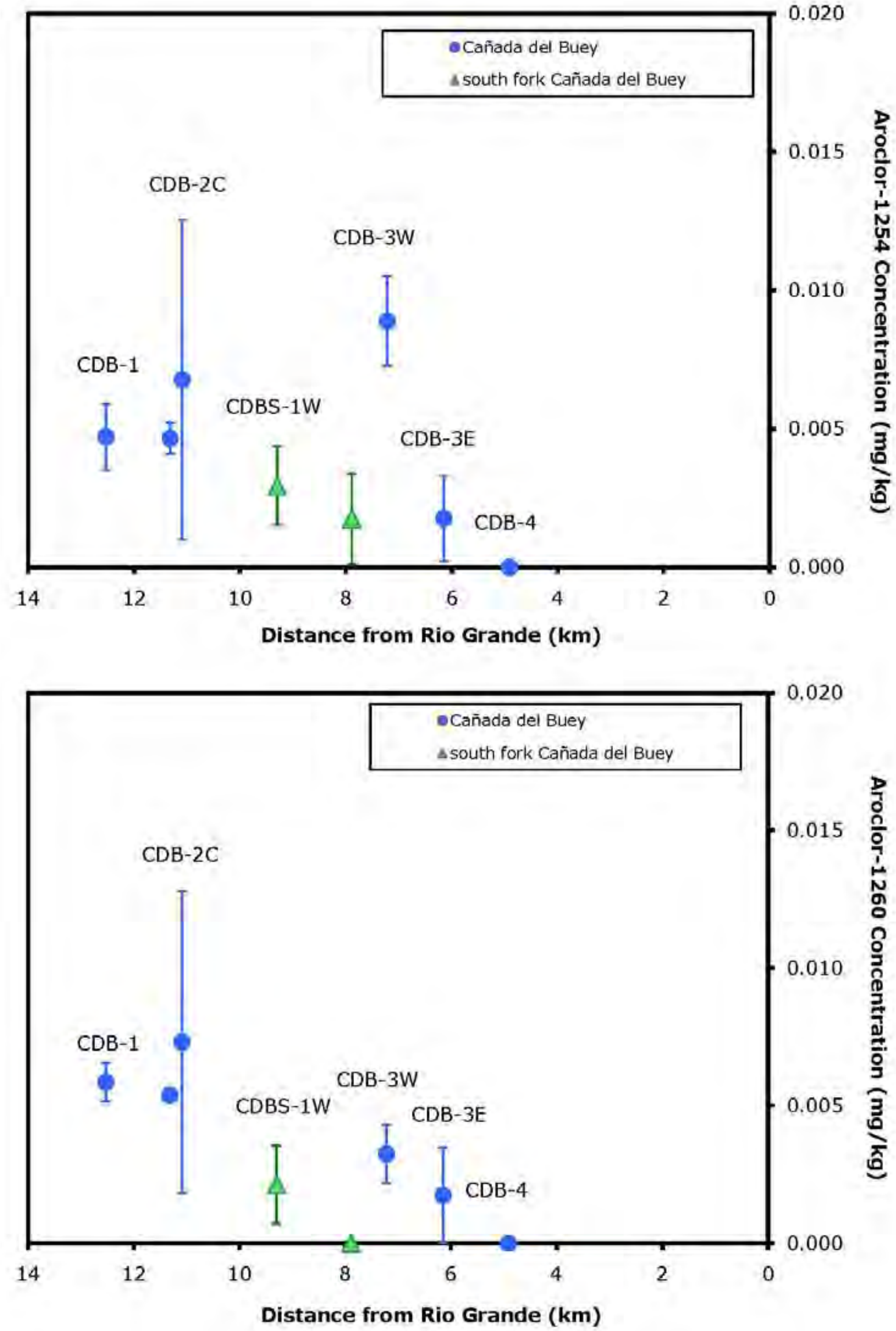


Figure 7.1-3 (continued)

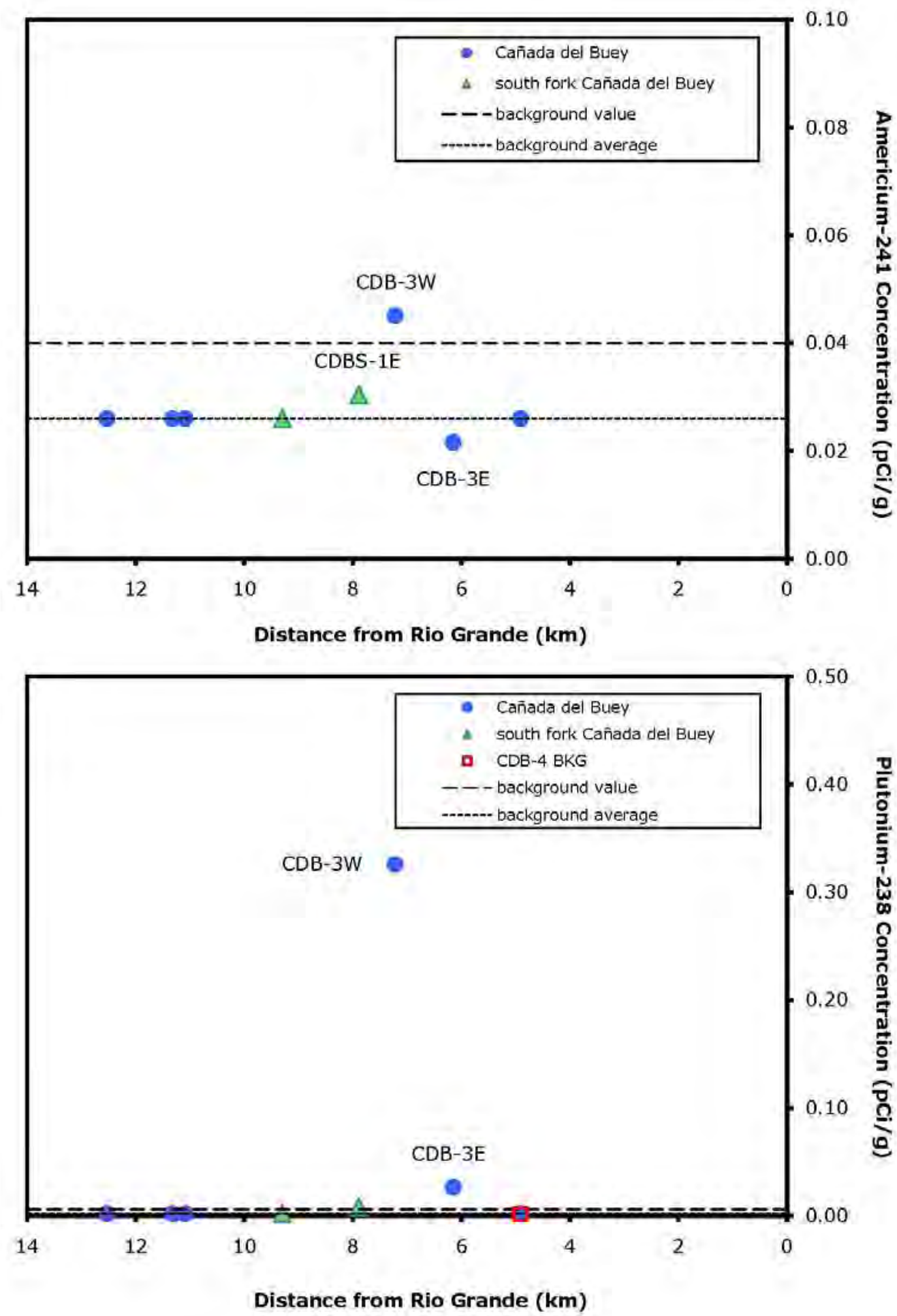


Figure 7.1-4 Estimated average concentrations of select radionuclides in fine facies sediment in Cañada del Buey

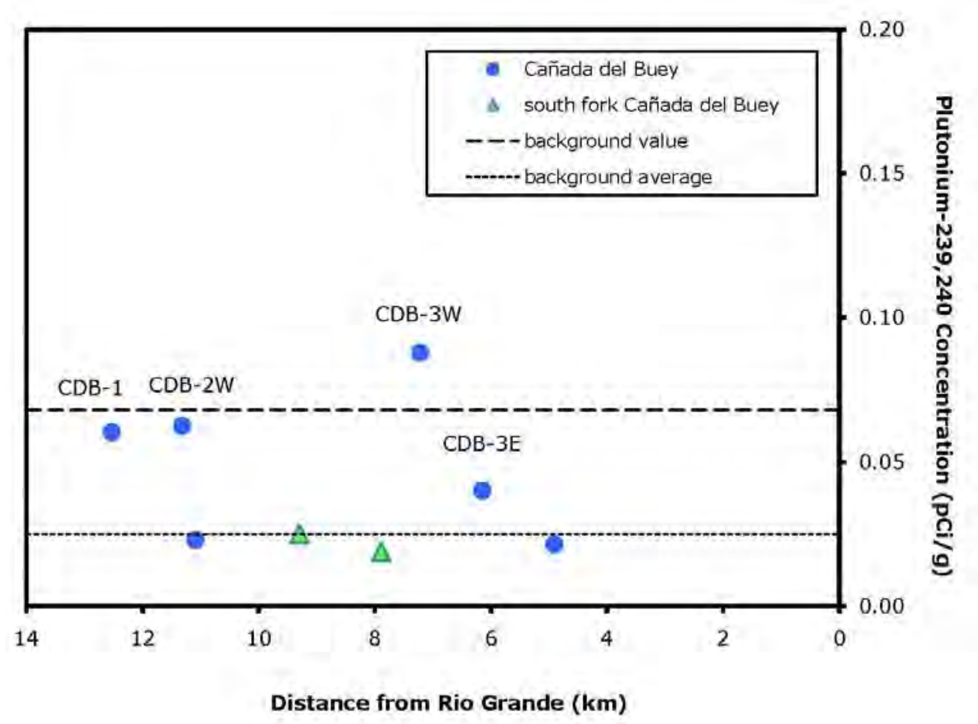


Figure 7.1-4 (continued)

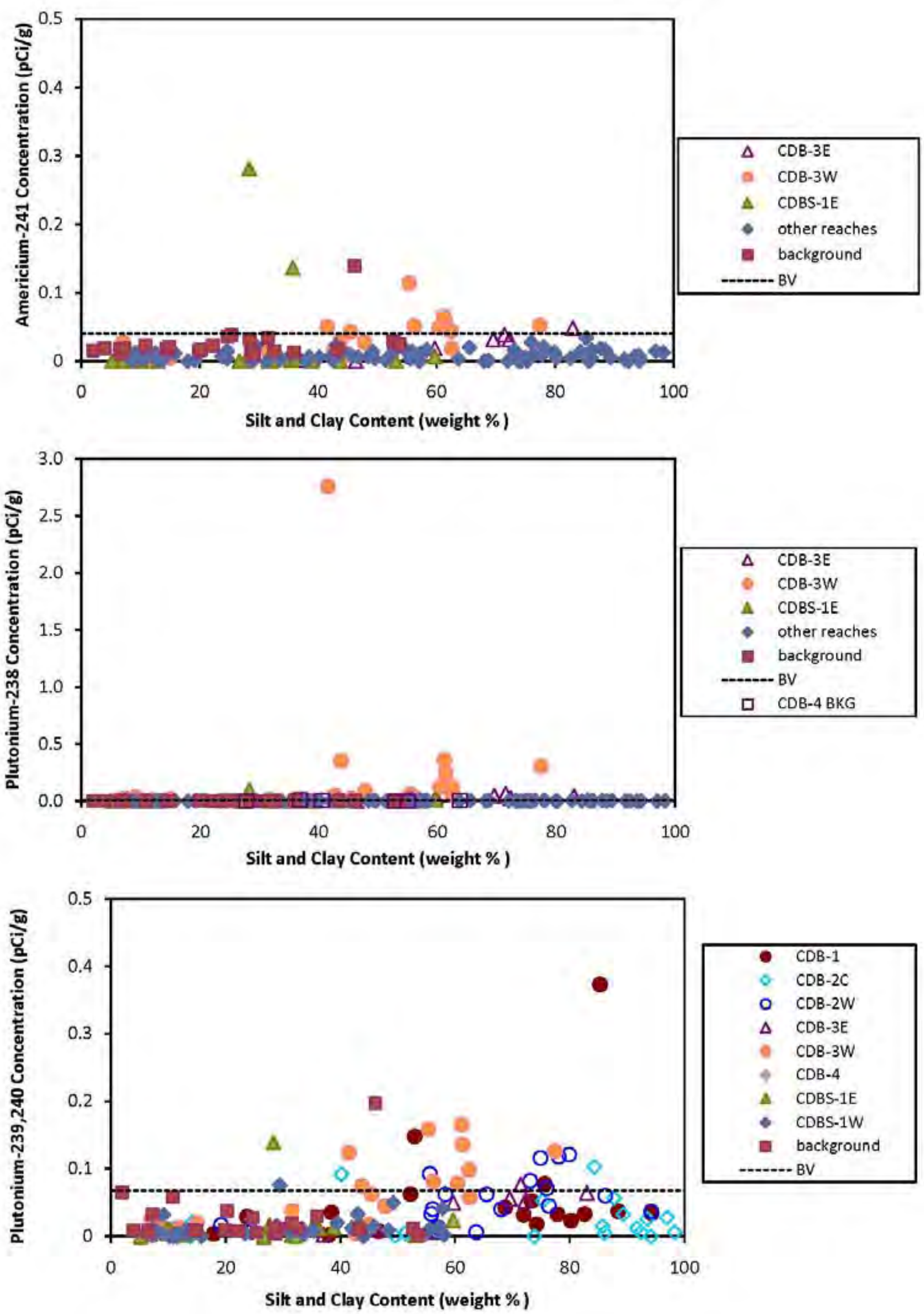


Figure 7.1-5 Concentrations of select radionuclides in Cañada del Buey and background sediment samples versus silt and clay content

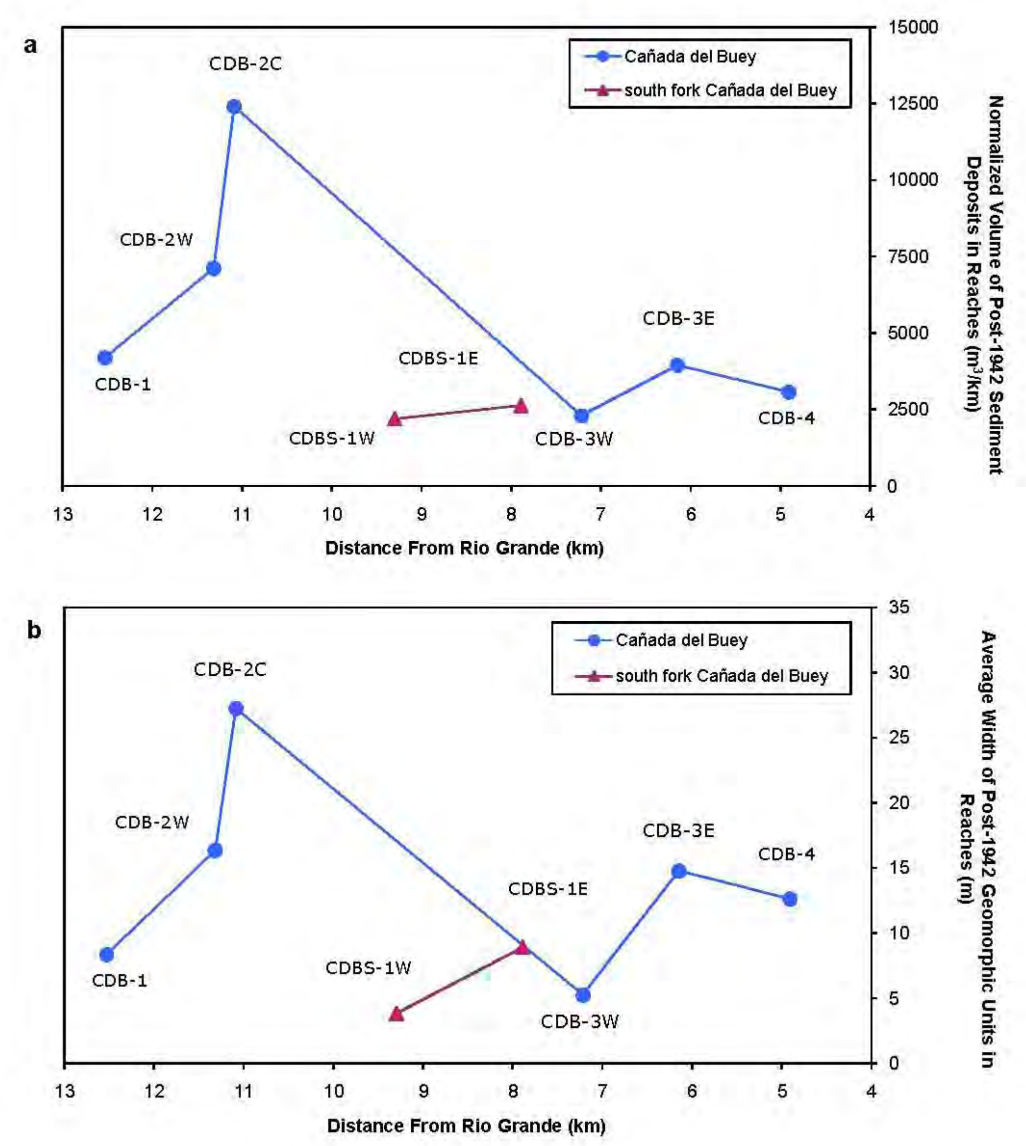


Figure 7.1-6 Longitudinal variations in normalized volume (a, in units of m^3/km), and average width (b) of post-1942 sediment and geomorphic units in the Cañada del Buey sediment investigation reaches

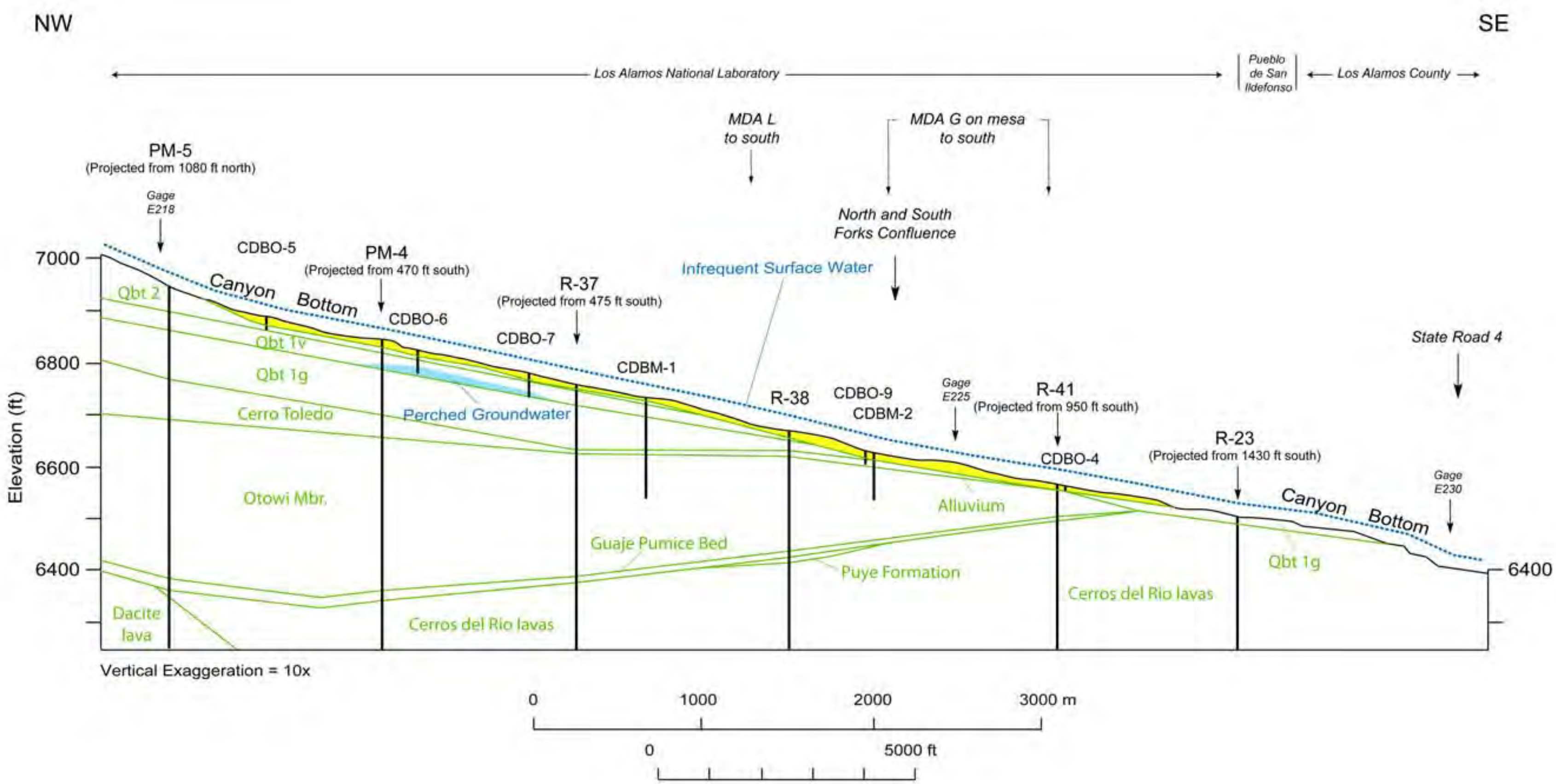


Figure 7.2-1 Conceptual hydrogeologic cross section for Cañada del Buey. Line of section follows the canyon stream channel.

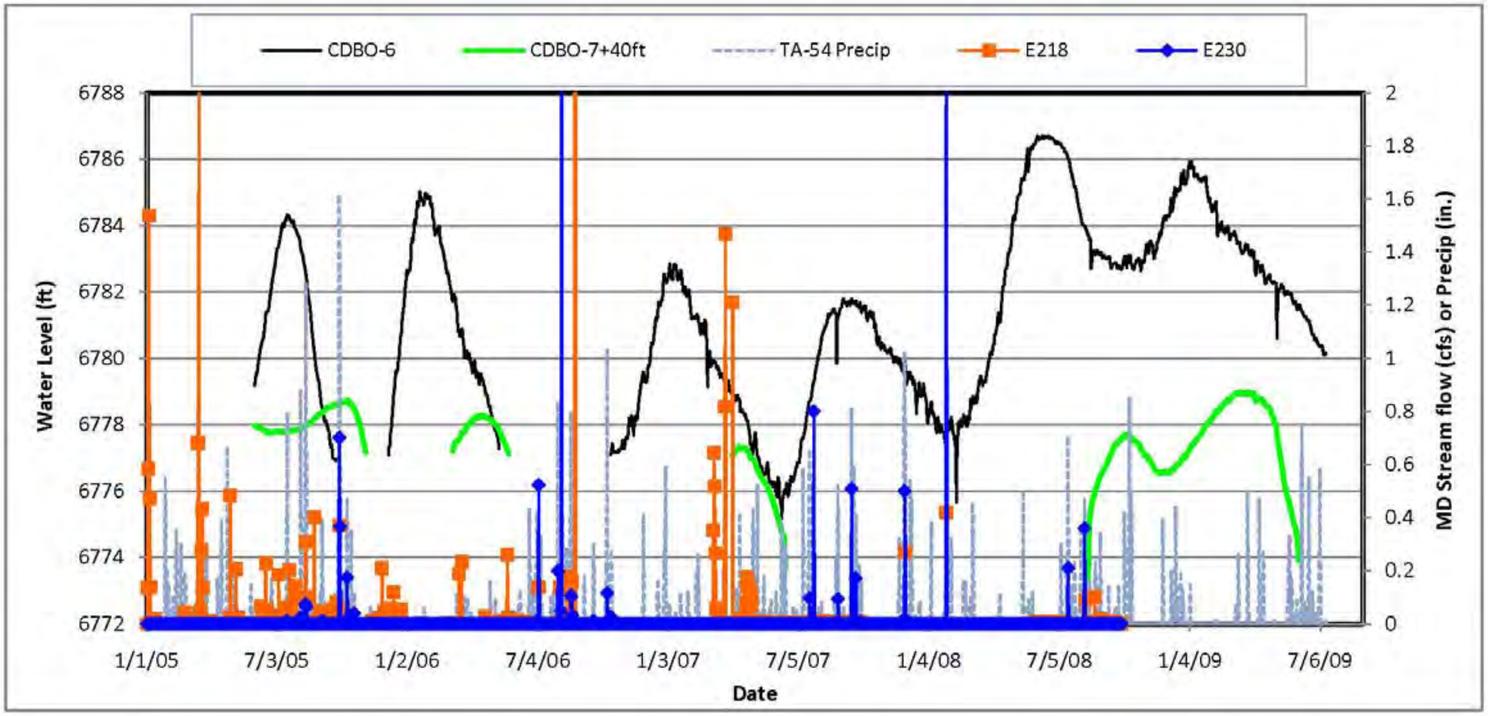


Figure 7.2-2 **Data for CDBO-6 water levels, adjusted CDBO-7 water levels, mean-daily stream flow at gages E218 and E230, and TA-54 precipitation. For CDBO-6, transducer data before April 30, 2007, do not represent water levels below 6776.83 ft. For CDBO-7, transducer data before April 2, 2007, do not represent water levels below 6737.14 ft (Koch and Schmeer 2009, 105181). CDBO-7 water-level data shown in this figure were adjusted upward by 40 ft so that it could be superimposed on the plot.**

Table 6.2-1
Inorganic COPCs in Cañada del Buey Sediment Samples

Reach	Aluminum	Antimony	Arsenic	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide [Total]	Fluoride	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Nitrate	Perchlorate	Potassium	Selenium	Thallium	Uranium (Calculated Total)	Vanadium	Zinc
Sediment BV[a]	15,400	0.83	3.98	127	0.4	4420	10.5	4.73	11.2	0.82	na[b]	13,800	19.7	2370	543	0.1	9.38	na	na	2690	0.3	0.73	6.99	19.7	60.2
Minimum Soil ESL[c]	pH dependent	0.05	6.8	110	0.27	na	2.3	13	15	0.1	45	pH dependent	14	na	220	0.013	9.7	na	na	na	0.52	0.032	25	0.025	48
Residential SSL[d]	78,100	31.3	3.59	15,600	77.9	na	2800[e]	23[e]	3130	1560	na	54,800	400	na	10,700	23[d]	1560	na	54.8	na	391	5.16	235	391	23,500
CDB-1	—[f]	—	7.07	163	—	—	—	5.21	—	2.79	—	15,400	22.6	—	—	—	—	—	0.000780 (J)	—	1.44 (UJ)	—	7.53	26.7	—
CDB-2C	—	3.20 (J)	8.88	139	—	—	—	—	—	1.32	—	14,000	27.7	—	—	—	—	—	0.00285	—	0.360 (J)	—	—	21.7	—
CDB-2W	—	0.934 (J+)	6.89	145	0.650 (U)	5540	—	9.99	14.7	1.37	—	—	97.1	—	889	0.168	--	--	0.00255 (J)	—	1.28 (UJ)	—	8.78	22.1	152
CDB-3E	25,000	—	5.71	245	—	—	17.2	8.73	14.7	--	1.93	23,800	23.1	4370 (J+)	732	—	—	5.59 (J)	0.0151 (J)	4420 (J+)	1.51 (J)	—	—	35.0	76.5
CDB-3W	—	1.60	8.55	142	0.488 (J)	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00177 (J)	—	1.21 (UJ)	—	—	20.5	—
CDB-4	—	—	—	130	—	5620	10.8	9	—	—	—	21,200	—	2400	—	—	—	—	—	—	1	1.1 (J)	3.76	34.4	—
CDB-4 BKG	—	—	—	150	—	16,000	—	9.3	—	—	—	17,000	—	—	—	—	12	—	—	—	1.2	—	—	29	—
CDBS-1E	—	1.15 (J-)	6.53	—	0.546 (U)	—	—	—	—	1.99	—	—	—	—	—	—	—	—	0.000705 (J)	—	1.04 (UJ)	—	—	--	—
CDBS-1W	—	1.81	7.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00304	—	1.15 (U)	—	—	--	—

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. Gray shading indicates the residential SSL was exceeded. All SSLs 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 (2009, 106420) unless otherwise noted.

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

[f] — = Not a COPC in that reach.

Table 6.2-2
Organic COPCs in Cañada del Buey Sediment Samples

Reach	Acenaphthene	Acetone	Aniline	Anthracene	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Chloroform	Chrysene	DDE(4,4'-)	DDT(4,4'-)	Dibenz(a,h)anthracene
Minimum Soil ESL[a]	0.25	1.2	na[b]	6.8	0.041	0.01	0.041	0.14	3	53	18	24	62	1	0.02	8	2.4	0.11	0.044	12
Residential SSL[c]	3440	67,500	850[d]	17,200	1.7	1.7	1.12	1.7	4.81	0.481	4.81	1720[e]	48.1	240,000[d]	280	5.72	481	11.5	15.8	0.481
CDB-1	—[f]	—	—	—	—	—	0.0266	0.0173	0.0126 (J-)	0.00708	—	—	—	—	0.0810 (J)	—	0.0164 (J-)	—	—	—
CDB-2C	—	—	—	0.00795 (J)	—	—	0.0045	0.0055	0.0410	0.0310	0.0513	0.0177	0.0214	0.434 (J)	—	0.000328 (J)	0.0455	—	0.00180 (J)	—
CDB-2W	—	0.0128 (J)	—	0.0147 (J-)	—	—	0.0138	0.0103	0.0688 (J-)	0.0446 (J-)	0.0704 (J-)	0.0279 (J-)	0.0327 (J-)	0.805	—	—	0.0382 (J-)	—	—	0.00361 (J-)
CDB-3E	—	—	—	—	—	—	0.0186	0.0069 (J)	—	—	—	—	—	—	0.0317 (J)	—	--	—	—	—
CDB-3W	0.0359 (J)	—	—	—	—	0.15	0.0986	0.0175 (J)	—	—	—	—	—	—	—	—	--	—	—	—
CDB-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	--	—	—	—
CDBS-1E	—	—	0.163 (J)	—	—	—	0.00150 (J)	—	—	—	—	—	—	—	—	—	--	0.00210	0.00404 (J)	—
CDBS-1W	—	0.00696	—	—	0.00770	—	0.0096	0.00370	—	—	—	—	—	—	0.103 (J)	—	—	—	0.00122 (J)	—

Table 6.2-2 (continued)

Reach	Dichlorobenzene(1,4-)	Di-n-butylphthalate	Endosulfan II	Ethylbenzene	Fluoranthene	Fluorene	Isopropyltoluene(4-)	Methylene Chloride	Methylnaphthalene(2-)	Phenanthrene	Phenol	Pyrene	Styrene	Tetrachloroethene	Toluene
Minimum Soil ESL[a]	0.88	0.011	0.64	na	10	3.7	na	2.6	2.5	5.5	0.79	10	na	0.18	23
Residential SSL[c]	32.1	6110	367	69.6	2290	2290	3210[g]	199	310[d]	1830	18,000[d]	1720	8970	6.99	5570
CDB-1	0.000526 (J)	—	—	—	0.0227 (J-)	—	—	0.00341 (J)	—	0.0131 (J-)	—	0.0243 (J-)	—	—	—
CDB-2C	—	—	—	0.000531 (J)	0.0748 (J-)	0.00404 (J)	—	0.00356 (J)	—	0.0438	—	0.0633 (J-)	0.00127 (J)	0.000343 (J)	0.000377 (J)
CDB-2W	—	—	0.0029	0.000353 (J)	0.0993 (J-)	0.0129 (J-)	—	—	—	0.109 (J-)	0.314 (J)	0.0933 (J-)	0.000782 (J)	0.000377 (J)	0.000397 (J)
CDB-3E	—	0.0263 (J)	—	—	—	—	—	—	—	—	—	0.0106	—	—	—
CDB-3W	—	—	—	—	0.0334 (J)	—	—	—	—	0.0179 (J)	—	0.0214 (J)	—	—	—
CDB-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CDBS-1E	—	—	—	—	—	—	—	0.00247 (J)	0.00830 (J)	0.00370 (J-)	—	0.00581 (J-)	—	—	—
CDBS-1W	—	—	—	0.000579 (J)	—	—	0.0121 (J)	—	—	—	—	—	0.00157	0.000395 (J)	0.00325

Notes: Values are in mg/kg. Values are maximum detected values. No SSLs were exceeded. No organic chemical analyses were performed for CDB-4 BKG sediment samples. All SSLs 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 (2009, 106420) unless otherwise noted.

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

[e] Pyrene SSL used as a surrogate for benzo(g,h,i)perylene based on structural similarity.

[f] — = Not a COPC in that reach.

[g] Isopropylbenzene SSL used as a surrogate for isopropyltoluene[4-] based on structural similarity.

Table 6.2-3
Cañada del Buey Sediment Radionuclide COPCs

Reach	Americium-241	Cesium-137	Plutonium-238	Plutonium-239/240	Tritium	Uranium-235/236	Uranium-238
Sediment BV[a]	0.04	0.9	0.006	0.068	0.093	0.2	2.29
Minimum Soil ESL[b]	44	680	44	47	36,000	55	55
Residential SAL[c]	30	5.6	37	33	750	17	86
CDB-1	—[d]	1.37	—	0.373	1.383	0.289	2.53 (J+)
CDB-2C	—	—	—	0.103	—	—	—
CDB-2W	—	2.03	—	0.121	0.181	—	2.95
CDB-3E	0.0482	—	0.0628	0.0767	—	—	—
CDB-3W	0.114	1.03	2.76	0.165	0.185	—	—
CDB-4	—	—	—	0.076	—	—	—
CDB-4 BKG	—	—	0.0287	--	—	—	—
CDBS-1E	0.281	—	0.0988	0.139	—	—	—
CDBS-1W	—	—	—	—	0.188	—	—

Notes: Values are in pCi/g. Values are maximum detected values greater than the sediment BV. No residential SALs were exceeded.

[a] BVs 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) unless otherwise noted.

[d] — = Not a COPC in that reach (i.e., all nondetect results < BV, all detected results < BV, or not analyzed).

Table 6.3-1
Inorganic COPCs in Filtered Shallow Perched Groundwater Samples

Location	Barium	Lead	Strontium	Vanadium	Zinc
LANL Alluvial GW BV[a]	68.57	1.88	120	5	10
Standard Level	1000	15	22000	260	10000
Standard Type	NMGSF[b]	MCL[c]	Reg[d]	Reg	NMGSF
CDBO-6	136	4.3	—[e]	6.5	137
CDBO-7	104	—	146	—	25.9

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

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

[b] NMGSF = NMAC 20.6.2, groundwater standards (filtered).

[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 6.3-2
Inorganic COPCs in Nonfiltered Shallow Perched Groundwater Samples

Location	Aluminum	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Strontium	Thallium	Uranium	Vanadium	Zinc
Standard Level	37,000	10	2000	4	7300	5	100	11	1300	26,000	15	880	180	730	22,000	2	30	260	11,000
Standard Type	Reg[a]	MCL[b]	MCL	MCL	Reg	MCL	MCL	Reg	MCL	Reg	MCL	Reg	Reg	Reg	Reg	MCL	MCL	Reg	Reg
CDBO-6	9460	1.7	462	4.5	39.5	0.13	5.5	4	3.7	8330	6.8	567	1.3	2.5	173	0.47	0.59	26.7	185
CDBO-7	100	—[c]	101	—	37.1	—	—	—	—	40.5	—	—	0.29	1.5	141	—	0.16	3.9	21.2

Notes: Values are in µg/L. Values are maximum detected value. Gray shading indicates a Standard screening value was exceeded.

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

[b] MCL = EPA maximum contaminant level.

[c] — = Analyte is not a COPC at that location.

Table 6.3-3
Radionuclide COPCs in Nonfiltered Shallow Perched Groundwater Samples

Location	Gross alpha/beta	Gross beta	Radium-226	Radium-228	Tritium	Uranium-234	Uranium-238
LANL Alluvial GW BV[a]	na[b]	na	na	na	57.28	na	na
Standard Level	na	na	5	5	1,000,000	300	300
Standard Type	na	na	MCL[c]	MCL	NMRPS[d]	NMRPS	NMRPS
CDBO-6	3.7	8.95	0.753	1.21	109	0.174	0.12
CDBO-7	—[e]	—	—	—	61	0.0628	0.0548

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

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

[b] na = Not available.

[c] MCL = EPA 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 6.3-4
Organic COPCs in Nonfiltered Shallow Perched Groundwater Samples

Location	Acetone	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Bis[2-ethylhexyl]phthalate	Chrysene	Di-n-octylphthalate
Standard Level	22,000	0.29	2.9	6	29	6
Standard Type	Reg[a]	Reg	Reg	MCL[b]	Reg	MCL
CDBO-6	3.29	0.215	0.251	7.23	0.312	9.36
CDBO-7	—[c]	—	—	—	—	—

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

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

[b] MCL = EPA maximum contaminant level.

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

Table 6.3-5
General Inorganic COPCs in Filtered Shallow Perched Groundwater Samples

Location	Ammonia as Nitrogen	Silicon Dioxide	Sodium	Total Phosphate as Phosphorus
LANL Alluvial GW BV[a]	250	64210	15,540	40
CDBO-6	303	—[b]	22,200	209
CDBO-7	—	68,300	26,300	197

Notes: Values are in µg/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] — = Analyte is not a COPC at that location (not detected, not analyzed, or maximum detect < BV).

Table 6.3-6
General Inorganic COPCs in Nonfiltered Shallow Perched Groundwater Samples

Location	Calcium	Magnesium	Potassium	Sodium	Total Kjeldahl Nitrogen
CDBO-6	24,200	5920	4140	23,200	35
CDBO-7	21,200	4780	2690	25,500	—*

Notes: Values are in µg/L. Values are maximum detected value.
* — = Analyte is not a COPC at that location (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*	Locations with Results > Lowest Comparison Value
Aluminum	Filtered	7	7690	750	µg/L	NMWQCC Acute Aquatic Life	Cañada del Buey above SR-4, Cañada del Buey near TA-46
Aroclor-1254	Nonfiltered	1	0.083	0.00064	µg/L	NMWQCC Human Health Persistent	Cañada del Buey near TA-46
Copper	Filtered	2	11	4.3	µg/L	NMWQCC Acute Aquatic Life	Cañada del Buey above SR-4, Cañada del Buey near TA-46
Gross alpha	Nonfiltered	15	24.3	15	pCi/L	NMWQCC Livestock Watering	Cañada del Buey above SR-4, Cañada del Buey near MDA G, Cañada del Buey near TA-46
Mercury	Nonfiltered	2	1.29	0.77	µg/L	NMWQCC Wildlife Habitat	Cañada del Buey above SR-4, Cañada del Buey near MDA G
Selenium	Nonfiltered	1	13.2	5	µg/L	NMWQCC Wildlife Habitat	Cañada del Buey above SR-4
Zinc	Filtered	2	45.2	42	µg/L	NMWQCC Acute Aquatic Life	Cañada del Buey near TA-46

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

Table 6.4-2
Ecologically Relevant Stormwater Comparisons

Analyte	Field Preparation	Maximum Detected Value (µg/L)	Benchmark (µg/L)*	Maximum > Benchmark?	Location with Maximum Detected Result
Aluminum	Filtered	7690	750	Yes	Cañada del Buey near TA-46
Copper	Filtered	11	4.3	Yes	Cañada del Buey near TA-46
Zinc	Filtered	45.2	42	Yes	Cañada del Buey near TA-46

* 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	Maximum Detected Value (µg/L)	Benchmark (µg/L)*	Maximum > Benchmark?
Aroclor-1254	0.083	4.65	No

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

Table 6.5-1
Cañada del Buey COPC and Stormwater Summary

Analyte	Sediment	Shallow Groundwater	Stormwater[a]
Metals			
Aluminum[b]	x[c]	x	x
Antimony	x	—[d]	x
Arsenic	x	x	x
Barium	x	x	x
Beryllium	—	x	x
Boron	—	x	x
Cadmium	x	x	x
Calcium	x	x	x
Chromium	x	x	x
Cobalt	x	x	x
Copper[b]	x	x	x
Iron	x	x	x
Lead	x	x	x
Magnesium	x	x	x
Manganese	x	x	x
Mercury	x	—	x
Molybdenum	—	x	x
Nickel	x	x	x
Potassium	x	x	x
Selenium	x	—	x
Silver	—	—	x
Sodium	—	x	x
Strontium	—	x	x
Thallium	x	x	x
Tin	—	—	x
Uranium	x	x	x
Vanadium	x	x	x
Zinc[b]	x	x	x

Table 6.5-1 (continued)

Analyte	Sediment	Shallow Groundwater	Stormwater[a]
Other Inorganic Chemicals			
Ammonia as Nitrogen	—	x	x
Chloride	—	—	x
Cyanide [Total]	x	—	x
Fluoride	—	—	x
Nitrate-Nitrite as Nitrogen	—	—	x
Perchlorate	x	—	—
Silicon Dioxide	—	x	x
Sulfate	—	—	x
Total Kjeldahl Nitrogen	—	x	x
Total Phosphate as Phosphorus	—	x	—
Dioxins and Furans			
Pentachlorodibenzofuran[2,3,4,7,8-]	—	x	—
Pentachlorodibenzofurans [Totals]	—	x	—
Pesticides and PCBs			
Aroclor-1242	x	—	—
Aroclor-1248	x	—	—
Aroclor-1254	x	—	x
Aroclor-1260	x	—	—
DDE[4,4'-]	x	—	—
DDT[4,4'-]	x	—	—
Endosulfan II	x	—	—
SVOCs			
Acenaphthene	x	—	—
Anthracene	x	—	—
Benzo[a]anthracene	x	—	—
Benzo[a]pyrene	x	—	—
Benzo[b]fluoranthene	x	x	—
Benzo[g,h,i]perylene	x	—	—
Benzo[k]fluoranthene	x	x	—
Benzoic Acid	x	—	—
Bis[2-ethylhexyl]phthalate	x	x	x
Chrysene	x	x	—
Di-n-butylphthalate	x	—	x
Di-n-octylphthalate	—	x	—
Dibenz(a,h)anthracene	x	—	—
Fluoranthene	x	—	—
Fluorene	x	—	—
Methylnaphthalene[2-]	x	—	—
Phenanthrene	x	—	—
Phenol	x	—	—

Table 6.5-1 (continued)

Analyte	Sediment	Shallow Groundwater	Stormwater[a]
Pyrene	x	—	—
VOCs			
Acetone	x	x	—
Aniline	x	—	—
Chloroform	x	—	—
Dichlorobenzene[1,4-]	x	—	—
Dichloroethane[1,2-]	—	x	—
Ethylbenzene	x	—	—
Isopropyltoluene[4-]	x	—	—
Methyl-2-pentanone[4-]	—	x	—
Methylene Chloride	x	—	—
Styrene	x	—	—
Tetrachloroethene	x	—	—
Toluene	x	x	—
Radionuclides			
Americium-241	x	—	x
Cesium-137	x	—	x
Gross alpha	—	x	x
Gross beta	—	x	x
Plutonium-238	x	—	x
Plutonium-239/240	x	—	x
Potassium-40	—	—	x
Radium-226	—	x	x
Radium-228	—	x	x
Strontium-90	—	—	x
Thorium-228	—	—	x
Thorium-230	—	—	x
Thorium-232	—	—	x
Tritium	x	x	—
Uranium-234	—	x	x
Uranium-235/236	x	—	x
Uranium-238	x	x	x

Note: Gray shading indicates analyte exceeded SAL or SSL for sediment or a standard for water.

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

[b] Acute aquatic community benchmarks for stormwater were exceeded for this analyte; however, no aquatic community is present in Cañada del Buey.

[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 Cañada del Buey

Type of COPC	COPC	Inferred Primary Source(s) in the Cañada del Buey Watershed[a]	Inferred Downcanyon Extent from Laboratory Sources[b]
Inorganic chemical	Aluminum	Natural background and possibly minor releases from TA-54	Cañada del Buey between reaches CDB-3E and CDB-4
	Antimony	Natural background and possibly minor releases from TA-46, TA-54, and possibly TA-51	Cañada del Buey between reaches CDB-3W and CDB-4
	Arsenic	Natural background	n/a[c]
	Cobalt	Natural background and possibly minor releases from TA-46	Reach CDB-2W
	Cyanide (total)	Cerro Grande burn area and possibly minor releases from TA-54	Reach CDBS-1E
	Iron	Natural background	n/a
	Lead	TA-46 and possibly paved areas at TA-52 and/or TA-63	Cañada del Buey between reaches CDB-2C and CDB-3W
	Perchlorate	Natural background	n/a
	Thallium	Natural background	n/a
Organic chemical	Aroclor-1242	TA-54 or TA-51	South fork Cañada del Buey between reaches CDBS-1W and CDBS-1E
	Aroclor-1248	TA-54	Cañada del Buey between reaches CDB-3W and CDB-3E
	Aroclor-1254	TA-54, TA-46, TA-52 and/or TA-63, and possibly TA-51	Cañada del Buey between reaches CDB-3E and CDB-4
	Aroclor-1260	TA-54, TA-46, TA-52 and/or TA-63, and possibly TA-51	Cañada del Buey between reaches CDB-3E and CDB-4
Radionuclide	Americium-241	TA-54	Cañada del Buey between reaches CDB-3E and CDB-4
	Plutonium-238	TA-54	Cañada del Buey between reaches CDB-3E and CDB-4
	Plutonium-239/240	TA-54, TA-46, and TA-52 (former TA-04)	Cañada del Buey east of reach CDB-3E

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

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

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

Table 8.1-1
HQs Based on Maximum Detected Concentrations of Inorganic COPCs in Cañada del Buey Sediment Samples and Soil ESLs

Reach	Aluminum	Antimony	Arsenic	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide [Total]	Fluoride	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Nitrate	Perchlorate	Potassium	Selenium	Thallium	Uranium (Calculated Total)	Vanadium	Zinc
Sediment BV (mg/kg)[a]	15,400	0.83	3.98	127	0.4	4420	10.5	4.73	11.2	0.82	na[b]	13,800	19.7	2370	543	0.1	9.38	na	na	2690	0.3	0.73	6.99	19.7	60.2
Minimum Soil ESL (mg/kg)[c]	pH dependent	0.05	6.8	110	0.27	na	2.3	13	15	0.1	31	pH dependent	14	na	220	0.013	9.7	na	na	na	0.52	0.032	25	0.025	48
CDB-1	—[d]	—	1	1.5	—	—	—	0.4	—	28	—	5< pH <8	1.6	—	—	—	—	—	no ESL	—	—	—	0.3	1100	—
CDB-2C	—	64	1.3	1.3	—	—	—	—	—	13	—	5< pH <8	2	—	—	—	—	—	no ESL	—	0.69	—	—	870	—
CDB-2W	—	19	1	1.3	—	no ESL	—	0.77	0.98	14	—	—	7	—	4	13	—	—	no ESL	—	—	—	0.35	880	3.2
CDB-3E	pH >5.5	—	1	2.2	—	—	7.5	0.67	0.98	--	0.062	5< pH <8	1.6	no ESL	3.3	—	—	no ESL	no ESL	no ESL	2.9	—	—	1400	1.6
CDB-3W	—	32	1.3	1.3	1.8	—	—	—	—	—	—	—	—	—	—	—	—	—	no ESL	—	—	—	—	820	—
CDB-4	—	—	—	1.2	—	no ESL	4.7	0.69	—	—	—	no ESL	—	no ESL	—	—	—	—	—	—	1.9	34	0.15	1376	—
CDB-4 BKG	—	—	—	1.4	—	no ESL	—	0.72	—	—	—	no ESL	—	—	—	—	1.2	—	—	—	2.3	—	—	1160	—
CDBS-1E	—	23	1	—	—	—	—	—	—	20	—	—	—	—	—	—	—	—	no ESL	—	—	—	—	—	—
CDBS-1W	—	36	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	no ESL	—	—	—	—	—	—

Notes: Gray shading indicates HQ >3.0 (or HQ >1.0 for T&E receptors). Values reported are HQs (unitless).

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

[b] na = Not available.

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

[d] — = Not a COPC.

Table 8.1-2
HQs Based on Maximum Detected Concentrations of
Radionuclide COPCs in Cañada del Buey Sediment Samples and Soil ESLs

Reach	Americium-241	Cesium-137	Plutonium-238	Plutonium-239/240	Tritium	Uranium-235/236	Uranium-238
Sediment BV (pCi/g)[a]	0.04	0.9	0.006	0.068	0.093	0.2	2.29
Minimum Soil ESL (pCi/g)[b]	44	680	44	47	36,000	55	55
CDB-1	—[c]	<0.01	—	<0.01	<0.01	<0.01	<0.01
CDB-2C	—	—	—	<0.01	—	—	—
CDB-2W	—	<0.01	—	<0.01	< 0.01	—	<0.01
CDB-3E	<0.01	—	<0.01	<0.01	—	—	—
CDB-3W	<0.01	<0.01	0.06	<0.01	<0.01	—	—
CDB-4	—	—	—	—	<0.01	—	—
CDB-4 BKG	—	—	—	<0.01	—	—	—
CDBS-1E	<0.01	—	<0.01	<0.01	—	—	—
CDBS-1W	—	—	—	--	<0.01	—	—

[a] BVs are from LANL (1998, 059730).
[b] ESLs are from the ECORISK Database, Version 2.3 (LANL 2008, 103352).
[c] — = Not a COPC values reported are HQs (unitless).

Table 8.1-3
HQs Based on Maximum Detected Concentrations of Organic COPCs in Cañada del Buey Sediment Samples and Soil ESLs

Reach	Acenaphthene	Acetone	Aniline	Anthracene	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[g,h,i]perylene	Benzo[k]fluoranthene	Benzoic Acid	Bis[2-ethylhexyl]phthalate	Chloroform	Chrysene	DDE[4,4*-]	DDT[4,4*-]	Dibenz[a,h]anthracene	Dichlorobenzene[1,4-]	Di-n-butylphthalate	Endosulfan II	Ethylbenzene	Fluoranthene	Fluorene
Minimum Soil ESL (mg/kg)[a]	0.25	1.2	na[b]	6.8	0.041	0.0072	0.041	0.14	3	53	18	24	62	1	0.02	8	2.4	0.11	0.044	12	0.88	0.011	0.64	24[c]	10	3.7
CDB-1	—[d]	—	—	—	—	—	0.65	0.12	<0.01	<0.01	—	—	—	—	4	—	<0.01	—	—	—	< 0.01	—	—	—	<0.01	—
CDB-2C	—	—	—	<0.01	—	—	0.11	0.04	0.013	<0.01	<0.01	<0.01	<0.01	0.434	—	<0.01	0.02	—	0.04	—	—	—	—	<0.01	<0.01	<0.01
CDB-2W	—	0.01	—	<0.01	—	—	0.34	0.07	0.023	<0.01	<0.01	<0.01	<0.01	0.805	—	—	0.02	—	—	<0.01	—	—	<0.01	<0.01	<0.01	<0.01
CDB-3E	—	—	—	—	—	—	0.45	0.05	—	—	—	—	—	—	1.6	—	—	—	—	—	—	2.4	—	—	—	—
CDB-3W	0.14	—	—	—	—	20	2.4	0.13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.01	—
CDB-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CDB-4 BKG	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CDBS-1E	—	—	no ESL	—	—	—	0.04	—	—	—	—	—	—	—	—	—	—	0.02	0.09	—	—	—	—	—	—	—
CDBS-1W	—	< 0.01	—	—	0.19	—	0.23	0.03	—	—	—	—	—	—	5	—	—	--	0.03	—	—	—	—	<0.01	—	—

Table 8.1-3 (continued)

Reach	Isopropyltoluene[4-]	Methylene Chloride	Methylnaphthalene[2-]	Phenanthrene	Phenol	Pyrene	Styrene	Tetrachloroethene	Toluene
Minimum Soil ESL (mg/kg)[a]	23[e]	2.6	2.5	5.5	0.79	10	300[f]	0.18	23
CDB-1	—	<0.01	—	<0.01	—	<0.01	—	—	—
CDB-2C	—	<0.01	—	<0.01	—	<0.01	<0.01	<0.01	<0.01
CDB-2W	—	—	—	0.02	0.4	<0.01	<0.01	<0.01	<0.01
CDB-3E	—	—	—	—	—	<0.01	—	—	—
CDB-3W	—	—	—	<0.01	—	<0.01	—	—	—
CDB-4	—	—	—	—	—	—	—	—	—
CDB-4 BKG	—	—	—	—	—	—	—	—	—
CDBS-1E	—	<0.01	<0.01	<0.01	—	<0.01	—	—	—
CDBS-1W	<0.01	—	—	—	—	—	<0.01	<0.01	<0.01

Notes: Gray shading indicates HQ >3.0 (or HQ >1.0 for T&E species). Values reported are HQs (unitless).

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

[b] na = Not available.

[c] ESL for benzene used as a surrogate.

[d] — = Not a COPC.

[e] ESL for toluene used as a surrogate.

[f] Interim ESL.

Table 8.1-4
COPECs Considered for Study Design for Cañada del Buey

Analyte	Cañada del Buey Maximum Concentration (mg/kg)	Minimum ESL (mg/kg)	Assessment Endpoint Where Cañada del Buey Sample > ESL
Antimony	3.2	0.05	plant, shrew, mouse
Chromium	17.2	2.3	plant, worm
Cyanide [total]	2.79	0.1	robin (herbivore), robin (insectivore), robin (omnivore), kestrel (intermediate carnivore)*, kestrel (top carnivore)*
Lead	97.1	14	robin (insectivore), robin (omnivore), robin (herbivore)
Manganese	889	220	plant
Mercury	0.168	0.013	robin (insectivore), robin (omnivore), worm, kestrel (intermediate carnivore)*
Thallium	1.1	0.032	shrew, mouse, plant
Vanadium	35	0.025	plant, robin (insectivore), robin (omnivore), robin (herbivore)
Zinc	152	48	robin (insectivore)
Aroclor-1248	0.145	0.0072	shrew, mouse, robin (insectivore), robin (omnivore)
Bis (2-ethylhexyl) phthalate	0.103	0.02	robin (insectivore), kestrel (intermediate carnivore)*, kestrel (top carnivore)*

* An HQ of 1 was considered for the American kestrel (top carnivore), which is a surrogate receptor for the Mexican spotted owl.

Table 8.1-5
Comparison of Concentrations for Plant COPECs in
Cañada del Buey with Concentrations from Sediment Used in Previous Plant Studies

COPEC	Sediment BV (mg/kg)	Plant ESL (mg/kg)	Cañada del Buey 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	3.2	0.073	Not detected	0.198
Chromium	10.5	2.4	17.2	18.4	524	28.2
Manganese	543	220	889	1080	614	1560
Thallium	0.73	0.1	1.1	0.356	0.87	3.27
Vanadium	19.7	0.025	35	20.3	29.7	35.9

Note: Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in Cañada del Buey.

Table 8.1-6
Comparison of Concentrations for Earthworm COPECs (mg/kg) in Cañada del Buey with Concentrations from Sediment Used in Previous Worm Studies

COPEC	Sediment BV (mg/kg)	Earthworm ESL (mg/kg)	Cañada del Buey 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	17.2	18.4	524	28.2
Mercury	0.1	0.05	0.168	0.796	1.2	0.836

Note: Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in Cañada del Buey.

Table 8.1-7
Comparison of Concentrations for Small Mammal COPECs in Cañada del Buey with Concentrations from Sediment Used in Previous Mammal Studies

COPEC	Sediment BV (mg/kg)	Shrew ESL (mg/kg)	Cañada del Buey Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)
Antimony	0.83	0.26	3.2	0.56	0.8
Thallium	0.73	0.032	1.1	2.6	0.8
Aroclor-1248	na*	0.0072	0.145	Not detected	Not detected

Note: Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in Cañada del Buey.

*na = Not available.

Table 8.1-8
Comparison of Concentrations for Robin COPECs in Cañada del Buey with Concentrations from Sediment Used in Previous Bird Studies

COPEC	Sediment BV (mg/kg)	Robin ESL (mg/kg)	Cañada del Buey Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)	Pajarito Canyon Maximum (mg/kg)
Cyanide [Total]	0.82	0.1	2.79	Not analyzed	1.69
Lead	19.7	21	97.1	56.8	77.2
Mercury	0.1	0.07	0.168	0.32	1.58
Vanadium	19.7	8.9	35	53.1	86.1
Zinc	60.2	48	152	169	154
Aroclor-1248	na*	0.041	0.145	Not detected	Not detected
Bis(2-ethylhexyl) phthalate	na	0.02	0.103	0.41	0.418

Note: Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in Cañada del Buey.

*na = Not available.

Table 8.1-9
Comparison of Concentrations for Kestrel (Mexican Spotted Owl Surrogate) COPECs in Cañada del Buey with Concentrations from Sediment Used in Previous Mammal Studies

COPEC	Sediment BV (mg/kg)	Kestrel ESL (mg/kg)	Cañada del Buey Maximum (mg/kg)	Los Alamos and Pueblo Canyons Maximum (mg/kg)	Mortandad Canyon Maximum (mg/kg)
Cyanide [Total]	0.82	0.47	2.79	2.11	0.377
Mercury	0.1	0.082	0.168	2.6	0.32
Bis(2-ethylhexyl) phthalate	na*	0.033	0.103	1.3	0.4

Note: Gray shading indicates maximum detected concentration from a previous study that exceeds the maximum detected concentration in Cañada del Buey.

*na = Not available.

Table 8.1-10
Summary of Cañada del Buey 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
			Count of Unbounded Results	Reach Average					
Antimony	plant	0.05	7	0.45	CDB-1	0.053	not detected	0.198	Natural background and minor releases from TA-46, TA-54, and TA-51
			20	0.94	CDB-2C				
			9	0.59	CDB-2W				
			20	1.03	CDB-3W				
			12	0.53	CDB-4				
			19	0.85	CDBS-1E				
			15	1.25	CDBS-1W				
Antimony	shrew	0.26	8	0.94	CDB-2C	0.56	0.8	not studied	Natural background and minor releases from TA-46, TA-54, and TA-51
			3	0.59	CDB-2W				
			14	1.03	CDB-3W				
			12	0.85	CDBS-1E				
			12	1.25	CDBS-1W				
Cyanide (total)	robin	0.1	2	0.64	CDB-1	1.8	0.13	not studied	Reach average is bounded by previous studies.
			1	1.1	CDBS-1E				
Cyanide (total)	Mexican spotted owl	0.47	2	0.64	CDB-1	2.11	0.377	not studied	Reach average is bounded by previous studies.
Lead	robin	21	3	35.4	CDB-2W	not studied	56.8	77.2	Reach average is bounded by previous studies.
Aroclor-1248	shrew	0.0072	1	0.145	CDB-3W	not studied	not studied	not studied	Potential TA-54 source, single detection. Adverse effects from a COPEC detected in a single sample are unlikely.
Aroclor-1248	robin	0.041	1	0.145*	CDB-3W	not studied	not studied	not studied	Potential TA-54 source, single detection. Adverse effects from a COPEC detected in a single sample are unlikely.

*Because there was only one detected result for Aroclor-1248, the value shown here is the maximum.

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

Analyte Name	Acenaphthene	Acetone	Aluminum	Anthracene	Antimony	Aroclor-1254	Barium	Benzo[g,h,i]perylene	Benzoic Acid (1)	Cadmium	Cobalt	Copper	Di-n-butylphthalate	Endosulfan II (2)	Fluoranthene	Fluorene	Iron	Isopropyltoluene[4-] (3)	Lead	Manganese	Methylnaphthalene[2-]	Mercury	Nickel	Phenanthrene	Phenol
Screen	3440	67,500	78,100	17,200	31.3	1.12	15,600	17,200	240,000	77.9	23	3130	6110	367	2290	2290	54,800	3210	400	10,700	310	23	1560	1830	18,000
CDB-1	—*	—	—	—	—	0.0238	0.0104	—	—	—	0.227	—	—	—	<0.01	—	0.281	—	0.0565	—	—	—	—	<0.01	—
CDB-2C	—	—	—	<0.01	0.102	<0.01	<0.01	<0.01	<0.01	—	—	—	—	—	<0.01	<0.01	0.255	—	0.0693	—	—	—	—	<0.01	—
CDB-2W	—	<0.01	—	<0.01	0.0298	0.0123	<0.01	<0.01	<0.01	—	0.434	<0.01	—	<0.01	<0.01	<0.01	—	—	0.243	0.0831	—	<0.01	—	<0.01	<0.01
CDB-3E	—	—	0.320	—	—	0.0166	0.0157	—	—	—	0.380	<0.01	<0.01	—	—	—	0.434	—	0.0578	0.0684	—	—	—	—	—
CDB-3W	<0.01	—	—	—	0.0511	0.0880	<0.01	—	—	<0.01	—	—	—	—	<0.01	—	—	—	—	—	—	—	—	<0.01	—
CDB-4	—	—	—	—	—	—	<0.01	—	—	—	0.404	—	—	—	—	—	0.387	—	—	—	—	—	<0.01	—	—
CDBS-1E	—	—	—	—	0.0367	<0.01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<0.01	—	--	<0.01	—
CDBS-1W	—	<0.01	—	—	0.0578	<0.01	—	—	—	—	—	—	—	—	—	—	—	<0.01	—	—	—	—	—	—	—

Table 8.2-1 (continued)

Analyte Name	Pyrene	Selenium	Styrene	Thallium	Toluene	Uranium (Calculated Total)	Vanadium	Zinc	SOF
Screen	1720	391	8970	5.16	5570	235	391	23,500	0.70
CDB-1	<0.01	—	—	—	—	0.0320	0.0683	—	0.50
CDB-2C	<0.01	<0.01	<0.01	—	<0.01	—	0.0555	—	0.92
CDB-2W	<0.01	—	<0.01	—	<0.01	0.0374	0.0565	<0.01	1.4
CDB-3E	<0.01	<0.01	—	—	—	—	0.0895	<0.01	0.21
CDB-3W	<0.01	—	—	—	—	—	0.0524	—	1.1
CDB-4	—	<0.01	—	0.213	—	—	0.0880	—	0.038
CDBS-1E	<0.01	—	—	—	—	—	—	—	0.066
CDBS-1W	—	—	<0.01	—	<0.01	—	—	—	0.70

Notes: Residential SLs are from NMED (2009, 106420), unless otherwise noted. Shaded cells indicate which reaches have SOFs >1 and which analytes have risk ratios >0.1. (1) EPA regional SSLs. (2) Endosulfan (CAS 115-29-7) surrogate: NMED SL. (3) Isopropylbenzene (CAS 98-82-8) surrogate: NMED SL. All values from EPA regional SSLs adjusted to 10^{-5} target risk level EPA SLs:(http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm). NMED SLs: (2009, 106420).

*— = Not a COPC.

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

Analyte Name	Aniline (1)	Aroclor-1242	Aroclor-1248	Aroclor-1260	Arsenic	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Bis[2-ethylhexyl]phthalate	Chloroform (1)	Chromium	Chrysene	DDE[4,4*-]	DDT[4,4*-]	Dibenz[a,h]anthracene	Dichlorobenzene[1,4-]	Ethylbenzene	Methylene Chloride	Tetrachloroethene	SOF
Screen	85	1.7	1.7	1.7	3.59	4.81	0.481	4.81	48.1	280	5.72	2800	481	11.5	15.8	0.481	32.1	69.6	199	6.99	
CDB-1	—*	—	—	0.0102	1.97	<0.01	0.0147	—	—	<0.01	—	—	<0.01	—	—	—	<0.01	—	<0.01	—	2.0
CDB-2C	—	—	—	<0.01	2.47	<0.01	0.0644	0.0107	<0.01	—	<0.01	—	<0.01	—	<0.01	—	—	<0.01	<0.01	<0.01	2.6
CDB-2W	—	—	—	<0.01	1.92	0.0143	0.0927	0.0146	<0.01	—	—	—	<0.01	—	—	<0.01	—	<0.01	—	<0.01	2.1
CDB-3E	—	—	—	<0.01	1.59	—	—	—	—	<0.01	—	0.0614	—	—	—	—	—	—	—	—	1.7
CDB-3W	—	—	0.0853	0.0103	2.38	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.5
CDB-4	—	—	—	—	--	—	—	—	—	—	—	0.0386	—	—	—	—	—	—	—	—	0.039
CDBS-1E	<0.01	—	—	—	1.82	—	—	—	—	—	—	—	—	<0.01	<0.01	—	—	—	<0.01	—	1.8
CDBS-1W	—	<0.01	—	<0.01	1.98	—	—	—	—	<0.01	—	—	—	—	<0.01	—	—	<0.01	—	<0.01	2.0

Notes: Residential SLs are from NMED (2009, 106420), unless otherwise noted. Shaded cells indicate which reaches have SOFs >1 and which analytes have risk ratios >0.1. All values from EPA regional SSLs adjusted to 10^{-5} target risk level.
(1) EPA regional SSLs. EPA SLs: http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm. NMED SLs: (2009, 106420).

*— = Not a COPC.

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

Reach	Cesium-137	Plutonium-238	Uranium-235/236	Uranium-238	SOF
Residential Screening Concentration (pCi/g)	5.6	37	17	86	
CDB-1	0.245	—*	0.017	0.0294	0.29
CDB-2W	0.363	—	—	0.0343	0.40
CDB-3E	—	<0.01	—	—	0.0033
CDB-3W	0.184	0.0746	—	—	0.26
CDBS-1E	—	<0.01	—	—	0.012
CDBS-1W	—	—	—	—	0.00025

Note: All values are from LANL (2005, 088493).
* — Not A COPC.

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

Reach	Analyte Class
CDB-1	M_c
CDB-2C	M_c
CDB-2W	M_c
CDB-3E	M_{nc},Mc
CDB-3W	M_c
CDB-4	M_{nc}
CDBS-1E	M_c
CDBS-1W	M_c

Note: Analyte class evaluated as M_c = metal, carcinogen; M_{nc} = metal, noncarcinogen.

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

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

[a] x = complete pathway.
[b] — = incomplete pathway.

Table 8.2-6
Risk-Based Screening Levels

COPC	End Point	Target Adverse-Effect Level	Recreational SSL (mg/kg)	Residential SSL (mg/kg)
Aluminum	nc	HQ = 1	100000+	—*
Arsenic	ca	Risk = 10^{-5}	27.7	—
Cobalt	nc	HQ = 1	15700	23
Iron	nc	HQ = 1	100000+	23500
Thallium	nc	HQ = 1	52.3	5.16

Notes: All SSLs from LANL (2007, 094496). mrem/yr: millirem per year; ca: carcinogen, nc: noncarcinogen, + maximum; toxicity-derived concentration greater than 100,000 mg/kg.

* — = Not a COPC for CDB-4 residential evaluation.

Table 8.2-7
Risk Ratios Based on EPCs for Sediment, Recreational Scenario, Noncarcinogens

Reach	Aluminum	Cobalt	Iron	Thallium	Total Risk Ratio	Total HI
Recreational SL (mg/kg)	100,000	15,700	100,000	52.3		
CDB-1	—*	—	—	—	—	—
CDB-2C	—	—	—	—	—	—
CDB-2W	—	—	—	—	—	—
CDB-3E	0.157	<0.010	0.146	--	0.522	0.30
CDB-3W	—	—	—	—	—	—
CDB-4	—	<0.010	0.127	0.017	0.143	0.14
CDBS-1E	—	—	—	—	—	—
CDBS-1W	—	—	—	—	—	—

Note: Residential SLs are from NMED (2009, 106420).
*— = Not a COPC.

Table 8.2-8
Risk Ratios Based on EPCs for Sediment, Recreational Scenario, Carcinogens

Reach	Arsenic	Total Risk Ratio	Total Risk
Recreational SL (mg/kg)	27.7		
CDB-1	0.19	0.19	1.9E-06
CDB-2C	0.19	0.19	1.9E-06
CDB-2W	0.19	0.19	1.9E-06
CDB-3E	0.13	0.13	1.3E-06
CDB-3W	0.22	0.22	2.2E-06
CDBS-1E	0.19	0.19	1.9E-06
CDBS-1W	0.20	0.20	2.0E-06

Note: Residential SLs are from NMED (2009, 106420).

Table 8.2-9
Risk Ratios Based on EPCs for Sediment, Residential Scenario, Noncarcinogens

Reach	Cobalt {1}	Iron	Thallium	Total Risk Ratio	Total HI
Residential SL (mg/kg)	23	23500	5.16		
CDB-4	0.26	0.54	0.17	0.97	0.97

Notes: Residential SLs are from NMED (2009, 106420), unless otherwise noted. (1) EPA regional SSLs. EPA SLs: (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

Table 8.2-10
EPCs for Sediment COPCs

Reach	End Point	Analyte	UCL (mg/kg)
CDB-1	ca[a]	Arsenic	5.351
CDB-2C	ca	Arsenic	5.263
CDB-2W	ca	Arsenic	5.278
CDB-3E	nc[b]	Aluminum	15704
CDB-3E	ca	Arsenic	3.531
CDB-3E	nc	Cobalt	5.034
CDB-3E	nc	Iron	14591
CDB-3W	ca	Arsenic	6.049
CDB-4	nc	Cobalt	5.954
CDB-4	nc	Iron	12671
CDB-4	nc	Thallium	0.877
CDBS-1E	ca	Arsenic	5.272
CDBS-1W	ca	Arsenic	5.499

[a] ca = Carcinogen.

[b] nc = Noncarcinogen.

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

%R	percent recovery
%RSD	percent relative standard deviation
AOC	area of concern
asl	above sea level
ATSDR	Agency for Toxic Substances and Disease Registry
BCG	Biota Concentration Guideline (DOE)
BE	barometric efficiency
BV	background value
BW	body weight
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
DCG	Derived Concentration Guideline (DOE)
DOE	Department of Energy (U.S.)
DRI	Desert Research Institute
EPA	Environmental Protection Agency (U.S.)
EPC	exposure point concentration
EQL	estimated quantitation limit
ERAGS	Ecological Risk Assessment Guidance for Superfund
ESL	ecological screening level
FIMAD	Facility for Information Management, Analysis, and Display
HE	high explosives
HQ	hazard quotient
IA	interim action
ICPES	inductively coupled plasma emission spectroscopy
ICR	incremental cancer risk
ICS	interference-check sample
ICV	initial calibration verification
IFGMP	“Interim Facilty-Wide Groundwater Monitoring Program”

IP	Individual Permit
IRIS	Integrated Risk Information System
IS	internal standard
LAL	lower acceptance limit
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level
MDA	material disposal area
MDL	method detection limit
mrem/yr	millirem per year
MRL	minimal risk level
MS	matrix spike
MSD	matrix spike duplicate
NFA	no further action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMHWA	New Mexico Hazardous Waste Act
NMSA	New Mexico Statutes Annotated
NOAEL	no observed adverse effect level
NOD	notice of disapproval
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
RME	reasonable maximum exposure
RPD	relative percent difference
RRF	relative response factor
RSI	request for supplemental information
SAL	screening action level

SF	slope factor
SL	screening level
SLERA	screening level ecological risk assessment
SMDB	Sample Management Database
SMDP	strategic management decision point
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
SWSC	Sanitary Wastewater System Consolidation (Plant)
T&E	threatened and endangered
TA	technical area
TPU	total propagated uncertainty
TRV	toxicity reference value
UAL	upper acceptance limit
UCL	upper confidence level
VOC	volatile organic compound
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 parameters.

Appendix B

Field Investigation Methods and Results

B-1.0 SEDIMENT INVESTIGATIONS IN REACHES

This appendix summarizes results from field investigations of potentially contaminated sediment deposits in reaches in Cañada del Buey that were conducted from 1999 to 2008 as part of implementation of the "Work Plan for Sandia Canyon and Cañada del Buey" (LANL 1999, 064617). 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 and 3. Unit designations followed those used in previous reports on canyons in and near the Los Alamos National Laboratory (LANL or the Laboratory) (e.g., LANL 2004, 087390; LANL 2006, 094161; LANL 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 Cañada del Buey investigation reaches are presented in Table B-1.0-1. Information for reaches CDB-3E and CDB-4 in Table B-1.0-1 are from previous reports (Drakos et al. 2000, 068739; LANL 2005, 088716; Reneau et al. 2005, 088716).

Sediment thickness measurements distinguished between fine facies sediment, with typical median particle size of silt to fine sand (0.015 to 0.25 mm) in the less than 2-mm fraction, and coarse facies sediment, with typical median particle size of coarse to very coarse sand (0.5 to 2 mm) in the less than 2-mm fraction. Samples with median particle size of medium sand (0.25 to 0.5 mm) were classified either as fine or coarse facies, depending on the stratigraphic context and the particle size of adjacent layers. Coarse facies sediment is characteristic of material transported along the streambeds as bed load, and fine facies sediment is characteristic of material transported in suspension (Malmon 2002, 076038, pp. 94-97; Malmon et al. 2004, 093018). Several methods were used to identify the bottom of post-1942 sediment deposits, including determining the depth of buried trees and associated buried soils and noting the presence or absence of materials imported to the watershed after 1942 (e.g., quartzite gravel, plastic). Sediment thickness measurements from the Cañada del Buey investigation reaches are shown in Table B-1.0-2 (see Attachment 1 on CD included with this document), except for measurements from reaches CDB-3E and CDB-4 that were presented in previous reports (Drakos et al. 2000, 068739; Reneau et al. 2005, 088716).

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 can be pH-dependant for some analytes. Particle size, organic matter, and pH data from the Cañada del Buey investigation reaches are shown in Table B-1.0-3 (see Attachment 1 on CD included with this document).

B-2.0 WATER INVESTIGATIONS

This section provides additional information concerning stream-flow measurements and water levels observed in the Cañada del Buey watershed since 2005.

Stream flow measured at gages E218, E225, and E230 (Plate 1) are used to assess spatial infiltration and surface-water balance along the canyon bottom between wells CDBO-5 and CDBO-4 (NMED 2009, 105600). These gages continuously monitor stream flow in the canyon bottom. Gage data from January 1, 2005, to September 30, 2008, are presented in Figure 7.2-2 and included in Attachment C-3. Precipitation data from the TA-54 meteorological station are also included. More recent data from these gages have not been validated and therefore are not included in this report. The stream gages in Cañada del Buey are dry most of the time (e.g., Ortiz et al. 2008, 105250). Table B-2.0-1 shows the number of days per year when flow was measured at the three gages.

Observations from alluvial monitoring wells CDBO-1 through CDBO-5, CDBO-8, and CDBO-9 were also compiled, although these wells have proven to be persistently dry. These data, which include both manual and automated measurements, allow interconnections between groundwater bodies to be assessed by correlating groundwater-level responses with surface-water flows recorded at gages and local precipitation events. Manual groundwater-level measurements have been obtained periodically at wells CDBO-1 through CDBO-4 since 1985 and at wells CDBO-5 through CDBO-9 since 1993. Manual groundwater-level measurements are summarized in Table B-2.0-2. Wells CDBM-1 and CDBM-2 were sounded for this investigation on January 1, 2009, and found to be dry (Table B-2.0-2). Automated pressure transducers were installed in January 2009 for monitoring of possible ground water levels in alluvial wells CDBO-4, CDBO-5, CDBO-8, and CDBO-9 to determine whether transient saturation occurs following storm runoff. The period of record thus far for these four wells shows that the wells have been dry. The results of continuous water-level measurements from transducers installed in these wells (CDBO-4, CDBO-5, CDBO-8, and CDBO-9) are presented in Table B-2.0-3.

Automated pressure transducers were placed in wells CDBO-6 and CDBO-7 in 2005 for collection of continuous water-level data; the results are reported in the annual groundwater level status reports (e.g., Koch and Schmeer 2009, 105181). Data from June 1, 2005 to July 14, 2009, are presented in Figure 7.2-2 and included in Attachment C-3. The data show that water levels at CDBO-6 fluctuate approximately 10 ft. The water level at CDBO-7 frequently declines below the bottom of the screen. Fluctuations at this location can be greater than 5 ft. These data are further interpreted in Section 7.2.1. Table B-2.0-4 summarizes information about the time lag between surface-water flows and peak water levels at wells CDBO-6 and CDBO-7. Note that peak groundwater levels may result from multiple runoff events, and the dates given for the surface flows are approximate. Figure 7.2-2 shows the runoff events measured at the stream gages and the hydrographs for CDBO-6 and CDBO-7; the lag times between the runoff events and the groundwater peaks can be readily observed. The peak groundwater level lag at CDBO-6 is typically 120 to 150 d after a large runoff event, while the lag at CDBO-7 is typically greater than 200 d.

The groundwater at monitoring well CDBO-6 is drawn down during sampling; the short-term water-level recovery is recorded by the pressure transducer. As an example of recovery after sampling, Figure B-2.0-1 shows hourly water-level data for CDBO-6 directly before and after the February 11, 2009, sampling event. The well has a 2-in.-diameter casing, and the transducer must be removed each time the well is sampled to allow insertion of the sampling pump. For the February 11, 2009, sampling event, the water level measured after sampling showed a drawdown of at least 3.3 ft, which takes about 3 d to recover. Based on the last sampling event in May 2009, 6.4 gal. of water was purged before collecting the sample, which is a typical purge volume. The hydraulic conductivity of the sediments at CDBO-6 must be relatively low to take several days to recover from a purge of less than 10 gal.

In addition, well CDBO-6 has about 92% barometric efficiency (BE), which is unusual for alluvial wells at the Laboratory. Most shallow alluvial groundwater has a BE near 0%, but some deeper alluvial groundwater in some canyons has higher BE values where the alluvial groundwater is present beneath buried soil horizons, which inhibit passage of atmospheric pressure to the shallow groundwater. The high CDBO-6 BE value supports the concept that the groundwater is in a perched intermediate zone that is not well connected to the atmosphere.

B-3.0 REFERENCES

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

Copies of the master reference set are maintained at the 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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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)

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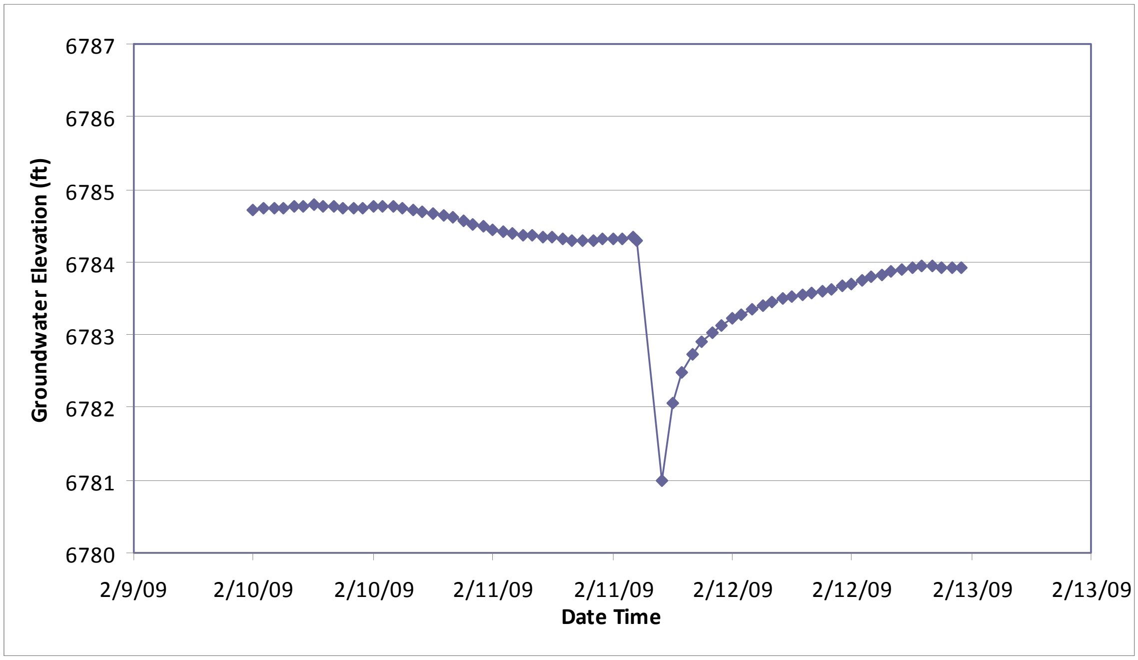

Figure B-2.0-1 Water-level data for CDBO-6 directly before and after the 2/11/09 sampling event

Table B-1.0-1
Physical Characteristics of Post-1942 Geomorphic Units in the Cañada del Buey Investigation Reaches

Reach	Geomorphic Unit	Average Unit Width (m)[a]	Sediment Facies	Estimated Average Sediment Thickness (m)	Typical Median Particle Size Class (<2-mm fraction)	Notes
CDB-1	c1	1.4	Fine	0.28	Coarse silt	Active channel; contains some post-fire sediment
			Coarse	0.17	Coarse sand	
	c1br	0.1	n/a[b]	0	n/a	Active channel on bedrock
	c2	5.8	Fine	0.41	Coarse silt	Abandoned post-1942 channel; contains some post-fire sediment
			Coarse	0.13	Coarse sand	
	f1	1.0	Fine	0.31	Coarse silt	Post-1942 floodplain; contains some post-fire sediment
			Coarse	0.12	Medium sand[c]	
	Total	**8.4**				
CDB-2W	c1	0.2	Fine	0.16	Fine sand[c]	Active channel; contains some post-fire sediment
			Coarse	0.47	Coarse sand	
	c2	7.8	Fine	0.36	Coarse silt	Abandoned post-1942 channel; contains some post-fire sediment
			Coarse	0.21	Coarse sand	
	f1	8.0	Fine	0.29	Coarse silt	Post-1942 floodplain; contains some post-fire sediment
			Coarse	0.02	Medium sand[c]	
	f2	0.3	Fine	0.03	Coarse silt[c]	Possible post-1942 floodplain
	Total	**16.3**				
CDB-2C	c1	1.4	Fine	0.11	Fine sand[c]	Active channel; dominated by post-fire sediment
			Coarse	0.77	Very coarse sand	
	c2	6.2	Fine	0.52	Coarse silt	Abandoned post-1942 channel; contains some post-fire sediment
			Coarse	0.24	Coarse sand	
	f1	19.5	Fine	0.23	Coarse silt	Abandoned post-1942 channel; contains post-fire sediment
	f2	0.1	Fine	0.05	Coarse silt[c]	Possible post-1942 floodplain
	Total	**27.3**				
CDB-3W	c1	2.0	Fine	0.29	Coarse silt	Active channel
			Coarse	0.27	Coarse sand	
	c2	1.9	Fine	0.25	Coarse silt	Abandoned post-1942 channel
			Coarse	0.24	Coarse sand	
	f1	1.4	Fine	0.2	Coarse silt	Post-1942 floodplain
	Total	**5.3**				

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
CDB-3E	c1	1.9	Fine	0.13	Coarse silt	Active channel
			Coarse	0.47	Coarse sand	
	c1b	0.4	Fine	0.18	Coarse silt[c]	Area of fine-grained sediment deposition adjacent to active channel
			Coarse	0.25	Coarse sand[c]	
	c2	3.3	Fine	0.24	Coarse silt	Abandoned post-1942 channel
			Coarse	0.17	Coarse sand	
	f1	9.1	Fine	0.12	Coarse silt	Post-1942 floodplain
			Coarse	0.02	Medium sand[c]	
	f2	0.1	Fine	0.12	Coarse silt[c]	Possible post-1942 floodplain
			Coarse	0.02	Medium sand[c]	
	Total	**14.8**				
CDB-4	c1	3.6	Fine	0.08	Fine sand[c]	Active channel
			Coarse	0.28	Coarse sand	
	c1b	0.6	Fine	0.14	Coarse silt	Area of fine-grained sediment deposition adjacent to active channel
			Coarse	0.25	Coarse sand	
	c2	1.4	Fine	0.30	Very fine sand	Abandoned post-1942 channel
			Coarse	0.28	Very coarse sand	
	f1	1.6	Fine	0.33	Very fine sand	Post-1942 floodplain
			Coarse	0.02	Medium sand[c]	
	f1b	0.5	Fine	0	n/a	Active floodplain with no young sediment
	f2	4.8	Fine	0.03	Fine sand[c]	Possible post-1942 floodplain
	Total	**12.6**				
CDBS-1W	c1	2.3	Fine	0.08	Medium sand	Active channel
			Coarse	0.31	Coarse sand	
	c2	1.1	Fine	0.2	Very fine sand	Abandoned post-1942 channel
			Coarse	0.14	Coarse sand	
	f1	0.5	Fine	0.16	Very fine sand	Post-1942 floodplain
			Coarse	0.02	Medium sand[c]	
	Total	**3.8**				
CDBS-1E	c1	1.1	Fine	0.21	Medium sand	Active channel
			Coarse	0.51	Coarse sand	
	c2	2.4	Fine	0.36	Fine sand	Abandoned post-1942 channel
			Coarse	0.28	Coarse sand	
	f2	5.4	Fine	0.06	Very fine sand	Possible post-1942 floodplain
	Total	**8.9**				

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

[b] n/a = Not applicable.

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

Table B-2.0-1
Number of Days of Flow per Year for Stream Gages E218, E225 and E230

Gage	2005	2006	2007	2008 (through 9/30)
E218	90	29	136	12
E225	0	1	0	1
E230	11	11	9	3

Table B-2.0-2
Manual Water-Level Sampling Results for Alluvial Wells, CDBM-1 and CDBM-2 in Cañada del Buey

Well	Time Period	# of TimesDry/Total # Times Sampled
CDBO-1	3/8/2006 – 11/3/2008	17/17
CDBO-2	3/8/2006 – 11/3/2008	18/18
CDBO-3	12/6/2005 - 11/3/2008	18/18
CDBO-4	12/7/2005 - 11/3/2008	18/18
CDBO-5	12/7/2005 - 11/3/2008	14/14
CDBO-8	7/2/2001 - 11/3/2008	25/25
CDBO-9	7/2/2001 - 11/3/2008	25/25
CDBM-1	1/9/2009	1/1
CDBM-2	1/9/2009	1/1

Note: Data from (Koch and Schmeer 2009, 105181).

Table B-2.0-3
Automated Water-Level Sampling Results for Alluvial Wells CDBO-4, CDBO-5, CDBO-8 and CDBO-9

Well	Time Period	Result
CDBO-4	1/9/09 – 7/14/09	Dry over entire period
CDBO-5	1/12/09 – 7/14/09	Dry over entire period
CDBO-8	1/12/09 – 7/14/09	Dry over entire period
CDBO-9	1/9/09 – 7/14/09	Dry over entire period

Note: First date in time period is transducer installation date.

Table B-2.0-4
Estimated Lag Time in Days Between Large Surface-Water Flows and Water-Level Peaks at CDBO-6 and CDBO-7

Date of Surface Flow	Date of CDBO-6 Peak	Lag between Surface Flow and CDBO-6 Peak (Days)	Date of CDBO-7 Peak	Lag between Surface Flow and CDBO-7 Peak (Days)
3/15/2005	7/28/2005	135	10/17/2005	216
9/28/2005	1/31/2006	125	4/26/2006	210
8/25/2006	1/14/2007	142	4/14/2007	232
3/24/2007	9/19/2007	179	(no peak)	(no peak)
1/28/2008	6/23/2008	147	10/14/2008	260
8/9/2008	1/9/2009	153	3/30/2009	233

Appendix C

Analytical Data

C-1.0 ANALYTICAL RESULTS

All available data packages are included as Attachment C-1 on DVDs. Data related to Cañada del Buey 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:

- Cañada del Buey Sediment Analytical Data
- Cañada del Buey Sediment Field QC Data
- Cañada del Buey Sediment Rejected Data
- Cañada del Buey Water Analytical Data
- Cañada del Buey Water Field QC Data
- Cañada del Buey Water Rejected Data

C-1.2 Data Obtained from Other Sources

Data obtained from sources other than the SMDB and WQDB and discussed in this report are included as Attachment C-3 on DVD. The water-level and gage data presented in Attachment C-3 were taken from "Groundwater Level Status Report for 2008, Los Alamos National Laboratory" (Koch and Schmeer 2009, 105181). These data can also be found at http://newnet.lanl.gov/water/level.asp and http://newnet.lanl.gov/water/gage.asp. Precipitation data were obtained from the LANL Weather Machine, http://weather.lanl.gov, from tower Technical Area 54. The total inorganic uranium results were calculated from the reported isotopic uranium results (see Section C-5.0).

C-2.0 SUMMARY OF SAMPLES COLLECTED

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

C-3.0 SAMPLE COLLECTION METHODS

Historical 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 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 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 the analytical laboratories that provide Level IV data packages are validated. Level IV data packages are defined as those containing chain-of-custody forms, quality assurance (QA) and QC documentation, the analytical laboratory form 1 (a summary of the analytical results), and the raw analytical data. Data validation packages are included in Attachment C-1 on DVDs.

Data validation for data from the SMDB is also performed by the same outside contractor. Data validation procedures were implemented in accordance with the requirements of the Laboratory "Quality Assurance Project Plan Requirements for Sampling and Analysis" (LANL 1996, 054609) and the Laboratory's analytical services statements of work (SOWs) for contract laboratories (LANL 1995, 049738; LANL 2000, 071233). All data obtained from the SMDB included in this report have accompanying Level IV data packages and have undergone routine validation according to SOPs specific to the analyte type (inorganic chemicals, organic chemicals, or radionuclides). The current SOPs, located at http://www.lanl.gov/environment/air/qa.shtml?1, 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 instances, the analysis was rerun and a valid result was obtained and is 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. Data qualifier definitions are listed in Appendix A.

C-5.0 INORGANIC CHEMICAL ANALYSIS METHODS

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

Laboratory control samples (LCSs), method blanks, matrix spike (MS) samples, and laboratory duplicate samples were analyzed to assess accuracy and precision of inorganic chemical analyses. Each of these QA/QC sample types is defined in the analytical services SOWs (LANL 1995, 049738; LANL 2000, 071233) 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 presented in Appendix A.

Inorganic Chemical Background Values

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

"Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (LANL 1998, 059730) was developed after axial view ICPES was widely used. However, 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 inorganic chemical 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 and soil screening levels. 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 calibration verification (ICV) and continuing calibration verification (CCV), 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).

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

C-8.0 OTHER ANALYSIS METHODS

Other analyses conducted on Cañada del Buey sediment and water samples are dissolved organic carbon, total organic carbon, pH, specific conductance, specific gravity, total dissolved solids, and total suspended solids. These analyses were conducted by the methods listed in Table C-8.0-1.

C-9.0 DATA QUALITY

Data quality issues, including rejected analytical results, are summarized by media. Because of the large number of records 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

A total of 31,725 results from sediment samples in Cañada del Buey reaches were reported. Of these results, 238 results were rejected during data validation. These rejected results represent <1% of all the sediment results and does not affect the ability to assess the contaminants within Cañada del Buey.

Thirty inorganic chemical results were rejected (R) for antimony, nitrate, and selenium because either the sample spike recovery was <30%, the LCS was not analyzed with the sample, or the sample was analyzed after a period equal to or greater than the hold time. A total of 46 radionuclide results for samples analyzed by gamma spectroscopy were rejected (R) for cesium-134, cesium-137, cobalt-60, europium-152, and sodium-22 because either spectral interference prevented positive identification of the analytes or the minimum detectable concentration documentation was missing. A total of 162 organic chemical results were rejected (R) for seven semivolatile organic compounds (SVOCs) and multiple volatile organic compounds (VOCs) in reach CDB-2C, multiple VOCs in reach CDB-2W, and all results for trichloro-1,2,2-trifluoroethane[1,1,2-] in reach CDBS-1W.

Although results were rejected for selenium, it was detected above the BV in other samples and was retained as a COPC. All of the antimony results for samples collected in reach CDB-3E were rejected, but the rest of the antimony data was usable and antimony was retained as a COPC. Nitrate was analyzed in samples from one reach and only two of the eight results were rejected. Cesium-134, cesium-137, cobalt-60, europium-152, and sodium-22 were rejected in multiple samples, but valid data were reported for these radionuclides in all of the reaches where results were rejected. Chloroform, ethylbenzene, 4-isopropyltoluene, methylene chloride, styrene, tetrachloroethene, and toluene all had a few detects and a few rejected results, but the majority of the results were nondetects. Trichloro-1,2,2-trifluoroethane[1,1,2-] results were nondetects in all samples, except for the rejected results in three reaches. All benzidine results were rejected in reach CDB-2C (7 samples) and all were nondetects in the 10 samples in reach CDB-4. Benzidine was not analyzed in any other reach. Therefore, the rejected sediment data do not affect the conclusions of the report.

A total of 909 inorganic chemical results were qualified as estimated (J, J-, or J+), or estimated, not detected (UJ).

All inorganic chemical results detected between the method detection limit (MDL) and the estimated detection limit (EDL) are qualified as estimated (J).

All inorganic chemical results that were qualified as J, J-, J+, or UJ were because of one of the following.

- The duplicate sample was analyzed on a non-Laboratory sample.
- Either the sample or duplicate sample results or both were ≥5 times the reporting limit (RL), and the difference between the samples is >2 times the RL for soil samples.
- The LCS %R was less than the lower acceptance limit (LAL) but >10%.
- The LCS %R was greater than the upper acceptance limit (UAL).
- A serial dilution sample was not analyzed with the samples.

- 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 UAL but <150% of the associated spike sample.
- The analyte was recovered below the LAL but >30% in the associated spike sample.
- The analyte was identified in the method blank but was >5 times.
- The analyte was considered estimated because the results are >5 times the amount in the method blank.
- The associated MS recovery was less than the LAL but >10%.
- The associated MS recovery was greater than the UAL.
- The associated interference-check sample (ICS) was recovered above the UAL.

A total of 4879 organic chemical results were qualified as estimated—either detected (J, J+, or J-) or not detected (UJ).

VOCs: VOC results were qualified as J, J+, or UJ because of one of the following.

- The quantitating IS area count is <10% of the expected value.
- The IS area count for the quantitating IS is <50% but >10% for organics window relation to the previous continuing calibration.
- The surrogate %R value is greater than the UAL, which indicates a potential for a high bias in the results and a potential for false positive results.
- The affected analytes were analyzed with an initial calibration curve that exceeded the percent relative standard deviation (%RSD) criteria and/or the associated multipoint calibration correlation coefficient is <0.995.
- The ICV and/or CCV were recovered outside the method-specific limits.

SVOCs: SVOC results were qualified as J or UJ because of one of the following.

- The associated IS area counts are < 50% but >10%R when compared with the area counts in the applicable continuing calibration standard.
- At least two sample surrogate recoveries in the same fraction were less than the LAL but >10%.
- The affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria and/or the associated multipoint calibration correlation coefficient is <0.995.
- The ICV and/or CCV were recovered outside the method-specific limits.
- The ICV and/or CCV were not analyzed at the appropriate method frequency.
- The extraction holding time was exceeded by <2 times the published method for holding time.

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

- The LCS %R was less than the LAL but >10%.
- The associated %RSD or percent difference exceeded criteria in the initial or continuing calibration standards.

- The ICV and/or CCV were recovered outside the method-specific limits.
- The result was reported as estimated by the laboratory.

Polycyclic Aromatic Hydrocarbons (PAHs): PAH results were qualified as J, J-, or UJ because either at least two sample surrogate recoveries in the same fraction were less than the LAL but >10%R or the result was reported as estimated by the laboratory.

Explosive Compounds: Explosive compound results were qualified as UJ because of one of the following issues.

- The associated LCS recovery was less than the LAL but >10%R.
- The ICV and/or CCV were recovered outside the method-specific limits.

Thirty-six radionuclide results were qualified as J+ because the tracer %R is greater than the UAL.

C-9.2 Water Data

A total of 9070 results from water samples collected in Cañada del Buey were reported. The results from these samples are provided on the DVD in Attachment C-2. Of the 9070 results reported, 72 results were rejected during data validation. These rejected results represent <1% of the water-sample results discussed here and does not affect the ability to assess the contaminants within Cañada del Buey.

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 nine 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.
- There was a nonspecified QC failure.

A total of 57 organic chemical results were rejected (R).

VOCs: VOC results were rejected (R) because the affected analytes were analyzed with a relative response factor (RRF) of <0.05 in the ICV and/or CCV, there was a nonspecified QC failure, or the sample was improperly preserved.

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 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.
- There was a nonspecified QC failure.

PCBs: PCB results were rejected (R) because either the holding time was >1 and ≤2 times the applicable holding time requirement or there was a nonspecified QC failure.

Explosive Compounds: Explosive compound results were rejected (R) because there was a nonspecified QC failure.

Dioxin/Furans: Dioxin/furan results were rejected (R) because the ICV and/or CCV were recovered outside the method-specific limits.

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

- The affected analytes are qualified as rejected because the relative error ratio was >4.
- There was a nonspecified QC failure.

A total of 362 inorganic chemical results were qualified as J, J-, J+, or UJ because of one of the following reasons.

- The sample and the duplicate sample results were ≤5 times the reporting limit (RL) and the duplicate RPD was >20%.
- 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.
- RPD is greater than 10% in the serial dilution sample.
- The spike %R value is greater than or equal to the UAL (125%) but less than or equal to 150%; the result is a detect, which indicates a potential high bias in the sample results.
- The spike %R value is greater than 30% and less than the LAL (75%), and the sample result is a nondetect, which indicates a potential for false negatives being reported.
- The affected analytes are considered estimated and biased high because this analyte was identified in the method blank but was >5 times.
- The associated MS recovery was below the LAL but >10%. Follow the external laboratory limits located within the associated data package.
- The holding time was >1 and ≤2 times the applicable holding time requirement.
- Negative blank samples results were greater than the MDL
- An applicable MS/matrix spike duplicate (MSD) analysis was not performed.
- The MS/MSD %R was >125%.
- The ICS was not within ±20% of the known value.
- There was a failed serial dilution RPD.
- The duplicate sample RPD is greater than the advisory limit and the sample result is a detect.
- The sample and the duplicate sample results were ≤5 times the RL and the duplicate RPD was >20%.
- The MS analysis was not performed on a sample associated with this request number.
- The spike %R value is greater than 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 less than 30% and the sample result is a detect, which indicates a potential low bias.
- The associated MS recovery was below the LAL but >10%.
- Negative blank samples results were greater than the MDL.
- Sample should not have been acidified but was. Error could not be corrected at the laboratory.
- There was a nonspecified QC failure.
- RL verification recovery was greater than the acceptance criteria.
- The result was less than the practical quantitation limit (PQL), but greater than the MDL.

A total of 446 organic chemical results were qualified as J, J-, J+, or UJ.

VOCs: VOC results were qualified as J or UJ because of at least one of the following.

- The result was less than the PQL but greater than the MDL.
- The affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria and/or the associated multipoint calibration correlation coefficient is <0.995.
- The affected analytes were analyzed with an RRF of less than 0.05 in the ICV and/or CCV.
- The ICV and or CCV were recovered outside the method-specific criteria.

SVOCs: SVOC results were qualified as J, J-, or UJ because of at least one of the following.

- The LCS recovery was greater than the acceptance criteria.
- 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 result is a nondetect, and two or more surrogates are greater than or equal to 10%R but less than the LAL, which indicates increased potential for false negative results.
- The sample result is greater than the estimated quantitation limit (EQL) and less than or equal to 5 times (10 times for common phthalates) the concentration of the related analyte in the blank, which indicates the reported detection is considered indistinguishable from contamination in the blank.
- The affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria and/or the associated multipoint calibration correlation coefficient is <0.995.
- The ICV and CCV were recovered outside the method-specific limits.
- The holding time was >1 and ≤2 times the applicable holding time requirement.
- Calibration %RSD was greater than the acceptance criteria but less than 60%
- The affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria and/or the associated multipoint calibration correlation coefficient is <0.995.
- There was a nonspecified QC failure.

Pesticides and PCBs: Pesticide and PCB results were qualified as UJ because of at least one of the following.

- The MS and/or the MSD analysis were not performed on a sample associated with a Laboratory request number.
- The result is less than the EQL and the surrogate %R value is greater than 10% but less than the LAL, which indicates a potential for false negative results being reported.
- No MS/MSD data were included in the data package.
- The spike %R value is greater than 10% and less than the LAL, which indicates a potential low bias in the results.
- The holding time was >1 and ≤2 times the applicable holding time requirement.
- There was a nonspecified QC failure.

Explosive Compounds: Explosive compound results were qualified as J or UJ because of at least one of the following.

- The MS and/or the MSD analyses were not performed on a sample associated with a LANL request number.
- The of the LCS analyte %R is less than the LAL and greater than or equal to 10%R, which indicates (1) the RL is approximate and probably biased low for nondetected results and (2) detected results likely are biased low.
- The holding time was exceeded.
- The sample was improperly preserved.
- The initial calibration slope or response factor criteria were not met.

Dioxins and Furans: Dioxin and furan results were qualified as UJ because either the RPD of the MS/MSD is greater than the acceptance criteria or there was a nonspecified QC failure.

A total of 104 radionuclide results were qualified as J, J-, J+, or UJ because of at least one of the following.

- Recovery of analyte in the LCS is less than the lower limit and the analyte is greater than the minimum detectable activity in the sample.
- The results for the affected analytes should be regarded as not detected (U) because the associated sample concentration was less than 3 times the 1 sigma TPU.
- The tracer %R value is 10%–30% inclusive and the sample result is greater than the minimum detectable activity.
- The tracer is less than the LAL but ≥10%R.
- The sample result is ≤5 times the concentration of the related analyte in the method blank.
- Analyte is not detected because the amount reported is less than the minimum detectable concentration.
- Recovery of the analyte in the LCS is greater than the upper limit and the analyte result is greater than the minimum detectable activity.
- The duplicate and sample results have a duplicate error ratio that is greater than 2.0.

- Planchets were flamed.
- Result values are less than 3 times the minimum detectable concentration.
- There was a nonspecified QC failure.

A total of 23 other results were qualified as J, J+, or J- because of at least one of the following.

- The affected analytes are considered estimated and biased high because the results are greater than 5 times the amount in the method blank.
- The holding time was >1 and ≤2 times the applicable holding time requirement.
- The affected analytes should be regarded as estimated because the extraction holding time was exceeded by 2 times the acceptable holding time.

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.

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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)
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, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn)
	SW-846:6020 (, Be, Ni, Se, Ag, Tl, U)
	SW-846:7471 (Hg)
	SW-846:7471A (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)
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 sulfate,)
	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)

Table C-6.0-1
Analytical Methods for Organic Chemicals

Analytical Suite	Analytical Method
Dioxins and Furans	SW-846:8290
	SW-846:8280
Explosive Compounds	SW-846:8321A_MOD
	SW-846:8330
PAHs	SW-846:8310
PCBs	SW-846:8082
Pesticides	SW-846:8081A
SVOCs	SW-846:8270
	SW-846:8270C
VOCs	SW-846:8260B

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
	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
	SW-846:9045C
Total Dissolved Solids	EPA:160.1
Total Suspended Solids	EPA:160.2
Dissolved Organic Carbon	EPA:415.1
Total Organic Carbon	SW-846:9060
	EPA:415.1

Attachments C-1 to C-3

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

Appendix D

Contaminant Trends

D-1.0 SEDIMENT

This section presents information on contaminants in sediments in Cañada del Buey 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 Cañada del Buey plotted versus distance from the Rio Grande. Figure D-1.1-1 shows inorganic COPCs, Figure D-1.1-2 shows organic COPCs, and Figure D-1.1-3 shows radionuclide COPCs. These plots help to identify sources for the COPCs and show how concentrations change with distance from sources. Different colors on these plots are used for the main canyon of Cañada del Buey and the south fork of Cañada del Buey. 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 data packages and that are validated are included in these plots.

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

D-1.2 Average Concentrations of Select Sediment COPCs

Tables D-1.2-1 through D-1.2-3 present average concentrations of sediment COPCs in Cañada del Buey 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 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-1.3 Statistical Analyses of Select Sediment COPCs

Statistical comparisons of concentrations of select inorganic COPCs in sediment samples from the Cañada del Buey reaches with concentrations in background samples were performed using a set of three nonparametric two-sample hypothesis tests: the Wilcoxon Rank Sum test (with Gehan ranking), the quantile test ,and the slippage test. The tests are designed to determine whether reach data are systematically greater than background data and are described in more detail below. Nonparametric or distribution-free tests do not require specific mathematical forms for the underlying distribution of concentrations. They are designed to handle the presence of outliers or nondetects that are often present in environmental data. The result of performing each statistical test on two data sets (one that represents background and one that represents a reach) is a test statistic and an associated significance level (also known as a p-value). The significance level is the probability that the test statistic would be as large or larger than the one produced if the two data sets were from the same distribution (i.e., if both were from the background distribution). When the significance level is small, this indicates that it is not likely that the two data sets came from the same distribution. The chosen significance level for the tests is 0.05 (i.e., such a large test statistic would occur by chance less than one out of 20 times when the sampled populations are the same). The comparison procedure indicates that concentrations in a reach are greater than background concentrations if any one of the three significance levels is less than 0.05.

Wilcoxon Rank Sum test (or Wilcoxon Mann–Whitney test). The Wilcoxon Rank Sum test evaluates whether measurements from one population consistently tend to be larger (or smaller) than those from another population based upon the assumption that the dispersion of the two distributions are roughly the same. This test determines which distribution is higher by comparing the relative ranks of the two data sets when the data from both sources are sorted into a single list. The assumption is that any difference between the background and reach concentration distributions is caused by a shift in the mean or median of reach concentrations to higher values (potentially because of the presence of contamination). This test is the nonparametric equivalent to the t-test (Gilbert 1987, 056179; Gilbert and Simpson 1990, 055612). The Wilcoxon Rank Sum test has similar or more power than the t-test for most distributions.

Gehan test. When some of the data are "censored" or reported as below a detection limit, the Gehan modification to the Wilcoxon Rank Sum test is used. The Gehan test uses a ranking procedure of sample results to accommodate nondetected results, together with the detected values, and then applies the Wilcoxon Rank Sum test. It handles data sets with nondetects reported at multiple detection limits in a statistically robust manner (Gehan 1965, 055611; Millard and Deverel 1988, 054953). The Gehan test can be used when nondetects are relatively frequent but requires not more than 50% nondetects in either the reach data or in the background data. If there are no nondetects in the data sets, the Gehan test is equivalent to the Wilcoxon Rank Sum test.

Quantile test. The quantile test determines whether more of the observations in the top 20% of the combined data set come from the reach data set than would be expected by chance, given the relative sizes of the reach and background data sets. If the relative proportion of the two populations being tested is different in the top 20% of the data than in the remainder of the data, the distributions may be partially shifted because of a subset of reach data being elevated.

Slippage test. This test is based on the maximum observed concentration in the background data set and the number ("n") of reach concentrations that exceed the maximum concentration in the background set (Gilbert 1987, 056179, pp. 5-8). The result (p-value) of the slippage test is the probability that n site samples (or more) exceed the maximum background concentration by chance alone. The test accounts for the number of samples in each data set (number of samples from a reach and number of samples from background) and determines the probability of n (or more) exceedances if the two data sets came from identical distributions.

Table D-1.3-1 presents the results of the statistical comparisons of the concentrations of select inorganic COPCs in Cañada del Buey sediment samples with concentrations in local background samples (CDB-4 BKG samples). These comparisons were made for six inorganic chemicals where their spatial distribution and relation to particle size suggest they largely or entirely reflect background conditions, as discussed in Section 7.1.1 (aluminum, antimony, arsenic, cobalt, iron, and thallium) in reaches where they are COPCs. One additional inorganic COPC, perchlorate, has a spatial distribution that suggests background variability, but there are no background data for perchlorate for comparison.

For three COPCs (cobalt, iron, and thallium), none of these tests showed any statistical differences between the CDB-4 BKG data and reach data (Table D-1.3-1). Aluminum is statistically different than background in the one reach where it a COPC (CDB-3E), antimony is statistically different from background in four of the five reaches where it is a COPC (CDB-2C, CDB-3W, CDBS-1E, and CDBS-1W), and arsenic is statistically different from background in six of the seven reaches where it is a COPC (CDB-1, CDB-2C, CDB-2W, CDB-3W, CDBS-1E, and CDBS-1W).

Box plots comparing reach data and background data with these six inorganic COPCs are shown in Figures D-1.3-1 to D-1.3-6. The boxes indicate the 25th and 75th percentiles of the data, the horizontal line in the boxes indicate median values, and dashed lines outside the boxes extend to the maximum and minimum of the data. The full set of concentrations are plotted as points overlaying the boxes with detected concentrations indicated by “x” and the reported detection limit of nondetect results indicated by “o.”.These plots also indicate that reach data for cobalt, iron, and thallium are similar to background data, whereas data for aluminum, antimony, and arsenic are elevated in one or more reaches.

Statistical regressions between COPC concentration, and silt and clay content were evaluated for aluminum, antimony, and arsenic to identify outliers in the data set that might indicate releases from Laboratory sites. There is no significant relation between antimony concentration and silt and clay content (R^2 = 0.008), although the antimony data are affected by a high frequency of nondetects and elevated detection limits, as discussed in Section 7.1.1. Elevated detected results from reach CDB-2C suggest possible releases of antimony from TA-46 (Section 7.1.1). In contrast, both aluminum and arsenic show significant positive relations between COPC concentration and silt and clay content (R^2 = 0.47 and 0.34, respectively). At a significance level of 0.001, two samples for aluminum from reach CDB-3E are identified as outliers in a plot of concentration versus silt and clay content (Figure D-1.3-7), suggesting releases from TA-54. At this significance level, no results for arsenic are identified as outliers (Figure D-1.3-8), and instead the data indicate generally elevated levels of arsenic in Cañada del Buey and no recognizable Laboratory sources.

D-2.0 SHALLOW GROUNDWATER

This section provides statistical summaries of analytical data for analytes detected in shallow groundwater in Cañada del Buey (Tables D-2.0-1 to D-2.0-4). Trace metals are shown in Table D-2.0-1, radionuclides are shown in Table D-2.0-2, organic compounds are shown in Table D-2.0-3, and other analyses are shown in Table D-2.0-4. All tables are included as an attachment on CD.

D-3.0 REFERENCES

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

Copies of the master reference set are maintained at the 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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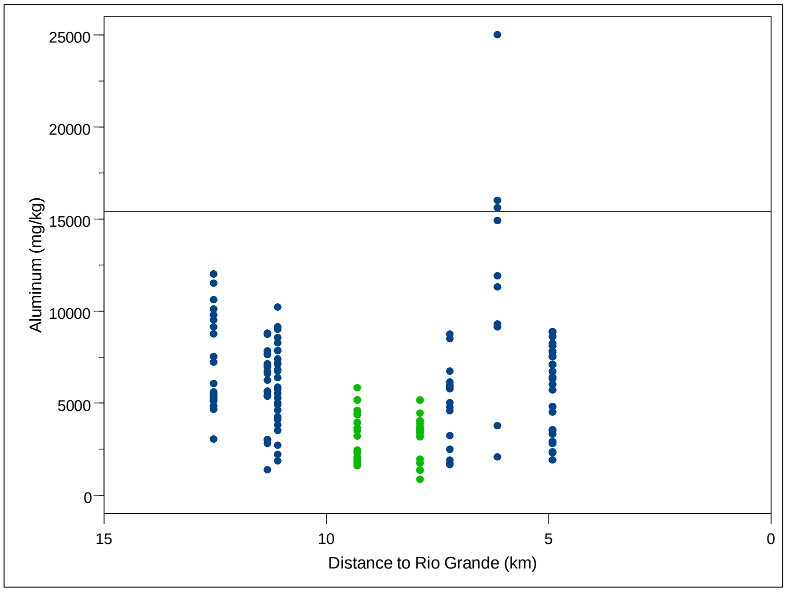
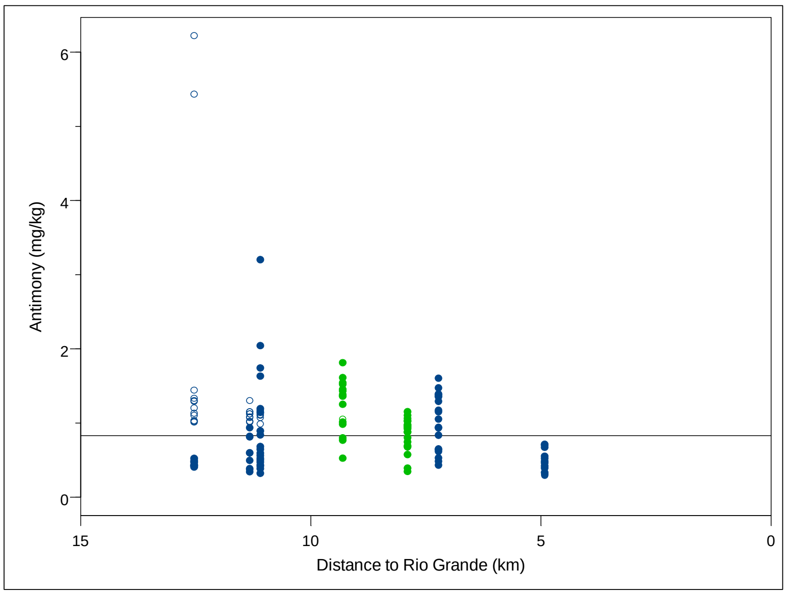


Aluminum



Antimony

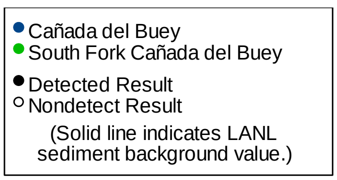
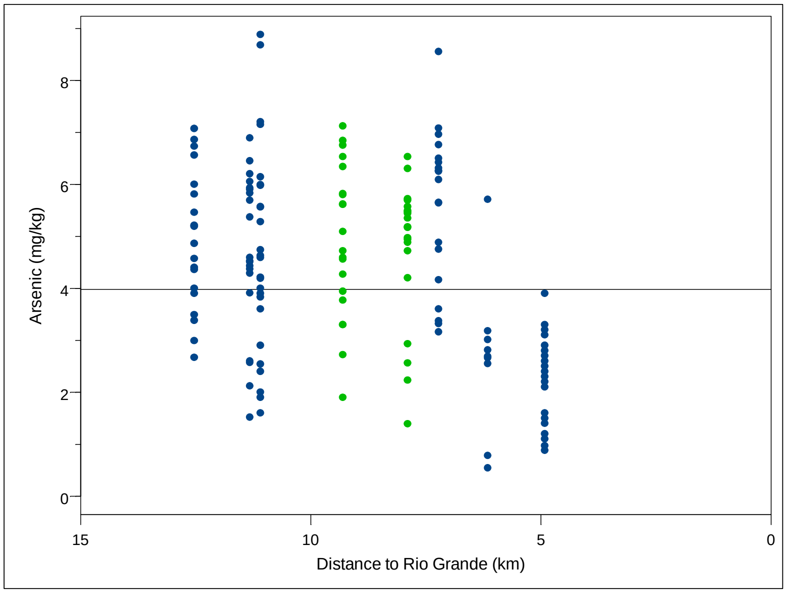
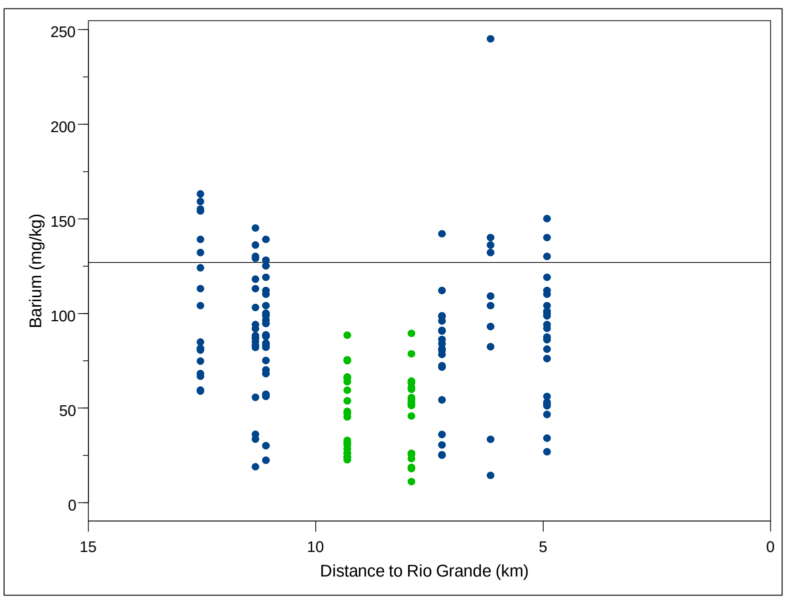


Figure D-1.1-1 Plots of sample results versus distance from the Rio Grande for all inorganic COPCs identified in sediment in the Cañada del Buey watershed



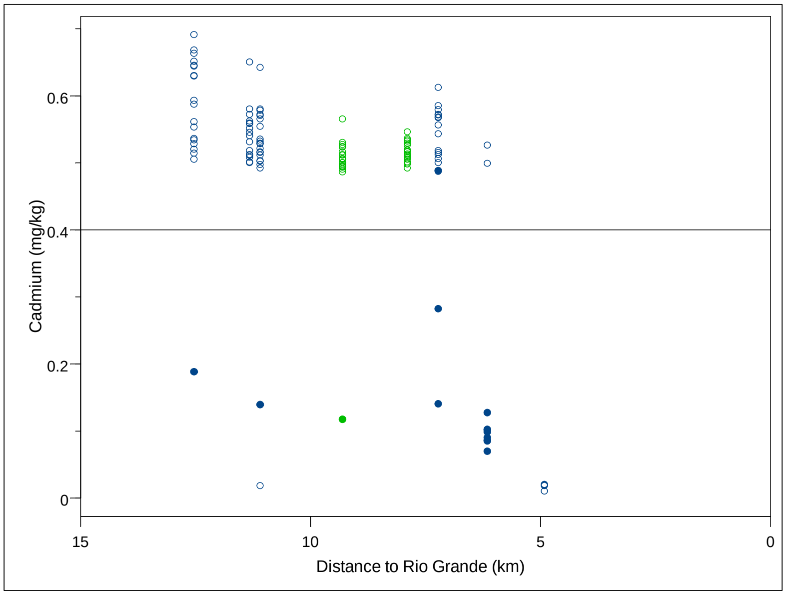
Arsenic



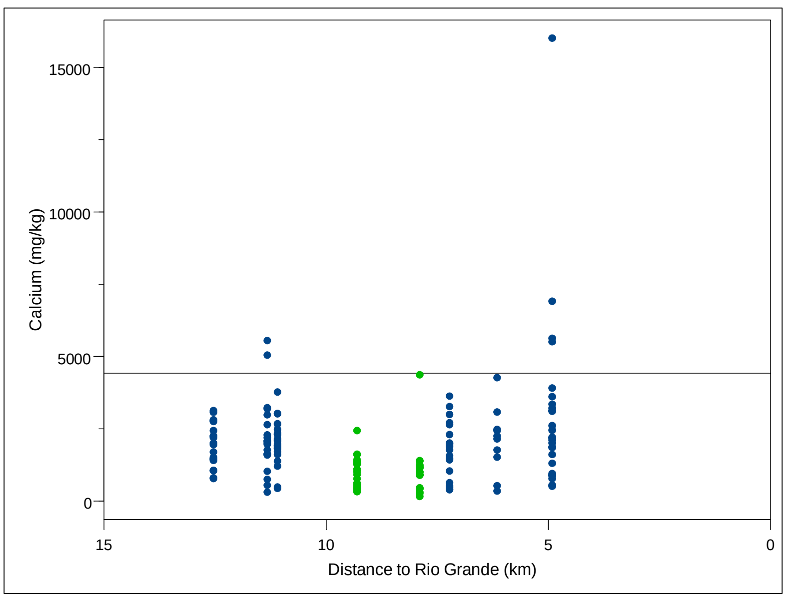
Barium

● Cañada del Buey
● South Fork Cañada del Buey
● Detected Result
○ Nondetect Result
(Solid line indicates LANL sediment background value.)

Figure D-1.1-1 (continued)



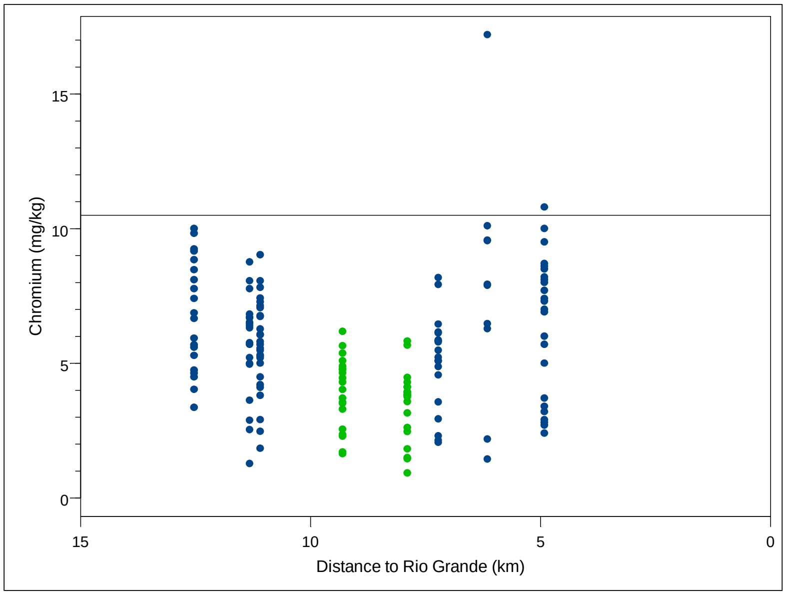
Cadmium



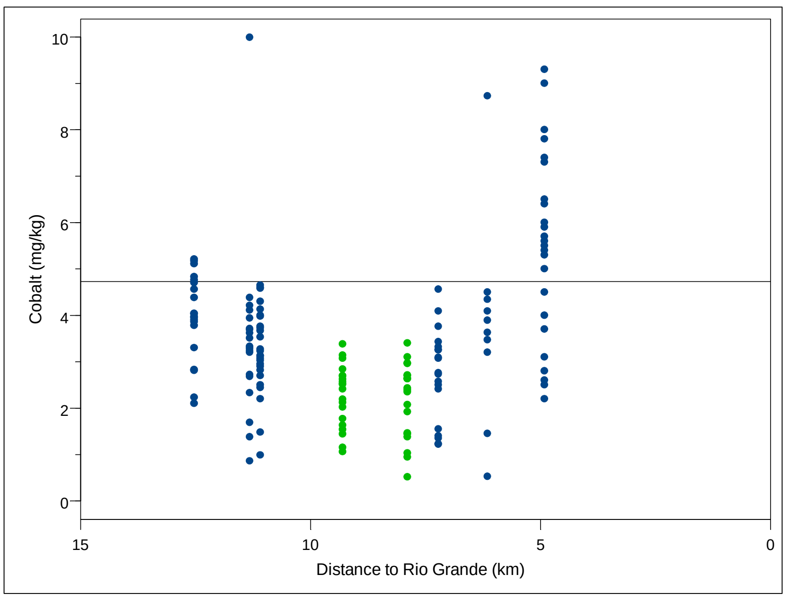
Calcium

Cañada del Buey
South Fork Cañada del Buey
Detected Result
Nondetect Result
(Solid line indicates LANL sediment background value.)

Figure D-1.1-1 (continued)



Chromium



Cobalt

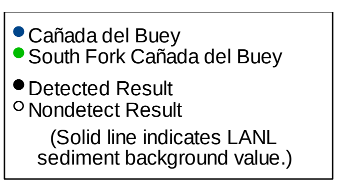
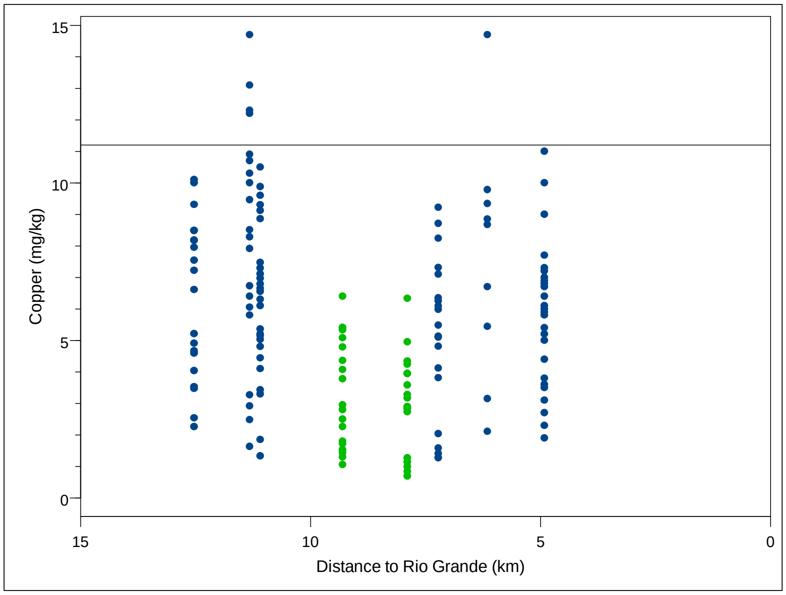
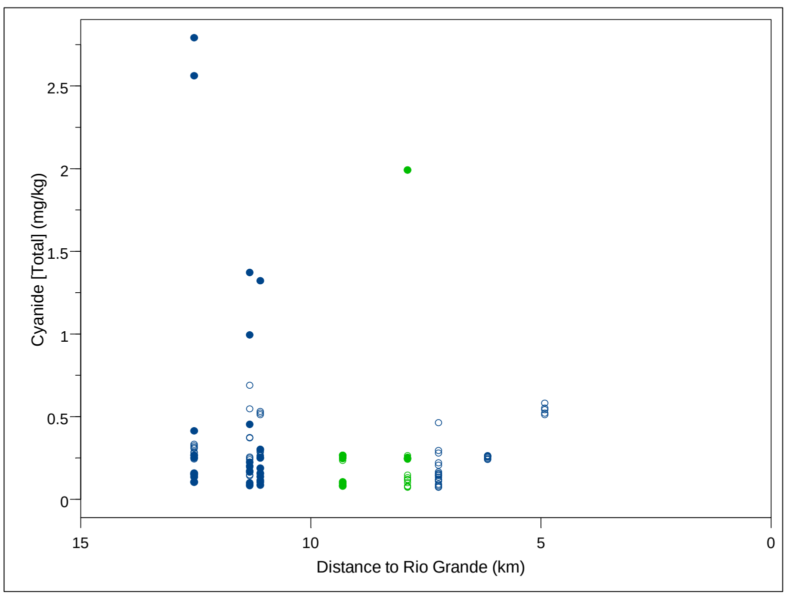


Figure D-1.1-1 (continued)



Copper



Cyanide [Total]

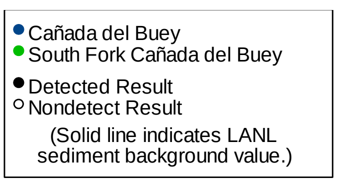
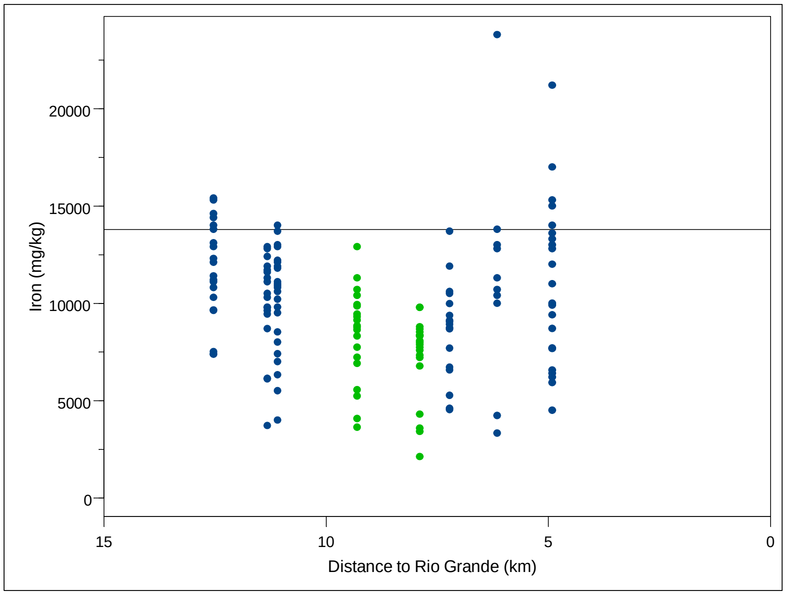
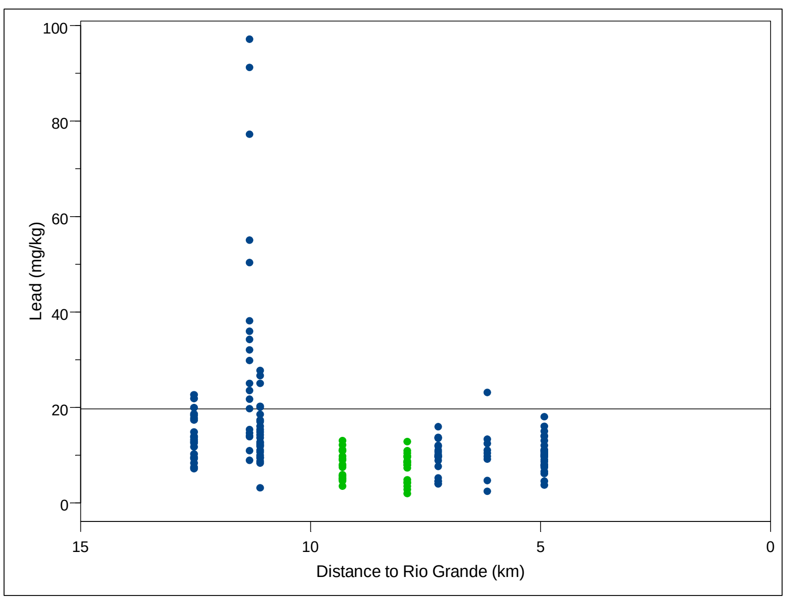


Figure D-1.1-1 (continued)



Iron



Lead

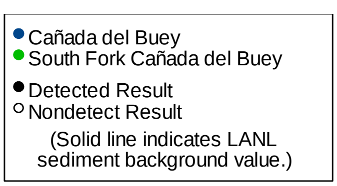
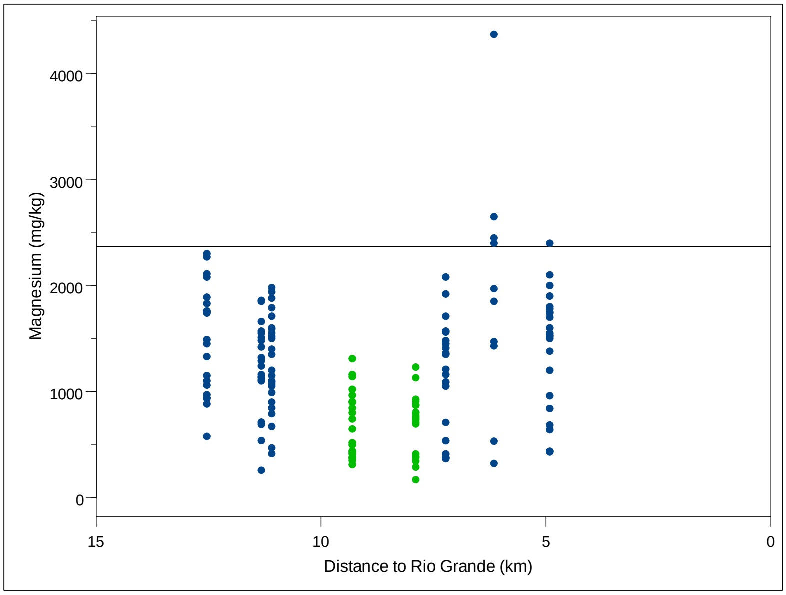
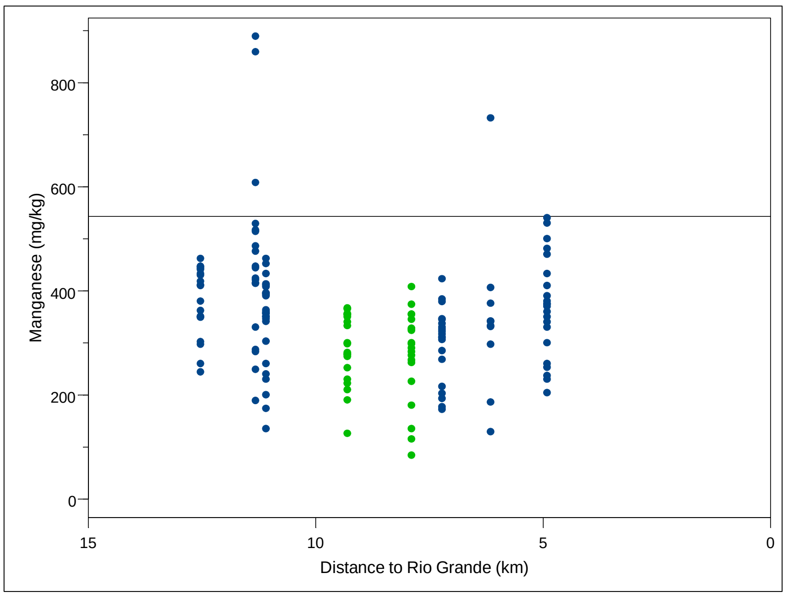


Figure D-1.1-1 (continued)



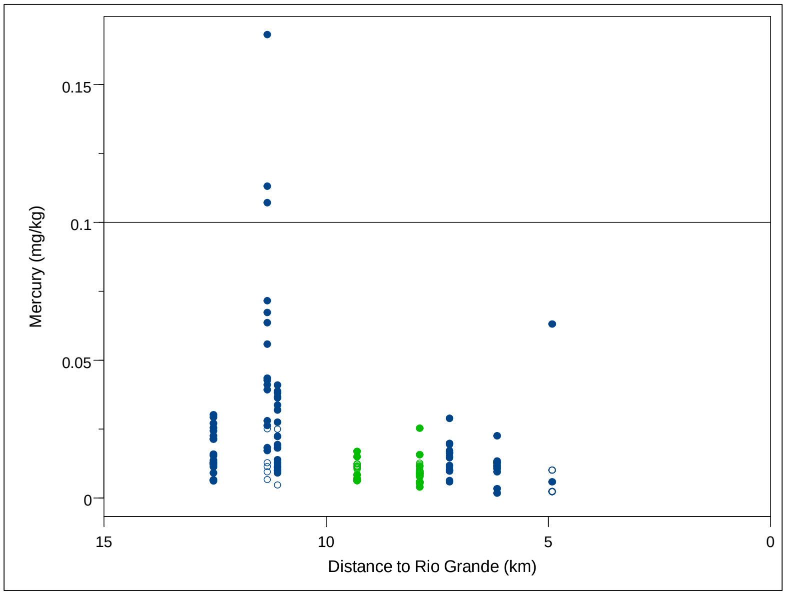
Magnesium



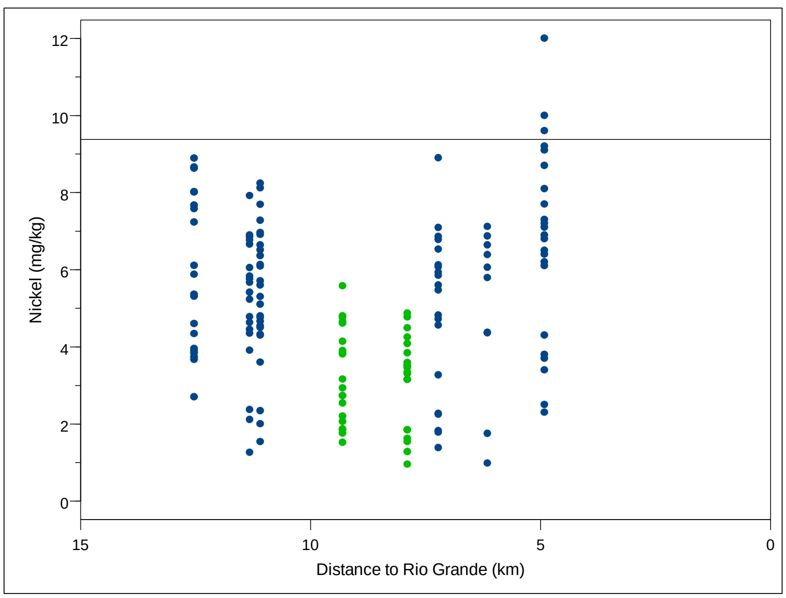
Manganese

● Cañada del Buey
● South Fork Cañada del Buey
● Detected Result
○ Nondetect Result
(Solid line indicates LANL sediment background value.)

Figure D-1.1-1 (continued)



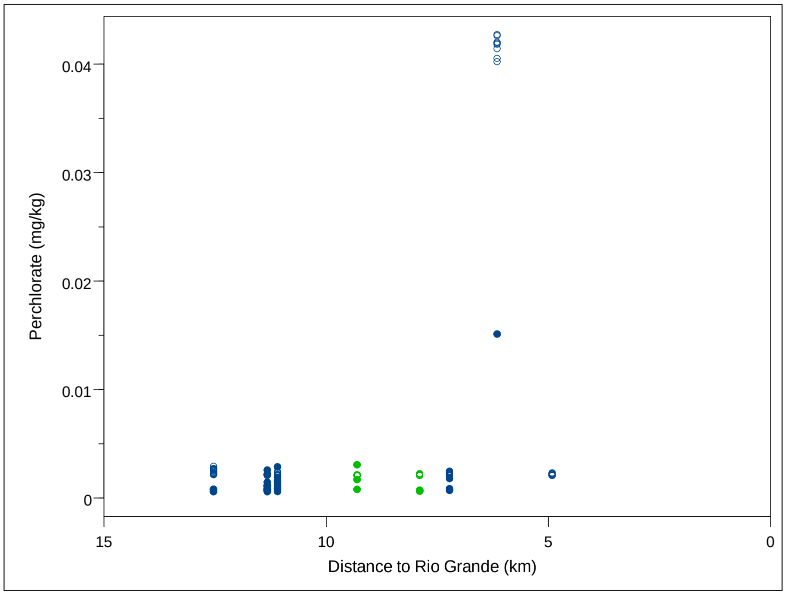
Mercury



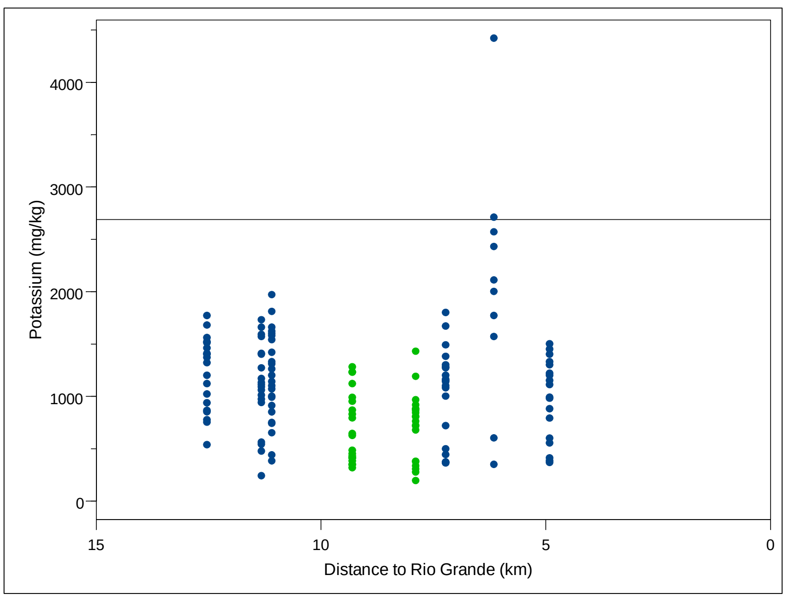
Nickel

● Cañada del Buey
● South Fork Cañada del Buey
● Detected Result
○ Nondetect Result
(Solid line indicates LANL sediment background value.)

Figure D-1.1-1 (continued)



Perchlorate

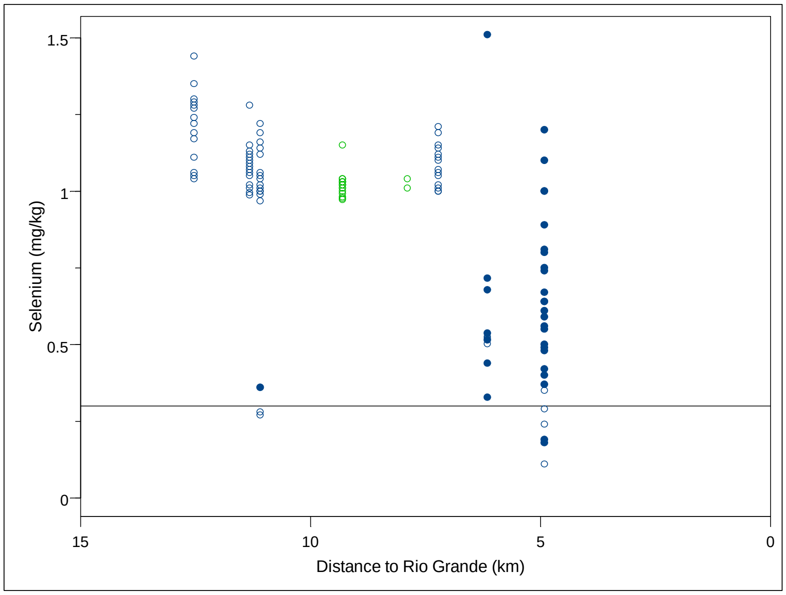


Potassium

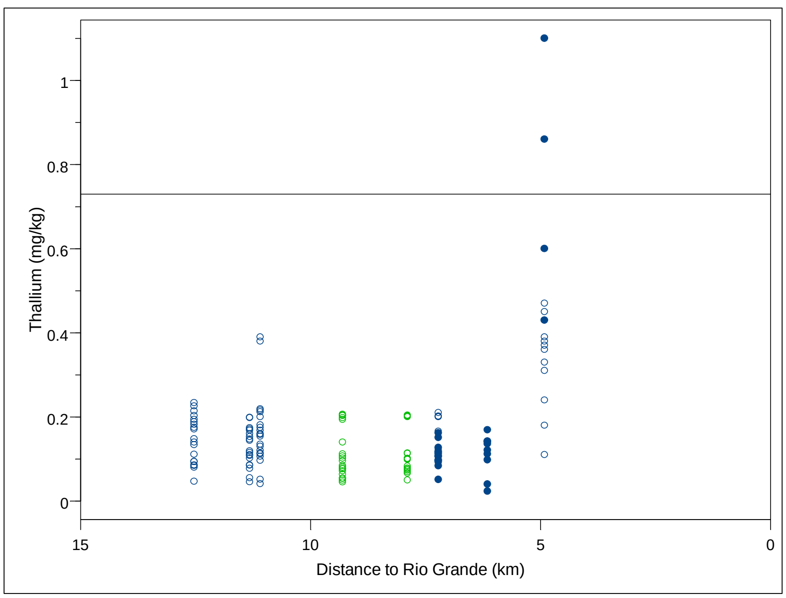
- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

(Solid line indicates LANL sediment background value.)

Figure D-1.1-1 (continued)



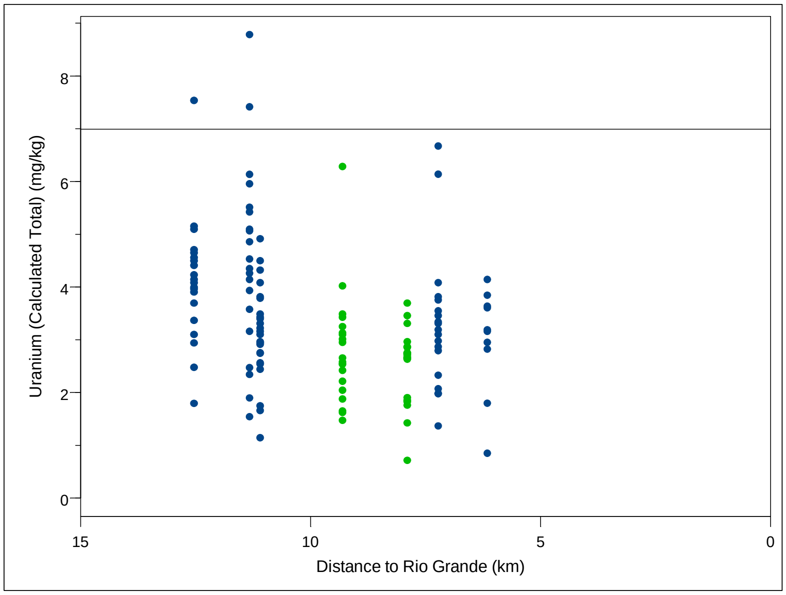
Selenium



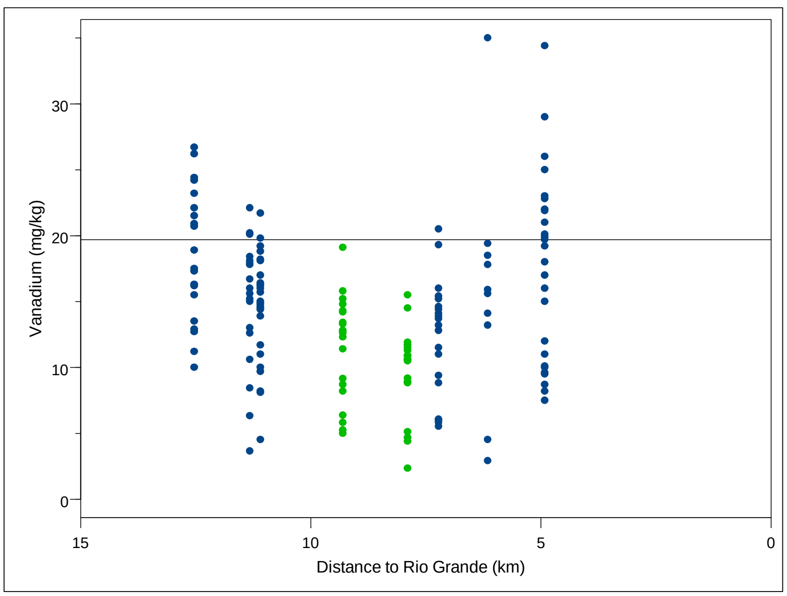
Thallium

● Cañada del Buey
● South Fork Cañada del Buey
● Detected Result
○ Nondetect Result
(Solid line indicates LANL sediment background value.)

Figure D-1.1-1 (continued)



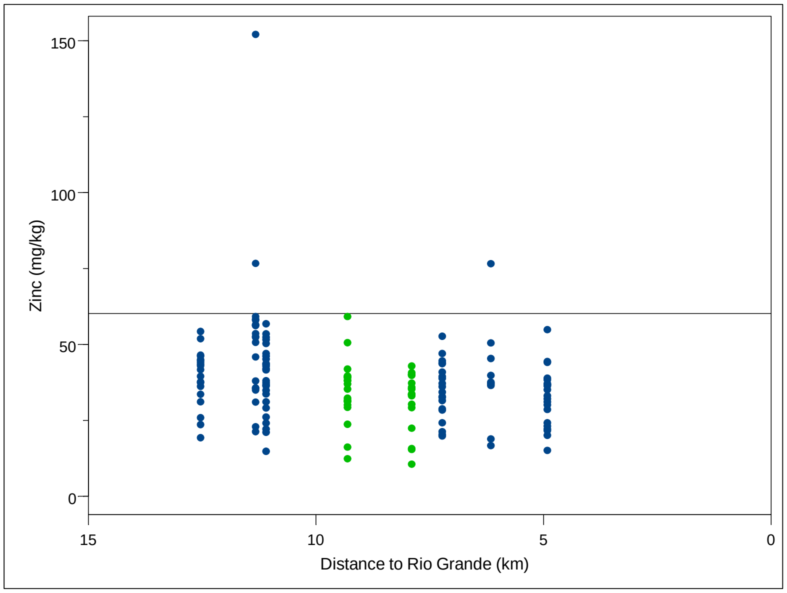
Uranium (Calculated Total)



Vanadium

Cañada del Buey
South Fork Cañada del Buey
Detected Result
Nondetect Result
(Solid line indicates LANL sediment background value.)

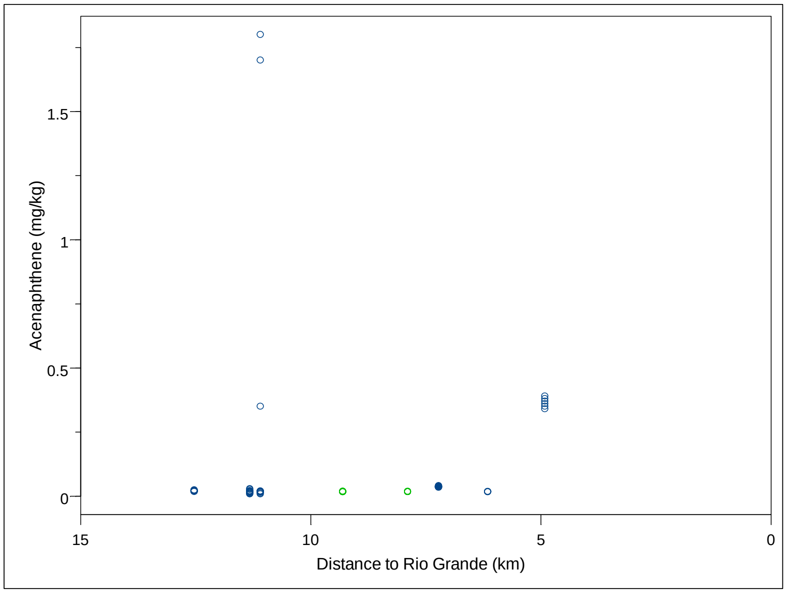
Figure D-1.1-1 (continued)



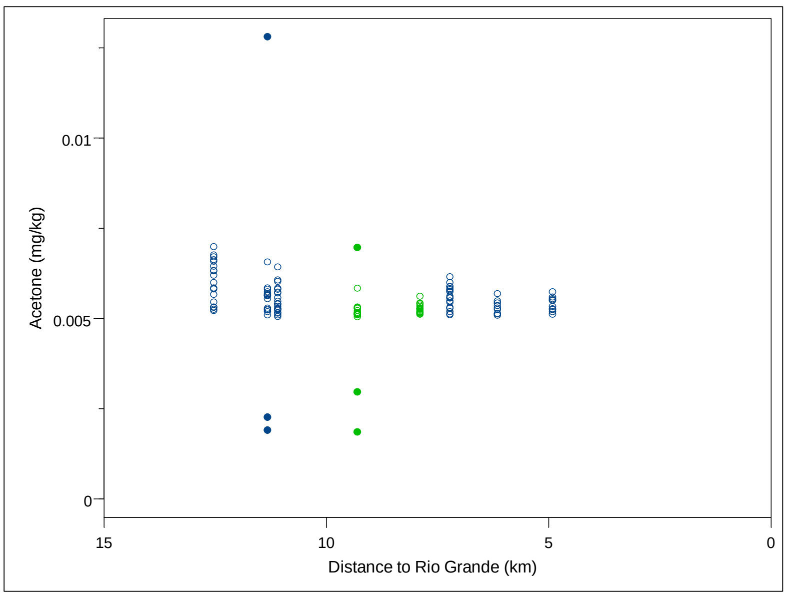
Zinc

Cañada del Buey
South Fork Cañada del Buey
Detected Result
Nondetect Result
(Solid line indicates LANL sediment background value.)

Figure D-1.1-1 (continued)



Acenaphthene



Acetone

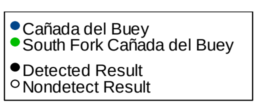
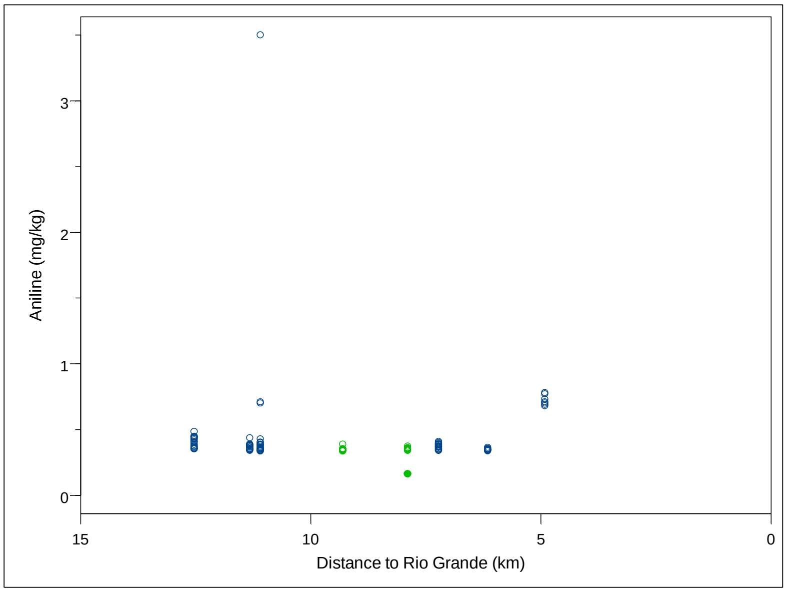
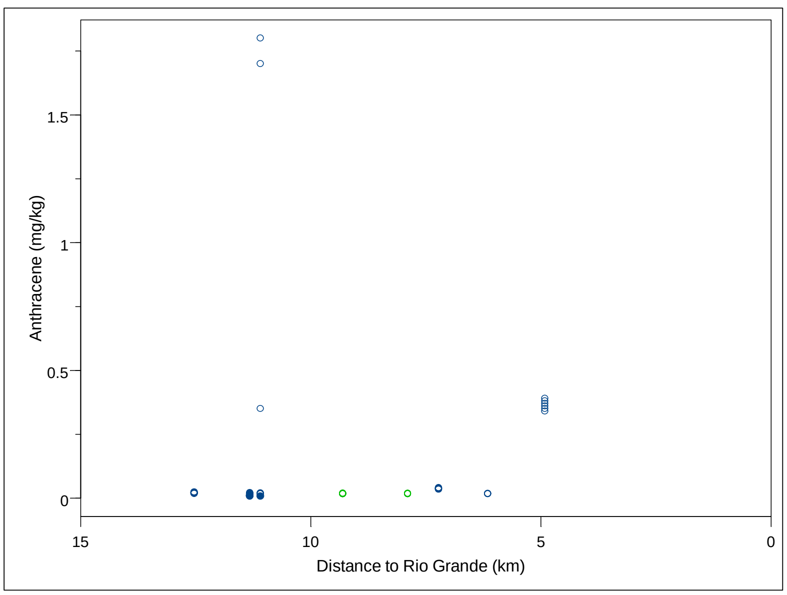


Figure D-1.1-2 Plots of sample results versus distance from the Rio Grande for all organic COPCs identified in sediment in the Cañada del Buey watershed



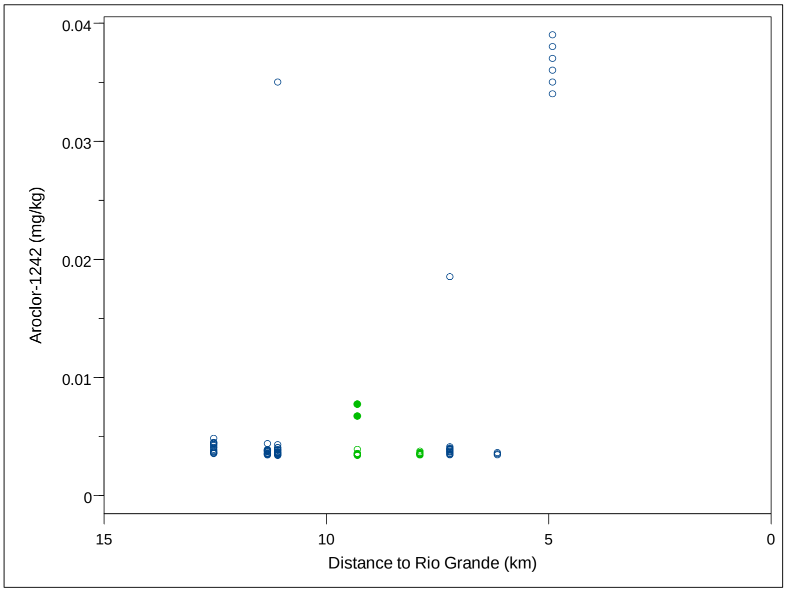
Aniline



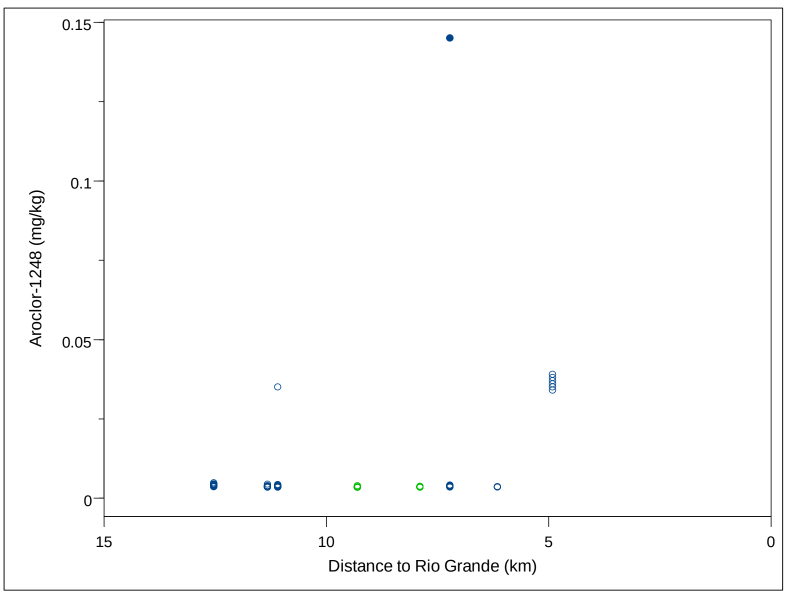
Anthracene

- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

Figure D-1.1-2 (continued)



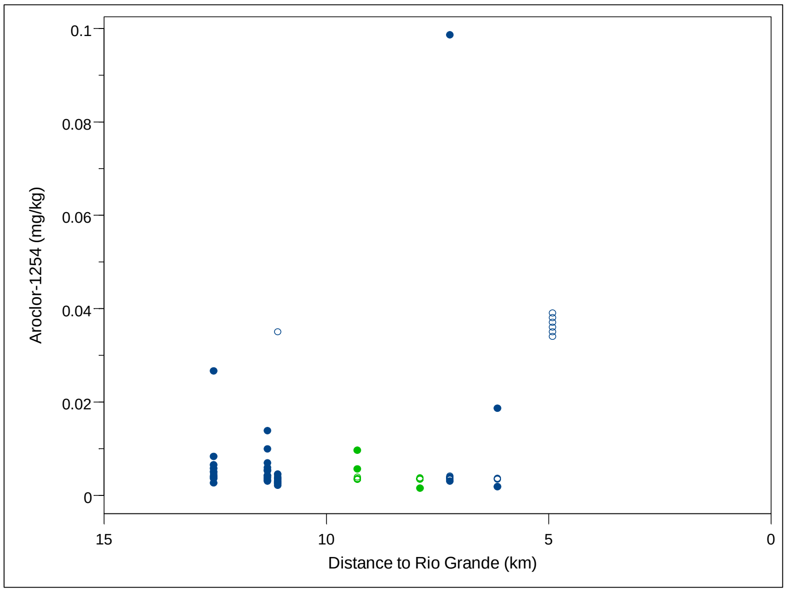
Aroclor-1242



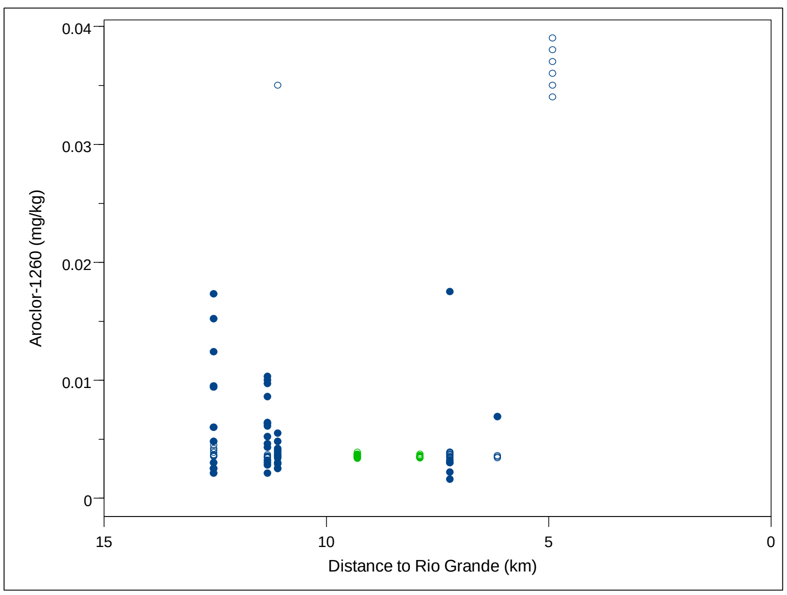
Aroclor-1248

- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

Figure D-1.1-2 (continued)



Aroclor-1254



Aroclor-1260

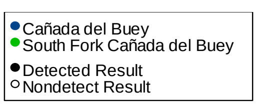
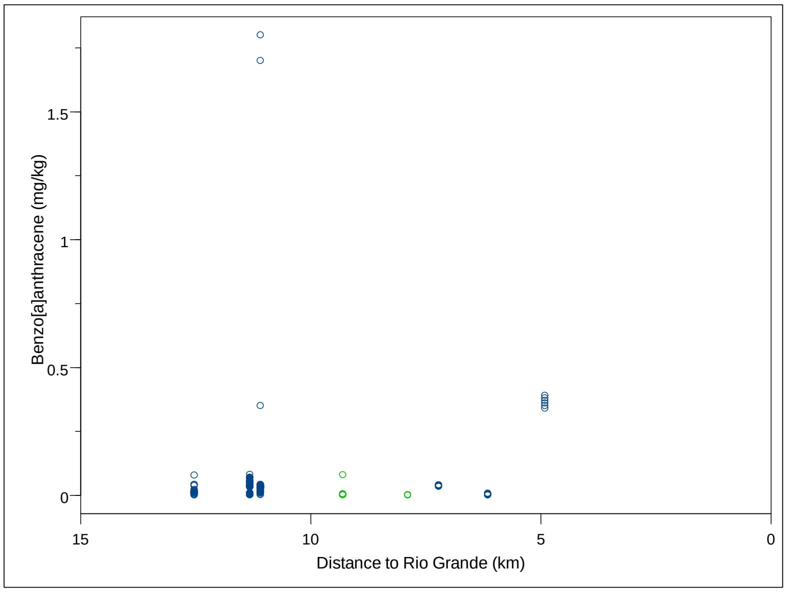
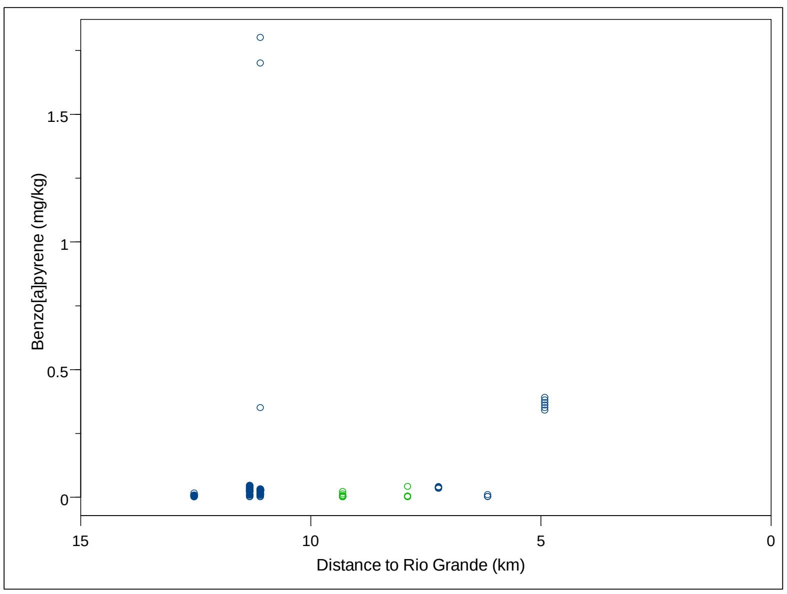


Figure D-1.1-2 (continued)



Benzo[a]anthracene



Benzo[a]pyrene

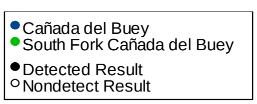
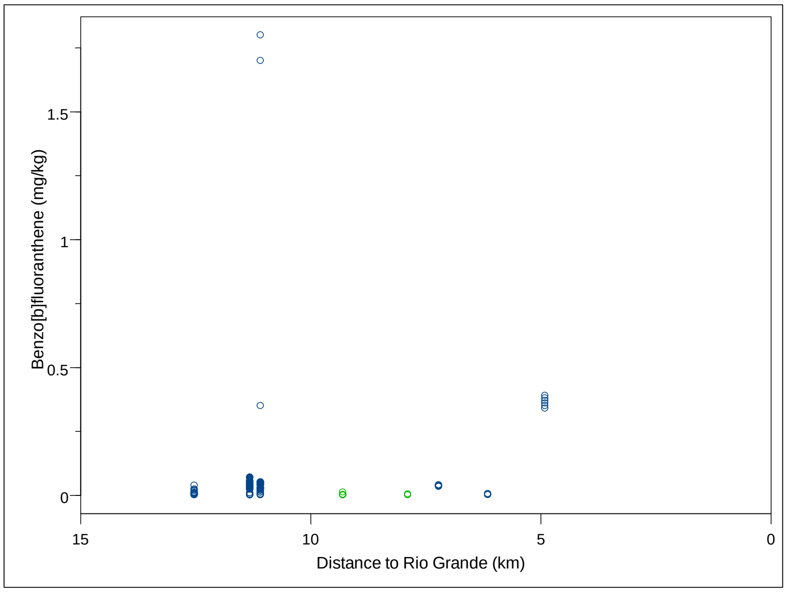
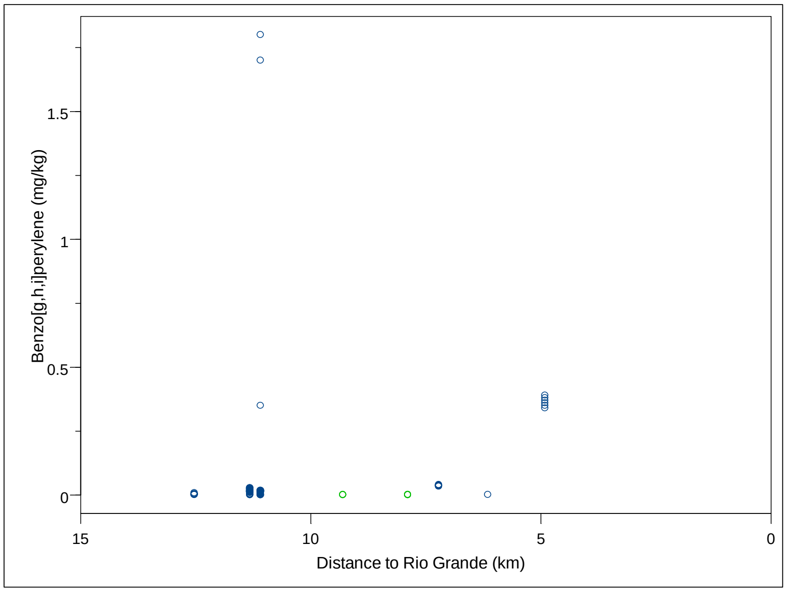


Figure D-1.1-2 (continued)



Benzo[b]fluoranthene



Benzo[g,h,i]perylene

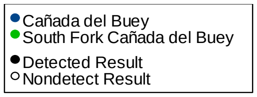
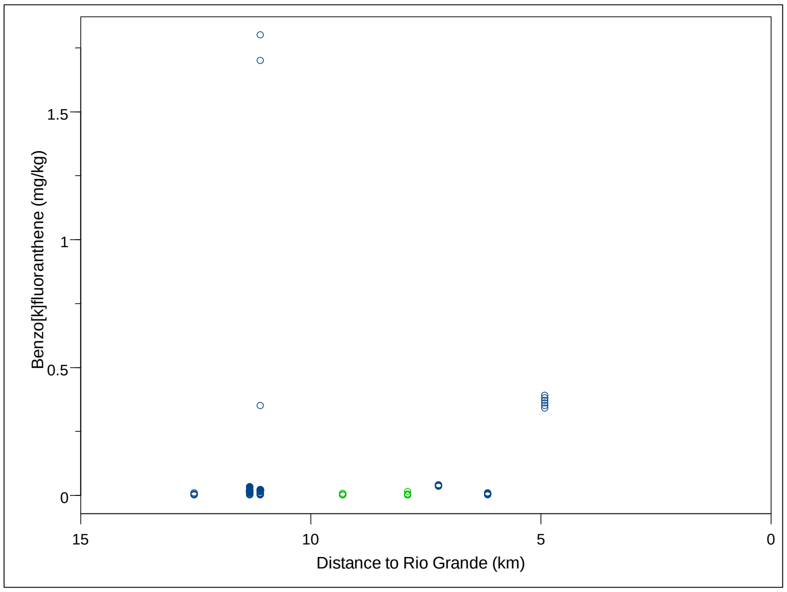
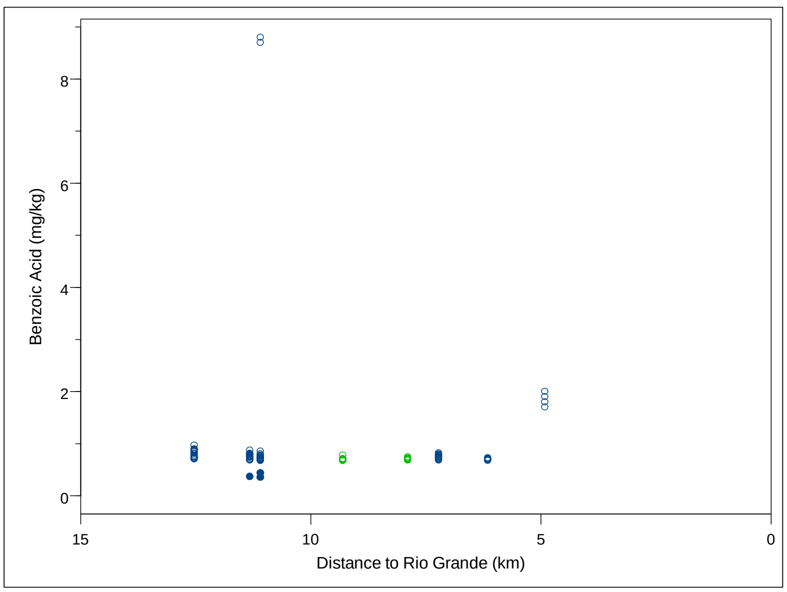


Figure D-1.1-2 (continued)



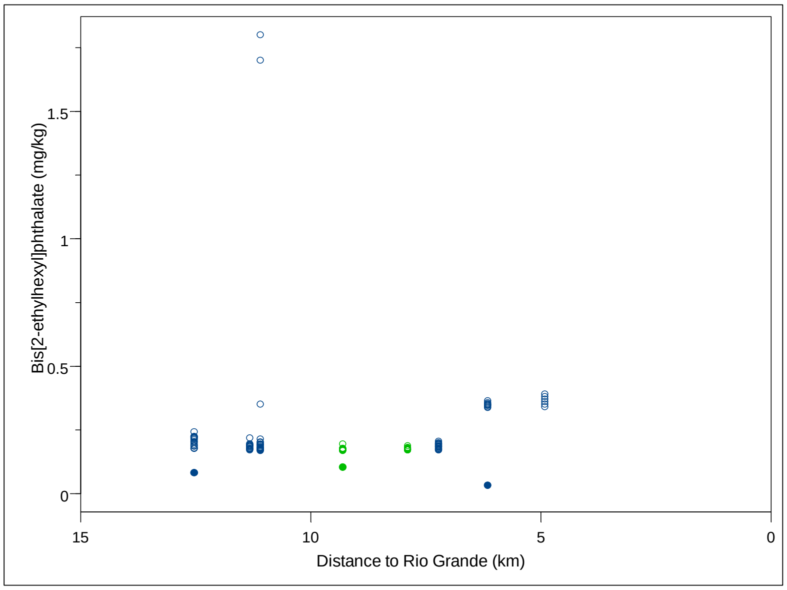
Benzo[k]fluoranthene



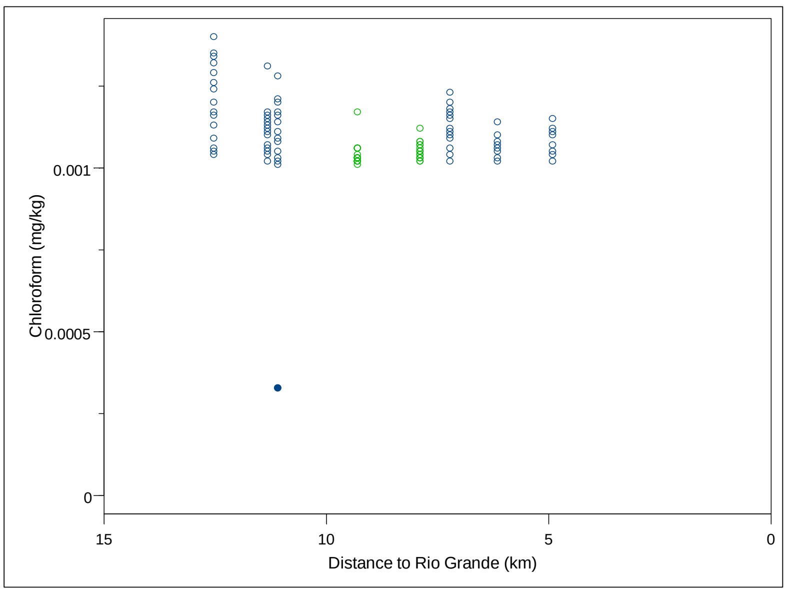
Benzoic Acid

- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

Figure D-1.1-2 (continued)



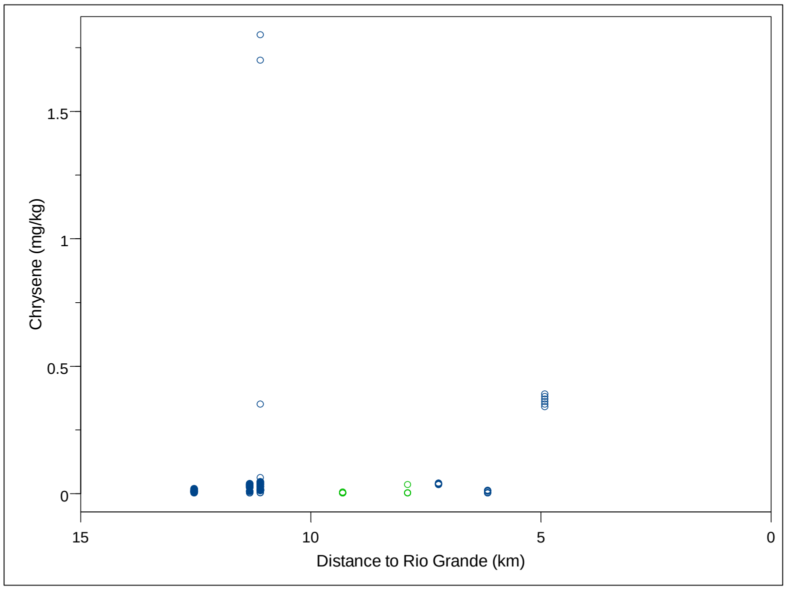
Bis[2-ethylhexyl]phthalate



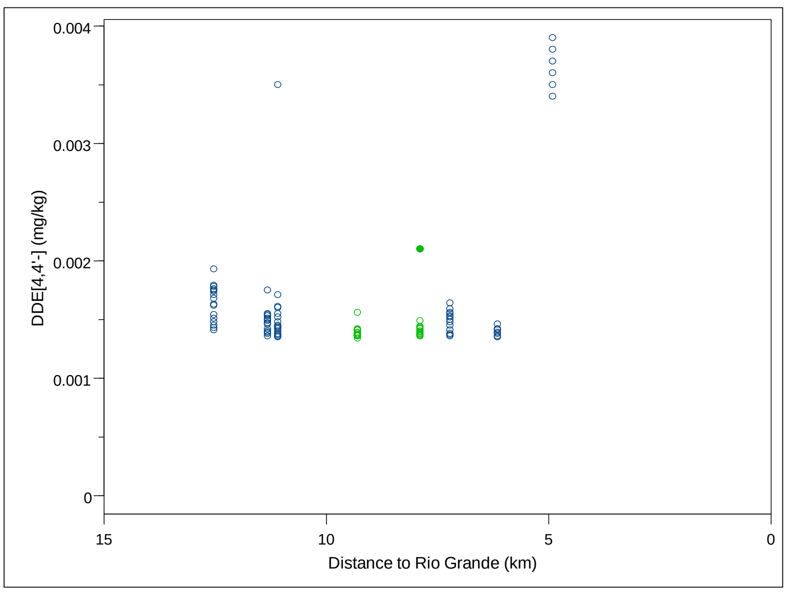
Chloroform"

- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

Figure D-1.1-2 (continued)



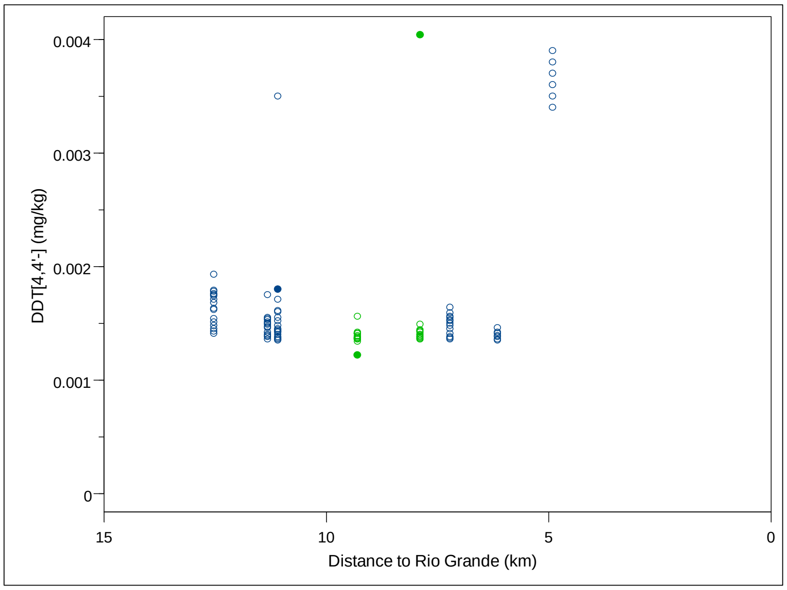
Chrysene



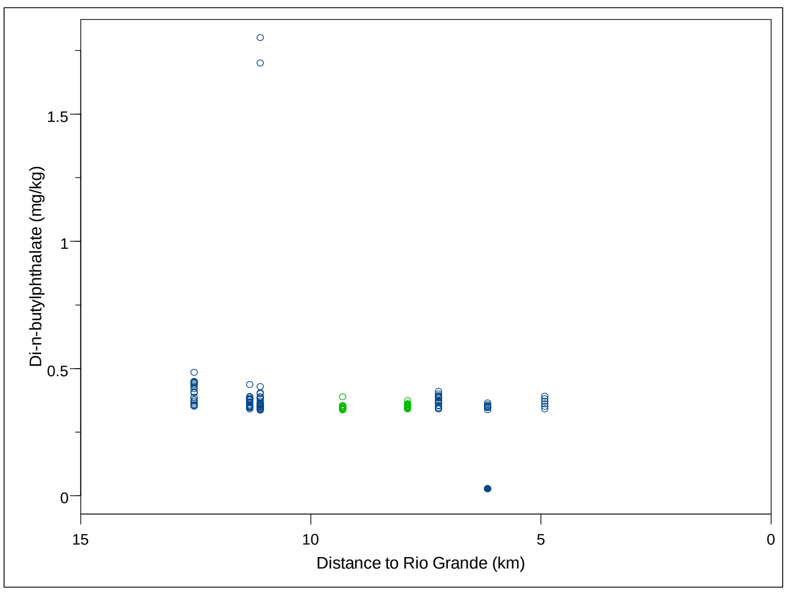
DDE[4,4'-]

- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

Figure D-1.1-2 (continued)



DDT[4,4'-]



Di-n-butylphthalate

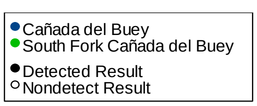
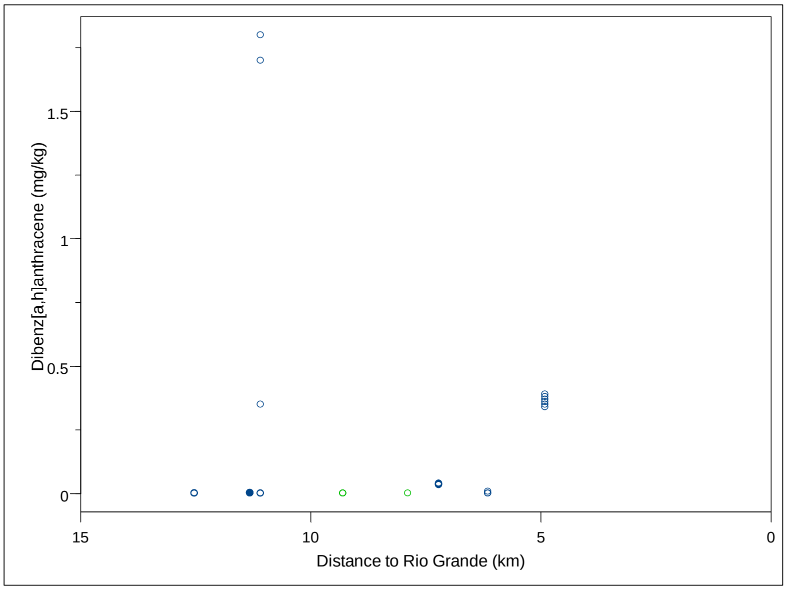
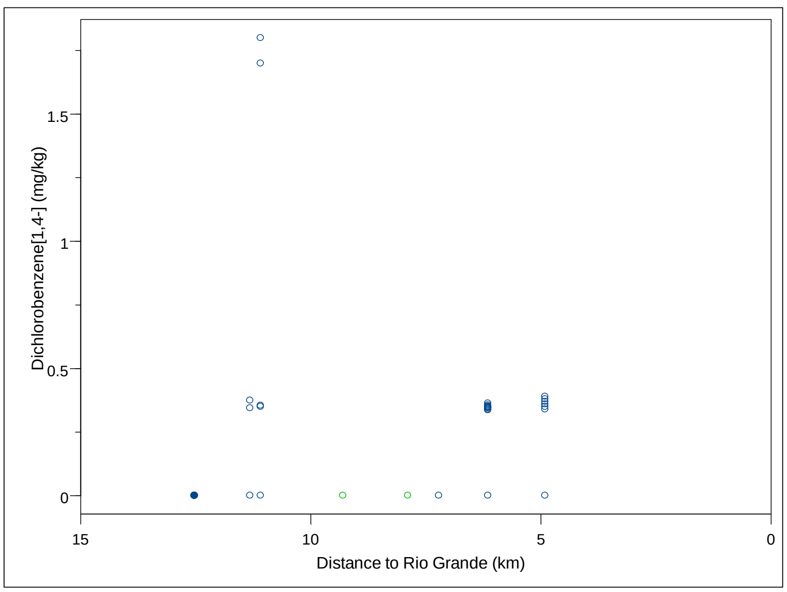


Figure D-1.1-2 (continued)



Dibenz[a,h]anthracene



Dichlorobenzene[1,4-]

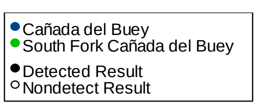
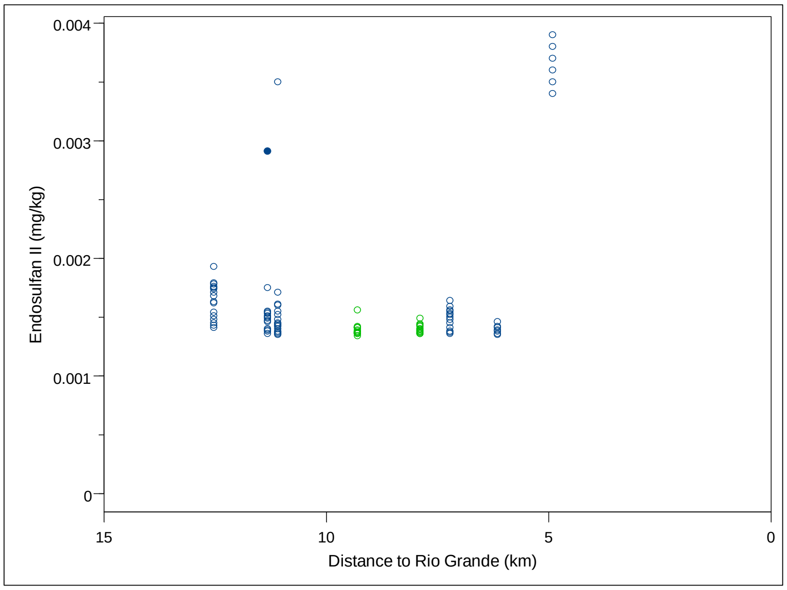
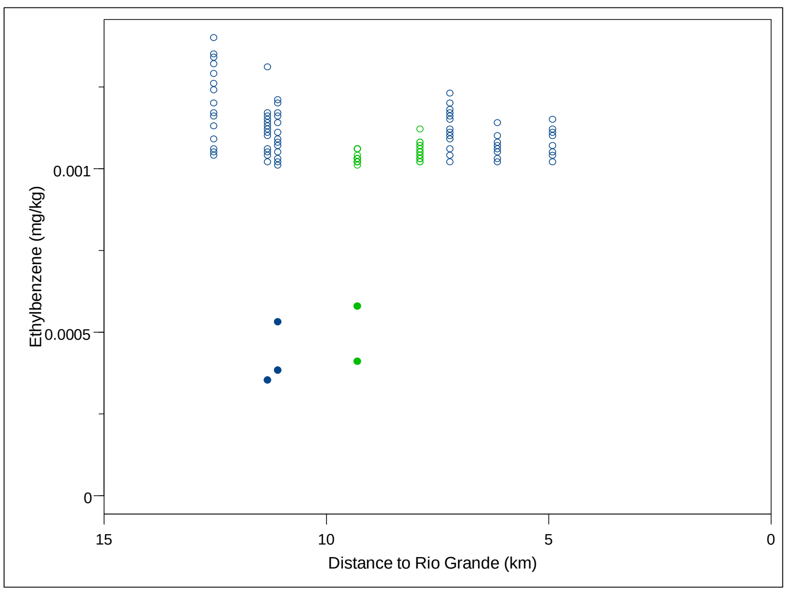


Figure D-1.1-2 (continued)



Endosulfan II



Ethylbenzene

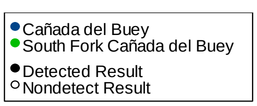
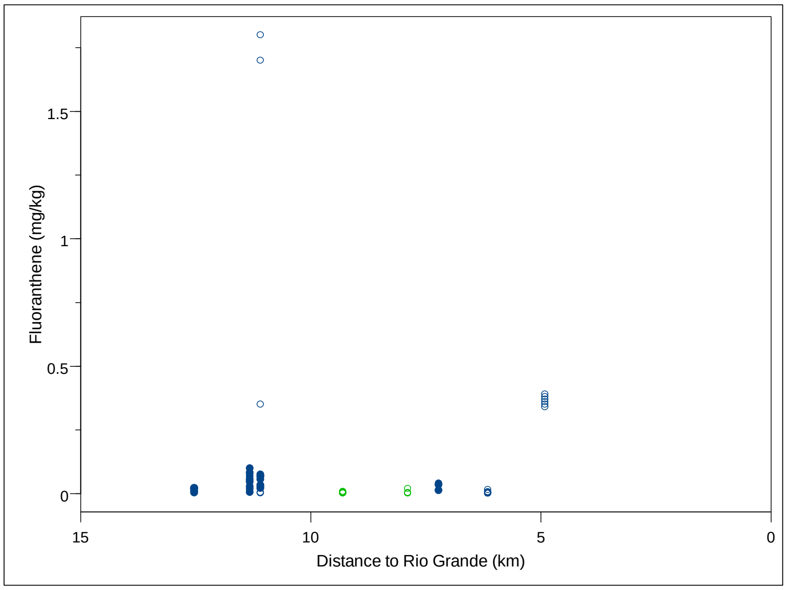
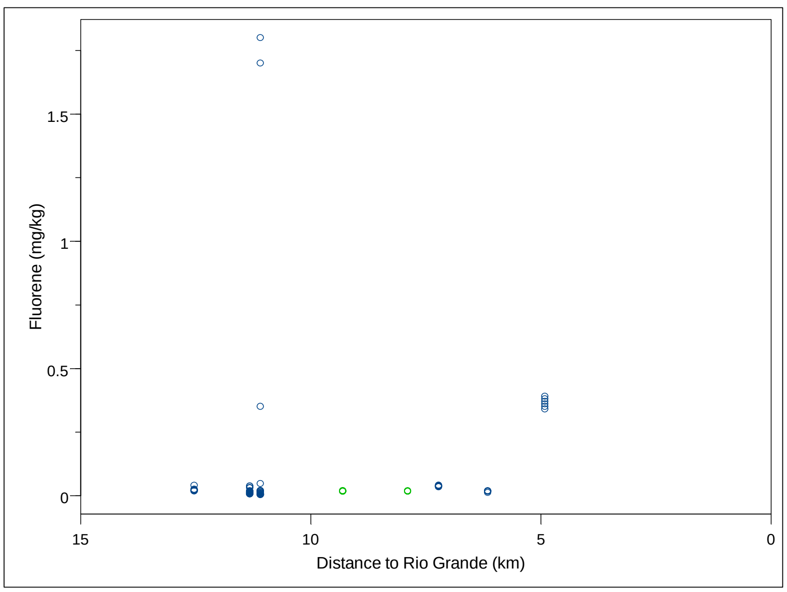


Figure D-1.1-2 (continued)



Fluoranthene



Fluorene

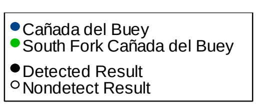
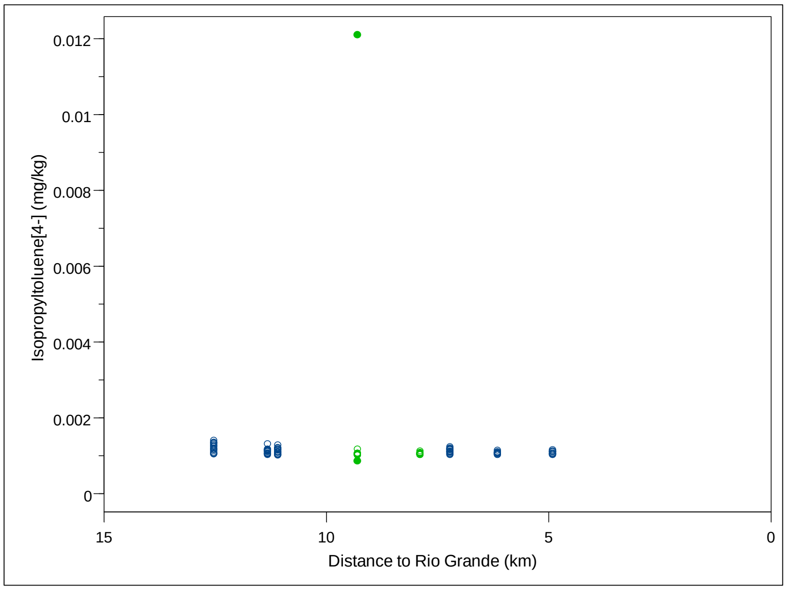
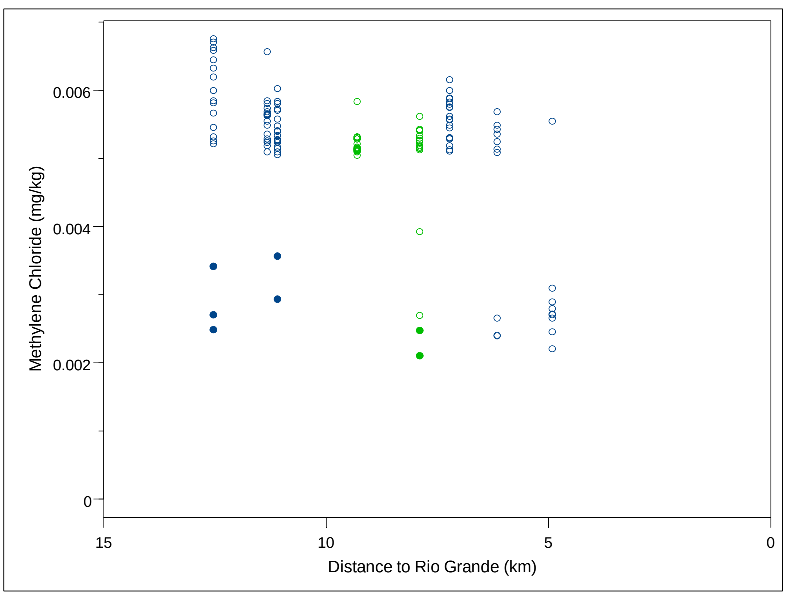


Figure D-1.1-2 (continued)



Isopropyltoluene[4-]



Methylene Chloride

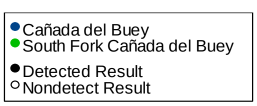
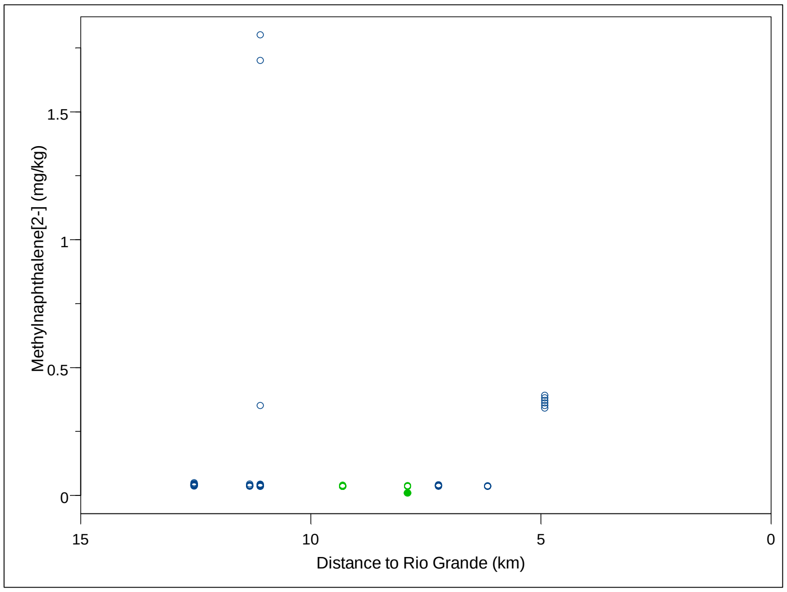
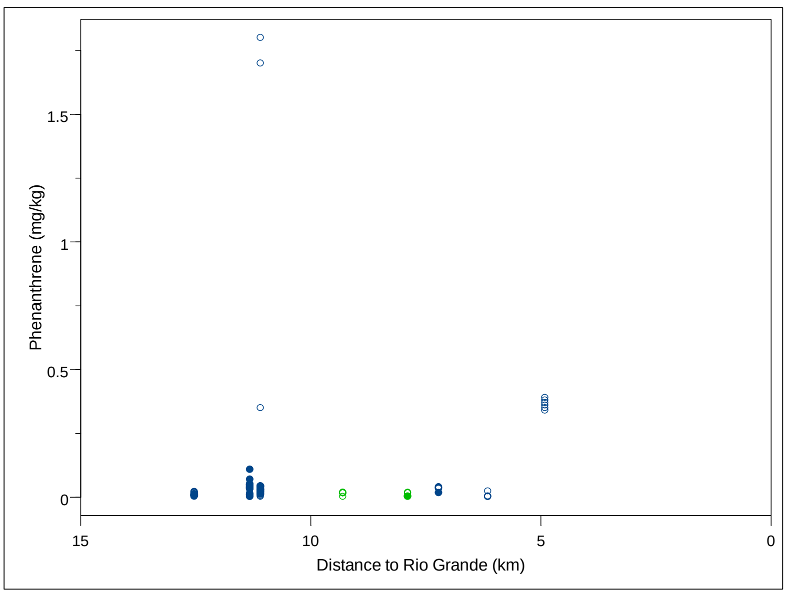


Figure D-1.1-2 (continued)



Methylnaphthalene[2-]



Phenanthrene

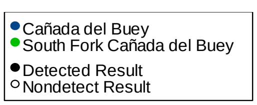
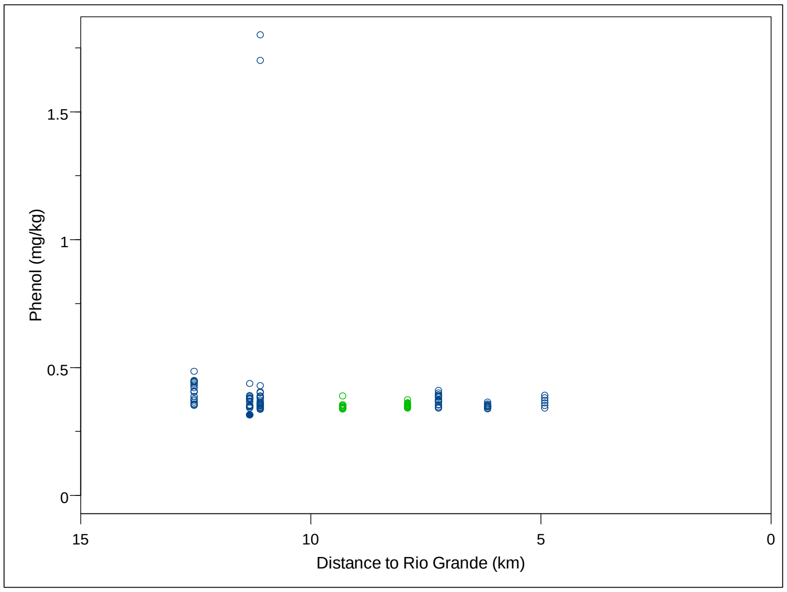
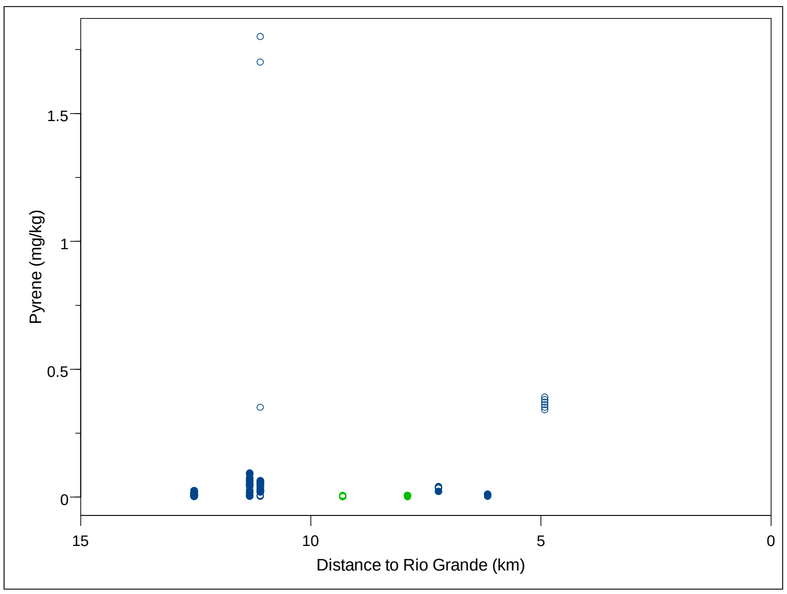


Figure D-1.1-2 (continued)



Phenol



Pyrene

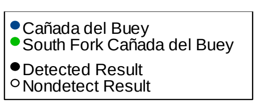
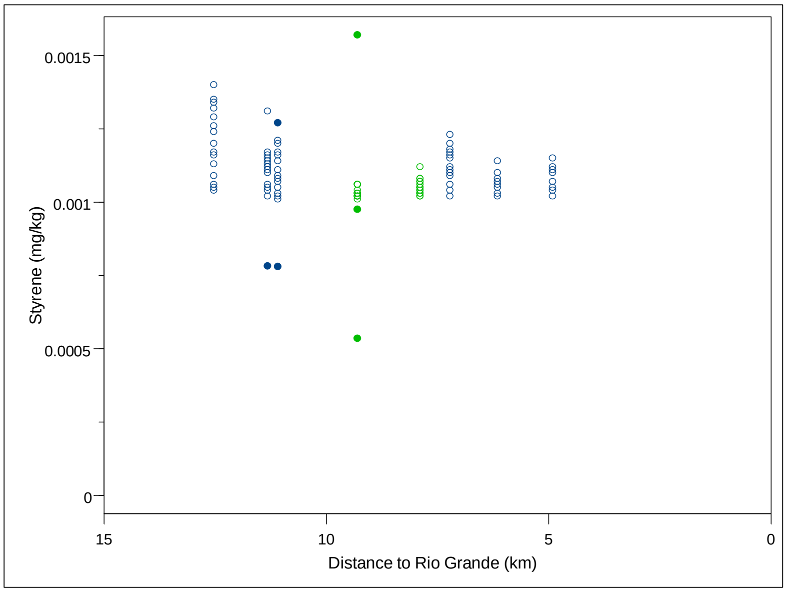
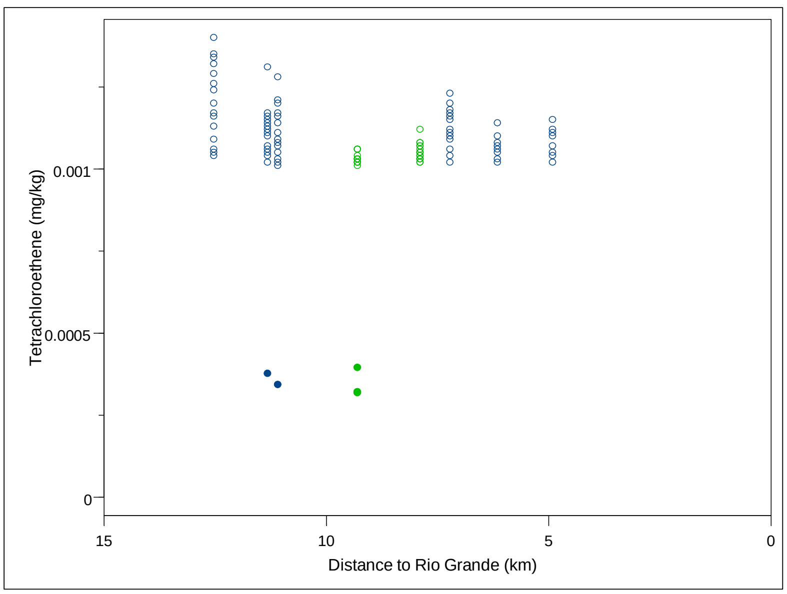


Figure D-1.1-2 (continued)



Styrene



Tetrachloroethene

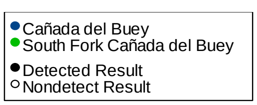
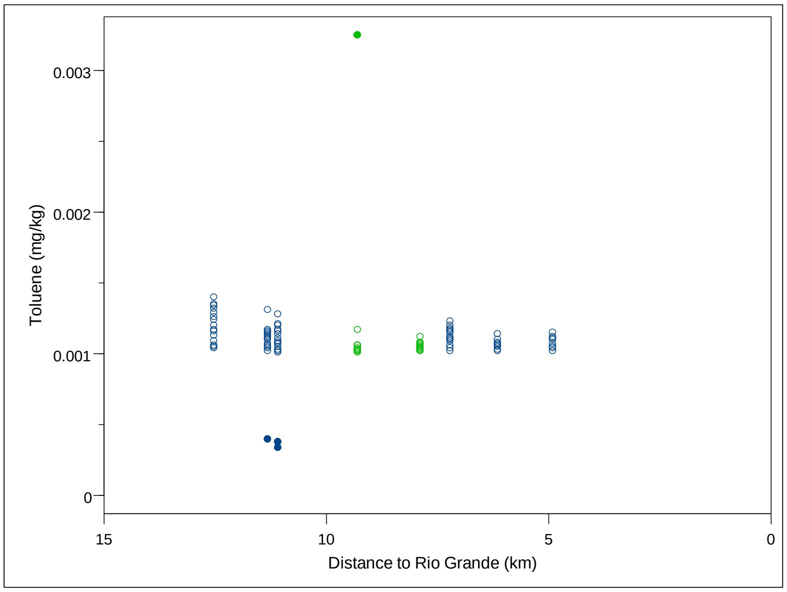
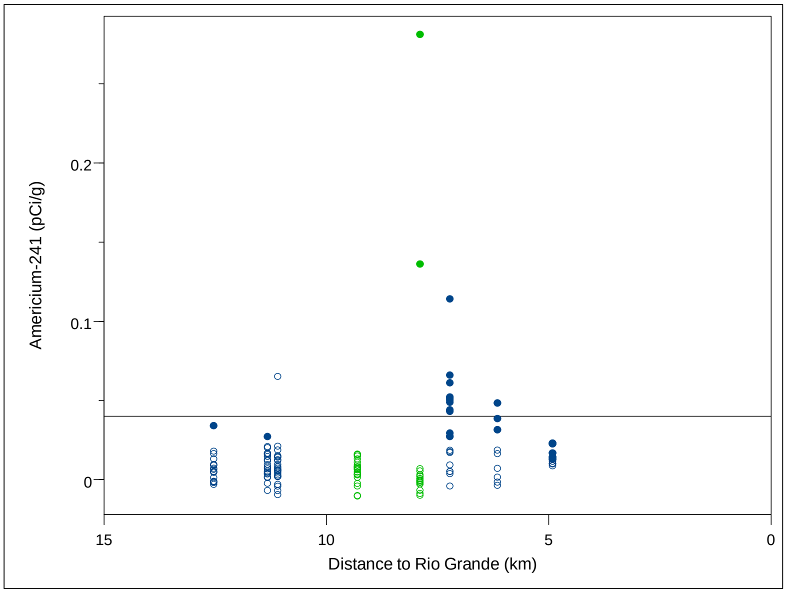


Figure D-1.1-2 (continued)

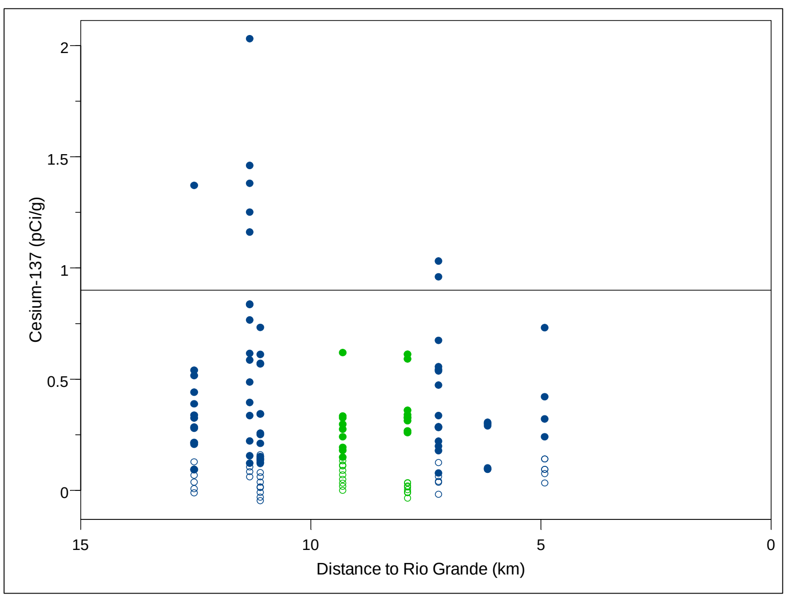


Toluene

Figure D-1.1-2 (continued)



Americium-241



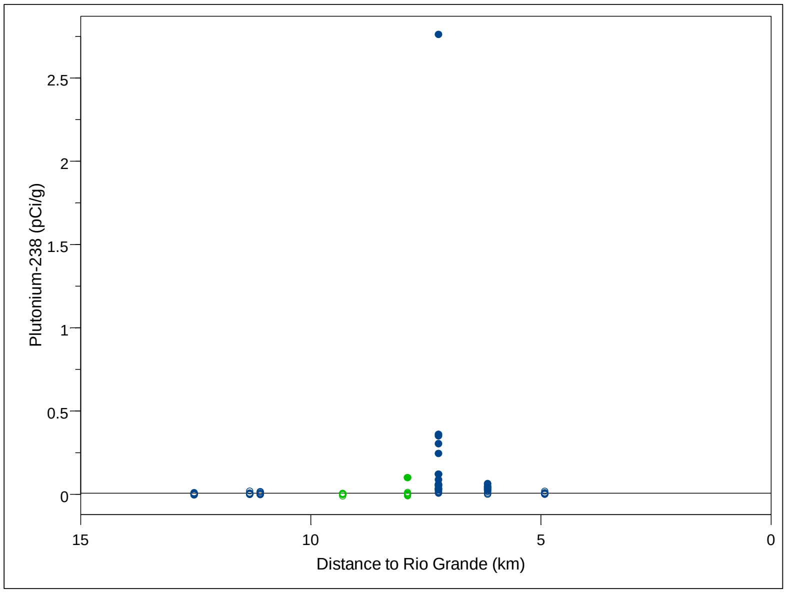
Cesium-137

● Cañada del Buey
● South Fork Cañada del Buey

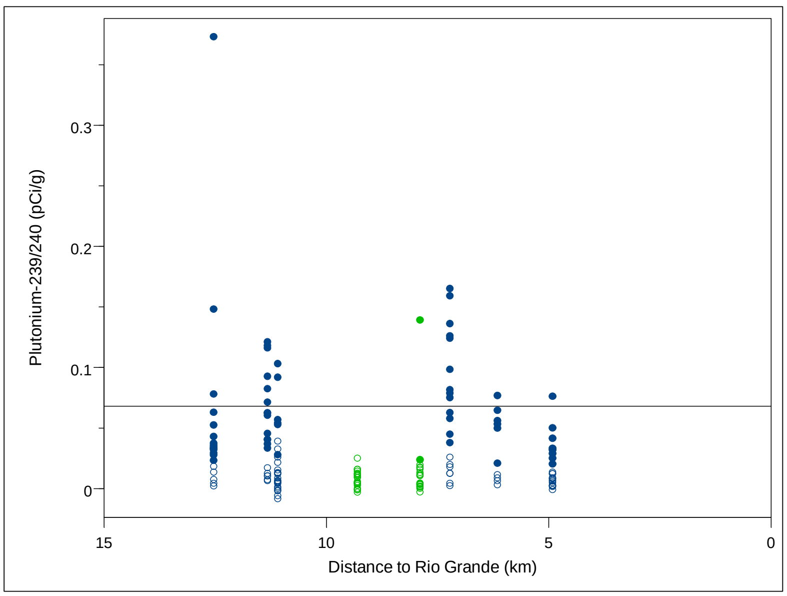
● Detected Result
○ Nondetect Result

(Solid line indicates LANL sediment background value.)

Figure D-1.1-3 Plots of sample results versus distance from the Rio Grande for all radionuclide COPCs identified in sediment in the Cañada del Buey watershed



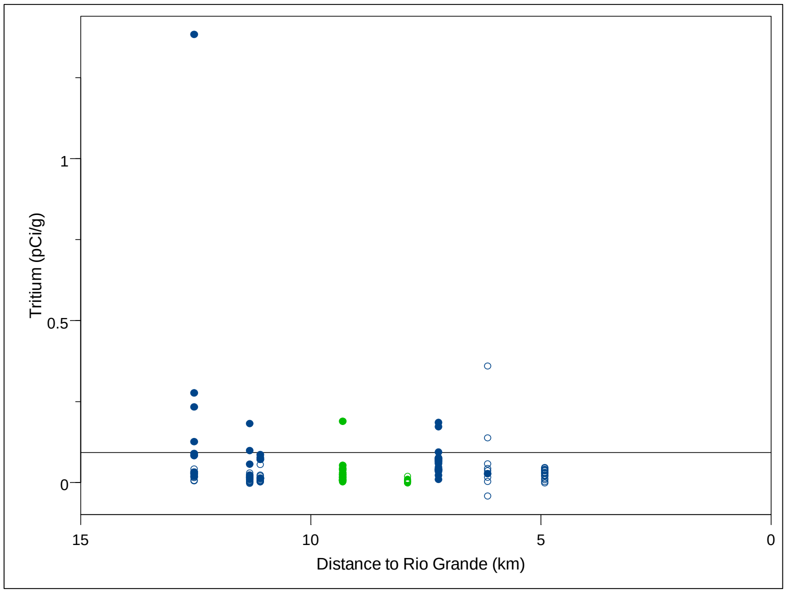
Plutonium-238



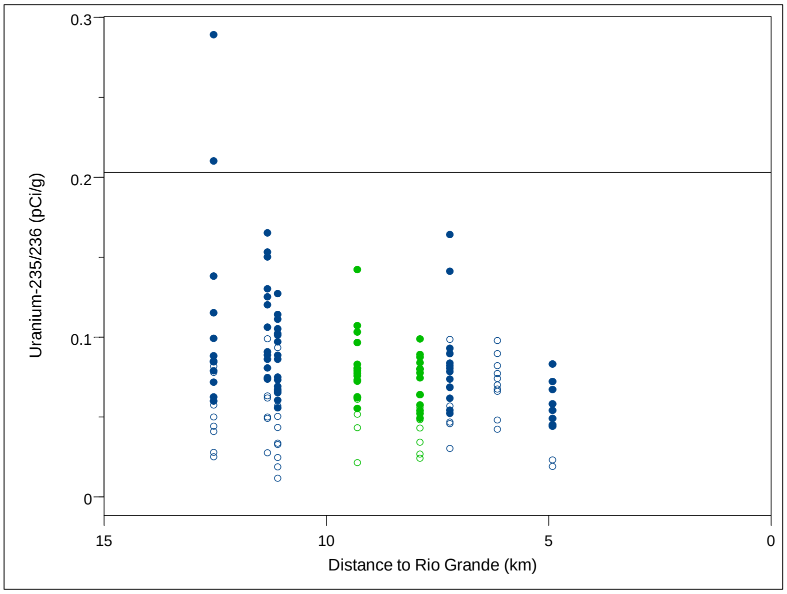
Plutonium-239/240

● Cañada del Buey
● South Fork Cañada del Buey
● Detected Result
○ Nondetect Result
(Solid line indicates LANL sediment background value.)

Figure D-1.1-3 (continued)



Tritium

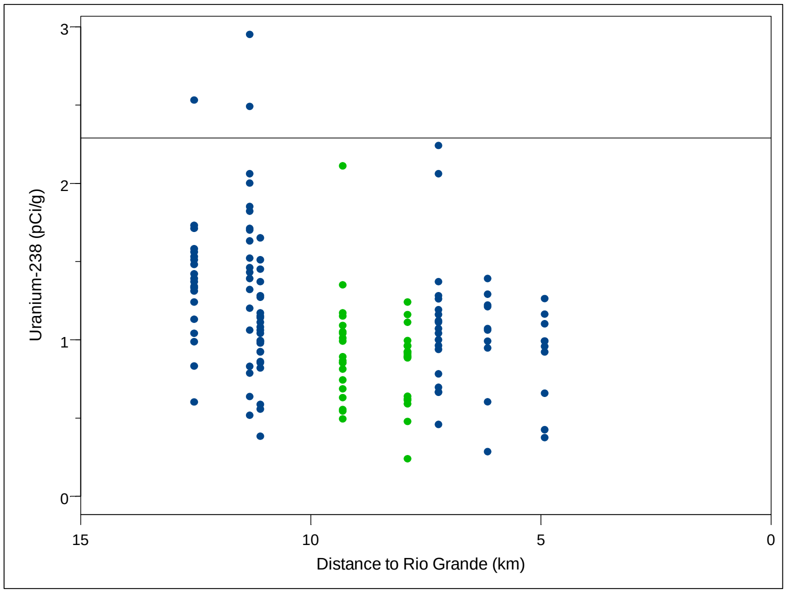


Uranium-235/236

- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

(Solid line indicates LANL sediment background value.)

Figure D-1.1-3 (continued)



Uranium-238

- Cañada del Buey
- South Fork Cañada del Buey
- Detected Result
- Nondetect Result

(Solid line indicates LANL sediment background value.)

Figure D-1.1-3 (continued)

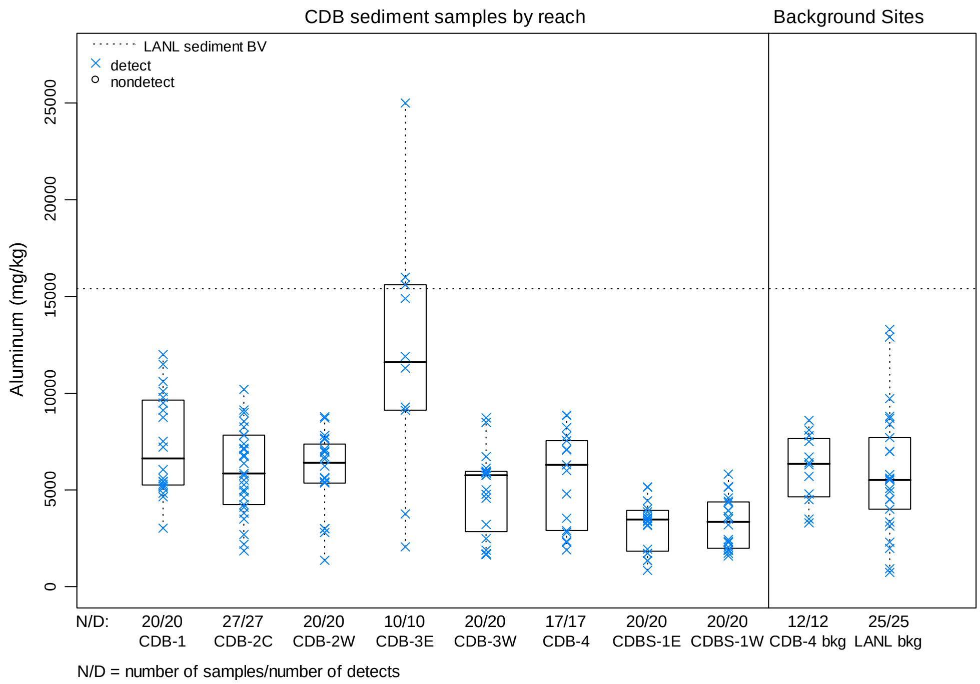


Figure D-1.3-1 Box plots of aluminum comparing Cañada del Buey reaches to background data

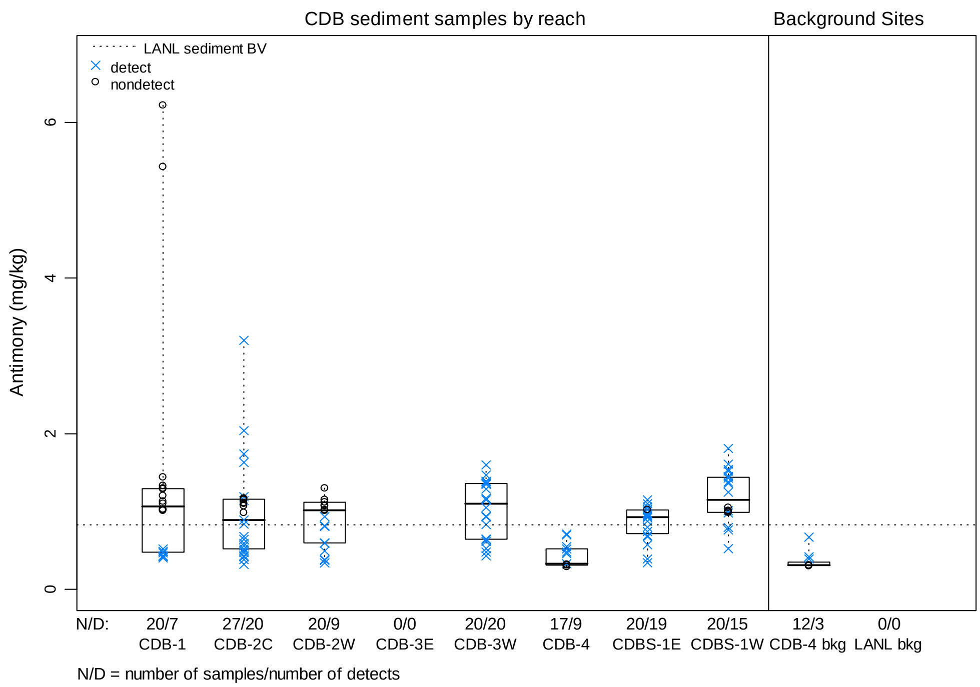


Figure D-1.3-2 Box plots of antimony comparing Cañada del Buey reaches to background data

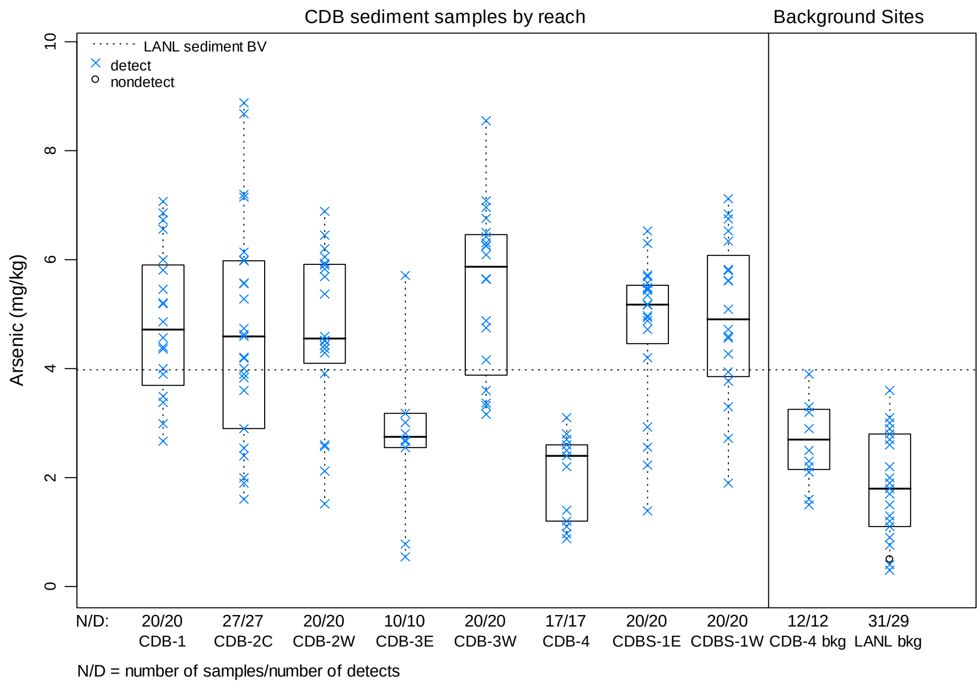


Figure D-1.3-3 Box plots of arsenic comparing Cañada del Buey reaches to background data

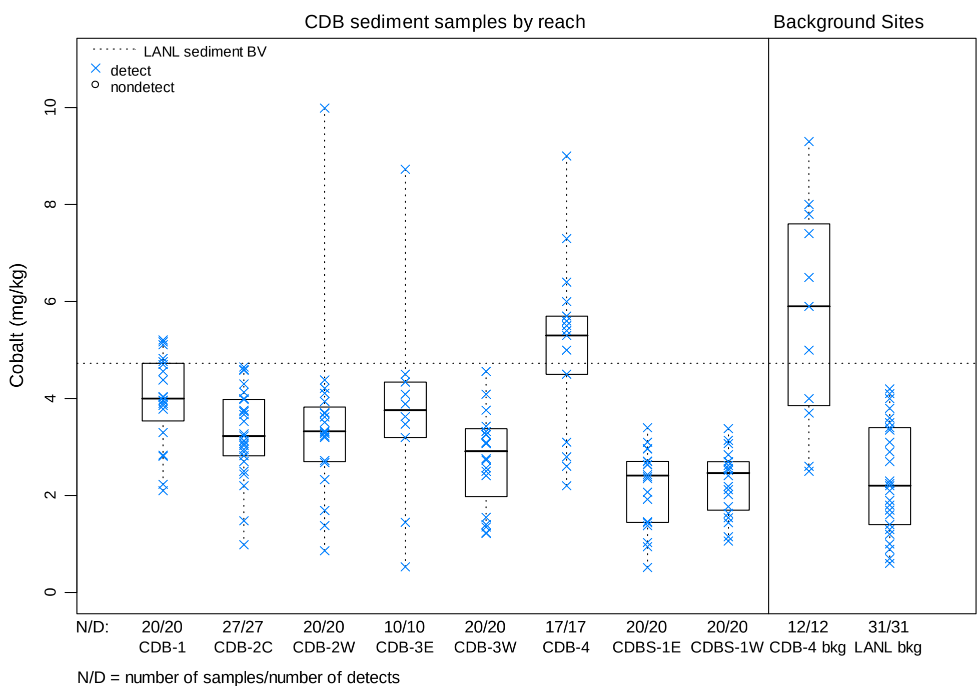


Figure D-1.3-4 Box plots of cobalt comparing Cañada del Buey reaches to background data

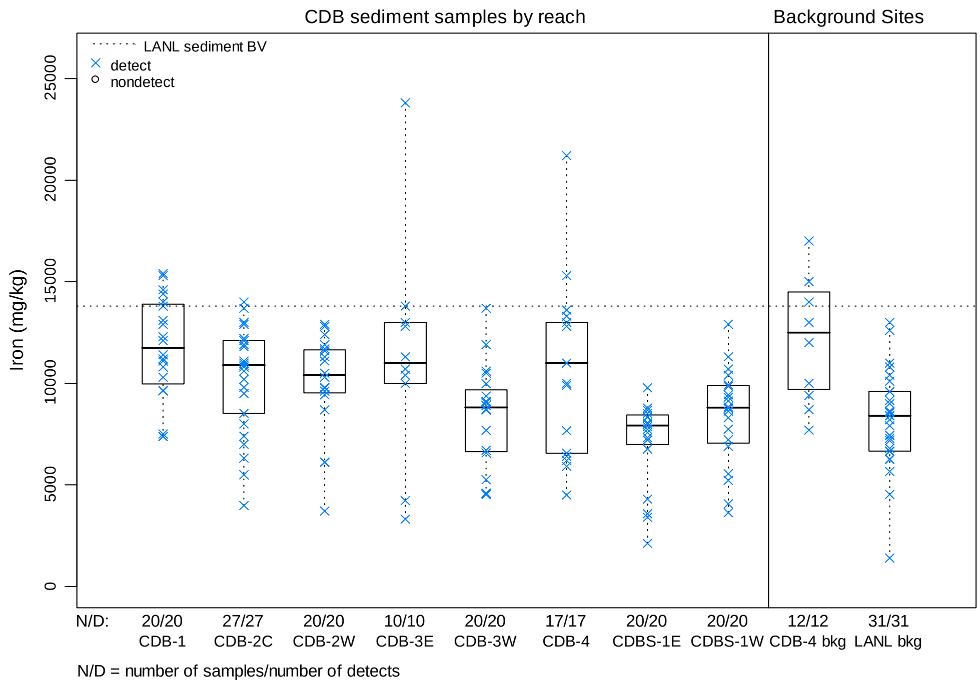


Figure D-1.3-5 Box plots of iron comparing Cañada del Buey reaches to background data

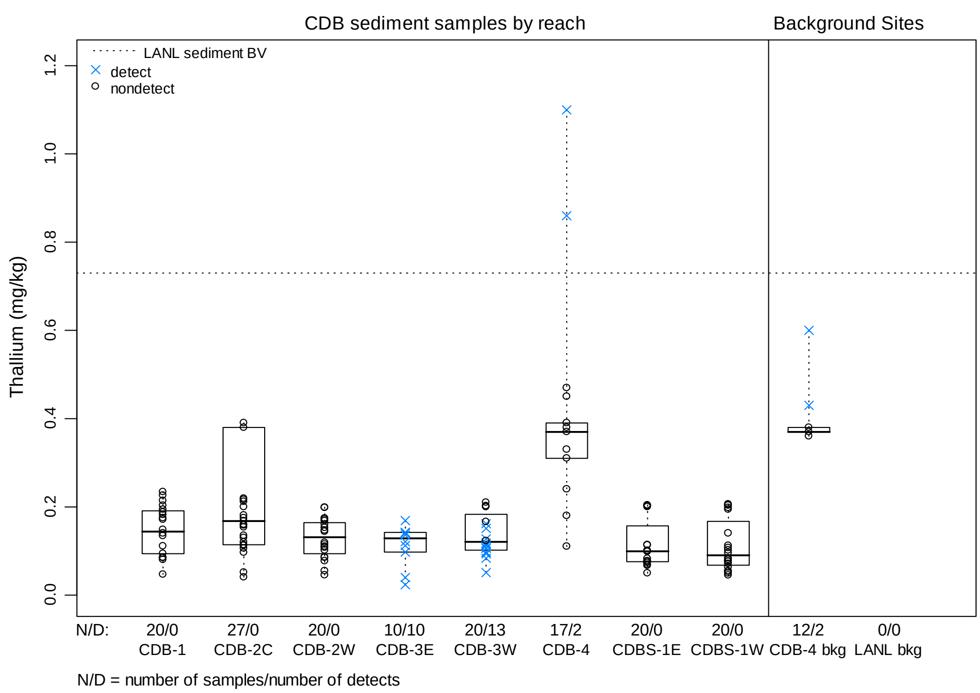


Figure D-1.3-6 Box plots of thallium comparing Cañada del Buey reaches to background data

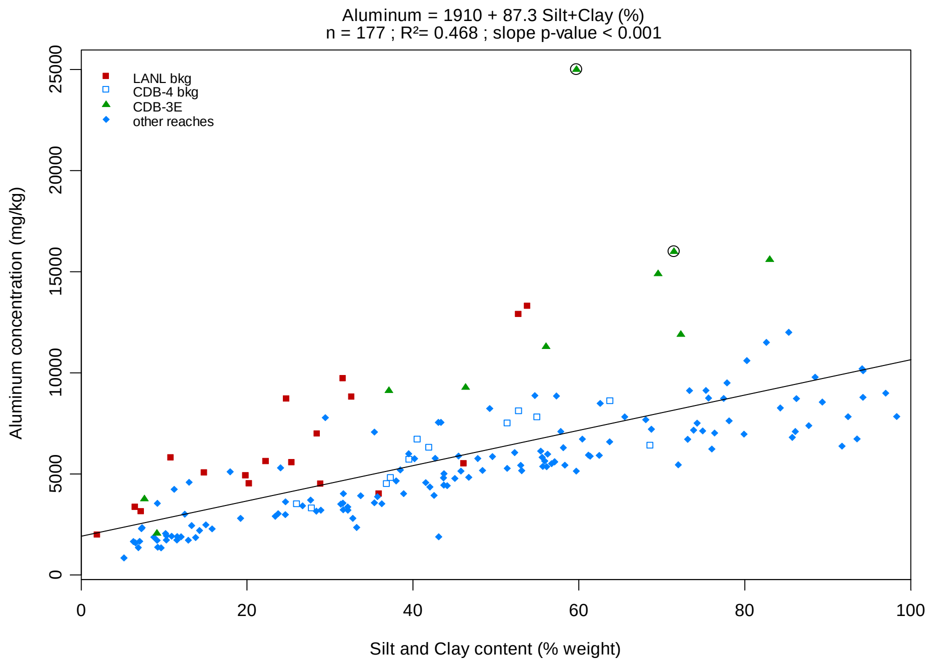


Figure D-1.3-7 Aluminum concentration versus silt and clay content; significant outliers (p<0.001) are circled

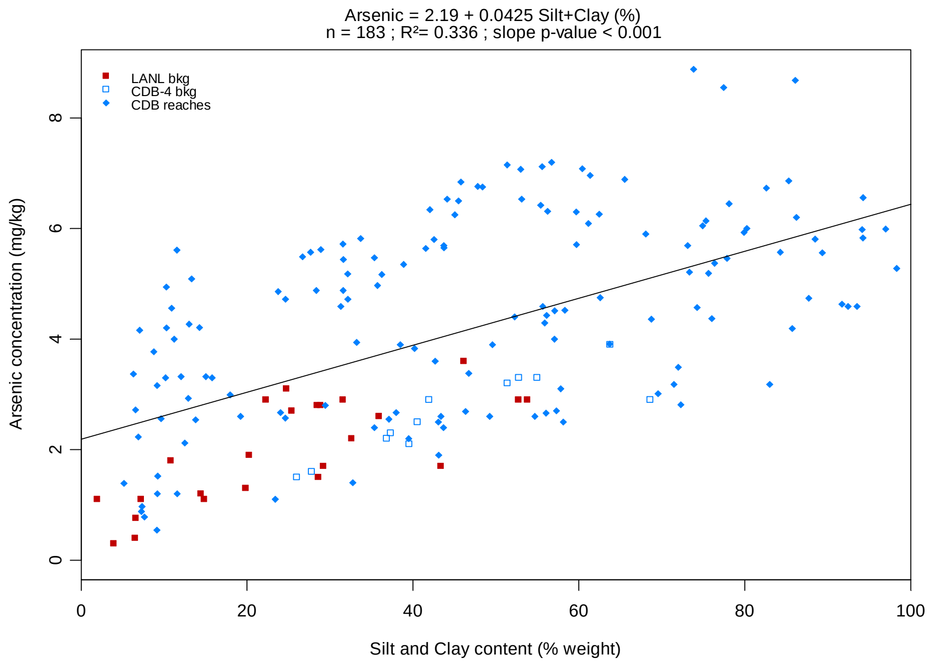


Figure D-1.3-8-8 Arsenic concentration versus silt and clay content; there are no significant outliers (p<0.001)

Table D-1.2-1
Summary of Average Concentrations of Select Inorganic Chemicals in Cañada del Buey Sediment Samples[a]

	Aluminum		Antimony						Arsenic		Cobalt		Cyanide						Iron		Lead		Perchlorate						Thallium					
	Fine Facies	Coarse Facies	Fine Facies			Coarse Facies			Fine Facies	Coarse Facies	Fine Facies	Coarse Facies	Fine Facies			Coarse Facies			Fine Facies	Coarse Facies	Fine Facies	Coarse Facies	Fine Facies			Coarse Facies			Fine Facies			Coarse Facies		
Reach	Average	Average	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Average	Average	Average	Average	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Average	Average	Average	Average	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		4.73		0.82						13800		19.7		none						0.73					
CDB-1	—[b]	—	—	—	—	—	—	—	5.04	3.51	4.17	2.90	0.52	0.48	0.43	0.28	0.14	0.00	12336	8183	14.7	10.1	0.00233	0.00120	0.00008	0.00218	0.00109	0.00000	—	—	—	—	—	—
CDB-2C	—	—	0.99	0.85	0.71	0.95	0.79	0.62	4.76	3.58	—	—	0.34	0.22	0.11	0.25	0.12	0.00	10775	6277	15.4	7.1	0.00164	0.00125	0.00086	0.00203	0.00102	0.00000	—	—	—	—	—	—
CDB-2W	—	—	0.87	0.59	0.30	0.90	0.51	0.12	5.31	2.20	3.93	1.57	0.39	0.31	0.23	0.22	0.14	0.06	—	—	41.2	12.3	0.00139	0.00112	0.00085	0.00180	0.00101	0.00022	—	—	—	—	—	—
CDB-3E	14138	2910	n.d.[c]	n.d.	n.d.	n.d.	n.d.	n.d.	3.22	0.66	4.48	0.99	—	—	—	—	—	—	13224	3775	12.5	3.5	0.04185	0.02093	0.00000	0.02765	0.01760	0.00755	—	—	—	—	—	—
CDB-3W	—	—	1.15	1.15	1.15	0.75	0.75	0.75	6.20	3.70	—	—	—	—	—	—	—	—	—	—	—	—	0.00192	0.00110	0.00029	0.00210	0.00105	0.00000	—	—	—	—	—	—
CDB-4	—	—	—	—	—	—	—	—	—	—	5.35	4.23	—	—	—	—	—	—	12208	6163	—	—	—	—	—	—	—	—	0.46	0.31	0.15	0.20	0.10	0.00
CDB-4 BKG	—	—	—	—	—	—	—	—	—	—	5.72	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	12400	n.d.	—	—	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	—	—	—	—	—	—
CDBS-1E	—	—	0.92	0.92	0.92	0.71	0.63	0.54	5.46	3.04	—	—	0.31	0.24	0.16	0.18	0.09	0.00	—	—	—	—	0.00181	0.00098	0.00014	0.00207	0.00103	0.00000	—	—	—	—	—	—
CDBS-1W	—	—	1.31	1.21	1.11	1.07	0.97	0.87	5.56	4.30	—	—	—	—	—	—	—	—	—	—	—	—	0.00202	0.00129	0.00055	0.00205	0.00102	0.00000	—	—	—	—	—	—

[a] All units are in mg/kg.

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

[c] n.d. = No data; includes rejected data.

Table D-1.2-2
Summary of Average Concentrations of PCBs in Cañada del Buey Sediment Samples[a]

Reach	Aroclor-1242						Aroclor-1248						Aroclor-1254						Aroclor-1260					
	Fine Facies			Coarse Facies			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	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean	Upper Bound on Mean	Mid-Point of Range	Lower Bound on Mean
CDB-1	—[b]	—	—	—	—	—	—	—	—	—	—	—	0.0059	0.0047	0.0035	0.0033	0.0021	0.0009	0.0065	0.0059	0.0052	0.0034	0.0022	0.0010
CDB-2C	—	—	—	—	—	—	—	—	—	—	—	—	0.0126	0.0068	0.0010	0.0034	0.0017	0.0000	0.0128	0.0073	0.0018	0.0034	0.0017	0.0000
CDB-2W	—	—	—	—	—	—	—	—	—	—	—	—	0.0052	0.0047	0.0041	0.0035	0.0018	0.0000	0.0056	0.0054	0.0052	0.0035	0.0018	0.0000
CDB-3E	—	—	—	—	—	—	—	—	—	—	—	—	0.0033	0.0018	0.0002	0.0110	0.0102	0.0093	0.0035	0.0017	0.0000	0.0052	0.0043	0.0035
CDB-3W	—	—	—	—	—	—	0.0139	0.0121	0.0104	0.0035	0.0018	0.0000	0.0105	0.0089	0.0073	0.0035	0.0018	0.0000	0.0043	0.0033	0.0022	0.0035	0.0018	0.0000
CDB-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CDBS-1E	—	—	—	—	—	—	—	—	—	—	—	—	0.0034	0.0017	0.0001	0.0034	0.0017	0.0000	—	—	—	—	—	—
CDBS-1W	0.0043	0.0029	0.0014	0.0034	0.0017	0.0000	—	—	—	—	—	—	0.0044	0.0029	0.0015	0.0034	0.0017	0.0000	0.0036	0.0021	0.0007	0.0034	0.0017	0.0000

[a] All units are in mg/kg.
[b] — = Not a COPC in reach (not detected).

Table D-1.2-3
Summary of Average Concentrations of Select Radionuclides in Cañada del Buey Sediment Samples

Reach	Americium-241		Plutonium-238		Plutonium-239/240	
	Fine Facies	Coarse Facies	Fine Facies	Coarse Facies	Fine Facies	Coarse Facies
BV	0.040		0.006		0.068	
CDB-1	—[a]	—	—	—	0.060	0.020
CDB-2C	—	—	—	—	0.023	0.008
CDB-2W	—	—	—	—	0.063	0.011
CDB-3E	0.022	0.007	0.026	0.016	0.040	0.015
CDB-3W	0.045	0.009	0.326	0.015	0.088	0.018
CDB-4	—	—	—	—	0.021	0.011
CDB-4 BKG	n.d.[b]	n.d.	0.002	n.d.	—	n.d.
CDBS-1E	0.030	-0.005	0.008	-0.003	0.019	0.005
CDBS-1W	—	—	—	—	—	—

Note: All units are in pCi/g.

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

[b] n.d. = No data.

Table D-1.3-1
Statistical Comparisons of CDB-4 BKG Data with Reach Data for Select Inorganic COPCs

Analyte	Reach	Number of Samples in Reach	Number of Detects in Reach	Number of CDB-4 BKG Samples	Number of CDB-4 BKG Detects	Detection Frequency >50%?	Significance Level			Statistically Different Than CDB-4 BKG?
							Gehan Test	Quantile Test	Slippage Test	
Aluminum	CDB-3E	10	10	12	12	Yes	0.006705	0.02871	0.000141	Yes
Antimony	CDB-2C	27	20	12	3	No	NA	0.05774	0.002864	Yes
Antimony	CDB-2W	20	9	12	3	No	NA	0.2481	0.06316	No
Antimony	CDB-3W	20	20	12	3	No	NA	0.04277	8.22E-05	Yes
Antimony	CDBS-1E	20	19	12	3	No	NA	0.04277	3.22E-06	Yes
Antimony	CDBS-1W	20	15	12	3	No	NA	0.04277	7.48E-07	Yes
Arsenic	CDB-1	20	20	12	12	Yes	4.20E-05	0.04277	8.22E-05	Yes
Arsenic	CDB-2C	27	27	12	12	Yes	0.000658	0.05774	0.000165	Yes
Arsenic	CDB-2W	20	20	12	12	Yes	0.000329	0.04277	8.06E-06	Yes
Arsenic	CDB-3E	10	10	12	12	Yes	0.5132	0.9323	0.4545	No
Arsenic	CDB-3W	20	20	12	12	Yes	7.08E-06	0.04277	2.74E-05	Yes
Arsenic	CDBS-1E	20	20	12	12	Yes	0.000247	0.04277	8.06E-06	Yes
Arsenic	CDBS-1W	20	20	12	12	Yes	6.20E-05	0.04277	2.74E-05	Yes
Cobalt	CDB-1	20	20	12	12	Yes	0.9861	1	1	No
Cobalt	CDB-2W	20	20	12	12	Yes	0.997	0.999	0.625	No
Cobalt	CDB-3E	10	10	12	12	Yes	0.9699	0.9323	1	No
Cobalt	CDB-4	17	17	12	12	Yes	0.8298	0.9933	1	No
Iron	CDB-1	20	20	12	12	Yes	0.7072	0.8777	1	No
Iron	CDB-2C	27	27	12	12	Yes	0.9725	0.9932	1	No
Iron	CDB-3E	10	10	12	12	Yes	0.7955	0.9323	0.4545	No
Iron	CDB-4	17	17	12	12	Yes	0.8847	0.9225	0.5862	No
Thallium	CDB-4	17	2	12	2	No	NA	NA	0.335	No

Notes: Yellow shading indicates reach data are significantly different from CDB-4 BKG data at a significance level of 0.05.
NA indicates the test is not applicable because the detection frequency is too low (<50% for Gehan test or <20% for quantile test)

Appendix E

Statistics and Risk Information

E-1.0 PART A—SCOPING MEETING DOCUMENTATION

Site ID	**Affected Media in Cañada del Buey Investigation Reaches**
Form of site releases (solid, liquid, vapor). Describe all relevant known or suspected mechanisms of release (spills, dumping, material disposal, outfall, explosive testing, etc.) and describe potential areas of release. Reference locations on a map as appropriate.	Sources of potential contamination in Cañada del Buey include Technical Area 46 (TA-46), TA-51, TA-52, TA-54, and former TA-04. These TAs and their associated areas of concern/solid waste management units (AOCs/SWMUs) are located on mesa tops adjacent to Cañada del Buey. Mechanisms of contaminant release to the Cañada del Buey system include contaminant releases from upgradient mesa-top septic systems, outfalls, drywells, container storage areas, surface disposal areas, lagoons, and contaminants mobilized by storm runoff. The eight investigation reaches in Cañada del Buey are CDB-1, CDB-2C, CDB-2W, CDB-3E, CDB-3W, CDBS 1E, CDBS-1W, and CDB-4. Investigation reaches and adjacent AOCs/SWMUs are shown on Plate 1 of this report.
List of primary impacted media **(Indicate all that apply.)**	**Surface soil**—Yes **Sediment**—Yes **Surface water**—No (stormwater only) **Subsurface**—No **Groundwater**—No **Other,** explain
Vegetation land-cover class **(Indicate all that apply.)**	**Aspen-Riparian-Wetland**—No **Cerro Grande Fire high affected**—No **Grassland** —Yes **Mixed conifer**—No **Spruce-Fir**—No **Open Water**—No **Ponderosa pine**—Yes **Piñon-juniper**—Yes **Shrub species**—Yes **Urban-Sparse-Bare Rock**—No
Is threatened and endangered species (T&E) habitat present? **list species if applicable**	The Mexican spotted owl is likely to nest, roost, and forage at varying levels in some of the reaches in Cañada del Buey (see Keller 2009, 106613).
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 Sandia Canyon and Cañada del Buey work plan provide a comprehensive list of SWMUs/AOCs in the watershed (LANL 1999, 064617).
Is there evidence of run-on/runoff, erosion or a terminal point of surface-water transport?	Run-on and runoff are evident in all Cañada del Buey reaches. Minor erosion was observed as a result of intermittent stormwater flow. Canyon bottoms serve as the terminal point for surface water transport via runoff from the mesa tops.
Other scoping meeting notes	All site visits to the reaches occurred in April 2009. Reaches were investigated individually on foot. Aquatic habitat and receptors were not observed in any of the Cañada del Buey reaches. No perennial water is present in Cañada del Buey. Surface water is limited to stormwater, short-lived snowmelt runoff, occasional discharges of purge water from a water-supply well, and effluent discharges from the White Rock wastewater treatment plant. Cañada del Buey sediment was sampled in 1999, 2000, 2004, and 2007. Some samples were collected before the Cerro Grande fire. Others were collected post-fire. Samples were collected in both fire-affected regions and those that were not impacted by the Cerro Grande fire.

E-1.1 Part B—Site Visit Documentation

E-1.1.1 Reach CDB-1

Site ID	CDB-1
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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 CDB-1 contains low-quality foraging habitat for the Mexican spotted owl (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Terrestrial receptors are present in reach CDB-1. No aquatic receptors are present.

Contaminant Transport Information:

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

Ecological Effects Information:

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

No Exposure/Transport Pathways:

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

Adequacy of Site Characterization:

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

contamination? **(yes/no/uncertain)** **Provide explanation.** **(Consider if other sites should aggregated to characterize potential ecological risk.)**	

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
The steam channel is discontinuous and indicates little flow of water through the reach. There was no evidence of water ponding in the reach and no observations of perennial water flow. There was little coarse material observed in the stream channel. These observations point to no aquatic biota or aquatic exposure pathways in this reach. Terrestrial species observed during the site visit included mule deer, red-tailed hawk, ants, woodpeckers, and numerous passerine birds. Fossorial mammal activity was also observed, as was evidence (tracks and scat) of site use by elk and coyote.

E-1.1.2 Reach CDB-2W

Site ID	CDB-2W
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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	Open ponderosa pine, shrub oak, and grass
Field notes on T&E habitat, if applicable	Reach CDB-2W contains high-quality nesting, roosting, and foraging habitat for the Mexican spotted owl (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes, terrestrial receptors are present in reach CDB-2W. No aquatic receptors are present.

Contaminant Transport Information:

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

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	Evidence of stormwater flood debris (assemblage of driftwood and pine cones) from overland flow was present in portions of the reach. The area was subject to a low severity burn during the Cerro Grande fire.

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

No Exposure/Transport Pathways:

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

Adequacy of Site Characterization:

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

Additional Field Notes:

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

The active stream channel in reach CDB-2W is not continuous. Stormwater spreads over a broad floodplain, and c1 geomorphic unit sediments are limited to the upstream end of the reach. Vegetative cover varied widely in this reach. A thicket of shrubs was at the upstream end of the reach, and there was an area with opportunistic plant species like dandelion and clover, which is likely indicative of physical disturbance. Overall, plant cover was high and the area occupied by an active stream channel was small. Another indication that flooding has been rare in this reach was observing an old ant nest in the channel below a head cut.

Herbaceous vegetation species observed included false lupine, mullein, wild rose, and numerous grasses. Terrestrial animals observed include fossorial mammals, fence lizard, woodpecker, white-winged dove. There are boxes associated with the Laboratory's cavity nesting bird monitoring network on the mesa above the reach. Evidence of use by elk and deer (tracks and scat) were also noted.

E-1.1.3 Reach CDB-2C

Site ID	CDB-2C
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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	Open ponderosa pine, gambel oak, piñon, juniper, and grass
Field notes on T&E habitat, if applicable	Reach CDB-2C contains high-quality nesting, roosting, and foraging habitat for the Mexican spotted owl (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Yes, terrestrial receptors are present in reach CDB-2C. No aquatic receptors are present.

Contaminant Transport Information:

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

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	Extensive physical disturbance was not evident in reach CDB-2C. There is a non-maintained vehicle route to a well located in reach CDB-2W and it has created a small area of physical disturbance. The area was subject to a moderate severity burn during the Cerro Grande fire.

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 adequate to characterize potential contaminant transport pathways.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
The stream channel in reach CDB-2C is discontinuous. Stormwater spreads over a broad floodplain in most of the reach, and c1 geomorphic unit sediments are limited to the easternmost end of the reach. There is a grassland located downstream of the active channel area which indicate minimal persistent surface water or flow from storm events. Additional vegetation species observed included barberry, box elder, penstemon, mullein, and clover. Dandelions and other weedy species were also present in portions of the reach. Wildlife receptors observed in reach CDB-2C included passerine birds, bluebird, woodpecker, and rabbit. Fossorial activity was evident. Tracks and scat of deer and elk were also present. There are boxes included in the Laboratory cavity nesting bird monitoring network on the mesa above the reach.

E-1.1.4 Reach CDB-3E

Site ID	CDB-3E
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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	Piñon, juniper, and sagebrush
Field notes on T&E habitat, if applicable	No T&E habitat is present in reach CDB-3E (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Terrestrial receptors are present in reach CDB-3E. No aquatic receptors are present.

Contaminant Transport Information:

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

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	Pumice present on the floodplain suggests transport of material by stormwater.

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

No Exposure/Transport Pathways:

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

Adequacy of Site Characterization:

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

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Reach CDB-3E contains a shallow braided channel with a fairly extensive floodplain in portions. Native sediments is sparse. Much of the coarse and fine materials are deposited from side channels from the mesa to the north. There was evidence for a flood that deposited sediments in the active channel between sampling event in 2004 and 2008. Floods in this part of the watershed are likely from local storm events with little or no flow from upstream reaches. Terrestrial vegetation consisted of piñon, juniper and sagebrush. Weedy vegetation was observed in the main channel, but biological soil crusts and ants have been noted in the braided channel areas indicating that there is minimal disturbance from flood events on these components of the terrestrial ecosystem. Terrestrial receptors observed included passerine birds, ants, and darkling beetles. Scat and tracks of coyote and elk were also present.

E-1.1.5 Reach CDB-3W

Site ID	CDB-3W
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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	Open ponderosa pine, juniper, scrub oak, and grasses.
Field notes on T&E habitat, if applicable	No habitat for T&E species is present in reach CDB-3W (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Terrestrial receptors are present in reach CDB-3W.

Contaminant Transport Information:

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

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	Physical disturbance to reach CDB-3W is minimal. Sediment transport is limited. However, tire tracks leading from the access road to the reach floodplain were observed.
Are there obvious ecological effects?	No

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

No Exposure/Transport Pathways:

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

Adequacy of Site Characterization:

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

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
Sediment transport and flooding in this reach is minimal, as evidenced by trees that do not show significant signs of burial by sediments. Ant nests were also noted in the active channel, which supports the lack of persistent surface water flow in the reach. There are some areas where water may pond near the road that is adjacent to the reach and a small area (less than a 1 m^2) of damp ground was noted. Persistent aquatic communities and exposure pathways were not indicated by this observation. Vegetation observed included ponderosa pine, apache plume, currant, sagebrush, juniper, piñon, and grasses. Soil biological crusts were also observed. Terrestrial animals observed included ants and passerine birds. Burrowing activity and elk scat were also noted.

E-1.1.6 Reach CDBS-1E

Site ID	CDBS-1E
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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	Open ponderosa pine, piñon, juniper, sagebrush and grasses
Field notes on T&E habitat, if applicable	Very low-quality roosting and foraging habitat for the Mexican spotted owl is present in reach CDBS-1E (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Terrestrial receptors are present in reach CDBS-1E

Contaminant Transport Information:

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

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	Physical disturbance to reach CDBS-1E is minimal. Presence of occupied ant mounds and cryptogamic soil crust in the active channel indicate that the area experiences infrequent surface flow.

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

No Exposure/Transport Pathways:

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

Adequacy of Site Characterization:

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

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
The reach has a well-defined active channel but it has little evidence for frequent flow even from storm events. There are numerous ant nests in the channel, which is basically terrestrial in all regards. Terrestrial plants observed in reach CDBS-1E included rocky mountain juniper, piñon, sagebrush, currant, and several herbaceous and grassy species. Soil biological crusts were noted in the reach. Animal receptors observed at reach CDBS-1E included ants, striped whiptail lizard, and passerine birds. Deer, elk, and coyote scat were also observed. Fossorial activity was evident in the reach.

E-1.1.7 Reach CDBS-1W

Site ID	CDBS-1W
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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	Ponderosa pine, scrub oak and grass.
Field notes on T&E habitat, if applicable	Moderate-quality roosting and foraging habitat for the Mexican spotted owl is present in reach CDBS-1W (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Terrestrial receptors are present in reach CDBS-1W. No aquatic receptors are present.

Contaminant Transport Information:

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

Ecological Effects Information:

Physical disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	Physical disturbance to reach CDBS-1W is minimal. Presence of occupied ant mounds and cryptogamic soil crust in the active channel indicate that the area is not frequented by overland flow.

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

No Exposure/Transport Pathways:

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

Adequacy of Site Characterization:

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

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
The reach has a well-defined active channel but it has little evidence for frequent flow from storm events. There are numerous ant nests in the channel, which is basically terrestrial in all regards. Bank cuts of the channeled streambed in reach CDBS-1W created before Laboratory construction and operation are still visible. Vegetation present in reach CDBS-1W included ponderosa pine, piñon, juniper, scrub oak, currant, sagebrush, chamisa, and several grasses. Terrestrial receptors observed included northern flicker, canyon wren, passerine birds, and striped whiptail lizards. Fossorial activity by small mammals and tracks/scat of elk were abundant. No aquatic community was present.

E-1.1.8 Reach CDB-4

Site ID	CDB-4
Date of Site Visit	4/30/3009
Site Visit Conducted by	J. Linville, S. Reneau, R. Ryti

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	Piñon, juniper, and grasses
Field notes on T&E habitat, if applicable	No habitat for T&E species is present in reach CDB-4 (Keller 2009, 106613).
Are ecological receptors present at the AOCs/SWMUs? **(yes/no/uncertain)** **Provide explanation.**	Terrestrial receptors are present in reach CDB-4.

Contaminant Transport Information:

Surface-water transport **field notes on the terminal point of surface water transport (if applicable)**	Surface water in reach CDB-4 is channelized ephemeral flow from stormwater runoff. Stormwater may resuspend and transport contaminants present in active channel sediment.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation.**	Yes, ephemeral surface water from stormwater serves as a transport pathway.
Interim action needed to limit off-site transport? **(yes/no/uncertain)** **Provide explanation/recommendation to project lead 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 CDB-4 shows evidence of transport and deposition of material following storm events or snowmelt runoff. Flow debris piles (driftwood, pine needles, leaves, and other material) are numerous in this reach, dissipating in size in the downstream direction.

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

No Exposure/Transport Pathways:

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

This section does not apply.

Adequacy of Site Characterization:

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

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.
The active channel is narrow and braided, with a sandy substrate and less vegetation than upstream reaches. Flow of ephemeral surface water is more evident than is infiltration. There is no evidence of ponding of water in this reach; instead the slope is relatively steep and water from storm events rapidly move through the reach. The reach is characterized by numerous basalt boulders and has deposits from past flood events, including black magnetite sands and silt deposits near the active stream channel. The active channel is fairly well-defined in this reach and is characterized by coarse sands within a fairly narrow basalt boulder confined channel. Passerine birds were observed in reach CDB-4. Coyote scat was also present. Fossorial mammal activity was not evident in the active channel.

E-1.2 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: There are no known sources of volatile organic compounds (VOCs) in affected media in Cañada del Buey. VOCs were detected in only 37 of 8513 results, represented by nine analytes. The lack of ubiquitous VOCs in the geomorphically active sediments is consistent with the basic processes of sediment transport, deposition, and remobilization. Thus, with little or no VOC source term in the canyons-affected media, exposure to terrestrial receptors via vapors is unlikely.

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

Question C:

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

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

Answer (likely/unlikely/uncertain): Unlikely

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

Question D:

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

Known or suspected presence of contaminants in groundwater.

- **The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1-m depth).**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: No persistent springs or seeps are present in Cañada del Buey.

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 may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1-m depth).**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: There is little alluvial groundwater in the watershed.

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: Mass wasting could lead to burial rather than exposure of contamination in the reaches.

<u>Question G</u>:

Could airborne contaminants interact with receptors through respiration of vapors?

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

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

Terrestrial Plants: 1

Terrestrial Animals: 1

Provide explanation: VOCs were infrequently detected at low concentrations in Cañada del Buey sediment samples.

<u>Question H</u>:

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.

<u>Question I</u>:

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

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

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

Terrestrial Plants: 2

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

Question J:

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

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

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

Terrestrial Animals: 3

Provide explanation: This is a potentially major pathway because bioaccumulating chemicals of potential concern (COPCs) were detected in Cañada del Buey sediment. While high explosive compounds were not detected in reach sediment, low concentrations of four polychlorinated biphenyl compounds (Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260) were detected in the 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 may dig through contaminated sediment and ingest dermal contamination while grooming.

Question L:

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

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

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

Terrestrial Animals: 2

Provide explanation: This is a minor pathway because of the type of COPCs present in Cañada del Buey (most are not lipophilic) and because 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.

<u>Question M</u>:

Could contaminants interact with plants or animals through external irradiation?

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

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

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: Gamma-emitting radionuclides (cesium-137 and uranium-235) were infrequently detected in sediment samples at concentrations above background. Concentrations for radionuclide COPCs were less than 2 times background concentrations.

<u>Question N</u>:

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

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

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

Terrestrial Plants: 0

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

<u>Question O</u>:

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

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

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

Terrestrial Animals: 0

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

<u>Question P</u>:

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

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

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

Terrestrial Animals: 0

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

<u>Question Q</u>:

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

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

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

Terrestrial Animals: 0

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

<u>Question R</u>:

Could contaminants in water or sediment interact with plants or animals through external irradiation?

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

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

Terrestrial Plants: 0

Terrestrial Animals: 0

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

<u>Question S</u>:

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

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

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

Aquatic Plants/Emergent Vegetation: 0

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

<u>Question T</u>:

Could contaminants in water or sediment bioconcentrate in sedimentary or water column organisms?

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

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

Aquatic Animals: 0

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

<u>Question U</u>:

Could contaminants bioaccumulate in sedimentary or water column organisms?

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

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

Aquatic Animals: 0

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

<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):

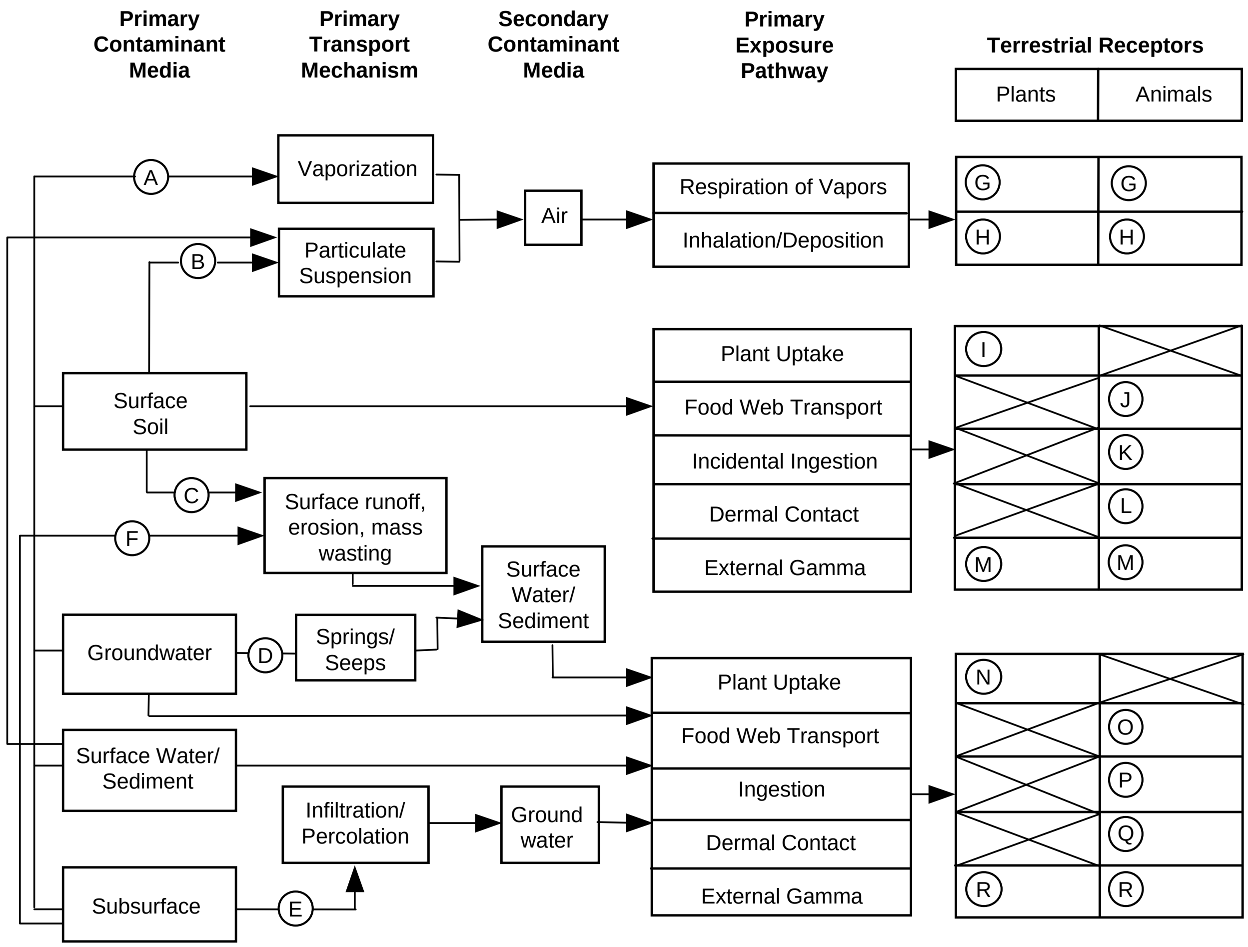
Aquatic Plants: 0

Aquatic Animals: 0

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

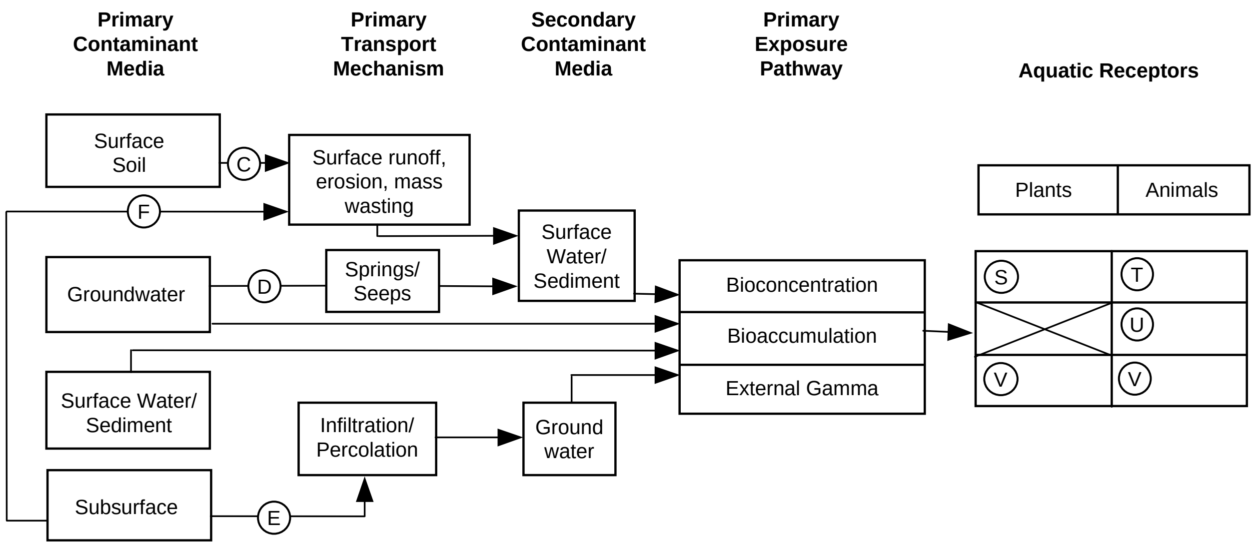
Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

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 Linville

Organization: Neptune and Company, Inc.

Phone number: (505) 662-0707, ext. 37

Date completed: 7/23/09

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: LANL

Phone number: (505) 665-6953

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

As discussed in Section 8.1.5, most chemicals of potential ecological concern (COPECs) identified for Cañada del Buey have biota study–relevant data from previous canyons investigations. This appendix presents relevant COPEC exposure data for each Cañada del Buey 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-2.0-1 is included in Attachment E-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).

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 or that are not censored at the detection limit and that are reported as the actual measurement value from the instrument with a nondetect qualifier (radionuclides). 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 4.00.04 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 4.00.04, 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

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.

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 4.00.04 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 (i.e. the next highest calculated UCL less than the maximum detected value). This approach is consistent with EPA guidance (EPA 2007, 102895). The calculated EPCs based upon the ProUCL UCLs for sediments are provided in Tables 8.2-9 and E-3.2-1. ProUCL data and assorted files are attached in Attachment E-2 on CD.

E-3.3 Supplemental Human Health Risk Scenario

The SSLs used for the supplemental human health risk scenario (residential) are provided in Table E-3.3-1. The risk assessment results for the residential scenario are provided in Table E-3.3-2. The ratios and sum of fraction values for the residential scenario are provided in Table E-3.3-3. Sediment EPCs used for this analysis are provided in Table 8.2-9 and E-3.2-1. Residential carcinogenic incremental lifetime cancer risks exceed 1×10^{-5} for all reaches evaluated, except CDB-3E, due to arsenic (Tables E-3.3-2 and E-3.3-3). The noncarcinogenic chemical hazard criterion does not exceed 1.0 in either of the two reaches that were evaluated (Tables E-3.3-2 and E-3.3-3).

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.

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

EPA (U.S. Environmental Protection Agency), April 2007. "ProUCL Version 4.00.02 User Guide," EPA/600/R-07/038, Office of Research and Development, Washington, D.C. (EPA 2007, 102895)

EPA (U.S. Environmental Protection Agency), April 2007. "ProUCL Version 4.0 Technical Guide," EPA/600/R-07/041, Office of Research and Development, Washington, D.C. (EPA 2007, 106124)

Keller, D., June 22, 2009. "Review of Reaches in the Cañada del Buey System for Threatened and Endangered Species Habitat for the Purpose of Ecological Screening/Risk Assessment," Los Alamos National Laboratory memorandum (ENV-EAQ:09-145) to S. Reneau (EES-16) from D. Keller (ENV-EAQ), Los Alamos, New Mexico. (Keller 2009, 106613)

LANL (Los Alamos National Laboratory), September 1999. "Work Plan for Sandia Canyon and Cañada del Buey," Los Alamos National Laboratory document LA-UR-99-3610, Los Alamos, New Mexico. (LANL 1999, 064617)

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)

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

Parameters	Residential Values[a]	Recreational Values[b] **(Adult Trail User and Child Extended Backyard)**
Target 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)	ED[c] × 365 d	ED × 365 d
Skin absorption factor	SVOC = 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)	$mg/kg\text{-}d^{-1}$	$mg/kg\text{-}d^{-1}$
Cancer slope factor–inhalation (chemical-specific)	$mg/kg\text{-}d^{-1}$	$mg/kg\text{-}d^{-1}$
Exposure frequency	350 d/yr	200 event/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

Table E-3.1-1 (continued)

Parameters	Residential Values[a]	Recreational Values[b] (Adult Trail User and Child Extended Backyard)
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

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

[a] Parameter values from NMED (2006, 092513).

[b] Parameter values from LANL (2007, 094496).

[c] ED = Exposure duration.

[d] n/a = Not applicable.

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

Table E-3.2-1
EPCs for Sediment COPCs

Reach	Analyte	Number Detects	Number non-Detects	% Number Detects	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Standard Deviation (mg/kg)	Skewness (mg/kg)	Coefficient of Variation	UCL (mg/kg)	UCL Method
CDB-1	Arsenic	20	0	0%	2.67	7.07	4.809	4.715	1.403	0.0736	0.292	5.351	95% Student's-t UCL
CDB-2C	Arsenic	27	0	0%	1.6	8.88	4.628	4.59	1.936	0.503	0.418	5.263	95% Student's-t UCL
CDB-2W	Arsenic	20	0	0%	1.52	6.89	4.687	4.555	1.528	-0.642	0.326	5.278	95% Student's-t UCL
CDB-3E	Aluminum	10	0	0%	2060	25,000	11,892	11,600	6576	0.426	0.553	15,704	95% Student's-t UCL
CDB-3E	Arsenic	10	0	0%	0.544	5.71	2.711	2.75	1.414	0.482	0.521	3.531	95% Student's-t UCL
CDB-3E	Cobalt	10	0	0%	0.527	8.73	3.783	3.76	2.158	1.026	0.57	5.034	95% Student's-t UCL
CDB-3E	Iron	10	0	0%	3320	23,800	11,334	11,000	5619	0.848	0.496	14,591	95% Student's-t UCL
CDB-3W	Arsenic	20	0	0%	3.16	8.55	5.452	5.87	1.545	-0.09	0.283	6.049	95% Student's-t UCL
CDB-4	Cobalt	29	0	0%	2.2	9.3	5.345	5.4	1.928	0.176	0.361	5.954	95% Student's-t UCL
CDB-4	Iron	29	0	0%	4500	21,200	11,453	12,000	3854	0.254	0.336	12,671	95% Student's-t UCL
CDB-4	Thallium	4	25	86%	0.43	1.1	0.748	0.73	0.294	0.262	0.393	0.877	95% KM (Percentile Bootstrap) UCL
CDBS-1E	Arsenic	20	0	0%	1.39	6.53	4.737	5.175	1.386	-1.231	0.293	5.272	95% Student's-t UCL
CDBS-1W	Arsenic	20	0	0%	1.9	7.12	4.93	4.905	1.474	-0.324	0.299	5.499	95% Student's-t UCL

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

COPC	End Point	Target Adverse-Effect Level	Residential SSL (mg/kg)
Aluminum	nc	HQ = 1	78,100
Arsenic	ca	Risk = 10^{-5}	3.9
Cobalt*	nc	HQ = 1	23
Iron	nc	HQ = 1	23,500
Thallium	nc	HQ =1	5.16

Notes: Residential SLs are from NMED (2009, 106420), unless otherwise noted.
* EPA regional SSLs. EPA SLs: http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm. NMED SLs: (2009, 106420).
nc = Noncarcinogen.
HQ = Hazard quotient.

Table E-3.3-2
Summary of Residential Risk Assessment Results

Reach	Total Sediment Risk	Total Sediment HI
CDB-1	1.4E-05	—*
CDB-2C	1.3E-05	—
CDB-2W	1.4E-05	—
CDB-3E	9.1E-06	1.0
CDB-3W	1.6E-05	—
CDBS-1E	1.4E-05	—
CDBS-1W	1.4E-05	—

Note: Shaded cells exceed 10^{-5} carcinogenic risk.
* — Incomplete pathway.

Table E-3.3-3
Risk Ratios Based on EPCs for Sediment, Residential Scenario

Carcinogens

Reach	Arsenic	Total Risk Ratio	Total Risk
Residential SL (mg/kg)	3.9		
CDB-1	1.37	1.37	1.4E-05
CDB-2C	1.35	1.35	1.3E-05
CDB-2W	1.35	1.35	1.4E-05
CDB-3E	0.91	0.91	9.1E-06
CDB-3W	1.55	1.55	1.6E-05
CDBS-1E	1.35	1.35	1.4E-05
CDBS-1W	1.41	1.41	1.4E-05

Noncarcinogens

Reach	Aluminum	Cobalt {1}	Iron	Total Risk Ratio	Total HI
Residential SL (mg/kg)	78,100	23	23,500		
CDB-3E	0.20	0.22	0.62	1.04	1.0

Notes: Shaded cells exceed 10^{-5} carcinogenic risk. Residential SLs are from NMED (2009, 106420), unless otherwise noted. (1) EPA regional SSLs. EPA SLs: http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm. NMED SLs: (2009, 106420).

Attachment E-1

Sediment Samples for Terrestrial Receptors
(on CD included with this document)

Attachment E-2

ProUCL Data and Associated Files
(on CD included with this document)

Appendix F

Summary of Stormwater Analytical Results

This appendix presents a summary of the stormwater results collected within Cañada del Buey from 2003 to 2009 (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
Cañada del Buey 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
Cañada del Buey above SR-4	Filtered	INORGANIC	Aluminum	14	12	2	826	346	1490	4	750	µg/L
Cañada del Buey above SR-4	Filtered	INORGANIC	Copper	14	7	7	3.04	2.04	4.6	1	4.3	µg/L
Cañada del Buey above SR-4	Nonfiltered	RAD	Gross alpha	11	11	0	303	65.5	979	11	15	pCi/L
Cañada del Buey above SR-4	Nonfiltered	INORGANIC	Mercury	13	6	7	0.407	0.098	1.29	1	0.77	µg/L
Cañada del Buey above SR-4	Nonfiltered	INORGANIC	Selenium	14	2	12	7.81	2.42	13.2	1	5	µg/L
Cañada del Buey near MDA G	Nonfiltered	RAD	Gross alpha	1	1	0	24.3	24.3	24.3	1	15	pCi/L
Cañada del Buey near MDA G	Nonfiltered	INORGANIC	Mercury	3	2	1	0.586	0.052	1.12	1	0.77	µg/L
Cañada del Buey near TA-46	Filtered	INORGANIC	Aluminum	7	5	2	1970	22.4	7690	2	750	µg/L
Cañada del Buey near TA-46	Nonfiltered	ORGANIC	Aroclor-1254	5	1	4	0.083	0.083	0.083	1	0.00064	µg/L
Cañada del Buey near TA-46	Filtered	INORGANIC	Copper	7	3	4	5.37	2	11	1	4.3	µg/L
Cañada del Buey near TA-46	Nonfiltered	RAD	Gross alpha	5	4	1	57.3	7.14	108	3	15	pCi/L
Cañada del Buey near TA-46	Filtered	INORGANIC	Zinc	7	3	4	30.9	5.3	45.2	2	42	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 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	—[a]	—	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[b]	Filtered	Copper, dissolved	7440-50-8	500	—	—	4.3
Lead[b]	Filtered	Lead, dissolved	7439-92-1	100	—	—	17.0
Mercury	Nonfiltered	Mercury	7439-97-6	10	0.77	—	1.4
Nickel[b]	Filtered	Nickel, dissolved	7440-02-0	—	—	4600	169
Selenium	Nonfiltered	Selenium	7782-49-2	50	5.0	4200	20.0
Silver[b]	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[b]	Filtered	Zinc, dissolved	7440-66-6	25,000	—	26,000	42
Cyanide, weak acid dissociable[c]	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

Table F-1.0-2 (continued)

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

Notes: 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). WQCC comparison values from State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC).

[a] — = None available.

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

[c] Results for cyanide, amenable to chlorination is compared to screening value for cyanide, weak acid.

Appendix G

Technical Letter Supporting Alluvial Wells Waiver

G-1.0 INTRODUCTION

This appendix presents a duplicate copy of a letter sent from Los Alamos National Laboratory to the New Mexico Environment Department (NMED), dated February 27, 2009 (LANL 2009, 105287). The letter presents data that indicate that the perched zone observed at CDBO-6 is of limited extent and has minimal contamination at very low concentrations (LANL 2009, 105287). The information was used to support a request to waive the installation of seven alluvial wells, as requested by NMED (LANL 2005, 091542). The information presented in this letter also supports the hydrologic conceptual model presented in Section 7.2 of this report.

The letter is an exact copy of that sent to NMED. No reformatting of text or figures has been done.

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

LANL (Los Alamos National Laboratory), July 29, 2005. "Response to the Notice of Disapproval for the Work Plan for Sandia Canyon and Cañada del Buey," Los Alamos National Laboratory document LA-UR-05-5776, Los Alamos, New Mexico. (LANL 2005, 091542)

LANL (Los Alamos National Laboratory), February 27, 2009. "Request to Waive Requirement to Install Additional Alluvial Wells in Cañada del Buey," Los Alamos National Laboratory letter (EP2009-0123) to J.P. Bearzi (NMED-HWB) from M.J. Graham (LANL) and D.R. Gregory (DOE-LASO), Los Alamos, New Mexico. (LANL 2009, 105287)

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Date: February 27, 2009
Refer To: EP2009-0123

James P. Bearzi, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Request to Waive Requirement to Install Additional Alluvial Wells in Cañada del Buey

Dear Mr. Bearzi:

This letter is provided to follow-up and to document the Los Alamos National Laboratory's (the Laboratory's) recommendation to waive the New Mexico Environment Department's (NMED's) requirement to install seven additional alluvial wells in Cañada del Buey (CdB). The technical basis for the Laboratory's request was presented in a meeting with NMED on December 10, 2008, and is presented as an attachment to this letter. The Laboratory proposes additional work herein that will enhance the conceptual model for the hydrology and geochemistry in CdB. The updated conceptual model that will likely derive from these new data will be presented in the CdB investigation report, due to NMED on August 31, 2009.

The requirement to install the seven alluvial wells in CdB comes from NMED's "Notice of Disapproval, Work Plan for Sandia Canyon and Cañada del Buey, Los Alamo National Laboratory." This action was agreed to by the Laboratory in its "Response to the Notice of Disapproval on the Work Plan for Sandia Canyon and Cañada del Buey." Since that time, the Laboratory has obtained and compiled data not previously presented to NMED prior to the December 10, 2008, meeting to substantiate its request to waive the requirement. The technical basis for the request is provided below.

A small, spatially limited saturated zone is observed below Cañada del Buey within Unit 1v-c of the Tshirege Member of the Bandelier Tuff (Qbt 1v–c), which lies stratigraphically below the alluvium at CdBO-6 and CdBO-7 (see cross-section, Attachment 1). This zone does not appear to extend as far to the east as CdBM-1 (see map, Attachment 2), as illustrated by the moisture profile for that borehole (Attachment 3), potentially because Qbt 1v–c pinches out to the east. The figure in Attachment 4 represents neutron-log moisture data from several instrumented boreholes in the vicinity of Material Disposal Area (MDA) H. The curves represent two modes of neutron-log data: an open borehole and a borehole a liner installed. The increases in relative moisture content are approximately aligned with Unit 1v–c at approximately 150-ft depth in boreholes 54-01023 and 54-15462. An increase in moisture content at the base of Unit 1 v–c is observed in core samples collected across the Laboratory and is thought to be from the fine-grained nature of the rocks in that horizon. However, these data may also indicate a lateral component of transport of pore moisture from either CdB or the Pajarito Canyon Watershed (specifically Threemile Canyon) where Unit 1v–c has also shown indication of increased moisture content. Notably, during recent drilling at R-37, just to the southeast of CdBO-6 and CdBO-7, water was not observed within the Unit 1v–c interval.

Saturated conditions have never been observed in the alluvium in CdB either during drilling or during periodic monitoring of 11 wells located in the canyon (wells CDBO-1 through CDBO-9 and CDBM-1 and CDBM-2, Attachment 2).

In exploring the source of the water found in CdBO-6 and CdBO-7, records from stormwater gage stations in CdB were used to correlate to water-level responses in CdBO-6 and CdBO-7 (Attachment 5). These data show that the water levels in the wells appear to respond to precipitation and runoff events recorded at nearby rain and runoff gages, indicating that stormwater runoff is the predominant source of recharge to these two wells. Other possible sources of recharge water to CdBO-6 and CdBO-7 were evaluated, including PM-4 purge water and potential leaks from the sanitary wastewater treatment plant, but the signature of those waters are not similar (Attachment 6). Analytical results from the alluvial wells are provided in Attachment 7 and indicate few contaminants and at low concentrations. In general, the alluvial groundwater and sediment within CdB have very limited contamination and at low concentrations. The sediment investigation reach CdB-4 (above NM 4) was found to be noncontaminated as presented in the "Evaluation of Possible Sediment Contamination in the White Rock Land Transfer Parcel: Reach CdB-4," prepared in October 2000.

Per the December 10, 2008 meeting with NMED, the following actions will be, or have already been, implemented by the Laboratory to build on the conceptual model for CdB.

- Pressure transducers were added to wells CdBO-4, CdBO-5, CdBO-8 and CdBO-9 in early January 2009 to evaluate whether transient saturation occurs following storm events and if so, whether the saturation is sufficiently long-lived to allow for sampling. In the past, these wells were only manually checked periodically for saturation.

- Nitrogen isotopes will be added to the analytical suite in wells CdBO-6 and CdBO-7. These isotope data may be useful for further understanding potential sources of the groundwater.

- The Laboratory will attempt to purge well CdBO-6 dry during the next sampling event to monitor recovery. This may provide information on the amount of groundwater and/or the recharge rate into the well.

The Laboratory believes that the information presented in this letter and attachments provide the basis for NMED to waive the requirement for installation of the seven additional alluvial wells. The Laboratory fully understands that new information could warrant reconsideration of the need for additional wells or other investigations, especially in light of corrective measures projects at Technical Area 54 MDAs.

If you have any questions, please contact Danny Katzman at (505) 667-6333 (katzman@lanl.gov) or Suzy Schulman at (505) 606-1962 (sschulman@doeal.gov).

Sincerely,

Michael J. Graham, Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,

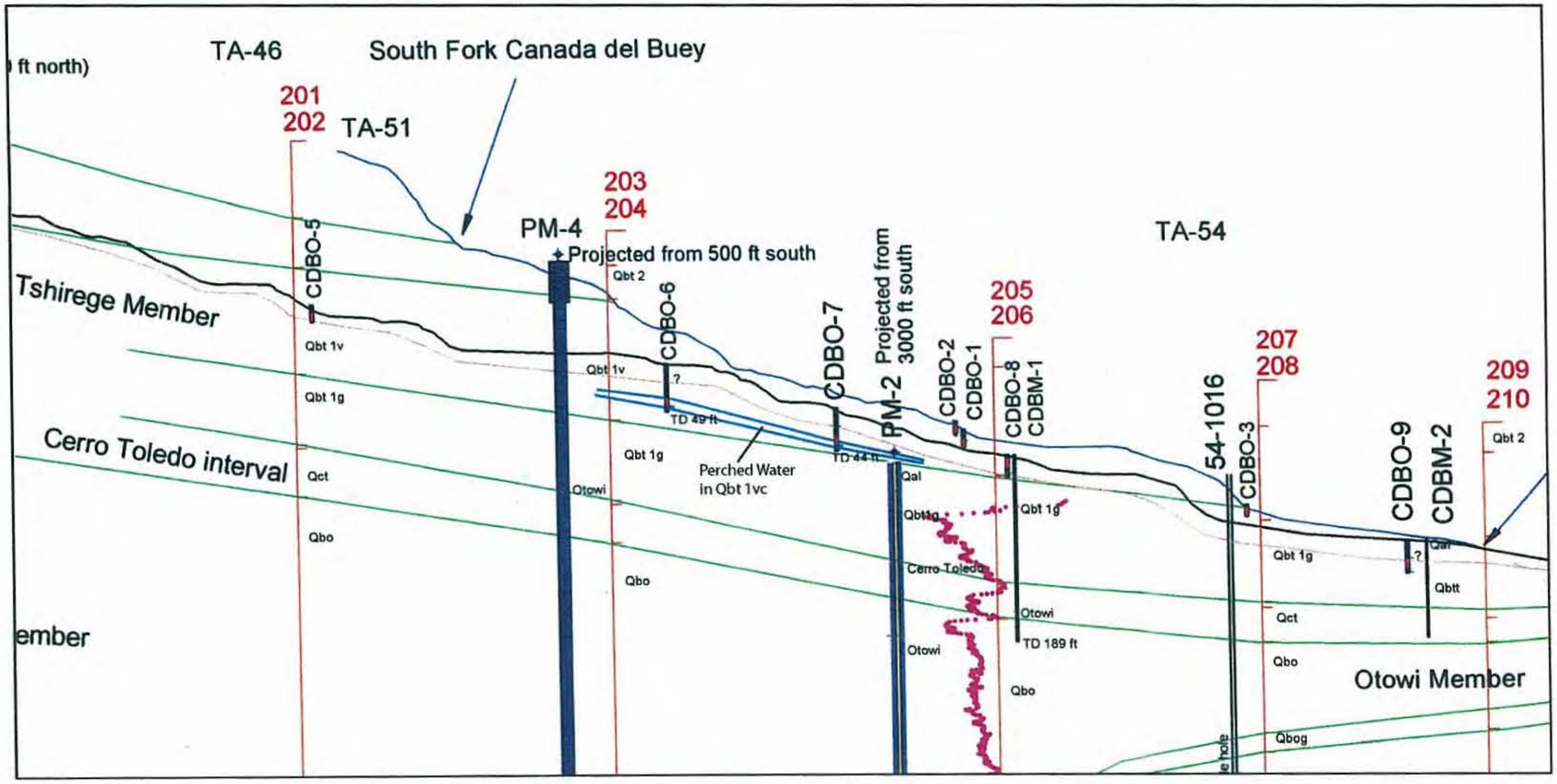
David R. Gregory, Project Director
Environmental Operations
Los Alamos Site Office

MG/DG/PH/DK:sm

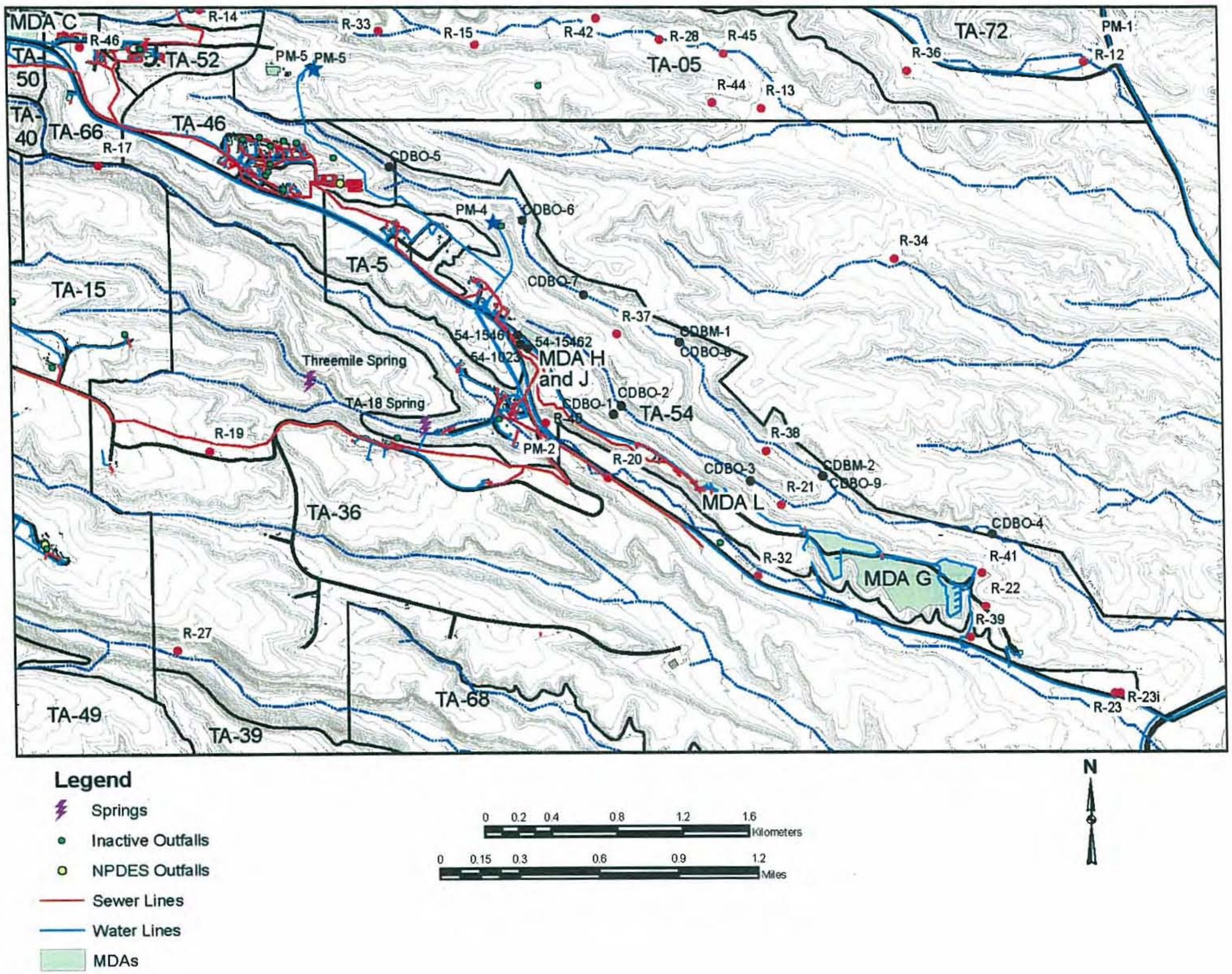
Enclosures: List of attachments (LA-UR-09-1135)

(1) Attachment 1: Geologic cross section of Cañada del Buey near CdBO-6 and CdBO-7
(2) Attachment 2: Map View of Cañada del Buey
(3) Attachment 3: Moisture data for CDBM-1 in Cañada del Buey
(4) Attachment 4: Moisture monitoring results for MDA H boreholes (% by volume)
(5) Attachment 5: CdBO-6 water level data, adjusted CdBO-7 water level data, stream flow data from Gages E218 and E230, and TA-54 precipitation data
(6) Attachment 6: Trilinear diagram showing major ion water chemistry at wells CdBO-6, R-37, R-40 and PM-4, TA-18 Spring, Threemile Spring, and surface-water samples collected near TA-46
(7) Attachment 7: Frequency-of-detection table for CdBO-6

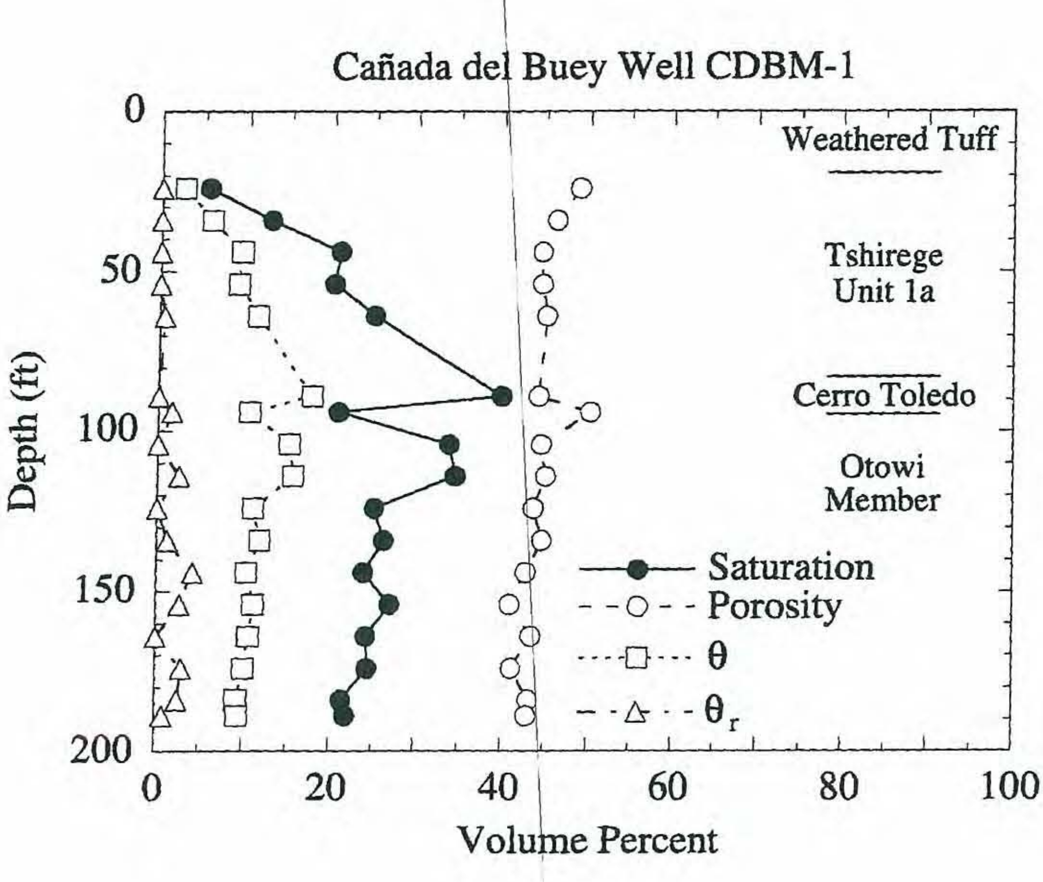
Cy: Laurie King, EPA Region 6, Dallas, TX
Steve Yanicak, NMED-OB, White Rock, NM
Tom Skibitski, NMED-OB, Santa Fe, NM
Keyana DeAguero, DOE-LASO (date-stamped letter emailed)
Suzy Schulman, DOE-LASO, MS A316
Danny Katzman, EP-LWSP, MS M992
Paul Huber, EP-LWSP, MS M992
Michael J. Graham, ADEP, MS M991
Alison M. Dorries, WES-DO, MS M992
Kristine Smeltz, WES-DO, MS M992
EP-LWSP File, MS M992
RPF, MS M707
IRM-RMMSO, MS A150 (date-stamped letter emailed)



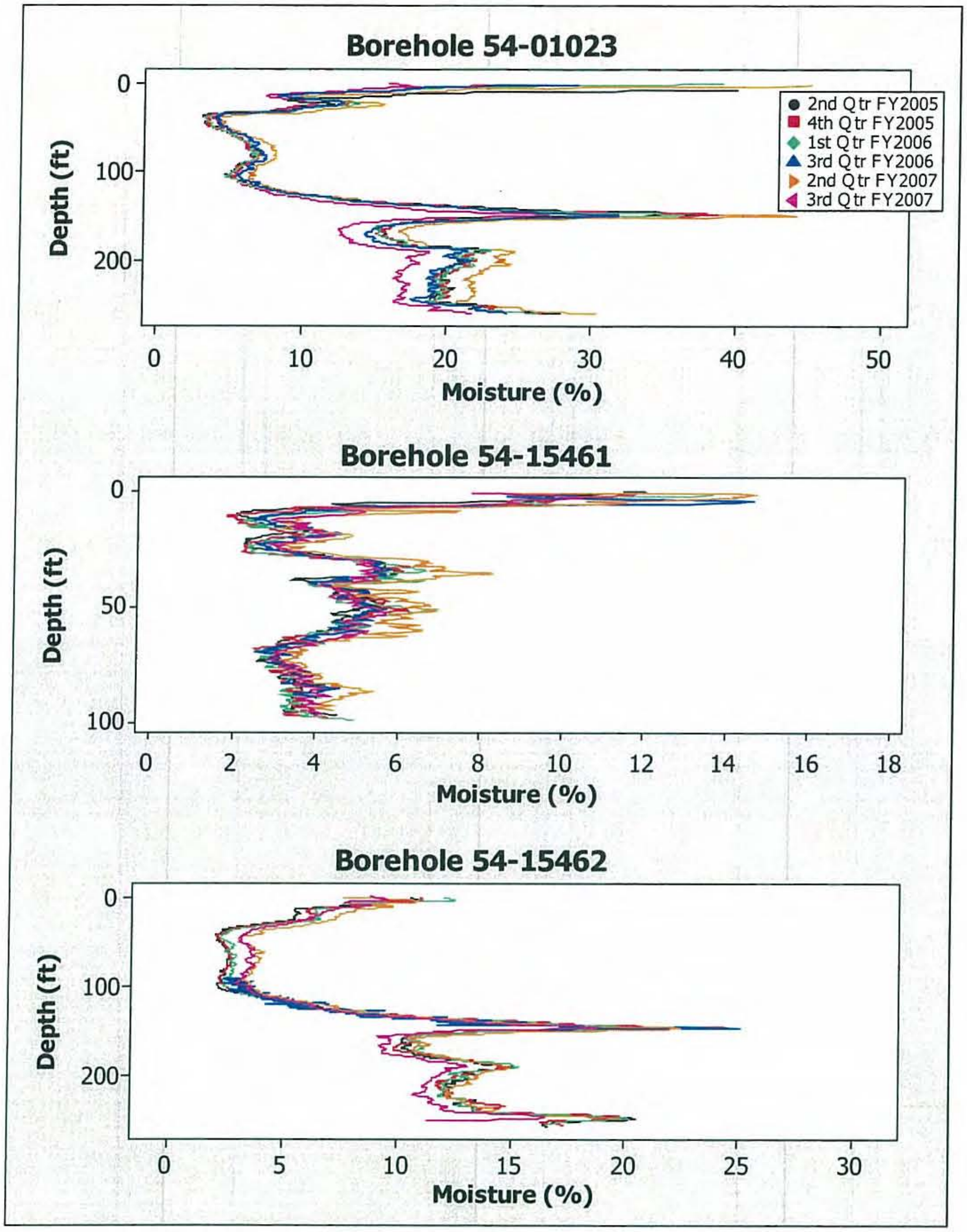
Attachment 1. Geologic cross-section of Cañada del Buey near CdBO-6 and CdBO-7



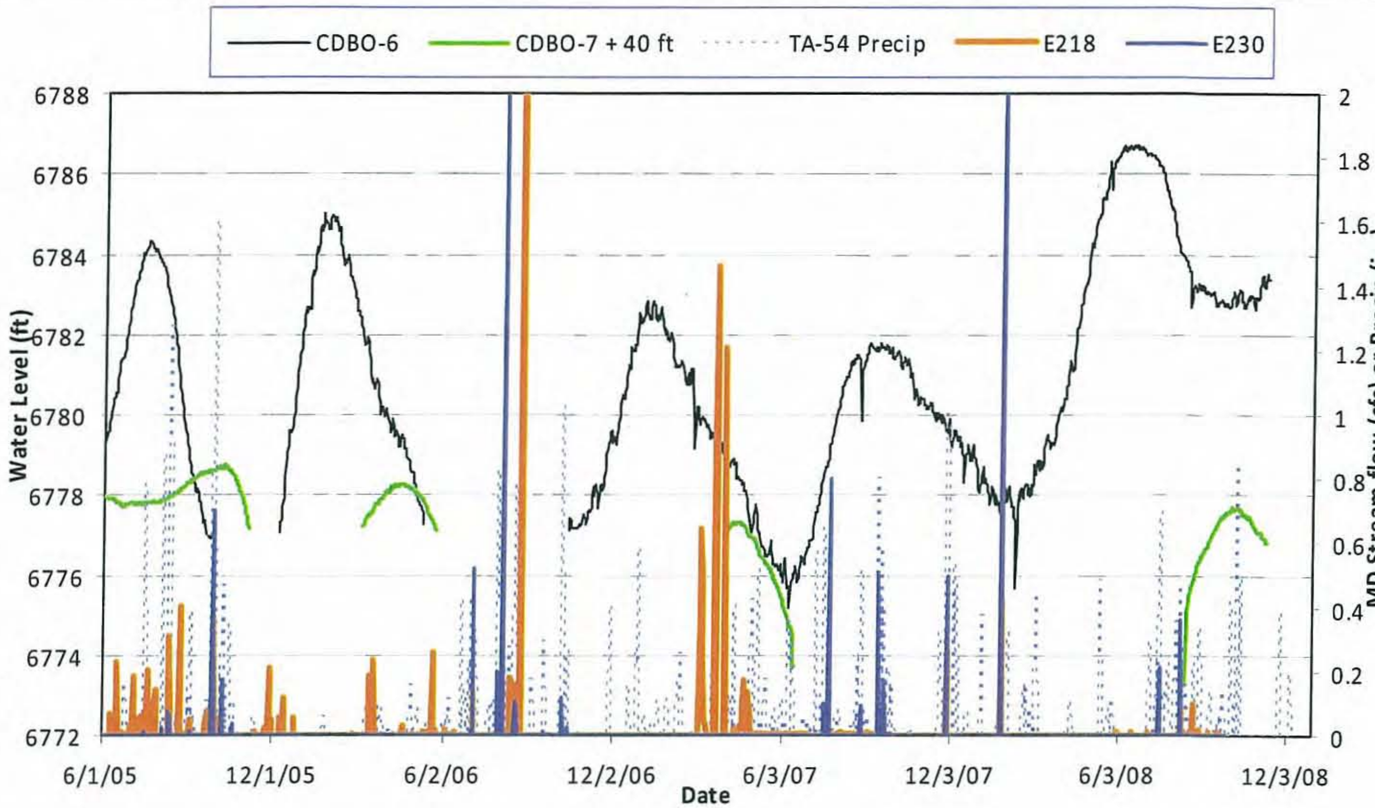
Attachment 2. Map view of Cañada del Buey



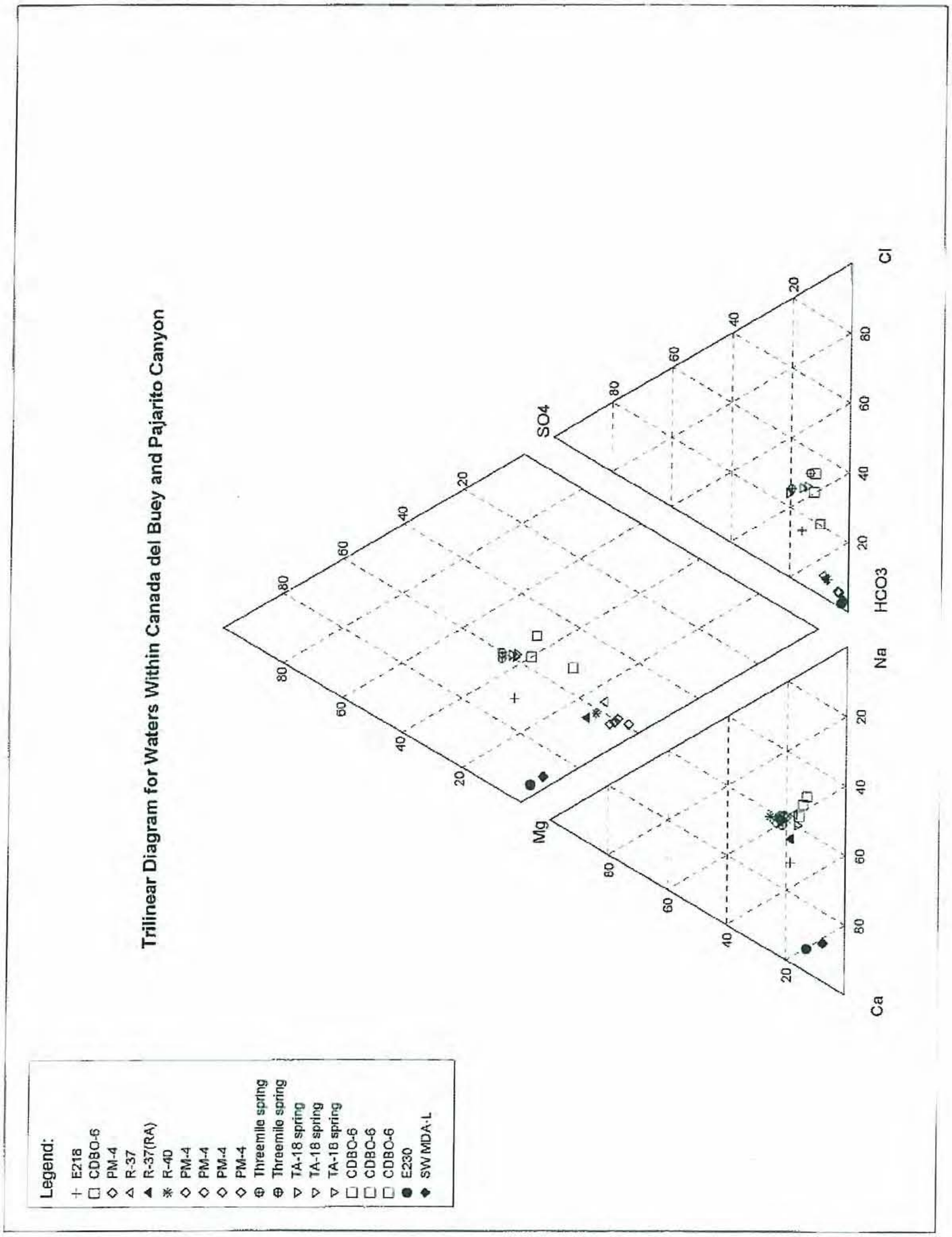
Attachment 3. Moisture data for CDBM-1 in Cañada del Buey. Note that volumetric water content (θ) is less than 20% over length of borehole and Qbt 1v–c (Unit 1b of theTshirege Member in this nomenclature) is absent.



Attachment 4. Moisture monitoring results for MDA H boreholes (% by volume)



Attachment 5. CdBO-6 water-level data, adjusted CdBO-7 water-level data, stream flow data from Gages E218 and E230, and TA-54 precipitation data. Note: the CdBO-6 transducer was lowered from 6776.2 to 6773.2 ft on 04/30/07; the CdBO-7 water level was adjusted upwards by 40 ft so it could be superimposed on this plot.



Attachment 6. Trilinear diagram showing major ion water chemistry at wells CdBO-6, R-37, R-40, and PM-4, TA-18 Spring, Threemile Spring, and surface-water samples collected near TA-46

Attachment 7,
CdBO-6 Frequency of Detection Table

Location	Port Depth (ft)	Suite	Analyte	F/UF	Units	No of Analyses	No of Detects	Min	Avg	Max	Standard	Standard Source
CDBO-6	34	Diox/Fur	Heptachlorodibenzodioxin[1,2,3,4,6,7,8-]	UF	ug/L	3	0	(0.00000237)	(0.00000258)	(0.00000269)		
CDBO-6	34	Diox/Fur	Heptachlorodibenzodioxins (Total)	UF	ug/L	3	0	(0.00000237)	(0.00000258)	(0.00000269)		
CDBO-6	34	Diox/Fur	Heptachlorodibenzofuran[1,2,3,4,6,7,8-]	UF	ug/L	3	0	(0.000000778)	(0.00000129)	(0.00000217)		
CDBO-6	34	Diox/Fur	Heptachlorodibenzofuran[1,2,3,4,7,8,9-]	UF	ug/L	3	0	(0.000000935)	(0.00000143)	(0.00000229)		
CDBO-6	34	Diox/Fur	Heptachlorodibenzofurans (Total)	UF	ug/L	3	0	(0.000000843)	(0.00000135)	(0.00000223)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzodioxin[1,2,3,4,7,8-]	UF	ug/L	3	0	(0.0000019)	(0.00000224)	(0.00000274)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzodioxin[1,2,3,6,7,8-]	UF	ug/L	3	0	(0.00000197)	(0.00000225)	(0.00000265)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzodioxin[1,2,3,7,8,9-]	UF	ug/L	3	0	(0.00000184)	(0.00000216)	(0.00000261)	0.000108438	Reg6
CDBO-6	34	Diox/Fur	Hexachlorodibenzodioxins (Total)	UF	ug/L	3	0	(0.0000019)	(0.00000222)	(0.00000266)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzofuran[1,2,3,4,7,8-]	UF	ug/L	3	0	(0.000000647)	(0.000000759)	(0.000000974)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzofuran[1,2,3,6,7,8-]	UF	ug/L	3	0	(0.000000686)	(0.000000796)	(0.00000101)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzofuran[1,2,3,7,8,9-]	UF	ug/L	3	0	(0.00000105)	(0.00000127)	(0.00000165)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzofuran[2,3,4,6,7,8-]	UF	ug/L	3	0	(0.000000752)	(0.000000867)	(0.00000108)		
CDBO-6	34	Diox/Fur	Hexachlorodibenzofurans (Total)	UF	ug/L	3	0	(0.000000773)	(0.000000909)	(0.00000116)		
CDBO-6	34	Diox/Fur	Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-]	UF	ug/L	2	1	0.00000876	0.00000876	0.00000876		
CDBO-6	34	Diox/Fur	Octachlorodibenzofuran[1,2,3,4,6,7,8,9-]	UF	ug/L	3	0	(0.00000152)	(0.00000254)	(0.00000316)		
CDBO-6	34	Diox/Fur	Pentachlorodibenzodioxin[1,2,3,7,8-]	UF	ug/L	3	0	(0.00000149)	(0.00000182)	(0.00000199)		
CDBO-6	34	Diox/Fur	Pentachlorodibenzodioxins (Total)	UF	ug/L	3	0	(0.00000149)	(0.00000216)	(0.00000299)		
CDBO-6	34	Diox/Fur	Pentachlorodibenzofuran[1,2,3,7,8-]	UF	ug/L	3	0	(0.00000124)	(0.00000154)	(0.00000169)		
CDBO-6	34	Diox/Fur	Pentachlorodibenzofuran[2,3,4,7,8-]	UF	ug/L	3	0	(0.00000112)	(0.0000014)	(0.00000166)		
CDBO-6	34	Diox/Fur	Pentachlorodibenzofurans (Totals)	UF	ug/L	3	0	(0.00000162)	(0.00000194)	(0.00000233)		
CDBO-6	34	Diox/Fur	Tetrachlorodibenzodioxin[2,3,7,8-]	UF	ug/L	3	0	(0.000000633)	(0.00000152)	(0.00000213)	0.00003	MCL
CDBO-6	34	Diox/Fur	Tetrachlorodibenzodioxins (Total)	UF	ug/L	3	0	(0.000000632)	(0.00000152)	(0.00000213)		
CDBO-6	34	Diox/Fur	Tetrachlorodibenzofuran[2,3,7,8-]	UF	ug/L	3	0	(0.000000668)	(0.00000147)	(0.00000214)		
CDBO-6	34	Diox/Fur	Tetrachlorodibenzofurans (Totals)	UF	ug/L	3	0	(0.000000669)	(0.00000147)	(0.00000214)		
CDBO-6	34	Geninorg	Alkalinity-CO3	F	mg/L	8	0	(0.725)	(1)	(1.45)		
CDBO-6	34	Geninorg	Alkalinity-CO3	UF	mg/L	2	0	(0.8)	(0.8)	(0.8)		
CDBO-6	34	Geninorg	Alkalinity-CO3+HCO3	F	mg/L	8	8	50.3	55.65	62.4		
CDBO-6	34	Geninorg	Alkalinity-CO3+HCO3	UF	mg/L	2	2	74.364	74.692	75.02		
CDBO-6	34	Geninorg	Alkalinity-HCO3	F	mg/L	2	2	54.2	58.25	62.3		
CDBO-6	34	Geninorg	Ammonia	F	mg/L	3	0	(0.2)	(0.2)	(0.2)		
CDBO-6	34	Geninorg	Ammonia	UF	mg/L	1	0	(0.2)	(0.2)	(0.2)		
CDBO-6	34	Geninorg	Ammonia as Nitrogen	F	mg/L	15	1	0.303	0.303	0.303	0.2085714	Reg6
CDBO-6	34	Geninorg	Bromide	F	mg/L	6	1	0.087	0.087	0.087		
CDBO-6	34	Geninorg	Calcium	F	mg/L	9	9	12.4	15.04	17.2		
CDBO-6	34	Geninorg	Calcium	UF	mg/L	5	5	14.6	17.08	24.2		
CDBO-6	34	Geninorg	Chloride	F	mg/L	16	16	14.7	19.16875	25.6	250	NMGSF
CDBO-6	34	Geninorg	Chloride	UF	mg/L	2	2	17.9	19.7	21.5		
CDBO-6	34	Geninorg	Cyanide (Total)	F	mg/L	2	1	0.00274	0.00274	0.00274	0.2	NMGSF
CDBO-6	34	Geninorg	Cyanide (Total)	UF	mg/L	6	1	0.00517	0.00517	0.00517	0.2	MCL
CDBO-6	34	Geninorg	Cyanide, Amenable to Chlorination	F	mg/L	1	1	0.00274	0.00274	0.00274	0.2	MCL
CDBO-6	34	Geninorg	Fluoride	F	mg/L	10	10	0.148	0.2087	0.229	1.6	NMGSF
CDBO-6	34	Geninorg	Fluoride	UF	mg/L	1	1	0.194	0.194	0.194	4	MCL
CDBO-6	34	Geninorg	Hardness	F	mg/L	9	9	42.9	51.84	59.3		
CDBO-6	34	Geninorg	Hardness	UF	mg/L	5	5	50.7	59.88	84.8		
CDBO-6	34	Geninorg	Magnesium	F	mg/L	9	9	2.91	3.47	3.95		

CDBO-6	34	Geninorg	Magnesium	UF	mg/L	5	5	3.44	4.182	5.92		
CDBO-6	34	Geninorg	Nitrate-Nitrite as Nitrogen	F	mg/L	18	14	0.0671	0.787	9.1	10	NMGSF
CDBO-6	34	Geninorg	Nitrate-Nitrite as Nitrogen	UF	mg/L	1	0	(0.1)	(0.1)	(0.1)	10	MCL
CDBO-6	34	Geninorg	Perchlorate	F	ug/L	6	6	0.298	0.338	0.352	24.5	Reg6
CDBO-6	34	Geninorg	Perchlorate	UF	ug/L	2	0	(1.45)	(1.915)	(2.38)	24.5	Reg6
CDBO-6	34	Geninorg	pH	F	SU	8	8	6.59	6.9275	7.13		
CDBO-6	34	Geninorg	pH	UF	mg/L	1	1	7.076	7.076	7.076		
CDBO-6	34	Geninorg	Potassium	F	mg/L	9	9	1.8	2.02	2.41		
CDBO-6	34	Geninorg	Potassium	UF	mg/L	5	5	2.13	2.726	4.14		
CDBO-6	34	Geninorg	Silicon Dioxide	F	mg/L	5	5	53	57.38	61		
CDBO-6	34	Geninorg	Silicon Dioxide	UF	mg/L	1	1	79.4	79.4	79.4		
CDBO-6	34	Geninorg	Sodium	F	mg/L	9	9	18.4	20.44	22.8		
CDBO-6	34	Geninorg	Sodium	UF	mg/L	5	5	19.1	21.04	23.2		
CDBO-6	34	Geninorg	Specific Conductance	F	uS/cm	8	8	52.1	185.5	219		
CDBO-6	34	Geninorg	Sulfate	F	mg/L	8	8	8.37	9.98	10.5	600	NMGSF
CDBO-6	34	Geninorg	Sulfate	UF	mg/L	1	1	7.91	7.91	7.91		
CDBO-6	34	Geninorg	Total Dissolved Solids	F	mg/L	15	15	112	165.8	205	1000	NMGSF
CDBO-6	34	Geninorg	Total Kjeldahl Nitrogen	F	mg/L	15	7	0.047	0.28	1		
CDBO-6	34	Geninorg	Total Kjeldahl Nitrogen	UF	mg/L	6	0	(0.01)	(0.10183)	(0.2)		
CDBO-6	34	Geninorg	Total Organic Carbon	UF	mg/L	5	3	1.44	1.74	2.04		
CDBO-6	34	Geninorg	Total Phosphate as Phosphorus	F	mg/L	8	7	0.054	0.152	0.22		
CDBO-6	34	Geninorg	Total Suspended Solids	UF	mg/L	6	6	25.6	123.9	181		
CDBO-6	34	Herb	D[2,4-]	UF	ug/L	1	0	(0.275)	(0.275)	(0.275)		
CDBO-6	34	Herb	Dalapon	UF	ug/L	1	0	(5.49)	(5.49)	(5.49)		
CDBO-6	34	Herb	DB[2,4-]	UF	ug/L	1	0	(0.275)	(0.275)	(0.275)		
CDBO-6	34	Herb	Dicamba	UF	ug/L	1	0	(0.275)	(0.275)	(0.275)		
CDBO-6	34	Herb	Dichlorprop	UF	ug/L	1	0	(0.275)	(0.275)	(0.275)		
CDBO-6	34	Herb	Dinoseb	UF	ug/L	1	0	(0.275)	(0.275)	(0.275)		
CDBO-6	34	Herb	MCPA	UF	ug/L	1	0	(54.9)	(54.9)	(54.9)		
CDBO-6	34	Herb	MCPP	UF	ug/L	1	0	(54.9)	(54.9)	(54.9)		
CDBO-6	34	Herb	T[2,4,5-]	UF	ug/L	1	0	(0.275)	(0.275)	(0.275)		
CDBO-6	34	Herb	TP[2,4,5-]	UF	ug/L	1	0	(0.275)	(0.275)	(0.275)		
CDBO-6	34	Hexp	2,4-Diamino-6-nitrotoluene	UF	ug/L	2	0	(1.3)	(1.3)	(1.3)		
CDBO-6	34	Hexp	2,6-Diamino-4-nitrotoluene	UF	ug/L	2	0	(1.3)	(1.3)	(1.3)		
CDBO-6	34	Hexp	3,5-Dinitroaniline	UF	ug/L	2	0	(1.3)	(1.3)	(1.3)		
CDBO-6	34	Hexp	Amino-2,6-dinitrotoluene[4-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)		
CDBO-6	34	Hexp	Amino-4,6-dinitrotoluene[2-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)		
CDBO-6	34	Hexp	Dinitrobenzene[1,3-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)	3.65	Reg6
CDBO-6	34	Hexp	Dinitrotoluene[2,4-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)		
CDBO-6	34	Hexp	Dinitrotoluene[2,6-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)		
CDBO-6	34	Hexp	HMX	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)	1825	Reg6
CDBO-6	34	Hexp	Nitrobenzene	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)		
CDBO-6	34	Hexp	Nitrotoluene[2-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)	2.92	Reg6
CDBO-6	34	Hexp	Nitrotoluene[3-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)	121.67	Reg6
CDBO-6	34	Hexp	Nitrotoluene[4-]	UF	ug/L	2	0	(0.649)	(0.649)	(0.649)	39.55	Reg6
CDBO-6	34	Hexp	PETN	UF	ug/L	2	0	(1.3)	(1.3)	(1.3)		
CDBO-6	34	Hexp	RDX	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)	6.1	Reg6
CDBO-6	34	Hexp	TATB	UF	ug/L	2	0	(1.3)	(1.3)	(1.3)		
CDBO-6	34	Hexp	Tetryl	UF	ug/L	2	0	(0.649)	(0.649)	(0.649)	146	Reg6

Attachment 7,
CdBO-6 Frequency of Detection Table

CDBO-6	34	Hexp	Trinitrobenzene[1,3,5-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)	1095	Reg6
CDBO-6	34	Hexp	Trinitrotoluene[2,4,6-]	UF	ug/L	2	0	(0.325)	(0.325)	(0.325)	22.4	Reg6
CDBO-6	34	Hexp	Tris (o-cresyl) phosphate	UF	ug/L	2	0	(1.3)	(1.3)	(1.3)		
CDBO-6	34	Metals	Aluminum	F	ug/L	9	9	133	554.33	2580	5000	NMGSF
CDBO-6	34	Metals	Aluminum	UF	ug/L	7	7	1050	4471.42	9460	36500	Reg6
CDBO-6	34	Metals	Antimony	F	ug/L	9	0	(0.153)	(0.937)	(2)	6	MCL
CDBO-6	34	Metals	Antimony	UF	ug/L	7	0	(0.203)	(1.069)	(2)	6	MCL
CDBO-6	34	Metals	Arsenic	F	ug/L	10	3	1.6	1.67	1.8	10	MCL
CDBO-6	34	Metals	Arsenic	UF	ug/L	8	2	1.7	1.95	2.2	10	MCL
CDBO-6	34	Metals	Barium	F	ug/L	10	10	78.1	96.94	163	1000	NMGSF
CDBO-6	34	Metals	Barium	UF	ug/L	8	8	83.5	144.68	462	2000	MCL
CDBO-6	34	Metals	Beryllium	F	ug/L	9	0	(0.158)	(2.146)	(5)	4	MCL
CDBO-6	34	Metals	Beryllium	UF	ug/L	7	2	0.343	2.4	4.5	4	MCL
CDBO-6	34	Metals	Boron	F	ug/L	9	5	31.1	38.34	58.1	750	NMGSF
CDBO-6	34	Metals	Boron	UF	ug/L	7	3	34.7	42.97	54.7	7300	Reg6
CDBO-6	34	Metals	Cadmium	F	ug/L	10	3	0.048	0.872	1.4	5	MCL
CDBO-6	34	Metals	Cadmium	UF	ug/L	8	2	0.13	0.15	0.179	5	MCL
CDBO-6	34	Metals	Chromium	F	ug/L	10	2	1.1	1.5	1.9	50	NMGSF
CDBO-6	34	Metals	Chromium	UF	ug/L	8	3	2.53	3.74	5.5	100	MCL
CDBO-6	34	Metals	Cobalt	F	ug/L	9	3	3.4	16.97	44.1	50	NMGSF
CDBO-6	34	Metals	Cobalt	UF	ug/L	7	3	2.12	4.17	6.39	730	Reg6
CDBO-6	34	Metals	Copper	F	ug/L	9	2	2.8	3.4	4	1000	NMGSF
CDBO-6	34	Metals	Copper	UF	ug/L	8	2	2.39	3.045	3.7	1300	MCL
CDBO-6	34	Metals	Iron	F	ug/L	10	7	83.9	353.7	1310	1000	NMGSF
CDBO-6	34	Metals	Iron	UF	ug/L	8	8	432	2543.9	8330	25550	Reg6
CDBO-6	34	Metals	Lead	F	ug/L	10	3	0.334	2.65	4.3	15	MCL
CDBO-6	34	Metals	Lead	UF	ug/L	8	5	0.61	2.77	6.8	15	Reg6
CDBO-6	34	Metals	Manganese	F	ug/L	10	5	3.8	28.3	88.3	200	NMGSF
CDBO-6	34	Metals	Manganese	UF	ug/L	8	8	4.7	84.69	567	1703.09	Reg6
CDBO-6	34	Metals	Mercury	F	ug/L	9	0	(0.03)	(0.103)	(0.2)	2	MCL
CDBO-6	34	Metals	Mercury	UF	ug/L	9	0	(0.0472)	(0.105)	(0.2)	2	NMGSU
CDBO-6	34	Metals	Molybdenum	F	ug/L	9	2	0.7	1.65	2.6	1000	NMGSF
CDBO-6	34	Metals	Molybdenum	UF	ug/L	7	2	0.79	1.135	1.48	182.5	Reg6
CDBO-6	34	Metals	Nickel	F	ug/L	9	6	0.68	2.23	7.98	100	MCL
CDBO-6	34	Metals	Nickel	UF	ug/L	7	5	1	1.7	2.84	100	MCL
CDBO-6	34	Metals	Selenium	F	ug/L	10	1	4.31	4.31	4.31	50	NMGSF
CDBO-6	34	Metals	Selenium	UF	ug/L	8	1	2.97	2.97	2.97	50	MCL
CDBO-6	34	Metals	Silicon Dioxide	F	mg/L	3	3	53.2	54.67	56.6		
CDBO-6	34	Metals	Silver	F	ug/L	10	0	(0.197)	(0.57)	(1)	50	NMGSF
CDBO-6	34	Metals	Silver	UF	ug/L	8	0	(0.2)	(0.7)	(1)	182.5	Reg6
CDBO-6	34	Metals	Strontium	F	ug/L	9	9	81.6	99.3	119	21900	Reg6
CDBO-6	34	Metals	Strontium	UF	ug/L	7	7	86.3	109.1	173	21900	Reg6
CDBO-6	34	Metals	Thallium	F	ug/L	9	1	0.54	0.54	0.54	2	MCL
CDBO-6	34	Metals	Thallium	UF	ug/L	7	1	0.47	0.47	0.47	2	MCL
CDBO-6	34	Metals	Tin	F	ug/L	9	0	(2.31)	(15.35)	(100)	21900	Reg6
CDBO-6	34	Metals	Tin	UF	ug/L	7	0	(2.31)	(18.65)	(100)	21900	Reg6
CDBO-6	34	Metals	Uranium	F	ug/L	7	5	0.057	0.174	0.61	30	NMGSF
CDBO-6	34	Metals	Uranium	UF	ug/L	6	5	0.1	0.35	0.59	30	MCL
CDBO-6	34	Metals	Vanadium	F	ug/L	9	8	3.7	4.86	6.5	182.5	Reg6

CDBO-6	34	Metals	Vanadium	UF	ug/L	7	7	4.3	10.18	26.7	182.5	Reg6
CDBO-6	34	Metals	Zinc	F	ug/L	10	9	2.1	22.1	137	10000	NMGSF
CDBO-6	34	Metals	Zinc	UF	ug/L	8	4	15.2	67.9	185	10950	Reg6
CDBO-6	34	PCB	Aroclor-1016	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	PCB	Aroclor-1221	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	PCB	Aroclor-1232	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	PCB	Aroclor-1242	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	PCB	Aroclor-1248	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	PCB	Aroclor-1254	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	PCB	Aroclor-1260	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	PCB	Aroclor-1262	UF	ug/L	1	0	(0.1)	(0.1)	(0.1)		
CDBO-6	34	Pest	Aldrin	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	BHC[alpha-]	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	BHC[beta-]	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	BHC[delta-]	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	BHC[gamma-]	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	Chlordane[alpha-]	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	Chlordane[gamma-]	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	DDD[4,4'-]	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	DDE[4,4'-]	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	DDT[4,4'-]	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	Dieldrin	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	Endosulfan I	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	Endosulfan II	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	Endosulfan Sulfate	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	Endrin	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	Endrin Aldehyde	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	Endrin Ketone	UF	ug/L	3	0	(0.04)	(0.042)	(0.044)		
CDBO-6	34	Pest	Heptachlor	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	Heptachlor Epoxide	UF	ug/L	3	0	(0.02)	(0.021)	(0.022)		
CDBO-6	34	Pest	Methoxychlor[4,4'-]	UF	ug/L	3	0	(0.2)	(0.21)	(0.22)		
CDBO-6	34	Pest	Toxaphene (Technical Grade)	UF	ug/L	3	0	(0.5)	(0.52)	(0.549)		
CDBO-6	34	Rad	Americium-241	F	pCi/L	2	0	(-0.0108)	(-0.0036)	(0.00359)		
CDBO-6	34	Rad	Americium-241	UF	pCi/L	4	0	(-0.0252)	(0.0021)	(0.0201)	20	NMRPS
CDBO-6	34	Rad	Cesium-137	F	pCi/L	2	0	(-0.339)	(0.323)	(0.985)		
CDBO-6	34	Rad	Cesium-137	UF	pCi/L	4	0	(-0.686)	(0.128)	(0.622)	1000	NMRPS
CDBO-6	34	Rad	Cobalt-60	F	pCi/L	2	0	(-0.205)	(-0.079)	(0.0462)		
CDBO-6	34	Rad	Cobalt-60	UF	pCi/L	4	0	(-0.674)	(0.65)	(2.71)	3000	NMRPS
CDBO-6	34	Rad	Gross alpha	F	pCi/L	1	1	3.43	3.43	3.43	15	MCL
CDBO-6	34	Rad	Gross alpha	UF	pCi/L	4	3	2.72	8.58	19.3	15	MCL
CDBO-6	34	Rad	Gross alpha/beta	UF	pCi/L	1	1	3.7	3.7	3.7		
CDBO-6	34	Rad	Gross beta	UF	pCi/L	4	4	3.26	10.1	21.4	50	SMCL
CDBO-6	34	Rad	Gross gamma	F	pCi/L	2	0	(7.31)	(52.2)	(97)		
CDBO-6	34	Rad	Gross gamma	UF	pCi/L	3	0	(29.9)	(99.6)	(156)		
CDBO-6	34	Rad	Neptunium-237	F	pCi/L	2	0	(-0.00959)	(1.5)	(3.01)		
CDBO-6	34	Rad	Neptunium-237	UF	pCi/L	4	0	(-15.3)	(-4.2)	(14.4)	20	NMRPS
CDBO-6	34	Rad	Plutonium-238	F	pCi/L	2	0	(0)	(0.0018)	(0.00361)		
CDBO-6	34	Rad	Plutonium-238	UF	pCi/L	4	1	-0.00544	-0.005	-0.00544	20	NMRPS
CDBO-6	34	Rad	Plutonium-239/240	F	pCi/L	2	0	(-0.00361)	(-0.0008)	(0.00202)		

Attachment 7,
CdBO-6 Frequency of Detection Table

CDBO-6	34	Rad	Plutonium-239/240	UF	pCi/L	4	1	-0.0136	-0.014	-0.0136	20	NMRPS
CDBO-6	34	Rad	Potassium-40	F	pCi/L	2	0	(11.8)	(14.7)	(17.5)		
CDBO-6	34	Rad	Potassium-40	UF	pCi/L	4	0	(-20.3)	(1.7)	(21.8)	4000	NMRPS
CDBO-6	34	Rad	Radium-226	F	pCi/L	1	1	0.502	0.502	0.502	5	MCL
CDBO-6	34	Rad	Radium-226	UF	pCi/L	4	2	0.491	0.64	0.789	5	MCL
CDBO-6	34	Rad	Radium-228	F	pCi/L	1	0	(0.675)	(0.68)	(0.675)	5	MCL
CDBO-6	34	Rad	Radium-228	UF	pCi/L	4	2	1.13	1.17	1.21	5	MCL
CDBO-6	34	Rad	Sodium-22	F	pCi/L	2	0	(-0.66)	(1.02)	(2.69)		
CDBO-6	34	Rad	Sodium-22	UF	pCi/L	4	0	(-0.197)	(0.04)	(0.165)	6000	NMRPS
CDBO-6	34	Rad	Strontium-90	F	pCi/L	2	0	(0.00476)	(0.03)	(0.0656)		
CDBO-6	34	Rad	Strontium-90	UF	pCi/L	4	0	(-0.0776)	(0.026)	(0.154)	8	MCL
CDBO-6	34	Rad	Thorium-228	UF	pCi/L	1	1	0.109	0.109	0.109		
CDBO-6	34	Rad	Thorium-230	UF	pCi/L	1	1	0.091	0.091	0.091		
CDBO-6	34	Rad	Thorium-232	UF	pCi/L	1	1	0.0542	0.0542	0.0542		
CDBO-6	34	Rad	Tritium	UF	pCi/L	6	4	40.04	84.01	112.7	20000	MCL
CDBO-6	34	Rad	Uranium-234	F	pCi/L	2	0	(0.00971)	(0.022)	(0.0336)		
CDBO-6	34	Rad	Uranium-234	UF	pCi/L	4	4	0.101	0.145	0.202	300	NMRPS
CDBO-6	34	Rad	Uranium-235/236	F	pCi/L	2	0	(0)	(0.003)	(0.006)		
CDBO-6	34	Rad	Uranium-235/236	UF	pCi/L	4	0	(0)	(0.01)	(0.018)		
CDBO-6	34	Rad	Uranium-238	F	pCi/L	2	0	(0.0267)	(0.033)	(0.0387)		
CDBO-6	34	Rad	Uranium-238	UF	pCi/L	4	3	0.0654	0.115	0.161	300	NMRPS
CDBO-6	34	Svoa	Acenaphthene	UF	ug/L	8	0	(0.16)	(0.96)	(1.49)	365	Reg6
CDBO-6	34	Svoa	Acenaphthylene	UF	ug/L	8	0	(0.14)	(0.96)	(1.49)		
CDBO-6	34	Svoa	Aniline	UF	ug/L	8	0	(0.17)	(9.46)	(14.9)	117.95	Reg6
CDBO-6	34	Svoa	Anthracene	UF	ug/L	8	0	(0.11)	(0.96)	(1.49)	1825	Reg6
CDBO-6	34	Svoa	Atrazine	UF	ug/L	4	0	(10)	(11.3)	(14.9)	3	MCL
CDBO-6	34	Svoa	Azobenzene	UF	ug/L	5	0	(10)	(11.1)	(14.9)	6.1	Reg6
CDBO-6	34	Svoa	Benzidine	UF	ug/L	6	0	(10)	(24.4)	(50.8)	0.000936	Reg6
CDBO-6	34	Svoa	Benzo(a)anthracene	UF	ug/L	8	0	(0.1)	(0.95)	(1.49)	0.295	Reg6
CDBO-6	34	Svoa	Benzo(a)pyrene	UF	ug/L	8	0	(0.07)	(0.95)	(1.49)	0.2	MCL
CDBO-6	34	Svoa	Benzo(b)fluoranthene	UF	ug/L	8	1	0.215	0.215	0.215	0.295	Reg6
CDBO-6	34	Svoa	Benzo(g,h,i)perylene	UF	ug/L	8	0	(0.26)	(0.97)	(1.49)		
CDBO-6	34	Svoa	Benzo(k)fluoranthene	UF	ug/L	8	1	0.251	0.251	0.251	2.95	Reg6
CDBO-6	34	Svoa	Benzoic Acid	UF	ug/L	8	0	(2.76)	(19.2)	(29.8)	146000	Reg6
CDBO-6	34	Svoa	Benzyl Alcohol	UF	ug/L	8	0	(0.23)	(9.5)	(14.9)	10950	Reg6
CDBO-6	34	Svoa	Bis(2-chloroethoxy)methane	UF	ug/L	8	0	(0.19)	(9.5)	(14.9)		
CDBO-6	34	Svoa	Bis(2-chloroethyl)ether	UF	ug/L	8	0	(0.16)	(9.5)	(14.9)	0.602	Reg6
CDBO-6	34	Svoa	Bis(2-ethylhexyl)phthalate	UF	ug/L	8	2	0.72	3.975	7.23	6	MCL
CDBO-6	34	Svoa	Bromophenyl-phenylether[4-]	UF	ug/L	8	0	(0.18)	(9.5)	(14.9)		
CDBO-6	34	Svoa	Butylbenzylphthalate	UF	ug/L	8	0	(0.13)	(9.5)	(14.9)	7300	Reg6
CDBO-6	34	Svoa	Carbazole	UF	ug/L	1	0	(9.8)	(9.8)	(9.8)	33.62	Reg6
CDBO-6	34	Svoa	Chloro-3-methylphenol[4-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)		
CDBO-6	34	Svoa	Chloro-3-methylphenol[4-]	UF	ug/L	8	0	(0.21)	(9.5)	(14.9)		
CDBO-6	34	Svoa	Chloroaniline[4-]	UF	ug/L	8	0	(0.11)	(9.5)	(14.9)	146	Reg6
CDBO-6	34	Svoa	Chloronaphthalene[2-]	UF	ug/L	8	0	(0.13)	(0.96)	(1.49)	486.67	Reg6
CDBO-6	34	Svoa	Chlorophenol[2-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	30.417	Reg6
CDBO-6	34	Svoa	Chlorophenol[2-]	UF	ug/L	8	0	(0.18)	(9.5)	(14.9)	30.417	Reg6
CDBO-6	34	Svoa	Chlorophenyl-phenyl[4-] Ether	UF	ug/L	8	0	(0.2)	(9.5)	(14.9)		
CDBO-6	34	Svoa	Chrysene	UF	ug/L	8	1	0.312	0.312	0.312	0.2	MCL

CDBO-6	34	Svoa	Dibenz(a,h)anthracene	UF	ug/L	8	0	(0.18)	(0.96)	(1.49)	0.0295	Reg6
CDBO-6	34	Svoa	Dibenzofuran	UF	ug/L	8	0	(0.18)	(9.5)	(14.9)	12.17	Reg6
CDBO-6	34	Svoa	Dichlorobenzene[1,2-]	UF	ug/L	8	0	(0.13)	(9.5)	(14.9)	600	MCL
CDBO-6	34	Svoa	Dichlorobenzene[1,3-]	UF	ug/L	8	0	(0.07)	(9.5)	(14.9)	600	MCL
CDBO-6	34	Svoa	Dichlorobenzene[1,4-]	UF	ug/L	8	0	(0.09)	(9.5)	(14.9)	75	MCL
CDBO-6	34	Svoa	Dichlorobenzidine[3,3'-]	UF	ug/L	8	0	(0.21)	(9.5)	(14.9)	1.49	Reg6
CDBO-6	34	Svoa	Dichlorophenol[2,4-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	109.5	Reg6
CDBO-6	34	Svoa	Dichlorophenol[2,4-]	UF	ug/L	8	0	(0.19)	(9.5)	(14.9)	109.5	Reg6
CDBO-6	34	Svoa	Diethylphthalate	UF	ug/L	8	0	(0.27)	(9.5)	(14.9)	29200	Reg6
CDBO-6	34	Svoa	Dimethyl Phthalate	UF	ug/L	8	0	(0.15)	(9.5)	(14.9)	365000	Reg6
CDBO-6	34	Svoa	Dimethylphenol[2,4-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	730	Reg6
CDBO-6	34	Svoa	Dimethylphenol[2,4-]	UF	ug/L	7	0	(0.2)	(9.4)	(14.9)	730	Reg6
CDBO-6	34	Svoa	Di-n-butylphthalate	UF	ug/L	8	0	(0.27)	(9.5)	(14.9)	3650	Reg6
CDBO-6	34	Svoa	Dinitro-2-methylphenol[4,6-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)		
CDBO-6	34	Svoa	Dinitro-2-methylphenol[4,6-]	UF	ug/L	8	0	(0.87)	(9.6)	(14.9)		
CDBO-6	34	Svoa	Dinitrophenol[2,4-]	F	ug/L	1	0	(20.8)	(20.8)	(20.8)	73	Reg6
CDBO-6	34	Svoa	Dinitrophenol[2,4-]	UF	ug/L	8	0	(0.65)	(18.94)	(29.8)	73	Reg6
CDBO-6	34	Svoa	Dinitrotoluene[2,4-]	UF	ug/L	8	0	(0.16)	(9.5)	(14.9)	73	Reg6
CDBO-6	34	Svoa	Dinitrotoluene[2,6-]	UF	ug/L	8	0	(0.18)	(9.46)	(14.9)	36.5	Reg6
CDBO-6	34	Svoa	Di-n-octylphthalate	UF	ug/L	8	1	9.36	9.36	9.36		
CDBO-6	34	Svoa	Dinoseb	UF	ug/L	5	0	(10)	(11.06)	(14.9)		
CDBO-6	34	Svoa	Dioxane[1,4-]	UF	ug/L	5	0	(10)	(11.06)	(14.9)	61.1	Reg6
CDBO-6	34	Svoa	Diphenylamine	UF	ug/L	8	0	(1.54)	(9.63)	(14.9)	912.5	Reg6
CDBO-6	34	Svoa	Diphenylhydrazine[1,2-]	UF	ug/L	3	0	(0.22)	(6.8)	(10.2)	0.84	Reg6
CDBO-6	34	Svoa	Fluoranthene	UF	ug/L	8	0	(0.09)	(0.95)	(1.49)	1460	Reg6
CDBO-6	34	Svoa	Fluorene	UF	ug/L	8	0	(0.07)	(0.95)	(1.49)	243.3	Reg6
CDBO-6	34	Svoa	Hexachlorobenzene	UF	ug/L	8	0	(0.16)	(9.5)	(14.9)	1	MCL
CDBO-6	34	Svoa	Hexachlorobutadiene	UF	ug/L	8	0	(0.19)	(9.5)	(14.9)	8.62	Reg6
CDBO-6	34	Svoa	Hexachlorocyclopentadiene	UF	ug/L	8	0	(0.04)	(9.4)	(14.9)	50	MCL
CDBO-6	34	Svoa	Hexachloroethane	UF	ug/L	8	0	(0.19)	(9.46)	(14.9)	48.02	Reg6
CDBO-6	34	Svoa	Indeno(1,2,3-cd)pyrene	UF	ug/L	8	0	(0.26)	(0.97)	(1.49)	0.295	Reg6
CDBO-6	34	Svoa	Isophorone	UF	ug/L	8	0	(0.17)	(9.5)	(14.9)	707.7004	Reg6
CDBO-6	34	Svoa	Methylnaphthalene[1-]	UF	ug/L	5	0	(1)	(1.1)	(1.49)		
CDBO-6	34	Svoa	Methylnaphthalene[2-]	UF	ug/L	8	0	(0.15)	(0.96)	(1.49)		
CDBO-6	34	Svoa	Methylphenol[2-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	1825	Reg6
CDBO-6	34	Svoa	Methylphenol[2-]	UF	ug/L	8	0	(0.2)	(9.46)	(14.9)	1825	Reg6
CDBO-6	34	Svoa	Methylphenol[3-,4-]	UF	ug/L	3	0	(10)	(10.1)	(10.2)		
CDBO-6	34	Svoa	Methylphenol[4-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	182.5	Reg6
CDBO-6	34	Svoa	Methylphenol[4-]	UF	ug/L	5	0	(0.13)	(9.1)	(14.9)	182.5	Reg6
CDBO-6	34	Svoa	Methylpyridine[2-]	UF	ug/L	2	0	(10)	(10.1)	(10.2)		
CDBO-6	34	Svoa	Naphthalene	UF	ug/L	8	0	(0.13)	(0.96)	(1.49)	30	NMGSU
CDBO-6	34	Svoa	Nitroaniline[2-]	UF	ug/L	8	0	(1.59)	(9.6)	(14.9)	109.5	Reg6
CDBO-6	34	Svoa	Nitroaniline[3-]	UF	ug/L	8	0	(1.08)	(9.6)	(14.9)		
CDBO-6	34	Svoa	Nitroaniline[4-]	UF	ug/L	8	0	(0.77)	(9.6)	(14.9)		
CDBO-6	34	Svoa	Nitrobenzene	UF	ug/L	8	0	(0.27)	(9.5)	(14.9)	3.4	Reg6
CDBO-6	34	Svoa	Nitrophenol[2-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)		
CDBO-6	34	Svoa	Nitrophenol[2-]	UF	ug/L	8	0	(0.1)	(9.5)	(14.9)		
CDBO-6	34	Svoa	Nitrophenol[4-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	292	Reg6
CDBO-6	34	Svoa	Nitrophenol[4-]	UF	ug/L	8	0	(4.84)	(10)	(14.9)	292	Reg6

Attachment 7,
CdBO-6 Frequency of Detection Table

CDBO-6	34	Svoa	Nitrosodiethylamine[N-]	UF	ug/L	5	0	(10)	(11.1)	(14.9)	0.0014	Reg6
CDBO-6	34	Svoa	Nitrosodimethylamine[N-]	UF	ug/L	8	0	(0.44)	(9.5)	(14.9)	0.0042	Reg6
CDBO-6	34	Svoa	Nitroso-di-n-butylamine[N-]	UF	ug/L	5	0	(10)	(11.1)	(14.9)	0.123	Reg6
CDBO-6	34	Svoa	Nitroso-di-n-propylamine[N-]	UF	ug/L	8	0	(0.17)	(9.5)	(14.9)	0.096	Reg6
CDBO-6	34	Svoa	Nitrosopyrrolidine[N-]	UF	ug/L	5	0	(10)	(11.1)	(14.9)	0.32	Reg6
CDBO-6	34	Svoa	Oxybis(1-chloropropane)[2,2'-]	UF	ug/L	8	0	(0.14)	(9.5)	(14.9)	9.54	Reg6
CDBO-6	34	Svoa	Pentachlorobenzene	UF	ug/L	5	0	(10)	(11.06)	(14.9)	29.2	Reg6
CDBO-6	34	Svoa	Pentachlorophenol	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	1	MCL
CDBO-6	34	Svoa	Pentachlorophenol	UF	ug/L	8	0	(1.2)	(9.6)	(14.9)	1	MCL
CDBO-6	34	Svoa	Phenanthrene	UF	ug/L	8	0	(0.12)	(0.96)	(1.49)		
CDBO-6	34	Svoa	Phenol	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	10950	Reg6
CDBO-6	34	Svoa	Phenol	UF	ug/L	8	0	(0.09)	(9.5)	(14.9)	5	NMGSU
CDBO-6	34	Svoa	Pyrene	UF	ug/L	8	0	(0.08)	(0.95)	(1.49)	182.5	Reg6
CDBO-6	34	Svoa	Pyridine	UF	ug/L	5	0	(0.09)	(9.1)	(14.9)	36.5	Reg6
CDBO-6	34	Svoa	Tetrachlorobenzene[1,2,4,5]	UF	ug/L	5	0	(10)	(11.1)	(14.9)	0.00003	MCL
CDBO-6	34	Svoa	Tetrachlorophenol[2,3,4,6-]	UF	ug/L	5	0	(10)	(11.1)	(14.9)	5	MCL
CDBO-6	34	Svoa	Trichlorobenzene[1,2,4-]	UF	ug/L	8	0	(0.11)	(9.5)	(14.9)	70	MCL
CDBO-6	34	Svoa	Trichlorophenol[2,4,5-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	3650	Reg6
CDBO-6	34	Svoa	Trichlorophenol[2,4,5-]	UF	ug/L	8	0	(0.28)	(9.5)	(14.9)	3650	Reg6
CDBO-6	34	Svoa	Trichlorophenol[2,4,6-]	F	ug/L	1	0	(10.4)	(10.4)	(10.4)	61.1	Reg6
CDBO-6	34	Svoa	Trichlorophenol[2,4,6-]	UF	ug/L	8	0	(0.1)	(9.5)	(14.9)	61.1	Reg6
CDBO-6	34	Voa	Acetone	UF	ug/L	7	2	1.6	2.45	3.29	5475	Reg6
CDBO-6	34	Voa	Acetonitrile	UF	ug/L	4	0	(25)	(25)	(25)	124.1	Reg6
CDBO-6	34	Voa	Acrolein	UF	ug/L	5	0	(5)	(6)	(10)	0.042	Reg6
CDBO-6	34	Voa	Acrylonitrile	UF	ug/L	7	0	(5)	(5.7)	(10)	1.24	Reg6
CDBO-6	34	Voa	Benzene	F	ug/L	1	0	(1)	(1)	(1)	5	MCL
CDBO-6	34	Voa	Benzene	UF	ug/L	8	0	(0.149)	(0.89)	(1)	5	MCL
CDBO-6	34	Voa	Bromobenzene	UF	ug/L	7	0	(1)	(1)	(1)	23.25	Reg6
CDBO-6	34	Voa	Bromochloromethane	UF	ug/L	7	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Bromodichloromethane	UF	ug/L	8	0	(0.024)	(0.88)	(1)	10.69	Reg6
CDBO-6	34	Voa	Bromoform	UF	ug/L	8	0	(0.085)	(0.89)	(1)	85.1	Reg6
CDBO-6	34	Voa	Bromomethane	UF	ug/L	8	0	(0.628)	(0.95)	(1)	8.661	Reg6
CDBO-6	34	Voa	Butanone[2-]	UF	ug/L	6	0	(5)	(5)	(5)	7064.52	Reg6
CDBO-6	34	Voa	Butylbenzene[n-]	UF	ug/L	7	0	(1)	(1)	(1)	60.83	Reg6
CDBO-6	34	Voa	Butylbenzene[sec-]	UF	ug/L	7	0	(1)	(1)	(1)	60.83	Reg6
CDBO-6	34	Voa	Butylbenzene[tert-]	UF	ug/L	7	0	(1)	(1)	(1)	60.83	Reg6
CDBO-6	34	Voa	Carbon Disulfide	UF	ug/L	7	0	(5)	(5)	(5)	1042.86	Reg6
CDBO-6	34	Voa	Carbon Tetrachloride	F	ug/L	1	0	(1)	(1)	(1)	5	MCL
CDBO-6	34	Voa	Carbon Tetrachloride	UF	ug/L	8	0	(0.124)	(0.89)	(1)	5	MCL
CDBO-6	34	Voa	Chloro-1,3-butadiene[2-]	UF	ug/L	5	0	(1)	(1)	(1)	14.31	Reg6
CDBO-6	34	Voa	Chloro-1-propene[3-]	UF	ug/L	5	0	(5)	(5)	(5)	1825	Reg6
CDBO-6	34	Voa	Chlorobenzene	UF	ug/L	8	0	(0.603)	(0.95)	(1)	100	MCL
CDBO-6	34	Voa	Chlorodibromomethane	UF	ug/L	8	0	(0.089)	(0.89)	(1)	7.89	Reg6
CDBO-6	34	Voa	Chloroethane	UF	ug/L	8	0	(0.14)	(0.89)	(1)	228.57	Reg6
CDBO-6	34	Voa	Chloroethyl vinyl ether[2-]	UF	ug/L	4	0	(0.852)	(3.96)	(5)		
CDBO-6	34	Voa	Chloroform	F	ug/L	1	0	(1)	(1)	(1)	60	MCL
CDBO-6	34	Voa	Chloroform	UF	ug/L	8	0	(0.198)	(0.899)	(1)	60	MCL
CDBO-6	34	Voa	Chloromethane	UF	ug/L	8	0	(0.179)	(0.897)	(1)	21.35	Reg6
CDBO-6	34	Voa	Chlorotoluene[2-]	UF	ug/L	7	0	(1)	(1)	(1)	121.67	Reg6

CDBO-6	34	Voa	Chlorotoluene[4-]	UF	ug/L	7	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Dibromo-3-Chloropropane[1,2-]	UF	ug/L	7	0	(1)	(1)	(1)	0.2	MCL
CDBO-6	34	Voa	Dibromoethane[1,2-]	F	ug/L	1	0	(1)	(1)	(1)	0.05	MCL
CDBO-6	34	Voa	Dibromoethane[1,2-]	UF	ug/L	7	0	(1)	(1)	(1)	0.05	MCL
CDBO-6	34	Voa	Dibromomethane	UF	ug/L	7	0	(1)	(1)	(1)	60.8	Reg6
CDBO-6	34	Voa	Dichlorobenzene[1,2-]	UF	ug/L	8	0	(0.7)	(0.96)	(1)		
CDBO-6	34	Voa	Dichlorobenzene[1,3-]	UF	ug/L	8	0	(0.104)	(0.89)	(1)		
CDBO-6	34	Voa	Dichlorobenzene[1,4-]	UF	ug/L	8	0	(0.34)	(0.84)	(1)		
CDBO-6	34	Voa	Dichlorodifluoromethane	UF	ug/L	7	0	(1)	(1)	(1)	394.595	Reg6
CDBO-6	34	Voa	Dichloroethane[1,1-]	F	ug/L	1	0	(1)	(1)	(1)	1216.67	Reg6
CDBO-6	34	Voa	Dichloroethane[1,1-]	UF	ug/L	8	0	(0.099)	(0.89)	(1)	25	NMGSU
CDBO-6	34	Voa	Dichloroethane[1,2-]	F	ug/L	1	0	(1)	(1)	(1)	5	MCL
CDBO-6	34	Voa	Dichloroethane[1,2-]	UF	ug/L	8	0	(0.158)	(0.89475)	(1)	5	MCL
CDBO-6	34	Voa	Dichloroethene[1,1-]	F	ug/L	1	0	(1)	(1)	(1)	7	MCL
CDBO-6	34	Voa	Dichloroethene[1,1-]	UF	ug/L	8	0	(0.09)	(0.89)	(1)	5	NMGSU
CDBO-6	34	Voa	Dichloroethene[cis-1,2-]	UF	ug/L	5	0	(1)	(1)	(1)	70	MCL
CDBO-6	34	Voa	Dichloroethene[trans-1,2-]	UF	ug/L	8	0	(0.105)	(0.89)	(1)	100	MCL
CDBO-6	34	Voa	Dichloropropane[1,2-]	UF	ug/L	8	0	(0.07)	(0.88)	(1)	5	MCL
CDBO-6	34	Voa	Dichloropropane[1,3-]	UF	ug/L	7	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Dichloropropane[2,2-]	UF	ug/L	7	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Dichloropropene[1,1-]	UF	ug/L	7	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Dichloropropene[cis-1,3-]	UF	ug/L	8	0	(0.035)	(0.88)	(1)		
CDBO-6	34	Voa	Dichloropropene[trans-1,3-]	UF	ug/L	8	0	(0.106)	(0.89)	(1)		
CDBO-6	34	Voa	Diethyl Ether	UF	ug/L	2	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Ethyl Methacrylate	UF	ug/L	5	0	(5)	(5)	(5)	547.5	Reg6
CDBO-6	34	Voa	Ethylbenzene	F	ug/L	1	0	(1)	(1)	(1)	700	MCL
CDBO-6	34	Voa	Ethylbenzene	UF	ug/L	8	0	(0.051)	(0.88)	(1)	700	MCL
CDBO-6	34	Voa	Hexachlorobutadiene	UF	ug/L	7	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Hexanone[2-]	UF	ug/L	7	0	(5)	(5)	(5)		
CDBO-6	34	Voa	Iodomethane	UF	ug/L	7	0	(5)	(5)	(5)		
CDBO-6	34	Voa	Isobutyl alcohol	UF	ug/L	3	0	(50)	(50)	(50)	1825	Reg6
CDBO-6	34	Voa	Isopropylbenzene	UF	ug/L	7	0	(1)	(1)	(1)	658.2	Reg6
CDBO-6	34	Voa	Isopropyltoluene[4-]	UF	ug/L	7	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Methacrylonitrile	UF	ug/L	5	0	(5)	(5)	(5)	1.043	Reg6
CDBO-6	34	Voa	Methyl Methacrylate	UF	ug/L	5	0	(5)	(5)	(5)	1419.4	Reg6
CDBO-6	34	Voa	Methyl tert-Butyl Ether	UF	ug/L	2	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Methyl-2-pentanone[4-]	UF	ug/L	7	0	(5)	(5)	(5)	1990.91	Reg6
CDBO-6	34	Voa	Methylene Chloride	F	ug/L	1	0	(5)	(5)	(5)	5	MCL
CDBO-6	34	Voa	Methylene Chloride	UF	ug/L	8	0	(0.971)	(4.5)	(5)	5	MCL
CDBO-6	34	Voa	Naphthalene	F	ug/L	1	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Naphthalene	UF	ug/L	5	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Propionitrile	UF	ug/L	3	0	(5)	(5)	(5)		
CDBO-6	34	Voa	Propylbenzene[1-]	UF	ug/L	7	0	(1)	(1)	(1)	60.83	Reg6
CDBO-6	34	Voa	Styrene	UF	ug/L	7	0	(1)	(1)	(1)	100	MCL
CDBO-6	34	Voa	Tetrachloroethane[1,1,1,2-]	F	ug/L	1	0	(1)	(1)	(1)	25.496	Reg6
CDBO-6	34	Voa	Tetrachloroethane[1,1,1,2-]	UF	ug/L	7	0	(1)	(1)	(1)	25.496	Reg6
CDBO-6	34	Voa	Tetrachloroethane[1,1,2,2-]	F	ug/L	1	0	(1)	(1)	(1)	3.31	Reg6
CDBO-6	34	Voa	Tetrachloroethane[1,1,2,2-]	UF	ug/L	8	0	(0.273)	(0.91)	(1)	10	NMGSU
CDBO-6	34	Voa	Tetrachloroethene	UF	ug/L	8	0	(0.385)	(0.92)	(1)	5	MCL

CDBO-6	34	Voa	Toluene	F	ug/L	1	0	(1)	(1)	(1)	1000	MCL
CDBO-6	34	Voa	Toluene	UF	ug/L	8	0	(0.262)	(0.91)	(1)	750	NMGSU
CDBO-6	34	Voa	Trichloro-1,2,2-trifluoroethane[1,1,2-]	UF	ug/L	7	0	(5)	(5)	(5)	59179.9	Reg6
CDBO-6	34	Voa	Trichlorobenzene[1,2,3-]	UF	ug/L	3	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Trichlorobenzene[1,2,4-]	UF	ug/L	5	0	(1)	(1)	(1)		
CDBO-6	34	Voa	Trichloroethane[1,1,1-]	F	ug/L	1	0	(1)	(1)	(1)	200	MCL
CDBO-6	34	Voa	Trichloroethane[1,1,1-]	UF	ug/L	8	0	(0.093)	(0.89)	(1)	60	NMGSU
CDBO-6	34	Voa	Trichloroethane[1,1,2-]	F	ug/L	1	0	(1)	(1)	(1)	5	MCL
CDBO-6	34	Voa	Trichloroethane[1,1,2-]	UF	ug/L	8	0	(0.193)	(0.899)	(1)	5	MCL
CDBO-6	34	Voa	Trichloroethene	F	ug/L	1	0	(1)	(1)	(1)	5	MCL
CDBO-6	34	Voa	Trichloroethene	UF	ug/L	8	1	0.3	0.3	0.3	5	MCL
CDBO-6	34	Voa	Trichlorofluoromethane	UF	ug/L	8	0	(0.057)	(0.88)	(1)	5	MCL
CDBO-6	34	Voa	Trichloropropane[1,2,3-]	UF	ug/L	7	0	(1)	(1)	(1)	0.095	Reg6
CDBO-6	34	Voa	Trimethylbenzene[1,2,4-]	UF	ug/L	7	0	(1)	(1)	(1)	12.43	Reg6
CDBO-6	34	Voa	Trimethylbenzene[1,3,5-]	UF	ug/L	7	0	(1)	(1)	(1)	12.33	Reg6
CDBO-6	34	Voa	Vinyl acetate	UF	ug/L	5	0	(5)	(5)	(5)	412.43	Reg6
CDBO-6	34	Voa	Vinyl Chloride	F	ug/L	1	0	(1)	(1)	(1)	2	MCL
CDBO-6	34	Voa	Vinyl Chloride	UF	ug/L	8	0	(0.096)	(0.89)	(1)	1	NMGSU
CDBO-6	34	Voa	Xylene (Total)	F	ug/L	1	0	(3)	(3)	(3)	10000	MCL
CDBO-6	34	Voa	Xylene (Total)	UF	ug/L	2	0	(3)	(3)	(3)	10000	MCL
CDBO-6	34	Voa	Xylene[1,2-]	UF	ug/L	7	0	(1)	(1)	(1)	1431.37	Reg6
CDBO-6	34	Voa	Xylene[1,3-]+Xylene[1,4-]	UF	ug/L	7	0	(2)	(2)	(2)		
Notes: Values in parentheses are nondetected values. Highlighted values are lower than applicable standard. Blank cells indicate no applicable standard.												

Attachment 1

Supplemental Tables for Appendixes B through E
(on CD included with this document)